Children's Hospital of Philadelphia

CARDIAC CENTER ANNUAL REPORT 2024

Children's Hospital of Philadelphia℠
Cardiac Center

INTRODUCTION

We are again honored to present the Annual Report of the Cardiac Center at Children's Hospital of Philadelphia. With more than 1100 employees, we remain one of the largest pediatric cardiac centers in North America with a celebrated history of ground-breaking clinical care, pioneering scientific discovery, and cutting-edge translational research that daily advances the care of our patients with complex congenital and acquired heart disease.

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.

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. The CHOP Cardiac Center Biobank in particular provides a unique resource for lifespan research and contains specimens from patients and their families all the way from prenatal encounters through their transition to adult congenital care.

In 2028, we will be among the first programs to move into the CHOP New Patient Tower, a 26-floor superstructure which will facilitate expansion of our clinical footprint, and growth of our flagship programs including single ventricle care, lymphatics, pulmonary vein disease, advanced valve therapies, heart failure, transplantation and mechanical circulatory support.

We continue to not only develop new programs that focus on coordinating care for our patients once they are discharged from the hospital, but also enhance our robust telehealth platforms to facilitate earlier hospital discharge and assure safety and postprocedural recovery. With new satellite offices throughout Pennsylvania and neighboring states we hope to extend the benefit of our expertise to as many children as possible.

As this report also helps to detail, the academic productivity of our faculty and staff is unparalleled internationally and fueled by our consistent and tireless pursuit of clinical innovation and discovery. In addition, we take great pride not only in the strength and size of our advanced fellowship training programs, but also novel platforms for nursing education and advancement.

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

Please enjoy.

Children's Hospital of Philadelphia℠
Cardiac Center

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

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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

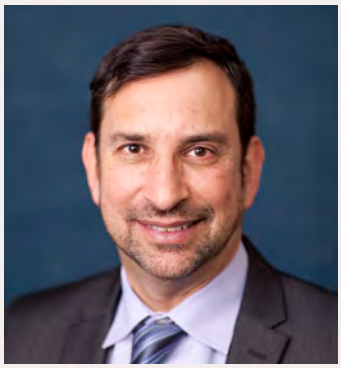
EMPATHY

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.

THE CARDIAC CENTER SERVICE LINE



Mark Schwartz

The Cardiac Center is recognized as one of the key "Service Lines" at CHOP. That designation recognizes the complexity and diversity of the Cardiac Center, and its need to continually evolve in a collaborative and integrated manner. With 4 medical divisions in 3 Academic departments, over 120 physicians and over 80 advanced practice staff as well as over 1100 employees in nursing, technical roles and administrative support, this is no small task at times.

However, to our families and patients that we care for, this collaboration is crucial to helping them navigate their journey in a more seamless manner – as one enterprise all working together as a team to provide the best care possible.

To better help guide us in this continual process, we have developed a five year strategic plan. Our previous plan was developed in 2017-2018. With that plan we set some important goals and strategies which shaped the past several years. Some of the initiatives related to the Service Line work included the creation of leadership roles in Education, Wellness, Information Technology, Patient-Family Experience and DEI. Leaders in these areas each built collaborative teams focused on development of strategies that could be implemented across the entire Cardiac Center. We are proud of the incredible success of each of these leaders and teams as well as the many other plan accomplishments we achieved over the past several years.

We are now nearing completion of our next 5-year plan – which will focus on these broad areas 1) Growth and Outreach; 2) Workforce of the Future and Education Excellence; 3) Industry Leading Patient and Family Experience 4) Groundbreaking/ World Leading Research, 5) Comprehensive Transitional Care Management – Care Anywhere, and 6) Advanced and Innovative Clinical Operations and Continuous Quality Improvement, supported by comprehensive Data Analytics. There were workgroups assembled with representation from across the Cardiac Center to develop the strategies in each area. The final plan will be completed in the summer of 2025. We are confident this will be a valuable roadmap as we head into the new era of the Roberts Children's Health Expansion, the CHOP Cardiovascular Institute and the further development of exciting technologies such as AI and predictive analytics.

This year's annual report includes updates from many of our key areas in our Service Line. We are proud of the many accomplishments and hard work and dedication of our many teams throughout the Cardiac Center. Their efforts continually have a direct correlation to our success and well-earned reputation as one of the premier congenital/pediatric cardiac programs in the world.

BY THE NUMBERS

Surgery Volume	
Cardiac Surgeries (CHOP)	898
Open Heart Surgeries (CHOP)	528
Adult Cases – HUP	62
Adult Cases – CHOP	2
Neonatal Cases	131
Heart Transplants	12
Lung Transplants	3
VAD Implants	15

Ambulatory and Imaging	
Outpatient Visits	40,943
Echocardiography Studies	36,730
Fetal Heart Echocardiography Studies	3,792
Fetal Heart Diagnosis of CHD	471
Special Delivery Unit Births (Cardiac)	201
Cardiac MRI	1,134
Exercise Studies	1,885

Cases By Complexity	
Stat 5	43
Stat 4	63
Stat 3	88
Stat 2	125
Stat 1	296
No Score	283

Interventional Cardiology	
Cardiac Catheterization (all procedures)	1,676
Cardiac Cath (not EP or Lymphatics)	1,240
Interventional	725
Electrophysiology	295
Lymphatics	141

Cardiac Center Admissions	
CICU Cardiac Admissions	1,135
CCU Cardiac Admissions	1,229
CICU ADC	32.45
CCU – ADC	30.38

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
2	Echocardiography Laboratories (IP and OP)
3	Exercise Physiology Laboratories (Main-Buerger, King of Prussia, Vorhees)
1	EKG/Holter Monitor Station
1	Fetal Heart Program (2 locations –Main Hospital and Bryn Mawr Satellite)
13	Satellite OP Cardiology Clinics
33	Hospital Affiliations for NICU and ED Coverage

CARDIAC CENTER EXECUTIVE COMMITTEE

Jonathan Chen, MD
Division Chief, Cardiothoracic Surgery/Co-Executive Director, Cardiac Center

Joseph Rossano, MD
Division Chief, Cardiology/Co-Executive Director, Cardiac Center

Andreas Loepke, MD
Division Chief, Cardiac Anesthesiology

Andrew Costarino, MD
Division Chief, Cardiac Critical Care Medicine

Vivek Allada, MD
Director, Cardiac Center Strategic Operations

Dan Kelly, MD
Director, Cardiovascular Research Institute

Sherri Kubis, RN, MSN
Director, Cardiac Center Nursing

Cara Rakow, MSN
Vice-President/Associate Chief Nurse Officer, Critical Care.

Jan Boswinkel, MD
SVP/COO Hospital Operations

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

FLAGSHIP AND FRONTIER PROGRAMS

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

STAFF

FETAL HEART PROGRAM PHYSICIAN ATTENDINGS

Shivani Bhatt, MD
Meryl Cohen, MD
Michele Cohen, MD
Karl Degenhardt, MD
Stanford Ewing, MD
Christine Falkensammer, MD
Elizabeth Goldmuntz, MD
Meghan Kiley Metcalf, MD
Shobha Natarajan, MD
Michael Quartermain, MD
Lindsay Rogers, MD
Jack Rychik, MD
Jill Savla, MD
Amanda Shillingford, MD
Anita Szwast, MD
Jennifer Tingo, MD

FETAL CARDIOVASCULAR IMAGING SONOGRAPHERS

Zhiyuan Tian
Peter Guo
April Hamilton
Peggy McCann
Debbra Soffer
Christina Werth

FETAL HEART PROGRAM NURSE COORDINATORS

Jill Combs
Elizabeth Coulter
Stephanie McNelis
Leslie Hayden

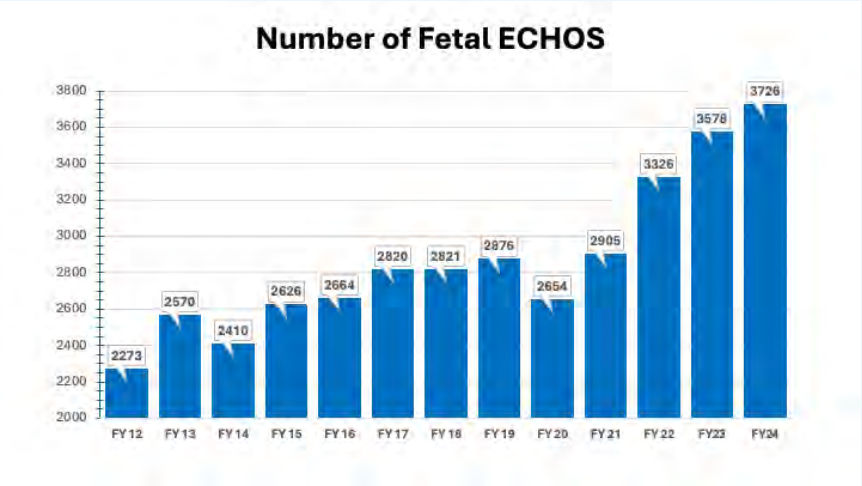
FETAL HEART PROGRAM SOCIAL WORKERS

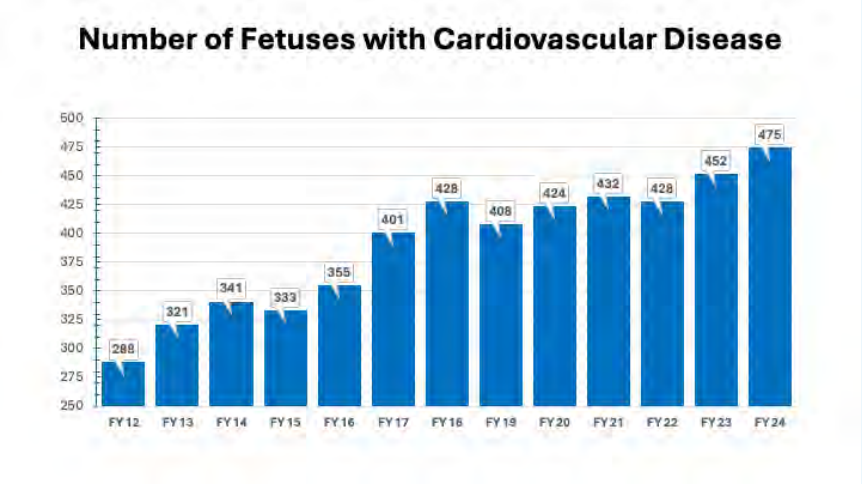
Lucia Figueroa
Sasha Rose Relyea

HIGHLIGHTS AND ACCOMPLISHMENTS FOR 2024

- One of the only centers in the nation encouraging and providing early fetal cardiovascular imaging for our patients and providers. Early fetal cardiovascular imaging at 14 weeks is standard care at the CHOP FHP which can provide families with critically important information for care and planning. Imaging can be performed even as early as 12 weeks in some cases.
- Extending high-level fetal cardiovascular services to the community through our FHP Bryn Mawr Annex. This provides the opportunity to bring our state-of-the-art services to the Main Line community with plans for further expansions in the future.
- We offer provocative testing such as maternal hyperoxygenation fetal echocardiography to supplement standard imaging techniques to create the best assessment possible of complex conditions.
- The CHOP FHP has joined the Fetal Heart Society as a platinum sponsor and is now one of highest volume contributors to numerous research studies being undertaken to improve understanding of a host of fetal cardiovascular conditions.
- The CHOP FHP continues to offer unique highly specialized care and treatment for a host of fetal cardiovascular conditions including fetal arrhythmias, treatment of fetal cardiac rhabdomyoma tumors, and an active program of fetal surgical intervention for pericardial teratoma and other complex conditions.

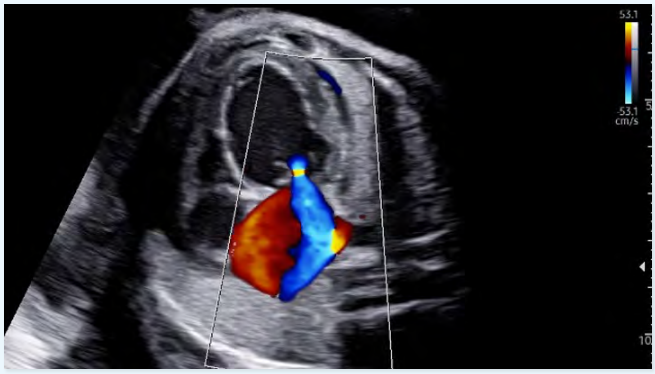
DATA & METRICS





RESEARCH HIGHLIGHTS

- Utility of maternal hyperoxygenation in helping to identify fetuses with high risk for atrial septal restriction and hypoxia at birth
- Discovery of placental abnormalities associated with fetal congenital heart disease
- Maternal psychological distress and anxiety in association with magnitude of complexity of fetal congenital heart disease in over 1,000 patients born at the CHOP Special Delivery Unit
- Efficacy of prenatal counseling for families of the fetus with single ventricle heart disease



ON THE HORIZON

- Expansion of early fetal cardiovascular imaging program
- Strengthening of ties to the obstetrical community through educational and training programs for detection of congenital heart disease
- Focus on expanding prenatal educational programs following detection of fetal cardiovascular disease
- Continued research investigation of placental structure and function in association with congenital heart disease
- Expanded research into the association of maternal psychological health and prenatal diagnosis of congenital heart disease
- Novel research exploring innovative technology for acquisition of fetal ECG signals in the normal and abnormal health states and comparing to fetal echocardiography data

HEART FAILURE / HEART TRANSPLANT & 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
Chitra Ravishankar, MD
Humera Ahmen, MD

Cardiothoracic Surgery
Katsuhide Maeda, MD
Jonathan Chen, MD
Stephanie Fuller, MD
Muhammad Nuri, 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)
Amber Caylor
Fiona Halloran, PA-C

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

CLINICAL AND PROGRAMMATIC HIGHLIGHTS

The Advanced Cardiac Therapies for Heart Failure (ACT-HF) 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. The Heart Failure, Cardiomyopathy, Heart Transplant, and Ventricular Assist Device programs exist as important components of the ACT-HF program. These children often require complex and innovative approaches to treatment, including use of mechanical circulatory support through ventricular assist devices (VADs) and heart transplantation. 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 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. In addition, we have been increasingly focused on identifying VAD patients who may be candidates for explantation of the VAD after achieving myocardial recovery, which may allow patients to avoid heart transplantation. 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 2024, the Heart Transplant Program performed 12 heart transplants in patients with cardiomyopathy and congenital heart disease, with 8 successful transplants from VAD. We continue to have a high volume of patients with ventricular assist devices (VADs), with 24 devices implanted in 21 patients and a total of 33 VAD patients actively followed 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.

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 International Society for Heart and Lung Transplantation, American Society of Clinical Investigation, American Heart Assocation (AHA) Scientific Sessions, AHA Basic Cardiovascular Sciences, and Single Ventricle Investigator Meeting. Implementation and clinical outcomes from the new Intensive Rehabilitation and Developmental Intensive Programs has also been shared at multiple conferences. Faculty within the program actively participate in national and international clinical trials of new heart failure therapies, including gene therapies for conditions such as muscular dystrophy and Danon disease.

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) abnormal expansion of endothelial cells, 2) depletion and dysfunction of mitochondria, 3) depletion of high energy precursors, 4) disruption of proteostasis regulators, 5) accumulation of essential amino acids, 6) inhibition of thin filament maintenance programs, and 7) shifts in immune cell profiles favoring a proinflammatory state.

ON THE HORIZON – NEW DEVELOPMENTS COMING IN 2025 CLINICAL PROGRAM

Moving forward, clinical teams continue to refine surgical approaches 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™. In addition, we are expanding the use of ventricular assist devices into patients with Fontan circulatory failure and lymphatic disease. We continue to heavily rely on 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 and comparable multiomics analyses as performed in adult right ventricular failure. Using preclinical models of right ventricular failure, CHOP Cardiac Center scientists and researchers have begun testing the efficacy of newer medications including the blockbuster SGLT2 inhibitors and direct myosin activators. These efforts include testing with in vivo mouse and ex vivo human and mouse derived samples. In addition, they are evaluating the therapeutic potential for novel molecular targets, including through directly increasing mitochondria number, modifying substrate availability, enhancing the activity of key metabolic enzymes, and addressing a potential novel link behind metabolic-mechanical coupling. Collectively, these will deliver new insights into the molecular underpinnings of right ventricular failure and provide a roadmap for prioritizing mechanistically driven new therapies to test clinically in patients.

JILL AND MARK FISHMAN CENTER FOR LYMPHATIC DISORDERS

KEY LEADERS & STAFF

Yoav Dori, MD, PhD, Program Director

Aaron DeWitt, MD, Medical Director

Chris Smith, MD, PhD, Attending Physician

Erin Pinto, MSN, CRNP, Advanced Practice Provider Manager Outpatient Cardiology

Vanessa Bustard, BSN, RN, CPN, Program Manager

Mudit Gupta, MD, Attending Physician

Danish Vaiyani, MD, Attending Physician

Jonathan Rome, MD, Attending Physician

Emmanuelle Favilla, MD, Attending Physician

Rachel Shustak, MD, Attending Physician

Lauren Biroc, CRNP, Nurse Practitioner

Meghen Scott, CRNP, Nurse Practitioner

Melissa Lyons, BSN, RN, Nurse Coordinator

Molly Brennan, BSN, RN, Nurse Coordinator

Diane Garofalo, Clinical Coordinator

Jihee Lee, Program Coordinator

Mark Schwartz, Med, MBA, Service Line Director, Division of Cardiology

Ganesh Krishnamurthy, MD, PhD, Attending Physician

Abhay Srinivasan, MD, Attending Physician

Fernando Escobar, MD, Attending Physician

Digvijay Shinde

Tanmay Verma

David Biko, MD, Director of Lymphatic Imaging

Pablo Laje, MD, Director of Lymphatic Surgery

Katsuhide Maeda, MD, Director of Cardiac Lymphatic Surgery

Dalal Taha, DO, NICU Liason

Samuel Rosenblatt, MD, PICU Liason

Jennifer Danzig-Silverman, MD, HPT Liason

Jefferson "Naylor" Brownell, MD, GI

Melanie Savoca, MS, RD, Dietician

OVERVIEW

The Jill & Mark Fishman Center for Lymphatic Disorders at Children's Hospital of Philadelphia is dedicated to advancing the diagnosis, treatment, and research of lymphatic disorders. The Center's mission is to provide cutting-edge, multidisciplinary care to patients while pioneering innovative therapies through collaborative research efforts. As a flagship program within CHOP, we integrate expertise from cardiology, radiology, surgery, and other specialties to enhance patient outcomes and quality of life.

Key objectives include:

- Developing and implementing advanced treatment strategies for complex lymphatic conditions.
- Expanding research initiatives to further understand lymphatic diseases and improve therapeutic options.
- Enhancing education and training opportunities for medical professionals specializing in lymphatic care.
- Strengthening partnerships with national and international institutions to drive global advancements in lymphatic medicine.

Through these initiatives, the Jill & Mark Fishman Center for Lymphatic Disorders continues to be a leader in the field, making a significant impact on patient care and medical innovation.

RELEVANT DATA & METRICS:

Over the past year, The Jill & Mark Fishman Center for Lymphatic Disorders at Children's Hospital of Philadelphia has experienced remarkable growth, solidifying its position as a leader in lymphatic care. With 113 new patient referrals, the program continues to expand its reach, providing expert care to individuals from over 30 states and three international countries. The team completed 131 complex lymphatic procedures, reflecting both the increasing demand for specialized interventions and the program's growing expertise. Additionally, over 100 patients were seen in clinic, ensuring comprehensive, multidisciplinary care. This year's 10% increase in domestic and international referrals and partnerships highlights the program's expanding global impact, reinforcing CHOP's commitment to advancing lymphatic care and improving patient outcomes worldwide.

STORIES OF INTEREST

Our partnership and collaboration with The Jill and Mark Fishman Center for Lymphatic Disorders and the Lymphatic Program from Rigshospitalet in Copenhagen, Denmark have been instrumental in advancing lymphatic research and clinical care. Through this collaboration, we are able to host insightful discussions on groundbreaking topics such as "Lymphatic Frontiers - From Bench to Bedside," "Pre-operative Risk Stratification for Non-Cardiac Surgery in the CHD Population," and "Tetralogy of Fallot Outcomes in Denmark." This partnership fosters international knowledge exchange, driving innovation and improving patient outcomes in the field of lymphatic disorders.

Dr. Vibeke Hjortdal, MD, PhD, DMsc
Dr. Benjamin Kelly, MD, PhD
Dr. Thomas Als Ringheim, MD, PhD-fellow
Dr. Lene Thorup, MD, PhD-fellow
Dr. Inger Norlyk Sheyanth, MD, PhD-fellow
Noah Nilsson, Medical student

HIGHLIGHTS AND ACCOMPLISHMENTS

This year, new initiatives were launched aimed at enhancing patient care, including discharge optimization. By proactively screening lymphatic patients and their families before travel, we can anticipate potential barriers and collaborate more effectively with their home practitioners. This approach ensures a smoother transition of care and better experience for our patients and their families.

ON THE HORIZON — NEW DEVELOPMENTS IN 2025

The 4th Annual Lymphatic Conference will be held at CHOP on September 19–20, 2025, focusing on New Horizons in Central Lymphology: Lymphatic Imaging, Interventions, Medical Therapy, and Microsurgery. This marks our first two-day conference featuring breakout sessions, and we are excited to host this event. Additional details will be shared as they become available.

F.O.R.W.A.R.D. PROGRAM

F.O.R.W.A.R.D. TEAM

Jack Rychik, MD Medical Director
Katie Dodds, CRNP Clinical Manager
David Goldberg, MD Cardiology
Elizabeth 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 Trainer
Lynn Callaway, MSW Social Work
Amanda Thaler Program Coordinator
Linda King, BBA Financial Counselor
Humera Ahmed, MD (Cardiology)
Jeff Roizen, MD (Endocrinology)
Tamir Diamon, MD (Hepatology)
Sarah Hendrickson, MD (Immunology)

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.

F.O.R.W.A.R.D. PROGRAM

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, the CHOP Cardiac Center 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.

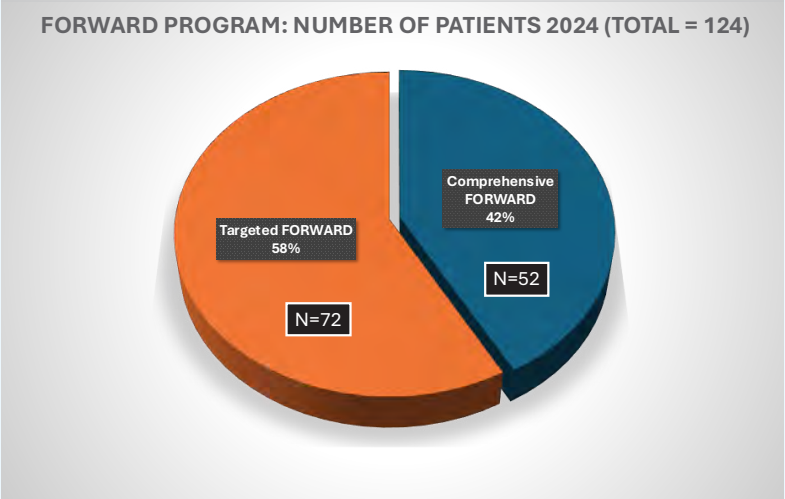
The FORWARD program is led by Dr. Jack Rychik, Medical Director, and Katie Dodds, MSN, CRNP, Clinical Program Manager and supported by an exceptional team of experts experienced and dedicated to advancing knowledge and providing care to individuals with single ventricle and Fontan circulation.

DATA METRICS

Patients and families are seen in the FORWARD program as either undergoing: 1) Comprehensive FORWARD evaluation with engagement and review by all the sub-specialties, or 2) as Targeted FORWARD evaluations with focus on heart, liver and other systems as indicated, typically reserved for follow up visits or other special conditions.

124 total FORWARD patients evaluated in 2024

- 72 Targeted FORWARD evaluations
- 52 Comprehensive FORWARD evaluations



HIGHLIGHTS AND 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 in 2024 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]
- Leadership in the Fontan Outcomes Network, a national learning network and registry focused on improving outcomes for those with Fontan circulation and their families
- 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
- Promotion and distribution 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 biology of liver fibrosis in the Fontan circulation
  - 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. Sci Transl Med. 2024 Apr 24;16(744):eadk6213. doi: 10.1126/scitranslmed.adk6213. Epub 2024 Apr 24. PMID: 38657025; PMCID: PMC11103255.
- Completion of a project looking at heart, liver and kidney fibrosis in those with Fontan circulation, supported by a grant from Additional Ventures
- Investigation of the relationships between exercise capacity and psychological health in the Fontan circulation
  - Seivert NP, Dodds KM, O'Malley S, Goldberg DJ, Paridon S, McBride M, Rychik J. Associations Between Exercise Capacity and Psychological Functioning in Children and Adolescents with Fontan Circulation. Pediatr Cardiol. 2024 Nov 5. doi: 10.1007/s00246-024-03701-8. Epub ahead of print. PMID: 39499284.
- 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

ON THE HORIZON...

- Exploration of clinical variables associated with magnitude of liver fibrosis in the Fontan circulation
- Expanded enrollment of subjects into the Fontan Outcomes Network, soon to partner with NPC-QIC to become the Single Ventricle Outcomes Network – SV_ONE
- Development of a patient-family education day symposium for those with Fontan circulation and their families
- Investigation of the association between rhythm disturbances and end-organ dysfunction in the Fontan circulation
- Exploration of serial longitudinal trajectory of biomarkers of organ wellness and exercise capacity in the Fontan circulation
- Research into the relationship between autonomic dysfunction and mental health in those with Fontan circulation

CENTER FOR PEDIATRIC HEART VALVE DISEASE

FACULTY

Jonathan Chen, MD
Muhammad Nuri, MD
Matthew Gillespie, MD
Michael Quatermain, MD
Lindsay Rogers, MD
Matthew Jolley, MD
Robert Levy, MD
Jill Savla, MD
Asif Padiyath, MD
Danish Vaiyani, MD

NURSE COORDINATOR
Keith Coleman

PROGRAM MANAGER
Sara Baumgarten

SONOGRAPHER
Yan Wang

JOLLEY LAB
Matthew Daemer
Christian Herz
Julia Iacovella
Devin Laurence
Wensi Wu
Christopher Zelonis

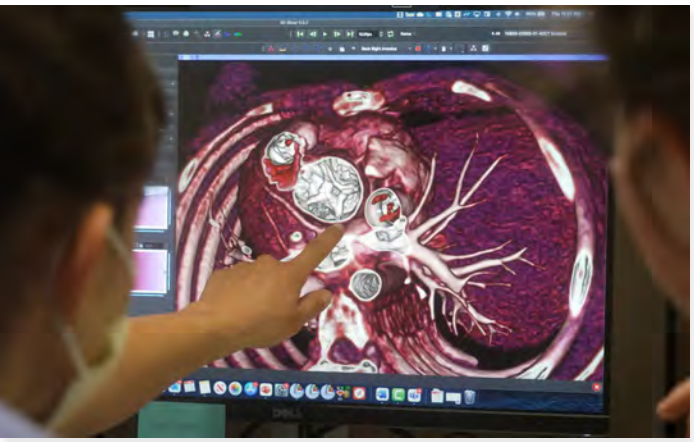
Established in 2020, the Topolewski Center for Pediatric Heart Valve Disease has continued to grow and revolutionize the diagnosis and treatment of pediatric heart valve disease. Vital to this work has been the ongoing development of novel imaging technology in the three dimensional and virtual reality domains to help create innovative interventional strategies (surgery or transcatheter-based) for complex valve disorders. The valve center has reviewed a total of 206 cases since 2020 with steady annual increases. The majority of these patient come to CHOP for diagnostic imaging and valve interventions.

CHOP's interventional cardiologists continue to lead the nation in transcatheter valve therapies, performing 42 valve replacements, 23 self-expandable valve and 19 balloon expandable valves, while 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.

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 with a focus on the role of the serotonin transporter. Dr. MatthewJolley'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. Their most recent work targets predictions of stress and strain with individual valve repairs with the hope of identifying the most durable repair options for individual children.

Finally, the Topolewski Pediatric Heart Valve Center has created several new resources for families https://open.chop.edu/courses/heart-valve-surgical-repair-options/ whose child has valve disease which discuss (a) mechanical valves (b) aortic valve repair options and (c) the Ross procedure, and will be adding to this library in 2025 videos regarding (d) tricuspid and (e) atrioventricular valve repair, as well as (f) transcatheter valve replacement.



HOME AND FOLLOW UP CARE

STUTMAN CARDIAC OUTREACH PROGRAM

FACULTY

Amy Schultz, MD, MSCE
Medical Director

Katelyn Zeoli, BSN, RN

Sara Baumgarten

Hollis Mclaughlin, BSN, RN

Danielle Campbell, MS, RDN, LDN, CLC

Amanda Thaler

Megan Fulmer, RN

Anna Simon, RN

Noelle Heavey, MSN, RN, CPN, NE-BC

The Stutman Cardiac Outreach Program is an outpatient support program which provides hospital-to-home transitional support and longer-term nutritional and feeding support to one of our most vulnerable populations: infants under 18 months of age being discharged after their initial admission or cardiac surgery. Supports offered through the program bridge the time between discharge and the first follow up appointment so that patients can successfully transition to home and back to the care of their outpatient providers. The program is led by Medical Director Amy Schultz, MD, Program Manager Sara Baumgarten and Nurse Manager Katelyn Zeoli, RN, BSN. The Stutman Cardiac Outreach Nurse Navigator, Hollis McLaughlin, RN, BSN, provides personalized outpatient support to a panel of 20-25 patients on average. The Stutman Cardiac Nurse Navigator contacts and follows up with families in the days after discharge and longitudinally to assess and troubleshoot key factors that affect how the baby and family transition to home. Stutman Program Dietician Danielle Campbell, MS, RDN provides nutrition and feeding support. In addition, we work in close collaboration with Speech-Language Pathology, Cardiac Surgery and Cardiology team members within CHOP and in the community. As such, the program also facilitates enhanced communication and collaboration between the Cardiac Center at CHOP and community healthcare providers.

The program offers:

- Outreach call from the Stutman Nurse Navigator within 24-48 hours of discharge
- Families are provided with contact information for the program and encouraged to reach out with questions and concerns
- 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-Language Pathology departments
- 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 Nurse Navigator continues to check in with families at regular intervals until the family feels ready to navigate the system independently
- Longitudinal feeding support, extending beyond the initial transition period, including support for weaning from tube feedings

STUTMAN CARDIAC OUTREACH PROGRAM

The Stutman Program has been in operation since November 2023 and has enrolled almost 200 patients. The program has assisted patients with early identification and treatment of wound infections, feeding intolerance and formula issues, appointment and procedure scheduling, Durable Medical Equipment vendor and private-duty nursing support, and helped to facilitate direct admission and transfer to CHOP from outside institutions for a higher level of care. The program has progressively expanded its enrollment criteria, now including patients under 18 months of age after their initial hospitalization, whether that be a Special Delivery Unit admission, a new postnatal diagnosis or discharge from the NICU. In 2024, the program formalized a structure to aid patients in progressing from tube feeding to full oral feeding which includes organized tracking of patients discharged on tube feedings and multidisciplinary review by Nursing, Dietician, Speech-Language Pathology, and Cardiology to develop and implement tube weaning strategies. The Stutman Cardiac Outreach Program is a valuable asset to the Cardiac Center, 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

CARDIAC CARE MANAGEMENT PROGRAM

FACULTY

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

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

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

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

Megan Fulmer BSN, RN
RN Care Manager

The Cardiac Care Management Program is a cornerstone of the Centralized Care Management Department, which serves over 1,400 patients. The program works within the larger framework of the Care Management Department, where cardiac patients benefit from a comprehensive support system. The Care Management Department is dedicated to assisting patients with complex medical conditions that span multiple body systems, often requiring expertise from various medical specialties at CHOP. These patients typically experience frequent inpatient admissions but are not currently served by a disease-specific care management model.

The program's Cardiac RN Care Managers, Anna Simon, and Megan Fulmer, manage a cohort of 75 cardiac patients, prioritizing care linked to their cardiac diagnoses although most of these patients also have complex chronic conditions impacting other organ systems as well. Anna and Megan utilize Population Health tools to drive daily workflows and proactive outreach. A primary goal is to take a proactive approach in addressing the care needs of their patients. They work closely with clinicians across the Cardiology department and the broader organization to support patient needs.

The RN Care Managers provide integrated, longitudinal care planning with a focus on seamless communication among the care team. This year, Anna and Megan enhanced their communication and collaborative efforts by actively participating in daily Progression of Care Rounds with the inpatient care team. They also collaborate with their Case Management colleagues and the Stutman Program Nurse Navigator to identify referrals and ensure thorough discussions about outstanding needs before discharge. Anna and Megan are involved in multiple forums aimed at enhancing care coordination for the cardiac population. They partner closely with the Cardiac Tube Weaning Program that encompasses other disciplines such as nutrition and speech therapy and aims to support safe feeding tube weaning for patients. These close relationships allow for effective teamwork, ensuring that all cardiac-related needs are addressed while also guiding families through the complexities of multi-specialty care.

A key aspect of the Cardiac Care Management program is providing intensive transition support. As noted above, they partner closely with the inpatient team to understand patients' needs for discharge and ensure prompt follow-up after discharge. Within two business days after discharge, Anna and Megan contact patients and their caregivers, addressing any questions or concerns, conducting medication reconciliation, reviewing the care plan, and ensuring that necessary supplies and equipment are delivered to the home. Over the course of this year, Anna and Megan made over 100 post-discharge calls, not only to patients on their panel but also to patients discharged from the cardiac units who are not currently followed by a disease specific program. In addition, Anna and Megan support their patients in the ambulatory setting. During FY25, Anna and Megan began attending complex care visits in the Compass Care clinic for their patients.

Throughout 2024, Anna and Megan expanded their reach by enrolling patients over 1 year of age, including some adolescents. The program's team members are excited to continue expanding our enrollment to support even more patients. To ensure that patients are connected to the Cardiac Care Management program, we developed a standardized enrollment process and a new referral order within the electronic health record system. This streamlined process ensures that all CHOP providers can easily refer patients to the program. Once referred, our RN Case Managers complete a screening for enrollment.

The Cardiac RN Care Managers are invaluable assets to our patients, families, the Cardiac Center, and the Care Management Department. They are committed to providing patient- and family-centered care, focusing on coordinating care for children with complex medical needs. By collaborating with the care team, they help families manage their child's care and navigate the healthcare system independently, always with an emphasis on meeting patient-centered goals. They support transitions across care settings, advocate for the child's healthcare needs, teach self-management skills, and work tirelessly to ensure a positive care experience for patients and their families.

TRANSITION TO HOME

KEY LEADERS & STAFF

Caylynn Markovitz RN

Natalie Bernard, BSN, RN

Emmanuelle Favilla MD

Transitions from the hospital to home are a tenuous and fragile time for patients and families. The opportunity to facilitate a safe and seamless discharge begins with pro-active work within the inpatient setting. The multi-disciplinary team has continued to support our vulnerable patients with collaboration among nursing, case management, social work, and clinicians. The work that initially started in the spring of 2022, 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, and Caylynn Markowitz, RN, as the nursing discharge coordinator, with continued leadership from Natalie Bernard, BSN, RN. Their work has focused on supporting families with anticipatory planning for eventual discharge, pertaining to factors ranging from caregiver education, insurance enrollment, and creating a sustainable framework for a patient's care at home. Caylynn and Dr. Favilla have developed a discharge roadmap, to increase transparency of the discharge process for families, and support anticipation of discharge needs. The latter is being tailored to be adapted to our heterogeneous patient population. Concurrently, processes are being refined to address medication and care plan safety, as well as feeding support and advances at the time of transition home. In turn, communication and collaboration with the outpatient transitional care teams has been developed over the last year, as has partnership with several ancillary teams to ensure the appropriate outpatient supports and care teams are in place prior to discharge.

The team is looking forward to continue building this essential multi-disciplinary collaboration as they continue to ensure partnership between the inpatient and outpatient care teams; in turn, striving to optimize our patients' care and families' experiences during what is often the most stressful of times in their journey with congenital heart disease.

CARDIAC CENTER COMMITTEES

CARDIAC CENTER QUALITY IMPROVEMENT

FACULTY

Shobha Natarajan, MD
Director, Cardiac Center QI

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

Katie Kennedy, MPH
Senior Enterprise Improvement Advisor

Brianna Heidenreich
Improvement Analyst

Andrea Kennedy
Cardiac Center Data Manager

Jenny Osborne
Cardiac Center Senior Manager of Clinical Operations

Susan Ferry
Cardiac Center QI and Safety 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

Under the direction of Drs. Natarajan and Hehir, the Cardiac Center Quality Improvement (QI) and Safety Core remains committed to its mission of fostering leadership in improvement science and patient safety. By bridging teams across the center, the Core aims to enhance multidisciplinary collaborations, engage leaders in QI and harm reduction, support a diverse array of projects, and provide the necessary education and infrastructure to achieve these goals.

In 2024 the team recruited Brianna Heidenreich, an extremely talented Improvement Analyst from the Center for Healthcare Quality and Analytics (CHQA). Shortly after bringing Brianna on board, the team was excited to add Katie Kennedy, a long-time Senior Improvement Advisor from CHQA who is well-known to the Cardiac Center for the many successful projects she has led. This expansion enabled the team to drive additional QI workstreams over the year and will continue with even more projects aimed at improving outcomes in the coming year.

PAST YEAR ACCOMPLISHMENTS

The Quality Improvement (QI) and Safety Core has strengthened its connections across the Cardiac Center by expanding the representation among leadership stakeholders involved in decision-making processes. Additionally, partnerships with Nursing have been fortified. The team has begun creating guidance for documents published internally within the center to provide greater accessibility for high-quality Clinical Practice Guidelines. With goals of improved clinical outcomes, improved transparency at all levels, and optimized communication, the QI and Safety teams have made strides this year. The QI, Safety, and Operations Steering Committee supervises efforts to enhance all aspects of care and has supported several significant projects over the past year. Projects have focused on key imperatives such as improving outcomes, increasing effectiveness and efficiency, reducing disparities in care, keeping patients safe and reducing unnecessary care. Some of these projects included:

Cardiac ICU Language Services Optimization

May-June 2024:	July-September 2024:	October-January 2024:	February 2025:	March 2025:
• Defining the Problem • QI Tools	• Data Review • Documentation Revision (.cardinterprtnote [41822])	• Language Services Education Meetings for Staff • iPad Repurposing (6 iPads and 2 VRI machines added for interpretation)	• Feb 18, 2025: Go Live C.L.E.A.R. Rounds Workflow Change • Staff Education • JobAid Creation	• Patient Survey of Feedback • Patient Handouts and Education Revision

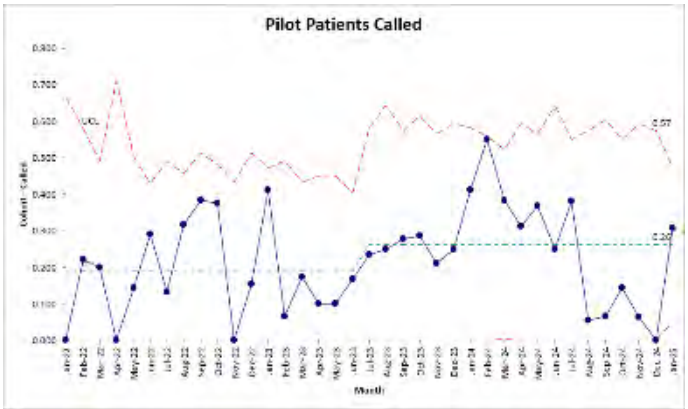
PROJECT C.L.E.A.R.: COMMUNICATIONS AND LANGUAGE EQUITY THROUGH ACCESS TO RESOURCES - `THE CICU LANGUAGE OPTIMIZATION QUALITY INITIATIVE:

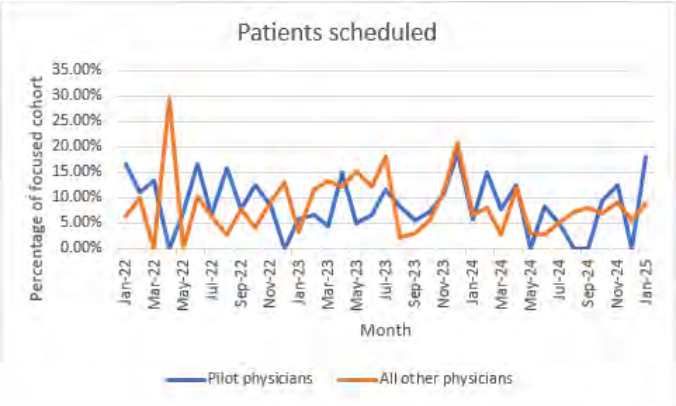
The aim of Project C.L.E.A.R. is to increase CICU-recommended inpatient days with an interpreter present from a Fiscal Year 2024 baseline of 49% by 15% (to 64%) by June 30th, 2025, for patients with primary listed language other than English (LOE), inclusive of language and Child Opportunity Index (COI).The Fiscal Year baseline was 48.7% for recommended inpatient days with an interpreter present and rose to 72.4%, thus achieving their Aim, while steadily increasing in-person interpretation rates. Cost neutral addition of iPads for virtual interpreting added six iPads and two video remote interpreting (VRI) stands for the CICU, allowing virtual

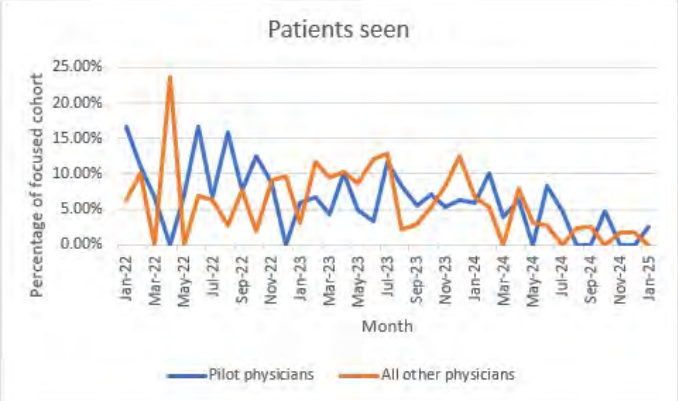
interpreting to increase from 39 times in October 2024 to 211 times in March 2025. Furthermore, COI was evaluated in the CICU patient population requiring interpreting and noted to be mostly "very low" scores. Language was further evaluated in 2024 by Length of Stay (LOS), and Spanish-speaking patients were spending a median of 29.02 more hours in the CICU than English-speaking patients. The impact of the in-person interpreting implementations are being evaluated in Spring 2025 and will help determine if LOS differences can decrease with standardization of interpreter services.

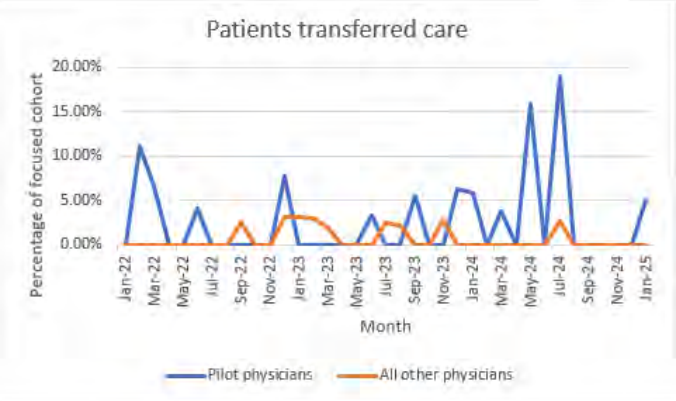
CARDIAC MISSED CARE OPPORTUNITIES

The cardiac missed care opportunities project has worked to identify patients with cardiac disease who have not adhered to follow-up recommendations. After these patients were identified, we have added additional layers of outreach to have these patients scheduled or accurately documented in the system if they have moved or no longer require follow-up. Since starting the project, our pilot group has increased the number of patient called by 19% and the number of patients scheduled by 4%. Additionally, we have improved documentation about patients transferring care by 108%. During this same time frame, all other cardiac physicians saw decreases in all of these metrics, showing the need for this work to be spread.







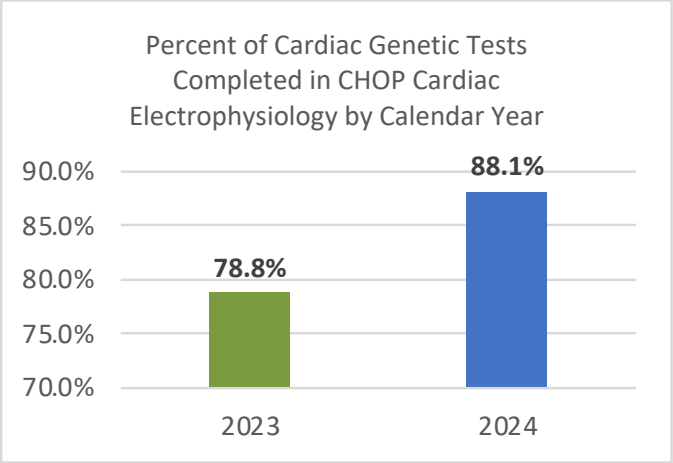


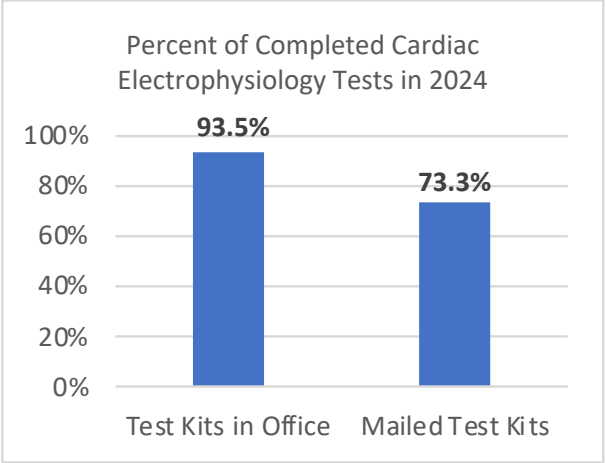
	Pilot							Other Physicians						
	Cohort	Called	Called %	Scheduled	Scheduled %	Transferred Care	Transferred Care %	Cohort	Called	Called %	Scheduled	Scheduled %	Transferred Care	Transferred Care %
Dec 22-Jan 24	251	54	21.51%	20	7.97%	5	1.99%	522	35	6.70%	55	10.54%	7	1.34%
Feb 24-Jan 25	241	62	25.73%	20	8.30%	10	4.15%	496	26	5.24%	33	6.65%	1	0.20%

CCU MINI-KAIZEN

In the fall, the Cardiac Center QI Team collaborated with CHQA to host an event dedicated to CCU Throughput Strategic Planning – The CCU Mini-Kaizen. This event brought together leaders and stakeholders from 6 East, 5 East, CICU, and post-discharge teams to help redefine and prioritize throughput efforts for the upcoming fiscal year. With the overarching goal of ensuring patients receive care at the appropriate level, participants conducted a deeper dive into the primary drivers of CCU throughput. Each workgroup reviewed process maps, built fishbone diagrams, and outlined key driver diagrams to diagnose areas that need to be improved upon. QI projects centered around medical readiness, family preparedness for discharge, and clinical management for oral feed optimization which will be supported this upcoming calendar year.

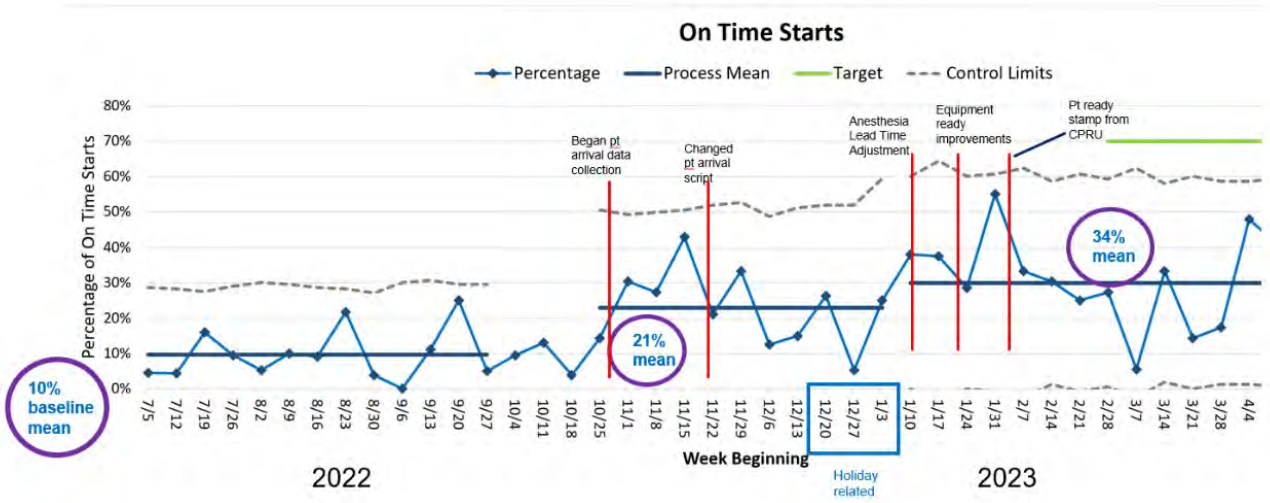
IMPROVING GENETIC TESTING COMPLETION RATES FOR PEDIATRIC PATIENTS AT RISK OF ARRHYTHMIA FROM INHERITED GENETIC CONDITIONS





Improving Genetic Testing Completion Rates for Pediatric Patients at Risk of Arrhythmia from Inherited Genetic Conditions aimed to identify barriers and improve genetic testing completion rates to 85% for EP patients by December 31, 2024. CHOP Cardiac EP increased testing completion between 1/1/23-6/30/23 from the baseline rate of 78.8% to 88.1% in the calendar year of 2024, exceeding their AIM. The main intervention-collecting genetic samples during the clinic visit resulted in a 93.5% completion rate and the mailed-out test kits decreased because of this in-clinic implementation. Storing test kits in clinic created easy access for staff to perform the collection. Canceled tests were related to cost, family confusion over sample collection, and difficulty contacting patients. In-clinic sample collection and genetic counselor involvement significantly improved genetic testing completion rates, enhancing patient access and equitable care. Standardizing workflows increased efficiency among team members.

IMPROVING ON-TIME STARTS IN CARDIAC MRI



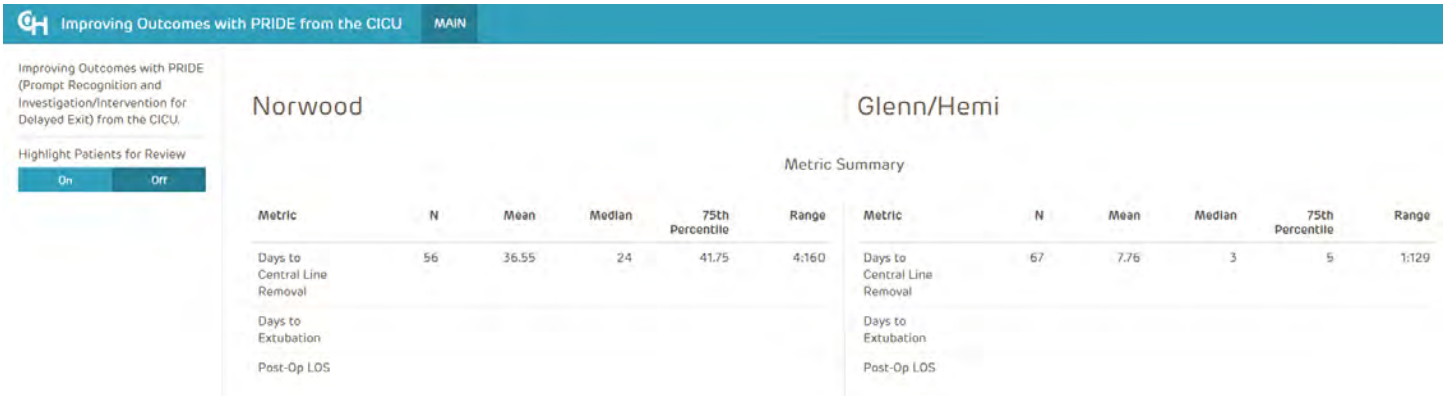
Improving On-time Starts in Cardiac MRI was the culmination of a multi-year project and has concluded with several notable achievements. These include the creation of a standard script for patient arrivals, the development of a process ensuring equipment readiness before the scan day, three rounds of enhancements to the protocoling form used by Cardiac Imagers, creating greater transparency, and the standardization of Cardiac Anesthesia preparation and communication processes. Additionally, changes were made to the registration process to reduce bottlenecks at patient arrival. As a result, on-time starts increased from 10% to 34%, a change that has been sustained since the project's final phase. This work was presented at the Pendergrass Research Symposium, where it received the Magna Cum Laude award. A manuscript was published. Moving forward, the work will be transitioned to operations for ongoing monitoring and necessary adjustments.

The QI/Safety Core held a successful Fall QI and Safety Forum in November. Drs. Natarajan and Hehir welcomed presenters:

- Hearts to Home, Emmanuel Favilla, MD
- Reducing Blood Orders in the Cath Lab, Jackie Morrison, MD
- Extubation Readiness, Amy Romer, MD
- Missed Care Opportunities, Ramiro Linzano-Diaz, MD,
- Clinical Communications, Safety Stand Ups & Clinical Care Conferences: Translating Safety into Action, Dave Hehir, MD.

Looking forward, projects in the works include:
CICU Mobility and Sleep Hygiene: Building upon QI work that was done in our PICU, the CICU aimed to improve the length of time between a patient being admitted into the CICU to the first time being mobilized. The cohort includes all CICU patients, no matter their diagnosis or age. The team has developed a set of acuity levels that indicate the appropriate mobility and sleep hygiene tasks for each patient and will start to be used in the unit in March 2025.

CICU Sedation Pathway: The CICU has worked on updating and expanding their sedation pathway to include both intubated and extubated patients. The goal is to develop a sedation/analgesia protocol that ensures patient safety and minimizes pain while reducing the overuse of sedation medications. Improved interdisciplinary communication at all stages of sedation will be achieved using this shared mental model based off patient acuity. The updated pathway will be implemented by the end of the 2025 calendar year.

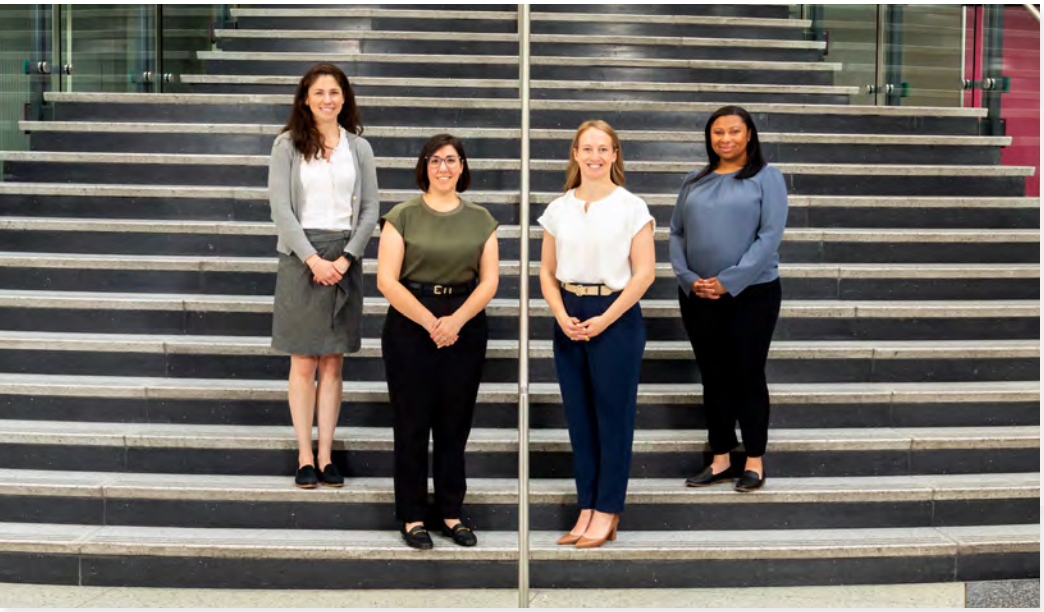


REDUCING RESIDUAL LESIONS AND EARLIER DETECTION OF RESIDUAL LESIONS IN THE POST-OPERATIVE PERIOD

A multi-disciplinary group, which includes leaders from Cardiology, Cardiothoracic Surgery, Cardiac Intensive Care, Cardiac Anesthesia and Cardiac Nursing, has taken on this large, yet important QI initiative. We have been working within the QI framework to define and diagnose various aspects of how residual lesions impact length of stay and more importantly, outcomes for patients after cardiac surgery. We have used national registry data and our own center's experience to define our cohort (those after Norwood operation and those after superior cavopulmonary anastomosis surgery), finished a driver diagram for the outcome of decreasing time to identifying a residual lesion and are now implementing change ideas that for this outcome. The echo subgroup has put together checklists for the TEE and epicardial imaging in the operating room including discussion of findings in a standardized way to ensure surgical team has all the information for proper decision-making. A standardized epicardial protocol is available to the surgeons to decrease unnecessary variation in the conduct of that imaging. Focused post-operative imaging and reporting protocols have been developed to assess the repair early on after surgery. The CICU subgroup has developed criteria to have an early, multi-disciplinary discussion about next steps if the patient is moving off course from the typical post-op pathway including prolonged intubation, high vasoactive infusion scores, delayed chest closure, prolonged central line days, and delayed initiation of enteral nutrition. Post-op CICU length of stay and hospital length of stay are also tracked but may be metrics that happen too late to correct the patient's course in a meaningful way. Major complications and re-interventions with dates will also be tracked.

Improving Outcomes with PRIDE (Prompt Recognition and Ivestigation/Intervention for Delayed Exit) from the CICU will be expanding this work to those patients who veer off course for any reason, including residual lesions. Some of the data is noted in the Dashboard above. Rob Olsen, Cardiac Center Data Analyst, is continuing to work on it. This work is critical to optimize outcomes for some of our most vulneerable patient populations. We are excited to move this initiative forward in the next year.

PATIENT & FAMILY EXPERIENCE PROGRAM



FACULTY

Sara Baumgarten

Emmanuelle Favilla, MD

Rachel Keashen, CRNP

Kianna Redd, BSN, RN, CPN

Christa Piccininni

The Cardiac Center Patient & Family Experience Program has been driven by Sara Baumgarten, Dr. Emmanuelle Favilla, Rachel Keashen, Kianna Redd, and Christa Piccininni. Over the course of the year, this committed group worked to enhance the experience of both patients and their families, ensuring that their time within the Cardiac Center was as supportive and positive as possible. Key initiatives included efforts to improve discharge readiness, which aimed to ease transitions from hospital to home, offering new moms breast pump bags to provide comfort and support, as well as introducing the "Moving Through the Visit" activity sheet and look book, which helped engage patients and families during appointments. Additionally, the team organized small gatherings in the Family Lounge to provide moments of relaxation, connection, and respite for families navigating challenging times.

In a special effort to build community and create lasting memories, the Patient & Family Experience team hosted a highly successful 'Cardiac Center Family Fun Day' at the Philadelphia Zoo on September 14th. The event was a tremendous success, attracting over 1,800 patients and their families, who enjoyed a day of fun, connection, and shared experiences. This initiative not only offered a break from the stress of medical care but also fostered a sense of camaraderie and support among families facing similar challenges. The event helped strengthen the bonds between the Cardiac Center and the families it serves, reinforcing the center's commitment to offering holistic care that prioritizes both the medical and emotional needs of patients and their families.

CARDIAC CENTER EDUCATION

FACULTY

Meryl Cohen, MD

Jenna Heichel, MSN CRNP

Christa Piccininni

Bri Johnson

The Cardiac Center Education committee continues to strive to foster a culture of continual learning and growth by enhancing inter-professional education and providing educational experiences for all colleagues across the Cardiac Center. The committee's areas of focus remain to expand access to literature and educational content, provide inter-professional learning opportunities, and broaden the digital educational repository.

As part of the committee's initiative to provide high quality educational content, they continue to coordinate a robust Cardiac Center Grand Rounds. Speakers include in-house colleagues as well as external guests with various backgrounds and disciplines. Presentations are recorded and cataloged in our Cardiac Center Library.

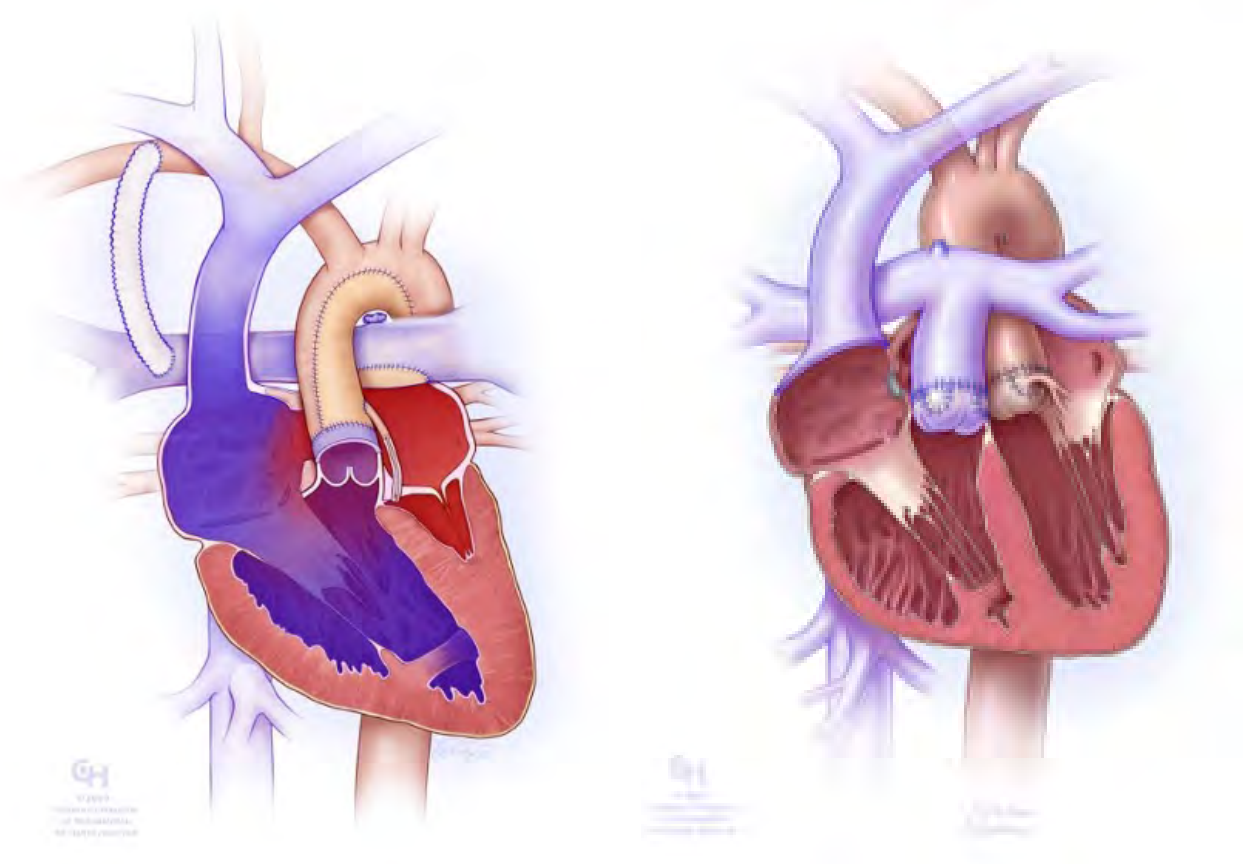
The committee continues to expand its digital educational repository, the Cardiac Center Library. Our medical librarian, Bri Johnson, has been instrumental in collating the content and developing new formats for additional materials. Content includes ongoing lecture series, pertinent literature in PDF format and the late Paul Weinberg's pathology lectures. We have developed a calendar to showcase upcoming and past educational offerings, complete with links to join the session as well as the recording when applicable. Recent additions include outpatient cardiology lectures, nursing education series, and updated VAD educational materials. https://chop.libguides.com/cardiaclibrary/home

We are continuing our annual asynchronous lecture series. In 2024, we coordinated a series on Acquired Heart Disease to include brief voice-over PowerPoint lectures from our heart failure and MCS experts. Topics included heart failure management, VAD devices and driving principles, as well as heart transplantation, rehabilitation and outcomes. We are currently coordinating a lecture series for 2025 on Atrioventricular Septal Defects.

Below is a list of our Cardiac Center Grand Rounds speakers in 2024:

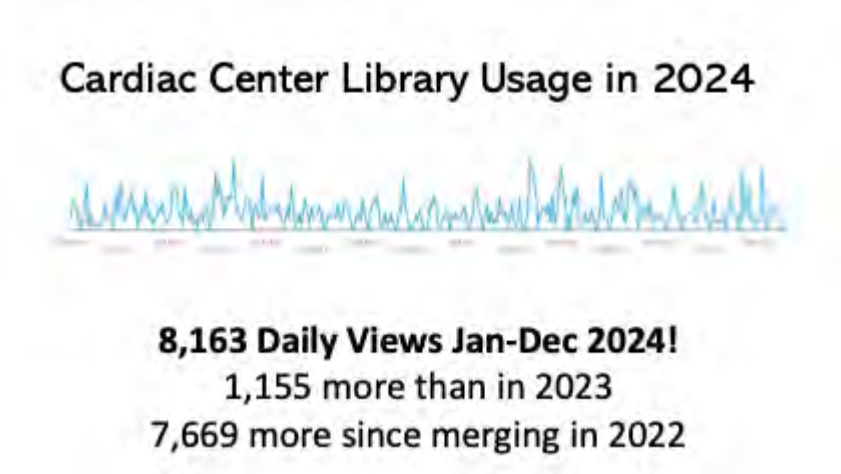
- March - Kiona Allen, MD (Lurie Children's, Chicago)
- June - Maryam Naim, MD
- August - Meryl Cohen, MD
- September - Matthew Jolley, MD
- November - Shoujun Li, MD (Fuwai Hospital, Beijing)

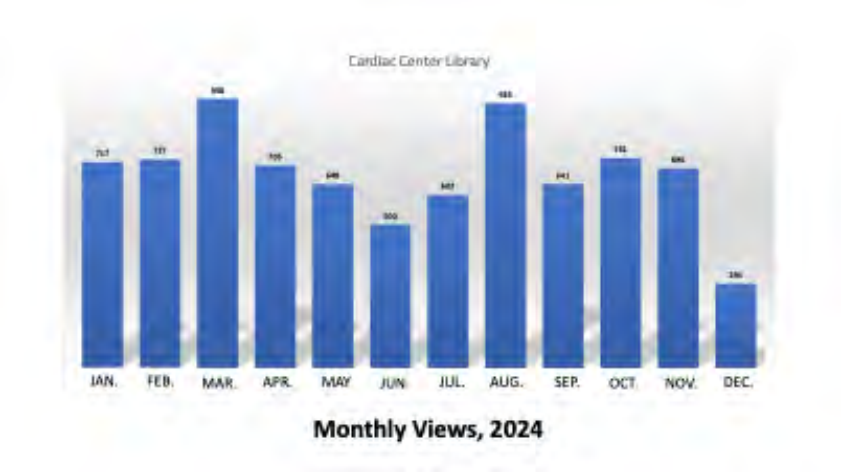
In efforts to improve the educational materials for our patients and families, we have revised and developed the written descriptions for each 'condition we treat'. This content is actively being reviewed by marketing and uploaded on the CHOP website. Our next step is to translate the materials in Spanish in PDF format. We continue to work with the CHOP media lab, Stream studios, to create new illustrations for our congenital heart defects and interventions or surgical repairs. The developed illustrations are complete with color and labels and drawn with beautiful anatomic detail, as shown below. They will be made available on our CHOP website as well as our Cardiac Center Library for both patient/family education as well as inpatient learning.

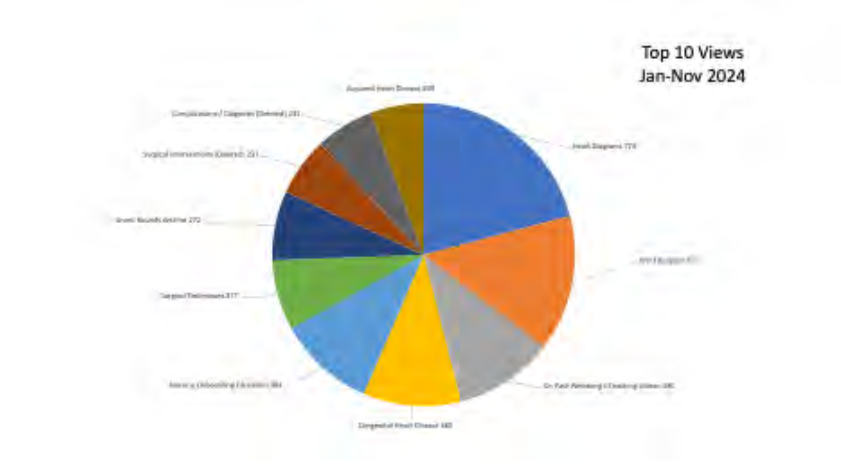


The APP Education series continues to provide monthly education across departments throughout the Cardiac Center. Sessions are held in person as well as through Teams to adhere to a wider audience. The presentations are recorded and stored on our Cardiac Center Library for asynchronous learning. We have worked closely with our CME accreditation team to offer continuing education for all participants.

Within the CICU, we have worked closely with nurse practitioners, Teresa Stegmann and Jarae Payne to develop a Cardiac Center Immersion Program for our newly hired Advanced Practice Providers. This is a 20-week program designed to provide a structured onboarding process with dedicated education on cardiology, ICU management, and advanced cardiac therapies. The schedule combines recorded lectures and skills/simulation sessions with progressive knowledge building throughout orientation. The hope is to guide the learner and preceptor(s) throughout orientation as well as enrich the process with simulation and shadow opportunities to develop a deeper understanding and foster working relationships across specialties.







This past year, we have started a quarterly education stakeholders meeting to bring together the education leaders across the Cardiac Center. These meetings are an opportunity to share our current projects, provide an opportunity to collaborate across departments and disciplines as well as to present areas in need for future work.

In the future, we hope to launch a Cardiac Center podcast series, “Heart of the Matter”. We are currently working on finalizing the logistics, developing a podcast-friendly introduction and curating a guest list of various topics. Our goal is to include educational topics, showcase events throughout the Cardiac Center and highlight various career paths and opportunities for professional development. Feel free to reach out if interested in joining this initiative!

CARDIAC CENTER INFORMATION TECHNOLOGY

Over the past year, the Cardiac Informatics Group centered around the Cardiac Center Data and IT (CCDIT) has achieved significant milestones that have greatly enhanced the efficiency and functionality of our Cardiac Center information systems. In Spring 2024, we successfully deployed Epic Cupid, which has been optimized throughout the year to streamline our cardiac workflows and data capture. This system has facilitated better management of patient data, efficiency in using Epic, and streamlining workflows.
As part of this modernization, in the summer of 2024 we started the Apollo Historic Backload project, to integrate over 30+ years of historic cardiac data into Epic, ensuring that comprehensive patient histories are available in Epic. Furthermore, we have refreshed and modernize our Cardiac Surgical Conference platform in Epic by introducing a new surgical conference template, schedule, and note system.

Spring 2024 also saw the deployment of Sickbay physiology monitoring platform, which has expanded its footprint and available tools over the past year. This plus the upcoming Capsule Medical Device Integration implementation will enhance our capability to gather and utilize real-time patient data from various medical devices, contributing to more precise and timely clinical interventions.

The Cardiac Center DTS team includes 4 dedicated analysts/engineers on the applications team, and 5 dedicated analysts/engineers on the Epic/Cupid team. This group has completed over 750 cardiac application enhancements and managed 47 cardiac application incidents. We have also successfully completed 590 Epic enhancements and handled 217 Epic cardiac incidents. Leveraging Cupid, Aaron Dorfman, MD developed a myriad of new Epic tools to improve clinician efficiency and data visibility in Epic. He continues as an advisor on the Epic Pediatric Cardiology Steering Board. In his role as ambulatory informatics clinical champion, Rob Palermo, DO has championed several new AI-based tools in the Cardiac Center, including ambient dictation for clinical notes and AI based clinical summaries in Epic. We have additionally welcomed Sarah Bakke, MSN, CRNP-C/PC as a new inpatient informatics clinical champion, joining with 15-20 physician, APP and nursing superusers in various areas of the Cardiac Center.

Michael Goldsmith, MD

CARDIAC CENTER WELL-BEING COMMITTEE

LEADERSHIP

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

Ashley Phillips, RN, BSN
Nursing Well-being Lead

Maryam Naim, MD, MSCE
Cardiac CCM Well-being Lead

Lindsey Loveland Baptist, MD
Cardiac Anesthesia Well-being Lead

Sarah Bakke, CRNP
APP Well-being Representative

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 to date (a total of $100,000 in grant funding) to support their work. The Well-being Committee's goal for 2025 is to continue to expand participation and to include representatives from all inpatient units across the Cardiac Center and also, to have an outpatient presence as well in our satellite offices across Pennsylvania and New Jersey.

The Cardiac Center Recognition Program, led by Ashley Phillips, RN has the mission to recognize all members of the Cardiac Center on their respective (recognition) days to share gratitude for each individual's contribution. Currently, 27 different departments/disciplines active throughout the Cardiac Center are recognized each academic year with a small gift. Recent efforts have successfully expanded recognition work to our satellite offices in Pennsylvania and New Jersey.

Carol Wittlieb-Weber, MD, led the 3rd annual Cardiac Center fitness initiative, *Hearts on the Mov*e. Through this initiative, 81 members of the Cardiac Center completed one of the races included in Philadelphia Marathon Weekend 2024 (39 8K, 35 half-marathon, 7 marathon) thanks to the support from the Exercise Lab team and funding from a Cardiac Center Academic Enrichment Award. The Hearts on the Move fitness initiative was recognized with a poster presentation at the inaugural CHOP Well-being Summit (held in November of 2024). Given the success of this program, *Hearts on the Move* will return for Philadelphia Marathon Weekend 2025!

CARDIAC CENTER WELL-BEING COMMITTEE

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 was in partnership with Arena Strive. The second phase of this work was just completed within the procedural spaces of the Cardiac Center with results showing improvement in burnout scores and measures of professional fulfillment.

Maryam Naim, MD, MSCE led efforts in the Division of Cardiac Critical Care Medicine focused on recruitment and scheduling to keep pace with the growth of the CICU and evolving coverage models. The division successfully recruited 1 new attending in the last academic year, and 1 for the upcoming year, an effort that will both support future growth but also will support retention of existing faculty. Dr. Naim continues to work with the leadership and scheduling teams to optimize work schedules to prioritize continuity of care and attending physician coverage at busy times in the unit as well as to provide mentoring and resources for junior attendings while supporting work-life integration.

Sarah Bakke, CRNP helped lead the first ever Cardiac Center Advanced Practice Provider Well-being Retreat which was held in April 2024. The retreat engaged over 40 APPs across the Cardiac Center, who attended in-person or via Teams, to explore stress management, burnout prevention, and financial wellness. Breakout sessions addressed the 2023 APP Wellbeing Survey key findings, focusing on areas for improvement in FY24. Additionally, chair massages and professional headshots were available. Planning is underway for the 2025 retreat to be held in April 2025 with a focus on professional fulfillment and personal growth.

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 Marie-Helene Bertino, author of Beautyland, for a book club held in partnership with the Critical Care Medicine female attendings. PWOC also read The Secret Life of Sunflowers, by Marta Molner, and took a trip to the Philadelphia Museum of Art for a private tour of impressionist art.

CARDIAC CENTER WELL-BEING COMMITTEE

This year PWOC was awarded a Joanne Decker Grant ($2500) to support its celebration of National Women Physician Day 2025. This year's event was co-sponsored by PWOC, the Office of Physicians Affairs, and the Physician Well-being Program. This year's celebration was open to all physicians and APPs at CHOP and included a networking reception and invited lecture by Dr. Cori Schreiber, MD, MPH, Executive Director FOCUS on Health and Leadership for Women, Perelman School of Medicine, University of Pennsylvania.

Cardiac Center Well-being work was highlighted at the inaugural CHOP Well-being Summit (November 7, 2024), with 4 posters accepted for presentation. Posters were presented on Hearts on the Move fitness initiative (presenter: Carol Wittlieb-Weber, top left), Physician Women of the Cardiac Center, PWOC (presenter: Avital Ludormirsky, top right), Cardiac Center Recognition (presenter: Ashley Phillips, bottom left), and Cardiac Center APP Retreat (presenter: Farzana Shah, bottom right).

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

PERSONNEL

LEADERSHIP

Andrea Kennedy, Manager Data Analytics
Kyle Winser, Analytics Lead
Kelly Veneziale, Clinical Data Specialist Lead

DATA TEAM

Robert Olsen, Sr. Data Analyst
Mitchell Walker, 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

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, C3PO, PC4, PAC3, CNOC, PediPerform (PLN), Fontan Forward and CCRC) which serve as expert consensus on common data definitions and data standards.

HIGHLIGHTS/ACCOMPLISHMENTS LAST YEAR

- Our team modernized over 80 assets allowing seamless integration to modernized data warehouse.
- Supported many Quality Improvement Projects including Postop Lesion, Inpatient Throughput CCU, CICU Extubation, CICU Family Communications + Interpreter, Missed Followups, Buerger Echo, and CICU Nursing.
- Developed reports to support PCGC collaborative research project.
- Supported decision making surrounding off-site expansion by working to develop location-based reports and support mapping displays.
- Developed prioritization dashboard to enhance accountability and efficiency on data projects.
- Developed Intake Center Dashboard to track patient flow for pre-operative outpatient visits.
- Developed CCU Discharge Dashboard to monitor implementations surrounding reduction in time from medical readiness to hospital discharge.

MAJOR PROJECTS

- The Cardiac Data and Analytics team worked on an enterprise-wide initiative that implemented a new cloud-based data platform to replace CHOP existing data warehouse. This required all existing data assets to be migrated to use the new system.
- Development of Cardiac Scorecards which are used to drive improvement and operational metrics surrounding Cath, Surgery, and Scheduling. These are used to follow up on goals pertaining to volume, efficiency, and staffing.

SUMMARY OF NEW/ COMPLETED WORK

- Total New Requests – 93
- Research - 22 (24%)
- Administrative/operational – 29 (31%)
- Quality Improvement – 24 (26%)
- Clinical Inquiry (non-research) – 11 (12%)
- Other – 7 (7%)

DIVERSITY, EQUITY, AND INCLUSION

LEADERSHIP

Maully Shah, MD
Medical Director, Diversity and Equity

Rachel Keashen, CRNP
Cardiac Center Diversity, Equity, & Inclusion – Patient Family Experience SubCommittee Co-Lead

Leigh Ann DiFusco, PhD, RN, PCNS-BC
Cardiac Center Diversity, Equity, & Inclusion – Patient Family Experience SubCommittee Co-Lead

Ramiro Lizano Santamaria, MD, FAAP, FACC
Cardiac Center Diversity, Equity, & Inclusion – Staff Experience SubCommittee Co-Lead

Liliana Flores Cruz, BSN, RN
Cardiac Center Diversity, Equity, & Inclusion – Staff Experience SubCommittee Co-Lead

Christa Piccininni
Project Specialist, Cardiac Center

The Cardiac Center Diversity, Equity, and Inclusion Committee is invested in its commitment to create and sustain a diverse, equitable and inclusive Cardiac Center, by engaging staff, patients, families, and the cardiac community through recognition of diverse perspectives in a psychologically safe environment. The Committee was formed in 2023 and chose to form two subcommittees (Patient Family Experience and Staff Experience) in order to focus their efforts more effectively.

PATIENT FAMILY EXPERIENCE SUBCOMMITTEE

The CC DEI Patient Family Experience Subcommittee is working on improving language services in the department.

Rachel Keashen and her team were awarded an Innovation Grant to spearhead the development of a study with the CHOP Qualitative Research Core. The study aims to understand the lived experiences of Cardiac Center patients and families who speak Spanish as their preferred language i. The study will evaluate this population's access to and use of language service options like interpretation, communication with healthcare teams and hospital staff, and understanding their care to prevent readmission. This work will allow our team to identify opportunities to improve and provide equitable care for patients with Limited English Proficiency.

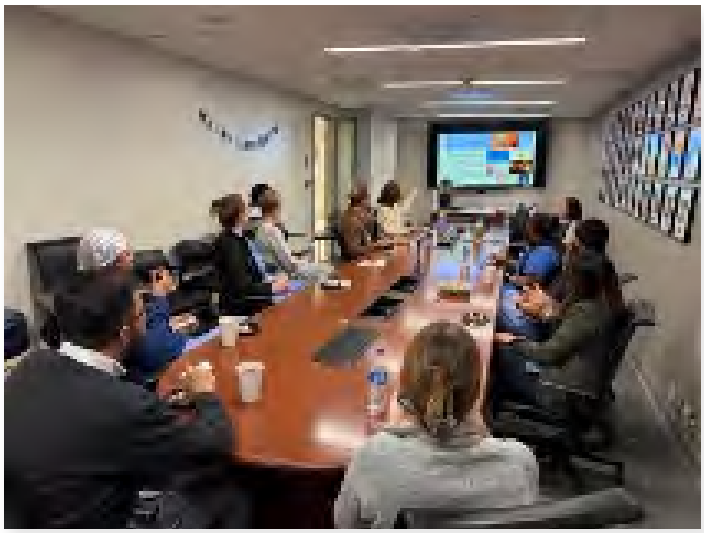
Additionally, Leigh Ann DiFusco is leading this subcommittee's initiative to explore data to identify and understand potential disparities in care among minoritized Cardiac Center patients and families. This inquiry is looking into the idea that advances in medical and surgical management alone may not be enough to sustain long-term survival to adulthood. Recognizing and addressing disparities in SDOH among the CHD population is critical in optimizing their long-term health outcomes. Survival to adulthood also is contingent upon elimination in disparate healthcare access and quality of services that occur with variations in SDOH as well as systemic inequities and structural racism.

STAFF EXPERIENCE SUBCOMMITTEE

The CC DEI Staff Experience Subcommittee has collaborated with the CC Education Program to bring new perspectives to Cardiac Center Grand Rounds lectures. In 2024, the Subcommittee invited Kiona Allen, former CHOP cardiology fellow and nationally recognized DEI expert, to provide a lecture titled "Opportunities for Advancing Medicine through Enhanced Diversity - The Time is Now". On June 17th, Dr. Katelyn Regan from CHOP's Gender and Sexuality Development Clinic will be presenting at CC Grand Rounds. Additionally, in collaboration with the Wellbeing Program, Dr. Daniel Soffer from Penn has been invited to give a talk on July 15th to speak about understanding our own diet and lifestyle choices, metabolism, and genetic predisposition as we take care of patients with heart disease.

Last summer, the Cardiac Center hosted two interns through Girls, Inc. The CC DEI Committee assisted with this initiative and provided guidance on how to ensure the interns had a well-rounded, inclusive experience.

In 2024, the subcommittee launched the DEI Holiday and Cultural Event Initiative to provide the opportunity for Cardiac Center staff to share about their faith and culture in a safe environment that respects traditions and avoids cultural bias. At these events, members of the Cardiac Center are invited to host and celebrate a holiday/cultural event occurring that month. A treat related to the holiday/cultural event is shared while volunteer staff member(s) share relevant information and personal experience. The events are scheduled on a rotating basis to ensure representation of celebrations across different religions and cultures are included. To date, Diwali and Hanukkah have been presented at these events.



This subcommittee's future plans include expanding the Holiday and Cultural Event Initiative, organizing career development, mentoring and networking events for all Staff Members in the Cardiac Center as well as supporting and enhancing recruitment and retention of diverse staff that represent the patients and families that we have the privilege to serve.

Starting in FY '26, the Cardiac Center will align with the broader enterprise initiative by rebranding its efforts under the name 'Inclusion & Belonging.'

INNOVATION AWARDS 2023-2024

INNOVATION AWARDS

Congratulations to the 2024 Cardiac Center Innovation Grant recipients!

- **Dr. Jennifer Lynch** – "Direct assessment of cerebral health after delayed umbilical cord clamping in newborns with critical congenital heart disease: An ancillary study of the CORD-CHD trial"
- **Dr. Brian White & Tiffany Ko** – "Resting-state Optical Neuroimaging During a Piglet Model of Pediatric Cardiac Arrest"
- **Dr. Laura Mercer-Rosa, Dr. Jonathan Edwards,** and **Dr. Rebecca Josowitz** – "Tetralogy of Fallot: Towards Precision Medicine to Explain Phenotypic Variability and Outcome"
- **Dr. Felina Mille** – "Individualized Cardiac Diagram Development via a Novel Application"

The committee was so impressed by everyone's innovative, thoughtful, and visionary proposals. The passion for advancing Cardiac Care is truly inspiring, and we are excited to see how all of these ideas will shape the future of our field.

Below are updates from the previously selected Innovation Grant recipients:

TITLE:
Development and use of novel optical devices for improved neuromonitoring during neonatal cardiac surgery

PRINCIPAL INVESTIGATOR:
Jennifer Lynch, MD, PhD

With funding we received from this Cardiac Center Innovation Award, we improved the design of our advanced optical neuromonitoring probe to achieve high data quality for continuous monitoring of cerebral oxygen delivery and utilization. We have translated this technology into the cardiac operating rooms and have so far conducted intraoperative neuromonitoring on a total of 32 neonates undergoing the Norwood procedure.

The technical and clinical findings from this study have been presented at national conferences, and multiple publications from this work are currently in progress. In Spring 2024, Lynch Lab graduate student Nicolina Ranieri presented the work from this project at the Congenital Cardiac Anesthesia Society's annual meeting and won the best abstract award.

INFANT PROGRAM
CHOP Cardiac Center

With generous funding from a Cardiac Center Innovation Award, the INpatient FAmily-centered NeurodevelopmenTal (INFANT) Program launched in March 2024. The multidisciplinary program aims to provide equitable neurodevelopmental care to infant (age <12 months) patients across the Cardiac Center's continuum of care. In its first year, the INFANT Program team was led by Dr. Colleen Driscoll (Program Director), Dr. Amanda Shillingford (Medical Director), and Cera Connelly & Emily Stevenson (Nursing Co-Leads), with Dr. Amy Jo Lisanti serving as a content expert consultant. The larger multidisciplinary leadership team met monthly and included representation from the CCU (Dr. Emmanuelle Favilla, Emilee Robinson, Emily Marchuk, Becky Westdorp), CICU (Dr. Liz Herrup and Grace Francisco), Rehab Therapies (Emily Roberts and Lydia Rawlins), Feeding and Nutrition teams (Julia Welc, Meghan Devine, Melanie Savoca, and Erin Sullivan), the Psychosocial Team (Kaylee O'Brien, Gino Poliziani, Melissa Greberman, & Taylor Goldberg), Outpatient Follow-up Teams (Lauren Zimmerman, Katelyn Zeoli, Caylynn Markovitz), and the NI/ICU (Dr. Casey Hoffman and Kristin Atlas). Most importantly, two parent partners – Peggy Paul Casella and Nora Strickland – have provided ongoing input and feedback.

In the last year, we have moved forward with several initiatives. We have established weekly neurodevelopmental care rounds for the CCU (6E/5E) and incorporated neurodevelopmental care content into the weekly CICU Multidisciplinary Rounds. Three providers have completed and two are in the process of completion of certification in the NeoNatal Neurobehavioral Scales – II, a neonatal neurobehavioral assessment to be incorporated into standard practice for infant cardiac surgical patients. We will soon be launching bedside developmental care rounds spanning the Cardiac Center inpatient units. On January 30, 2025, we hosted the first INFANT Program Conference – a free, full-day, internal conference focused on developmental care in congenital heart disease, with 100 Cardiac Center providers attending (see photos). With each of these initiatives, we are seeing both anecdotal and measurable improvements in the neuroprotective care provided to our infant patients. We are excited to continue this work, with aims to place the Cardiac Center at CHOP at the forefront of cardiac neurodevelopmental care.

INNOVATION AWARD "LOST IN TRANSITION"

Drawing from her own experiences of transitioning from the CHOP Cardiac Center to HUP ACHD, MarlaJan "MJ" Wexler, BSN, RN saw a vital need for additional support to the Transition Readiness and Awareness for Cardiac Kids (TRACK) program. MJ officially joined the TRACK team, led by Dr. Emily Ruckdeschel and Dr. Sumeet Vaikunth, as the Nurse Coordinator in January 2024. With her Innovation Award proposal "Lost in Transition," MJ has significantly enhanced the program's impact. With increased RN support, TRACK achieved a remarkable milestone in its first year of funding.

Under MJ's coordination, TRACK conducted 74 telemedicine appointments in 2024, more than doubling the number from the previous year. Among these appointments, 27 patients were deemed ready to transition to Adult Congenital Heart Disease (ACHD) care. Impressively, 18 of these patients have already commenced their care journey with ACHD, either attending initial visits or having appointments scheduled for 2025.

MJ's dedication has ensured thorough follow-up for these patients and their families, particularly focusing on those at higher risk of experiencing challenges during the transition process. Her efforts guarantee a seamless continuation of cardiac care, minimizing any gaps in treatment for these individuals.

Dr. Ruckdeschel and MJ worked with an Epic Analyst to develop a Cardiology Transition Smart Form, a valuable tool for tracking patients' transition progress. This innovative form automatically updates the Transition of Care section in patients' charts, streamlining documentation. Healthcare providers can easily access and utilize this smart form using the dot phrase .cardiologytransitiontools.

2025 is off to a successful start with significant changes already in place. RN-led TRACK appointments are now available for general cardiology patients, enhancing the support and education provided to more families. Additionally, an Epic Healthy Planet build tailored to cardiology transitions is underway. Plans are also in motion for educational webinars aimed at assisting patients and their families during the transition process. Don't hesitate to order TRACK consults for your patients as early support and education are crucial in the transition journey!

MEDICAL DIVISIONS AND PROGRAMS

DIVISION OF CARDIOTHORACIC SURGERY

LEADERSHIP

Jonathan M. Chen, MD
Chief, Pediatric Cardiothoracic Surgery
Mortimer J. Buckley, Jr. MD Endowed Chair
Co-Executive Director, Cardiac Center

Stephanie Fuller, MD, MS
Thomas L. Spray Endowed Chair
Professor of Clinical Surgery
Surgical Director, Philadelphia Adult Congenital Heart Center
Program Director, Congenital Cardiothoracic Surgery

J. William Gaynor, MD
Professor of Surgery
Daniel M. Tabas Endowed Chair

Katsuhide Maeda, MD, PhD
Associate Professor of Surgery
Director, Mechanical Circulatory Support and ECMO
Surgical Director, Cardiac Lymphatics
Alice Langdon Warner Endowed Chair

Muhammad Nuri, MD
Associate Professor of Clinical Surgery
Surgical Director, Heart Valve Center
Children's Hospital of Philadelphia Endowed Chair

INTRODUCTION

The CHOP Division of Cardiothoracic Surgery remains one of the highest volume centers in North America, performing over 600 open cardiac procedures and nearly 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, staged biventricular conversion, complex valve repairs 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 2024 was 2.47% for all STAT Procedures which represented an observed/expected ratio of 0.86, 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. In addition to open heart surgery procedures, our surgeons 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 President-elect 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.

OR NURSING

The Cardiothoracic Operating Nursing Team currently consists of twenty 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. As a team who is on the periphery, a general highlight is to witness a successful and smooth heart transplant for any one of our patients. 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. We continue to grow our team, to match growth in the Cardiac Center.

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 (EACTS), The American Association for Thoracic Surgery (AATS), and the Society for Thoracic Surgeons (STS). Some of our most mature research projects are detailed below:

- **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 contacted adult survivors and asked them to participate in study evaluating long-term outcomes. This project is 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 was presented at the American Association for Thoracic Surgery 2024 Annual Meeting. The manuscript was published by the Journal of the American College of Cardiology.
- **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. Dr. Mavroudis received a Cardiac Center Innovation Award to investigate novel neuroprotective strategies. We have begun a fruitful collaboration with Dr. Zolt Arany at Penn to investigate the impact of cardiopulmonary bypass on brain metabolomics (initially focused on branched chain amino acids. This work has led to presentation at the Annual Meetings of the European Association for Cardio-Thoracic Surgery and the Society of Thoracic Surgeons. We have also begun a series of experiments to assess the impact of hypoxemia on cerebral mitochondrial function. This is supported a grant from The Thoracic Surgery Foundation to Dr. Mavroudis.

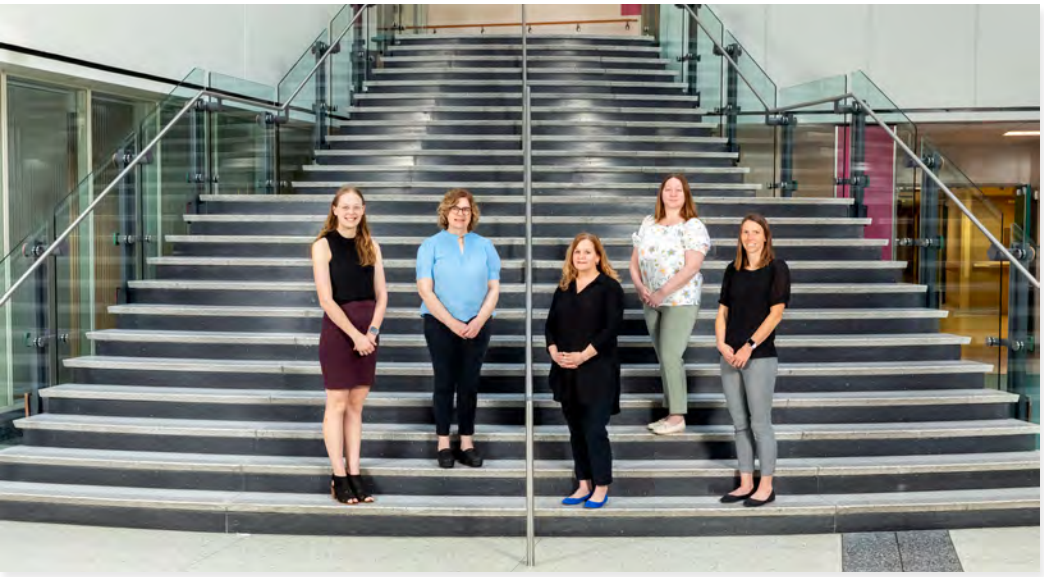
- **Surgical Creation of a Lympho-Venous Anastomosis to Treat Lymphatic Failure in a Swine Model of Right Heart Failure:** The central hypothesis is that the surgical creation of a thoracic duct-to-pulmonary vein lympho-venous anastomosis will effectively treat lymphatic failure and provide relief from 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 the 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 and an analysis of the incidence and outcomes of prosthetic valve endocarditis. We have initiated participation in a multi-institutional pivotal trial of a synthetic surgically implanted balloon expandable pulmonary valve (Autus Valve). The works is supported by grants from Big Hearts to Little Hearts and Edwards Lifesciences LLC through Baylor College of Medicine.
- **Cardiac Center/Cardiovascular Institute/Birth Defects Biorepository (CC/CVI/BDB):** To date, the CC/CVI/BDB has enrolled 1,820 probands with a wide variety of birth defects, including 981 with complex CHD, 160 with neural tube defects, and 140 with congenital diaphragmatic hernia since its inception in 2019. Total enrollment is 4,734 subjects, including 1,322 complete family trios. Whole genome sequencing has been completed in 2,991 subjects including 852 complete trios. Available biospecimens include placenta for 982 pregnancies, cardiac tissue (77 great vessel specimens, 56 myocardium specimens, 30 cardiac valve specimens), and thymus. Thus far, 40 data requests have been approved by the Scientific Review Committee.. 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. In addition, to the Cardiac Center, the Esophageal Atresia and Bladder Exstrophy Programs have begun enrolling subjects using the BDB infrastructure. The work performed by the BDB was recognized by the selection of Stacy Woyciechowski and Rebecca Josowitz as Emerging Innovators in Collaborative Research at CHOP based on BDB support of Dr. Josowitz's project to investigate mechanisms of abnormal placental development in CHD.
- **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 was published in 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. The primary analysis has been completed. The main results paper was published in JAMA Open. Current investigations are focused on transplant-free survival, and the impact on brain development and placental function. We have been invited to submit grant proposals to The CHOP/Penn SYNERGY program and to the Additional Ventures Single Ventricle Research Fund. A manuscript describing the beneficial impact of progesterone on morbidity and mortality in HLHS is under review at JAMA Open.
- **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. These data were presented at the 2023 Annual Meeting of the America 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. We recently completed data analysis for a multi-institutional study using machine learning to estimate exposure patterns of bisphenol A (BPA) and phthalate metabolites in urine obtained from infants undergoing cardiac surgery. The manuscript is under review at Environmental Health Perspectives.
- **AATS Tetralogy Of Fallot Inception Cohort Registry:** The AATS TOF Registry is a multi-institutional prospective study. The primary object is to develop an inception cohort of patients diagnosed with unrepaired TOF to determine the impact of various treatment strategies on outcomes and aid in the development of an evidence based/data driven treatment algorithm. Total enrollment is currently 363 subjects (500 planned) and CHOP has contributed 96 subjects. An initial report describing the registry was presented at the 2023 Annual Meeting of the America Association for Thoracic Surgery. The manuscript was published in the Journal of Thoracic and Cardiovascular 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.

Yasuyuki Kobayashi, M.D., Ph.D., graduated from Okayama University in 2012 and later trained at Okayama University Hospital, The Hospital for Sick Children, the London Health Science Centre, and most recently Boston Children's Hospital where his research interests focus on atrioventricular inflow relation to ventricular growth in staged recruitment for unbalanced atrioventricular canal patients.

CT SURGERY RESEARCH TEAMS



PERFUSION

OVERVIEW

The Perfusion team is currently a team of 10 full time and 3 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 2024 the Perfusion team supported 541 open heart procedures and 29 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 18 mechanical circulatory support implants and supported a total of 26 patients on devices this year. Durable long term and short term mechanical support is offered for all patient sizes including the use of the Impella, Heartmate 3, Berlin Heart Active, and Centrimag.

The Perfusion Services team renewed their Pillar Award for Perfusion Excellence which is sponsored by The American Society of Extracorporeal Technology and is awarded to perfusion departments which demonstrate excellence as displayed in a number of key areas. The Perfusion team supports perfusion education through partnerships with three perfusion schools- Medical University of South Carolina, University of Nebraska, and Jefferson University.

DIVISION OF 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

DEPARTMENT OF PEDIATRICS

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.

HIGHLIGHTS / ACCOMPLISHMENTS:

- Rachel Keashen, CRNP recognized at CHOP Diversity, Equity, and Inclusion (DEI) Breakthrough Marker's Summit
- Dr. Victoria Vetter published "Cardiovascular Toxicity of Energy Drinks in Youth: A Call for Regulation" in Journal of Pediatrics
- Dr. Jack Rome recipient of 2024 Cardiac Center Distinguished Achievement Award
- Melissa Wasserman recognized for her service and contributions by Editor-in-Chief of Cardiovascular Imaging Case Reports (CASE)
- Allentown Cardiology awarded Press Ganey's "Guardian of Excellence – Physician Experience – Children's Healthcare" Award
- Allentown, Voorhees, and Princeton received for Press Ganey's Patient Experience Achievement of 99th percentile Peer Ranking
- Katie Dodds, CRNP was the recipient of the 2024 Hometown Heart Award from "Mended Little Hearts of Philadelphia Region"
- Dr. Sumi Nadaraj was appointed the Medical Director of Central New Jersey Cardiology Practices
- Carol Wittlieb-Weber received the Joanne Decker Award to support Cardiac Center Female Faculty
- Dr. Laura Mercer-Rosa appointed Associate Medical Director of the Echo Lab

- Dr. Julie Brothers appointed Medical Director of the Cardiology Exercise Lab
- Dr. Meryl Cohen elected into the Philadelphia College of Physicians Call of Fall 2024
- Dr. Rossano awarded the PI Award for Excellence from the AHA Heart Failure/Collaboratory
- Dr. Maully Shah spent two weeks as Fulbright Specialist at National Institute of Cardiovascular Diseases in Bratislava, Slovakia
- Dr. Jack Rychik joined the Global Health team to speak at the Global Health Expo in Riyadh, Saudi Arabia on Fetal Health
- Dr. Rebecca Josowitz and Stacy Woyciechowski nominated as one of 2024-2025 Emerging Innovators in Collaborative Science
- Dr. Robert Levy delivered the Annual Pediatric and Congenital Cardiovascular Basic Science Lecture
- Dr. Jessica Tang awarded the Paul Weinberg Award for Excellence in Teaching

NEW RECRUITS

The Division continued to grow with two new recruits who started in 2024 and three anticipated in 2025

STARTED IN 2024:

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

STARTING IN 2025:

- Amir Toib, MD – Outpatient, Pennsylvania Satellites
- Emily Olson, MD – Outpatient, Voorhees Specialty Care Center
- Anila Chaudhary, MD – Outpatient, Pennsylvania Satellites

The Division of Cardiology continued to grow – now with **88 physicians**. With clinics at the main campus and at 13 outpatient locations, the Center sees over 42,000 visits annually, performs over 38,000 echocardiography studies, over 1,300 cardiac MRI studies and over 1,600 cardiac catheterizations. Details and more statistics can be found later in this report in each specialty section. We expanded our comprehensive Community Hospital Network to support 19 regional hospitals in Pennsylvania and 9 hospitals in New Jersey.

- Expanding partnerships with regional programs, starting with our new relationship with Cooper Health in New Jersey. Supported by our CHOP-Voorhees cardiology team, the scope of this program is to support newborns (NICU + Nursery), inpatients, outpatient clinics and fetal cardiology services.
- 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.
- Increased access with an Outpatient General Cardiology Advanced Practice Provider (APP) Program

CARDIOLOGY FELLOWS

The pediatric cardiology fellowship training program at CHOP is one of the nation's oldest, largest and most well-established pediatric subspecialty training programs with continuous ACGME accreditation since 1965. The program has a long history in training excellent pediatric cardiologists and leaders in the field.

CURRENT CARDIOLOGY FELLOWS

First Year
Victoria Carvajal, MD
Cody Aaron Gathers, MD
Mathew Hakimi, MD
Divya Nair, MD
Suganya Subramaniam, MD
Maribeth Teresczuk, MD
Luke Wooster. MD

Second Year
Sunakshi Bassi, MD
Grace Lee, MD
Maliha Naeem, MD
Radhika Rastogi, MD
William Russell, MD
Matthew Schreier, MD

Third Year
Elizabeth Carter, MD
Rodrigo Cardoso Cavalcante, MD
Ehssan Faraj, MD
Avital Ludomirsky, MD, MPP, MHS
Andrew Freddo, MD, PhD
Emily Olson, MD

Fourth Year
Abdulmajeed Alruwaili, MD
Ivor Asztalos, MD, MSCE, MBMI
Anila Chaudhary, MD
Rebecca Josowitz, MD, PhD
Rebecca Moore, MD
Jacqueline Morrison, MD, HMQS
Helen Stanley, MD

Graduated June 2024
Jeremiah Joyce, MD
Scott Weinreb, MD
Imran Masood, DO
Yuval Barak Coren, MD MSc

- 2024 Ann Newman Fellow: Avital Ludomirsky, MD
- 2024 Ann Newman Lecturer: Jeffrey A. Towbin, MD
- Lectureship: Studies on "Final Common Pathways" Associated with Cardiomyopathies and Arrythmias

FELLOW ACHIEVEMENTS IN 2024

- Coauthored 17 peer reviewed publications
- Presented at least 17 scientific abstracts at national meetings
- Received research funding through cardiac center grants, Matthew's Hearts of Hope grant and held two NIH funded T32 grants
- Completed UPenn Mater's Programs in Healthcare Quality Improvement and Patient Safety & Biomedical Informatics
- Completed the Clinical Research Certificate Program at University of Pennsylvania
- Accepted to the National Clinical Scholars Program and Master's in Medical Education Programs at University of Pennsylvania
- Received the American Heart Association Research ATOP Research Travel Award
- Represented CHOP fellows as Chair and Vice Chair of the Resident and Fellow Advisory Council
- Volunteered overseas in Botswana and Pakistan

OUTPATIENT CARDIOLOGY

SENIOR PHYSICIAN LEADERSHIP

Vivek Allada, MD Medical Director, Outpatient and Community Cardiology

Matthew Elias, MD Medical Director, Pennsyvania 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 Wellbeing Lead

NURSING/MANAGERS

Lisa Mitchell, RN Clinical Program Director, Cardiology Labs

Christine Pascua Program Director Echo Lab

Joanne Brown EKG/Holter Lab 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 Jerse

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 GENERAL CARDIOLOGY ADVANCED PRACTICE PROVIDER PROGRAM

Louise Fromuth, CRNP

Rachel Keashen, CRN

Kaitlin Lewis, CRNP

Monica Gianopulos, CNRP

OUTPATIENT CARDIOLOGY

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.

Outpatient Leadership Team 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.

CLINIC SITES

BUERGER CENTER CLINIC:

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

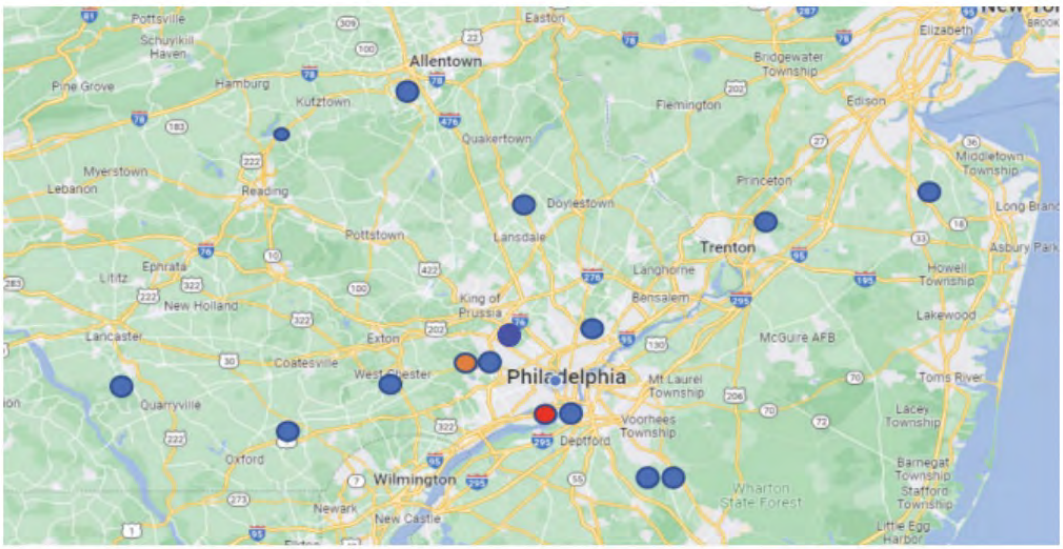
SATELLITES CLINICS:

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
- Pocono Clinic, 205 Applegate Rd, Stroudsburg PA, 18360

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



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 twenty-eight 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.

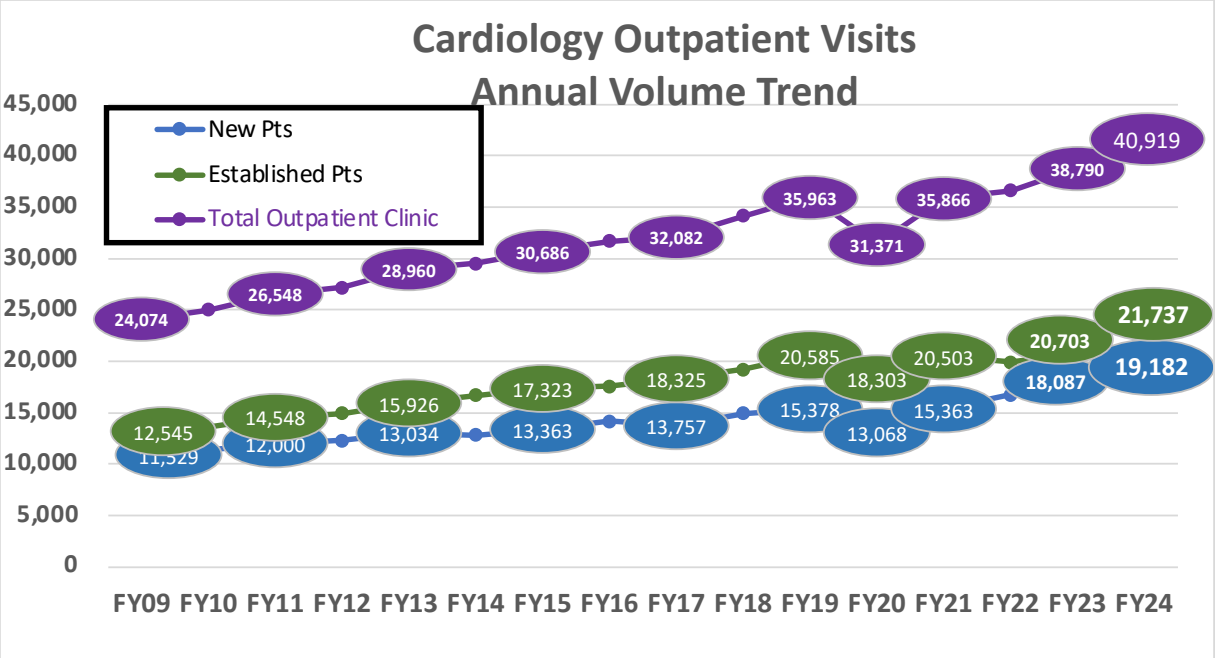
PENNSYLVANIA

- 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. Mary Medical Center – 1201 Langhorne-Newtown Rd, Langhorne, PA 19047

NEW JERSEY LOCATIONS

- 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
- Cooper University Hospital - 1 Cooper Plaza, Camden, NJ 08103
- Hunterdon Medical Center, 2100 Wescott Dr, Flemington, NJ 08822
- Penn Princeton Medical Center – 1 Plainsboro Rd, Plainsboro, NJ 08536
- St. Peters University Hospital – 254 Easton Ave, New Brunswick, NJ 08901
- Virtua Health System
  - Voorhees Hospital – 100 Bowman Ave, Voorhees, NJ 08043
  - Our Lady of Lourdes Hospital – 1600 Haddon Ave, Camden NJ 08103
  - Marlton Hospital – 90 Brick Road, Marlton NJ 08053
  - Mount Holly Hospital – 175 Madison Avenue, Mount Holly, NJ 08060

OUTPATIENT VOLUME: BY THE NUMBERS



Over the years, outpatient cardiology volume continues to show significant growth (briefly interrupted by COVID in FY20). In FY24, we have 71 outpatient cardiology providers at fourteen clinic sites, with forty-four providers going to multiple sites. This team saw over 40,000 cardiology clinic visits for the first time in our history.

OUTPATIENT CARDIOLOGY OPERATIONS

OUTPATIENT CARDIOLOGY PROGRAM HIGHLIGHTS:

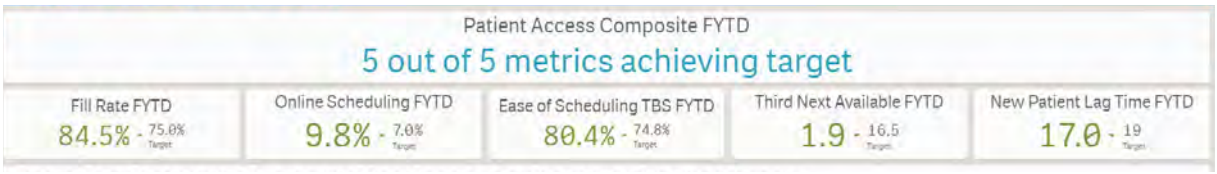
Working to make our patients' lives better

- In 2024, the outpatient cardiology group improved Press-Ganey survey results – tracking patient-family experience, "TOP-BOX" (scoring 9's or 10 out of 10) in three key areas improved to highest ever achieved in outpatient cardiology: Overall 93%; Access 85%; Moving thru clinic 79%

The year 2024 has been celebrated by numerous successful initiatives in outpatient pediatric cardiology:

- To better connect with our pediatricians, we initiated the Cardiac Life Cycle Webinar Series: "From before birth to the young adult, state of the art on what the pediatrician needs to know about the heart in the young"
- We added Cooper University Hospital in New Jersey to our cardiology network. Coverage includes inpatient support for the NICU, PICU, general pediatrics, and newborn nursery, as well support for the Emergency Department. In addition CHOP cardiologists staff an outpatient cardiology clinic and Fetal echocardiography clinic at Cooper University Hospital. Cooper 2nd and 3rd year pediatric residents now rotate at CHOP for their pediatric cardiology core rotation. The CHOP/Cooper relationship is supported by our Voorhees cardiology program.
- Outpatient Cardiology was instrumental in implementing both EPIC Refuel and EPIC Cupid projects
- 2024 marked the one-year anniversary of our move to the 12th floor Buerger Cardiology clinic space. In our first year in Buerger we've completed over 17,000 outpatient visits, over 14,000 EKGs, 3,600 Holters, almost 2,000 exercise tests and approximately 14,000 echos.
- Improving access to outpatient cardiology care is one of our prime goals
  - Our Allentown practice added new clinic exam rooms
  - We continue to expand Outpatient Cardiology Advanced Practice Nurse Practitioner (APP) program. The goal for this program is meet the increasing demand for cardiology services and to improve access for new patients.
  - Streamlining pre-clinic insurance authorization process

- These efforts have culminated in achieving all our key performance indicators for FY24:



NEW FACULTY:

Ezequel Sagray, MD joined our St. Peters/Princeton Cardiology practice

AWARDS AND ACCOMPLISHMENTS:

Dr. Matt Elias was nominated for the Physician Partnering Award. He has played a pivotal part in establishing the role of outpatient nurse practitioners in general cardiology through preceptorship, professionalism, and exemplary clinical care.
Dr. Carol Wittlieb-Webber received the Joanne Decker Award to support our Cardiac Center female faculty group,
Rachel Keashen, CRNP who was awarded the Breakthrough Maker Award at the CHOP Diversity, Equity & Inclusion (DEI) Breakthrough Makers Summit
Allentown and Voorhees Cardiology teams have received an award for achieving 99th Percentile Peer Ranking in FY24 for the Press Ganey Survey Section: "Nurse/MA" which measures how well nursing staff listen to and interact with patients and families.
The Outpatient Cardiology Team serves our patients and achieves our vision: "Best care for all children".

EKG HOLTER TEAM

SPUH TEAM

TELEMEDICINE

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 especially 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 14,000 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.

PATIENT STORIES: HC

3 month old with complex single ventricle heart disease (double outlet right ventricle, mitral atresia, severe pulmonary stenosis). He initially underwent balloon septal angioplasty of his atrial septum and stenting of his patent ductus arteriosus (x2). He is monitored by his local cardiologist as well as our infant single ventricle monitoring team. On a routine telemedicine visit he was noted to have concerning clinical changes including faster breathing, lower saturations by pulse oximetry (heart rate correlated using a digital stethoscope), a change in his murmur on exam and irritability, prompting referral for direct admission to CHOP for further evaluation and intervention as indicated. Upon arrival in the hospital his progressive desaturation was confirmed. Within hours he had onset of marked desaturation to 30% with a code called with successful resuscitation and transfer to our Cardiac ICU. An echocardiogram showed that the connection between the upper chambers of his heart which was essential for survival had closed septum with a decompressing vessel from the left atrium to the innominate vein and no flow to the left pulmonary artery. He underwent an interventional cardiac catheterization where this connection(atrial septal defect) was recreated, stented as well as additional stenting of his left pulmonary artery, balloon angioplasty of his PDA stent and right pulmonary artery with an excellent result. Thereafter, he demonstrated notable clinical improvement. Telemedicine and remote technologies were truly life-saving.

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 2024:

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 lifesaving in some. These data were published in 2023. We have now completed ~ 750 telecardiology visits, ~400 using digital stethoscopes. 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.

PATIENT STORIES: JA

25-day-old neonate with single ventricle heart disease (tricuspid atresia with normally related great arteries and pulmonary stenosis) who did not require any post-natal intervention. There were no concerns during an in-person cardiology visit several days earlier. An expedited TCV was performed due to isolated lower trending saturations by pulse oximetry as reported by caregivers, decreasing from 80 to 75%. During this visit, lower oxygen saturations were confirmed by correlating the heart rate (measured with pulse oximeter) with the heart rate measured by auscultation with the DS. Cardiac exam via the DS also showed a change in the murmur to being higher pitched compared to the exam at the previous TCV. These findings were concerning for a more restrictive ventricular septal defect (VSD). This prompted an urgent direct admission to the hospital where our concerns were confirmed by transthoracic echocardiography and the patient underwent placement of an aortopulmonary shunt placement to augment pulmonary blood flow prior to clinical deterioration.

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 ~ 2200 telemedicine lipid visits.

3. TELEMEDICINE TRANSITION TO ADULT CONGENITAL HEART DISEASE PROGRAM:

A. Clinical Champions: Emily Ruckdeschel, MD, Marlajan Wexler RN, CPN

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 ~150 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.

PATIENT STORIES: EB

5-month-old infant with single ventricle heart disease consisting of D-transposition of the great arteries, large VSD, hypoplastic left ventricular outflow track (LVOT) (subpulmonic) and diminutive main pulmonary artery (MPA) palliated as a neonate with a PDA stent. The patient's parents reported a saturation of 79% earlier that day via our remote patient monitoring app. During a routine scheduled TCV, the patient had fluctuating saturations but sustained periods in the 68–72% range. Although the patient was in no distress, they appeared more cyanosed compared to their previous TCV. We correlated the heart rate via auscultation with the DS to confirm accuracy. Upon cardiac auscultation, we noted diminution in the grade of the murmur via the DS as compared to the prior TCV. We directed this patient for an urgent admission with echocardiography confirming our clinical suspicion of PDA stent narrowing. The infant had expedited surgical intervention with a bilateral bidirectional Glenn shunt prior to clinical deterioration. Intraoperative inspection demonstrated a nearly occluded PDA stent.

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 700 visits completed; quality metrics in progress

6. CARDIOLOGY E-CONSULTS:

A. Matthew Elias, MD and the Community Cardiology service: allow primary care providers to obtain initial cardiology guidance without having to refer the patient for an in-person appointment

7. 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. NICU Cardiology Catch program launching April 2025
2. Further expansion of current programs: we anticipate addition of remote patient monitoring and QI metrics.
3. New programs launching in the Cardiac Center 2025:
   a. Advanced Cardiac Therapies for Heart Failure Patients (ACT-HF) Program: use of telehealth in our VAD program and eventual RPM, technologies, etc
   b. Lymphatics : use of telemedicine

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.

INTERVENTIONAL CARDIOLOGY

TEAM

Matthew J. Gillespie, M.D., FSCAI, FPICS

Jonathan J. Rome, M.D., F.A.C.C.

Yoav Dori, M.D., Ph.D.

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

Ryan M. Callahan, M.D., FSCAI, FPICS

Christopher L. Smith, M.D., Ph.D.

Jessica Tang, M.D.

Mudit Gupta, M.D., Ph.D.

Lauren Ford, CRNP

Erin Pinto, CRNP

The CHOP Interventional Cardiology Section is among the busiest and most forward-thinking congenital interventional programs in the world. The team of eight interventional cardiologists treated over 1500 patients in 2024. 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.

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, M.D.** along with Lymphatic specialists **Yoav Dori, M.D. Ph.D., Christopher L. Smith, M.D., Ph.D,** and **Mudit Gupta, M.D., 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, M.D., M.S.C.E**, CHOP is a participating center in the ***COMPASS*** *(**C**omparison of **M**ethods of **P**ulmonary Blood Flow **A**ugmentation: **S**hunt versus **S**tent)* 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 currently one of the busiest PVS labs in the country.

Pulmonary flow restrictors and State-of-the-Art Patient, Clinician, 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 CathLab 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 RESEARCH HIGHLIGHTS:

CHOP's catheterization laboratory is the lead site for The Pulse Oximetry Accuracy in Children study, a multicenter prospective study funded by the National Heart Lung and Blood Institute (R01 HL171313-02) evaluating whether pulse oximeters are accurate in children with different skin colors.

> "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

OTHER NOTABLE 2024 PUBLICATIONS

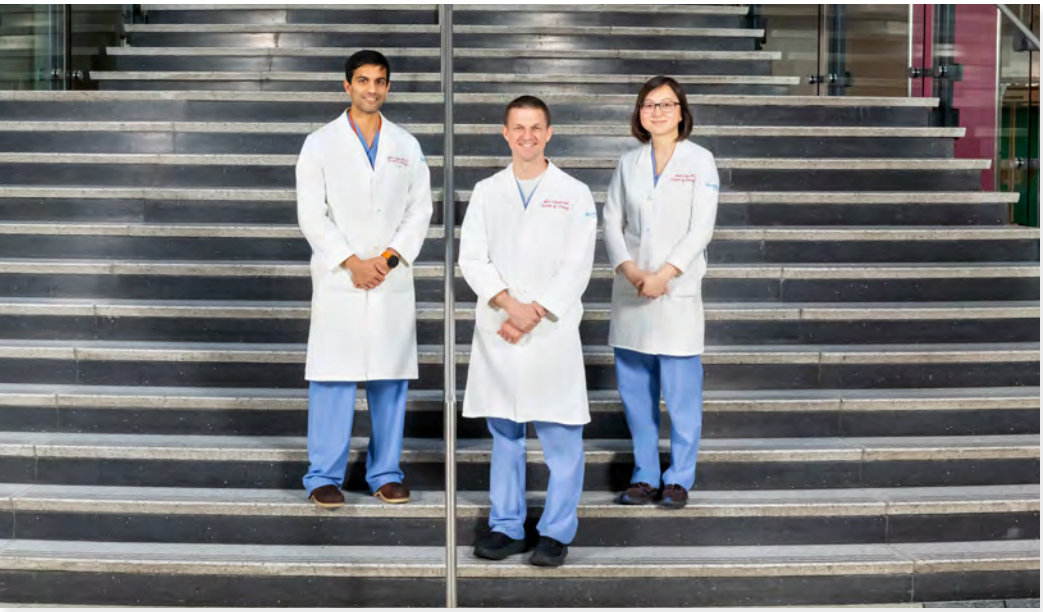
1. **Barak-Corren Y**, Herz C, Lasso A, **Dori Y**, Tang J, **Smith CL, Callahan R, Rome JJ, Gillespie MJ, Jolley MA, O'Byrne ML**. Calculating Relative Lung Perfusion Using Fluoroscopic Sequences and Image Analysis: The Fluoroscopic Flow Calculator. Circ Cardiovasc Interv. 2024 Jan; 17(1):e013204. doi: 10.1161/CIRCINTERVENTIONS.123.013204. PMID: 38152881
2. **Barak-Corren Y, Gupta M, Tang J, Smith CL, Callahan R, Dori Y, Rome JJ, Gillespie MJ, O'Byrne ML. From Text to Data: Automatically Extracting Data From Catheterization Reports Using Generative Artificial Intelligence**. *JSCAI*. 2024, Sep. 102242. doi: 10.1016/j.jscai.2024.102242
3. McElhinney DB, **Gillespie MJ**, Aboulhosn JA, Cabalka AK, Morray BH, Balzer DT, Qureshi AM, Hoskoppal AK, Goldstein BH. **Transcatheter Pulmonary Valve Replacement With the Harmony Valve in Patients Who Do Not Meet Recommended Oversizing Criteria on the Screening Perimeter Plot**. *Circ Cardiovasc Interv*. 2024, May. 17(5):e013889. doi: 10.1161/CIRCINTERVENTIONS.123.013889. PMID: 38606564
4. Quinn BP, Gunnelson LC, Kotin SG, Gauvreau K, Yeh MJ, Hasan B, Lozier J, Barry OM, Shahanavaz S, Batlivala SP, Salavitabar A, Foerster S, Goldstein B, Divekar A, Holzer R, Nicholson GT, **O'Byrne ML**, Whiteside W, Bergersen L. Catheterization for Congenital Heart Disease Adjustment for Risk Method II. *Circ Cardiovasc Interv.* 2024 Jan 23:e012834. doi: 10.1161/CIRCINTERVENTIONS.123.012834. PMID: 38258562
5. Qureshi AM, Sommer RJ, Morgan G, Paolillo JA, Gray RG, Love B, Goldstein BH, Sugeng L, **Gillespie MJ**; GORE ASSURED Clinical Trial Investigators. **Long-Term Results of the Atrial Septal Defect Occluder ASSURED Trial for Combined Pivotal/Continued Access Cohorts**. *JACC Cardiovasc Interv*. 2024, Oct. 17(19):2274-2283. doi: 10.1016/j.jcin.2024.07.013. PMID: 39297855
6. **Rastogi R**, Okunowo O, Faerber JA, **Mavroudis CD**, Whitworth H, **Giglia TM**, Witmer C, **Raffini LJ**, **O'Byrne ML**. Incidence, Management, and Outcomes of Pulmonary Embolism at Tertiary Pediatric Hospitals in the United States. *JACC:Advances*. 2024, Apr. 3(4) 100895. doi: 10.1016/j.jacadv.2024.100895
7. Wong-Siegel JR, Glatz AC, McCracken C, Lee C, Kitahara CM, Veiga LHS, Zhang Y, Goldstein BH, Petit CJ, Qureshi AM, Nicholson GT 3rd, Law MA, Meadows J, Shahanavaz S, **O'Byrne ML**, Batlivala SP, Pettus J, Beshish A, Mascio CE, Romano JC, Stack KO, **Asztalos I**, Downing TE, Zampi JD. **Cumulative Radiation Exposure and Lifetime Cancer Risk in Patients with Tetralogy of Fallot Requiring Early Intervention.** *JACC Adv.* 2024, Sep. 3(10):101239. doi: 10.1016/j.jacadv.2024.101239. PMID: 39290814; PMCID: PMC11406038

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 Professional Excellence & Advancing Knowledge (PEAK) this past year.

PULMONARY VEIN STENOSIS PROGRAM



LEADERS/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

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

Jihee Lee, BS
Program Coordinator

Kim Butler BSN, RN
Nurse Coordinator

Jessica Tang, MD
Interventional Cardiologist

Adam Feinstein BS
Switch Research Coordinator

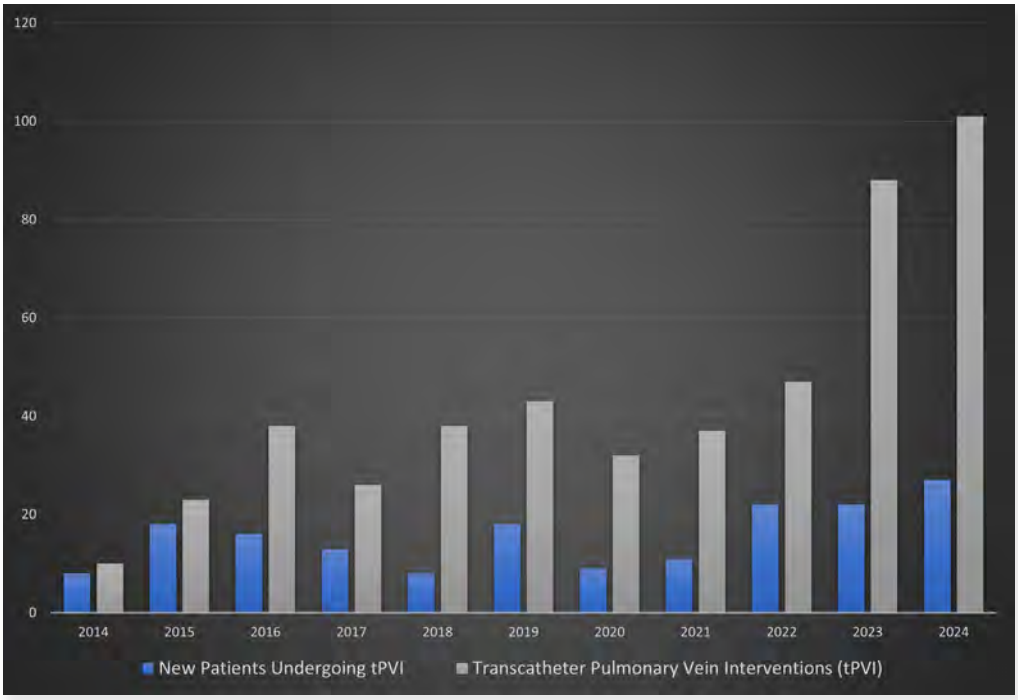
OVERVIEW

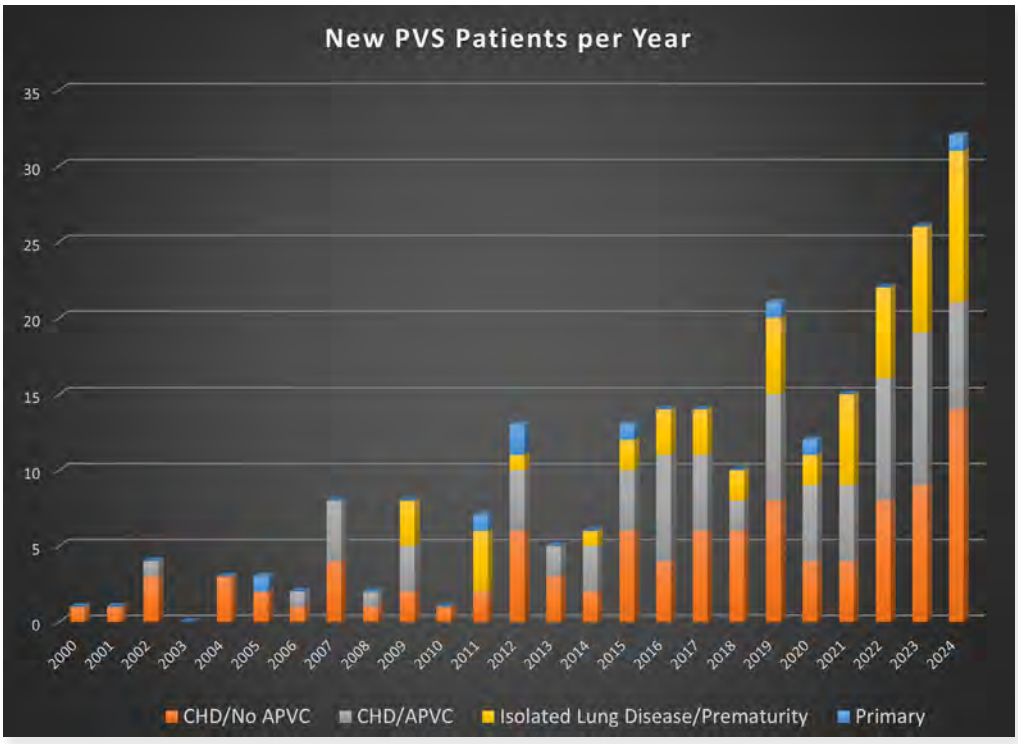
The Pulmonary Vein Stenosis (PVS) Program provides individualized therapies for patients with PVS, including innovative interventional techniques and the latest medical therapies. The program includes four interventional cardiologists, two pulmonary hypertension specialists, a cardiothoracic surgeon, a radiologist, nurse practitioner, nurse coordinator, program coordinator and research coordinator. The PVS program continues to see significant growth, including 32 new patients during 2024, 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.

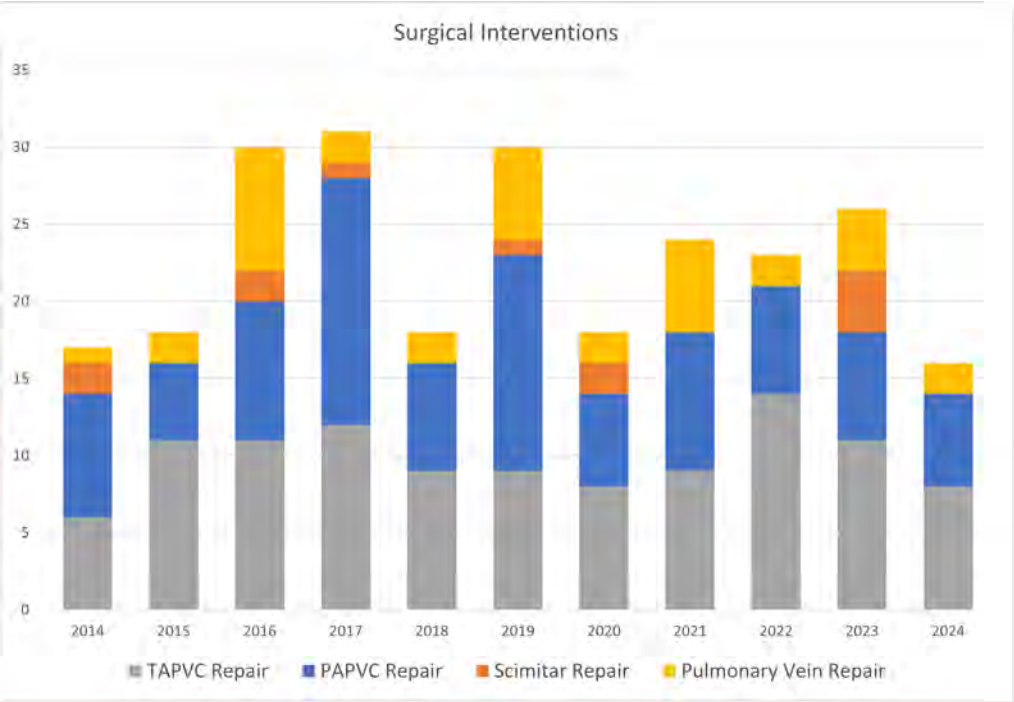
2024 HIGHLIGHTS

- Updated CHOP PVS Website (Pulmonary Vein Stenosis | Children's Hospital of Philadelphia (chop.edu))
- Performed 39 new PVS consultations and 22 PVS related second opinions (4 international)
- Members of the PVS team gave 9 invited presentations (1 international, 3 national, 5 local)
- Received CHOP Innovation Award for PVS specific clinical research study

PVS METRICS







RESEARCH HIGHLIGHTS

- Two pulmonary vein focused manuscript publications
- Five pulmonary vein focused abstract presentations at various national scientific sessions (ACC, SCAI, PICS)
- Nine active/approved IRB PVS related research protocols
- Enrollment now open in the prospective trial (NCT06440408) determining the feasibility of measuring wall shear stress using cardiac MRI in pulmonary veins of high risk infants
- Enrollment complete (30/30 patients enrolled) in the multi-centered prospective trial (NCT04696289) applying a standardized pulmonary vein catheterization assessment to patients with known or suspected PVS
- Ongoing investigations with our porcine PVS model which is being used to explore the mechanism of PVS, test new interventional techniques and develop new medical therapies

ELECTROPHYSIOLOGY

TEAM

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

V. Ramesh Iyer, MD, CEPS, CCDS

Christopher Janson, MD, CEPS, CCDS

Chris Srinvasan, MD, CEPS, CCDS

Victoria Vetter, MD, MPH

Ivor Asztalos, MD, MSCE
EP Fellow

Kate Spivak, PAC

Bridget Boyle, PA-C

Emily Brown, RN, BSN

Dana Sleeman, RN, BSN

Tammy Sweeten
EP Specialist

Maureen Murphy
EP Lab Technician

Marva Prince
Program Coordinator

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, RHYTHMIA Dx™) 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.

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. 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).

FIRST PEDIATRIC FDA APPROVAL OF NOVEL DEFIBRILLATION LEAD

Dr. Maully Shah was the CHOP PI for the new small diameter implantable cardioverter defibrillator (ICD) lead which recently received FDA approval. As the world's smallest defibrillation lead (4.7 French, or 1.6mm), the OmniaSecure™ lead represents a meaningful innovation in electrophysiology, and is indicated for stimulation in the right ventricle for adults and adolescent pediatric patients ages 12 and up, including those with smaller anatomies. We are the only Children's Hospital in the world that participated in this clinical trial. This collaboration led to a first pediatric FDA labeling on a cardiac rhythm device.

NEW EP PROCEDURES

NOVEL EXTRA-VASCULAR ICD IMPLANTATION

We were one of the first pediatric hospitals to implant the novel extra-vascular ICD (EV-ICD) system after its FDA approval. Unlike traditional ICDs that are implanted transvenously, the EV-ICD is implanted with a device in the sub-cutaneous space of the lateral chest wall and the ICD lead is tunnel in a substernal location. The benefits of this system are to avoid vascular and lead complications and the relatively small subcutaneous device may offer a treatment option for smaller patients who may otherwise need more invasive procedures such as a sternotomy. Our first patient had hypertrophic cardiomyopathy with a high risk of sudden cardiac death and had several complications from conventional ICD devices. The patient chose the EV-ICD for its potential benefits over traditional ICD systems.

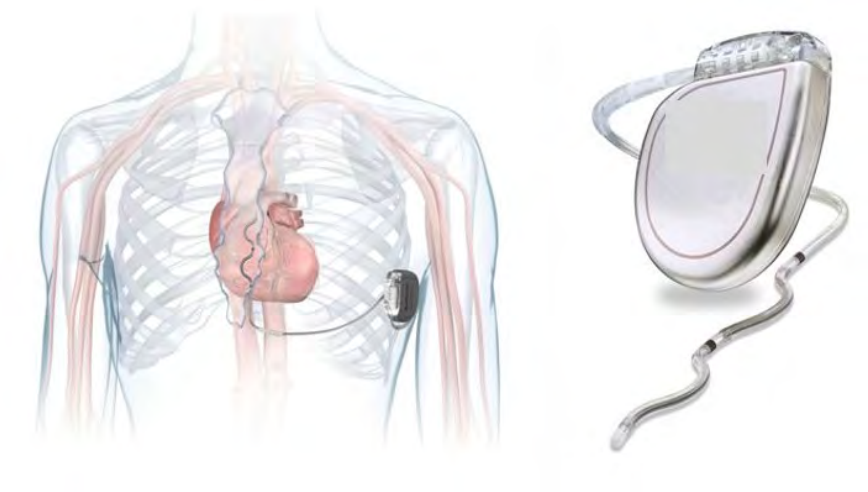
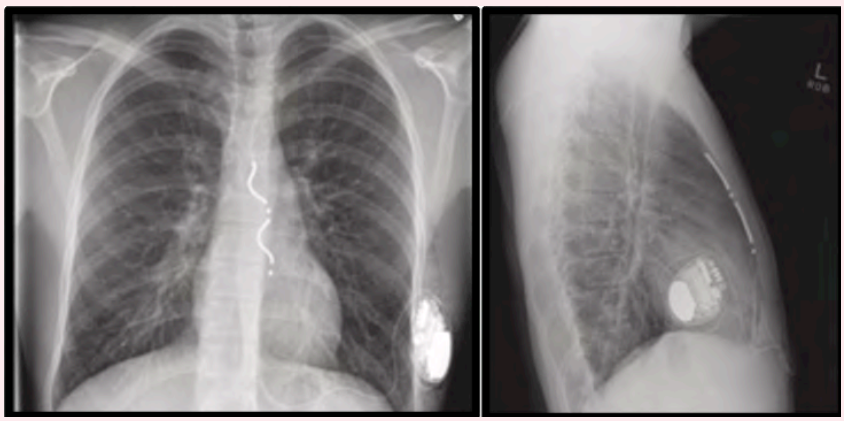
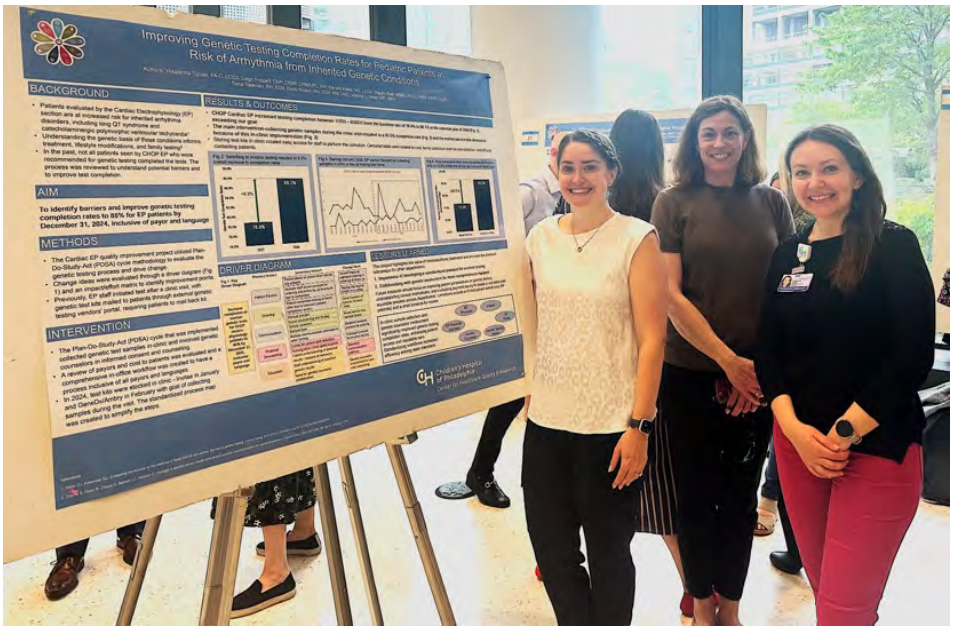


Figure: Extra-vascular ICD system: Showing the ICD lead tunneled under the sternum through a small substernal incision and the generator placed in a subcutaneous pocket in the lateral chest wall (Chest X ray PA and Lateral views below)





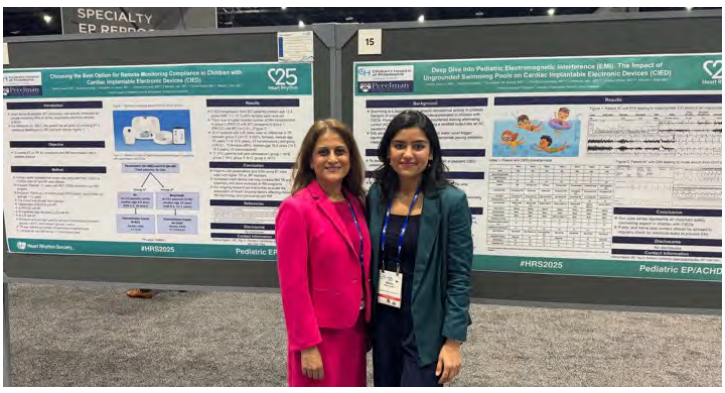
EP QA/QI PROJECT

Kate Spivak's QI project was selected for presentation at the CHOP Quality and Safey Day

NATIONAL AND INTERNATIONAL SCIENTIFIC CONFERENCES

Dr. Christopher Janson and Dr. Maully Shah were invited as faculty to the XI PediRhythm: Pediatric& Congenital Heart Rhythm Disorders Congress in Rome, Italy. Dr.Maully Shah was invited as faculty at the 2025 European Heart Rhythm Society Association (EHRA) Congress in Vienna, Austria. Dr. Chandra Srinivasan was invited as faculty at the Pediatric Cardiology Course organized by Open Medical Institute in Mexico City, Mexico. Dr. Victoria Vetter, Dr. Maully Shah and Kate Spivak were invited as faculty to the 2025 Heart Rhythm Society Scientific (HRS) Sessions in San Diego, CA.

Electrophysiology Fellow Ivor Asztalos and cardiology fellow Maiha Naeem gave important abstract EP presentations at HRS 2025.



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).

SUMMARY OF RESEARCH STUDIES WITH CURRENT AND ANTICIPATED PUBLICATIONS:

1. Transcatheter Leadless Pacing in Children
2. Conduction System Pacing in children- Multicenter study
3. Early safety of efficacy and safety of the novel small caliber ICD lead
4. Comparison of Cryo vs. Radiofrequency Ablation of postero- septal accessory pathways: An Analysis of The NCDR®IMPACT Registry
5. Characteristics and Outcomes of Pediatric Patients Undergoing Subcutaneous ICD Implantation – An Analysis of the NCDR EP Device Implant Registry
6. Race and Ethnicity Are Associated with Diagnosis and Management of Wolff-Parkinson-White Pattern in Children
7. Risk stratification of sudden cardiac death in Pediatric Arrhythmogenic Cardiomyopathy- Multicenter study
8. Utility of Ivabradine for Postoperative Junctional Ectopic Tachycardia- Multicenter study
9. Predictors of Response to Cardiac Resynchronization Therapy in Pediatric and Congenital Heart Disease Patients
10. Catheter Ablation of Ventricular Tachycardia before Transcatheter Pulmonary Valve Replacement in Tetralogy of Fallot (CATAPULT STUDY)
11. Management and outcome of "lone" atrial fibrillation in children and young adults- Multicenter study (participant in multicenter NIH funded study)

ROLES IN NATIONAL AND INTERNATIONAL PROFESSIONAL & SCIENTIFIC SOCIETIES

1. Dr. Maully 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 Nominations committee and on the International Board of Heart Rhythm Examiners' (IBHRE) continuous competency certification and test writing committees. Dr. Shah is a member of the CDC funded Philadelphia County Sudden Death in the Young Advanced Review Team.
2. Dr. Christopher Janson is the associate program director for the CHOP cardiology fellowship program. He is a member of the Pediatric and Congenital Electrophysiology Society (PACES) research committee, as well as the PACES QI committee
3. Dr. Chandra Srinivasan serves on the PACES QI committee.
4. Dr. Ramesh Iyer's focus is on health care policy.
5. Dr. Victoria Vetter is the Director of Youth Heart Watch at CHOP and affiliate of Project Adam.
6. Kate Spivak (PA) serves on the PACES Allied Health Professionals Education Committee . She is also co-chair for Electrophysiology in the Association of Physician Assistants in Cardiology (APAC)

INTERNATIONAL COLLABORATION

Dr. Maully Shah was a Fulbright Specialist at the National Institute of Cardiovascular Diseases in Bratislava, Slovakia where she spent two weeks providing procedural expertise in the field of pediatric electrophysiology. During the visit she performed catheter ablations in children with complex arrhythmias , consulted on patients and gave lectures to pediatric cardiologists and medical students. She also collaborated with the adult electrophysiology department in the application of new ablation technology called Pulse Field Ablation in the treatment of atrial arrhythmias in patients with congenital heart disease. Dr. Shah continues to collaborate with institutions across India to provide electrophysiology expertise and second opinions regarding arrhythmia management.

STATISTICS

Electrophysiology Outpatient Clinic Visits 1606
Device clinic visits 386
Device Implantation Procedures 93
Catheter Ablations and Electrophysiology studies 270
Device Remote monitoring 2807
EKG 55,993
Holters 5635
Transtelephonic/MCOT monitors 919

AWARDS

Victoria Vetter, MD received the Catalyst Award at the 20th Simon's Heart Foundation Soiree in February. The award acknowledged 12 founding partners who have provided guidance and impacted the Foundation's mission over the years.

Dr. Maully Shah received the 2025 Distinguished Service award from the Global Indian Electrophysiology Forum (GIEF) for outstanding service in Electrophysiology and expanding the footprint of Pediatric Electrophysiology globally. The award was presented at the 2025 Heart Rhythm Society Meeting in San Diego, CA.

Kate Spivak (PA) completed the Heart Rhythm Society's LEAP program (Leadership and Education for Allied Health Professionals). She was also awarded the Certificate for Cardiac Device Specialist (CCDS)

YOUTH HEART WATCH

FACULTY

Victoria L. Vetter, MD, MPH
Medical Director

Meghan K. Metcalf, MD
Medical Director, NJ

Maryam Y. Naim, MD, MSCE
Associate Medical Director

Lindsey Flanagan, MPH
Program Coordinator

Abenezer Lemma
Research Coordinator

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 2024, Youth Heart Watch (YHW) designated 56 schools as Heart Safe, resulting in over 150 schools in PA and NJ that are currently meeting best practices in cardiac emergency preparedness on their campuses. We are currently working with approximately 300 additional schools to implement the Heart Safe program, as well as several youth athletic groups, churches, and recreation centers. Led by Dr. Meghan Metcalf, Youth Heart Watch has expanded further into NJ where our team is working with school and community groups across the state. Our YHW team has presented at several conferences including the Pennsylvania Chapter of the American Academy of Pediatrics, Project ADAM National Conference, University of Kentucky Children's Health Grand Rounds, School District of Philadelphia Nurses Professional Development, Camden County School Nurses Association, and the NJ State School Nurses Association.

Nearly 800 community members have received CPR and AED training in the last year thanks to Youth Heart Watch, including school staff, students, coaches, and parents. With the help of funds generously provided by the Blake Gives Back Foundation, YHW donated seven AEDs to youth athletics and community sites.

Primary prevention of sudden cardiac arrest is accomplished through community heart screenings. With funds from CHOP's Excel Grant and Blake Gives Back Foundation, we screened 274 children over three screening events at the Germantown Boys and Girls Club, Hank Gathers Recreation Center, and Alan Horowitz Sixth Man Center Powered by Philadelphia Youth Basketball. Children received free electrocardiograms to identify heart conditions that could potentially put them at risk for experiencing a cardiac arrest. Children identified to have risk factors or abnormalities on their ECG receive further testing onsite via an echocardiogram and visit with a cardiologist for additional history and physical examination. Youth Heart Watch partners with other CHOP teams at the ECG screening events to provide health education and resources on various topics for families including nutrition, physical activity, mental health, health equity, smoking/vaping, asthma, audiology, and violence and injury prevention. In an effort to support the effectiveness of large-scale ECG screenings in children, Dr. Vetter presented current research on the efficacy of ECG screening at the Cardiac Safety Research Consortium Think Tank at Duke University and at the American Heart Association Scientific Session in 2024. The proceedings of the Think Tank conference and discussion are expected to be published in the American Heart Journal in 2025.

With regard to advocacy, the YHW team has worked diligently to advocate for legislation at the state and federal levels. Partnering with the NFL's Smart Heart Sports Coalition, YHW has supported Pennsylvania legislation to require schools to have AEDs, trained staff, cardiac emergency response plans, and practiced drills. Students from the University of Pennsylvania working with YHW conducted research to estimate the cost of funding this legislation to provide AEDs to schools in need. On a federal level, the team has supported the HEARTS Act (cardiomyopathy Health Education, Awareness, Research and Trainings in Schools) that unanimously passed the US House and Senate and was signed into law in December, 2024. The HEARTS Act will provide funding for schools in need to purchase AEDs and CPR training for students and staff, require the government to review guidelines and make resources available.

Drs. Vetter and Naim published a recent paper in the Journal of Pediatrics on energy drink dangers (Vetter and Naim, J Peds 175: 2024). Further, Dr. Vetter has worked with New Jersey Representative Robert Menendez, Jr. to create and introduce the Sarah Katz Caffeine Safety Act. In January 2024, Dr. Vetter presented at the Parent Heart Watch Heart to Heart meeting at Duke University on the need for caffeine regulations with a call to action directed at the FDA and again in January 2025 on the progress and challenges in this area. The team continues to work with legislators and advocacy partners to support the passing and implementation of all these efforts.

In 2023, research students from the University of Pennsylvania's working with YHW presented their summer research abstracts at the World Congress of Pediatric Cardiology and Cardiac Surgery in Washington DC. Students' research included the study of triggers of SCA in youth, the differences in automated and manual Qtc interval measures between hypertrophic cardiomyopathy patients and healthy individuals, and the echocardiogram measurements in children with hypertrophic cardiomyopathy by age of presentation. The abstracts were published in the Cardiology in the Young, Volume 34, Issue S1 in November 2024.

In 2025, Youth Heart Watch will build on the work laid in 2024 and prior years. We will be speaking at the Pennsylvania State School Nurses and Practitioners Annual Conference and the New Jersey State School Nurses (NJSSNA) Annual Meeting to present on the Heart Safe Schools program and continue school outreach. We have developed plans for a psychosocial support program titled Helping Empower and Assist in Recovery from Trauma following Sudden Cardiac Arrest (HEARTS) Program to provide support and resources to patients and others impacted by an out-of-hospital cardiac arrest including families, friends, bystanders, first responders, schools, and community members. Resources will be gathered and accessible on the Youth Heart Watch website for those in need.

Youth Heart Watch has plans to partner with Aidan's Heart, Simon's Heart, and Jefferson-Einstein to participate in Parent Heart Watch's first annual National Heart Screening Day on February 1st, and the team plans to hold an additional screening event in the fall.

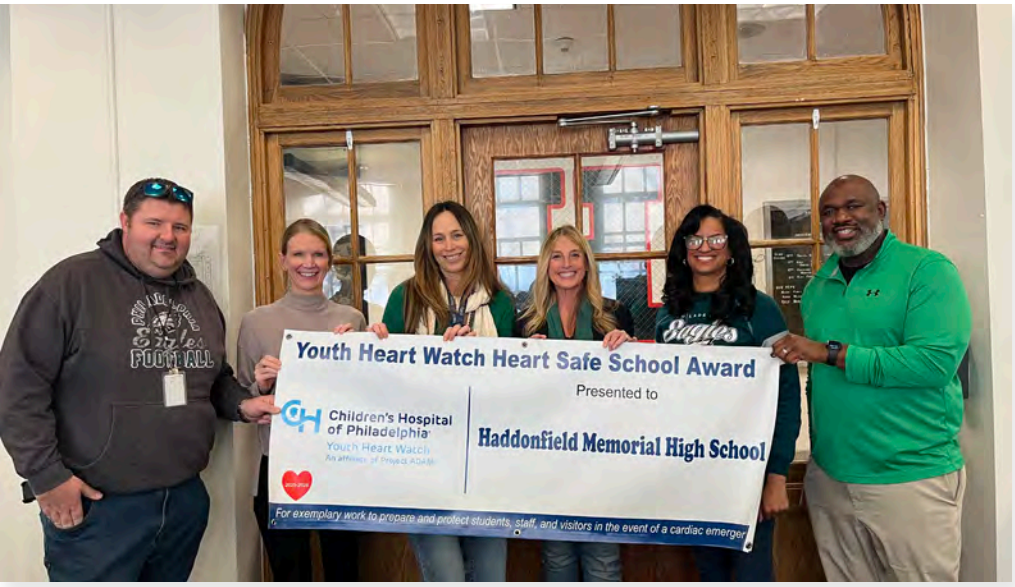
2024 PUBLICATIONS

Modified torso vs distal limb electrode placement for performing ECGs in children: A method comparison study.
Asztalos IB, Artis AS, Zavez AE, **Vetter VL**.J Electrocardiol. 2024 Nov-Dec;87:153810. doi: 10.1016/j.jelectrocard.2024.153810. Epub 2024 Sep 24.PMID: 39442283

Cardiovascular Toxicity of Energy Drinks in Youth: A Call for Regulation.
Vetter VL, Naim MY.J Pediatr. 2024 Dec;275:114224. doi: 10.1016/j.jpeds.2024.114224. Epub 2024 Aug 2.PMID: 39095009 No abstract available.

Outcomes Associated with Giant Coronary Artery Aneurysms after Kawasaki Disease: A Single-Center United States Experience.
Elias MD, Brothers JA, Hogarty AN, Martino J, O'Byrne ML, Patel C, Stephens P, Tingo J, **Vetter VL**, Ravishankar C, Giglia TM.J Pediatr. 2024 Nov;274:114145. doi: 10.1016/j.jpeds.2024.114145. Epub 2024 Jun 13.PMID: 38878963

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. 2024 Apr;21(4):454-461. doi: 10.1016/j.hrthm.2023.11.015. Epub 2023 Nov 18.PMID: 37981292



ECHOCARDIOGRAPHY

LEADERSHIP

SONOGRAPHERS

ATTENDINGS

FACULTY

MEDICAL DIRECTOR:
Michael Quartermain, MD

ASSOCIATE MEDICAL DIRECTOR:
Laura Mercer-Rosa, MD, MSCE

ECHO LAB CORE DIRECTORS:

- Center for Human Phenomic Science (CHPS): **Laura Mercer-Rosa, MD, MSCE**
- Echo Lab Research: **Laura Mercer-Rosa, MD, MSCE**
- Quality Improvement: **Shobha Natarajan, MD**
- Education: **Lindsay Rogers, MD, Med**

PROGRAM DIRECTOR:
Christine Pascua, B.Sc, RCS, RCCS, FASE

PROGRAM MANAGERS:

- KOPH: **Mike Convery, RDCS, MBA**
- Satellites: **Melissa Wasserman, RDCS, RCCS**
- Main Campus: **Devon Ash, RDCS**

TECHNICAL SUPERVISORS:

- **Valerie Capone, RDCS**

INTERIM FLOW LEADS:

- **Penelope Hazin, RDCS**
- **Stephanie Kren, RDCS**

LEAD SONOGRAPHERS:

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

INTRODUCTION

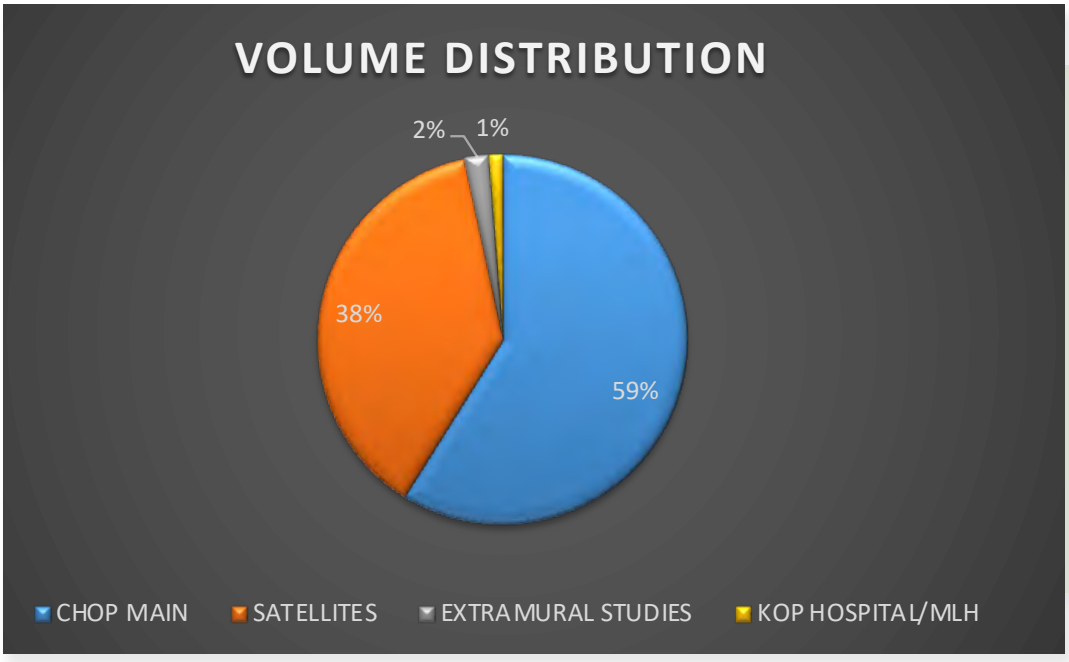
The Cardiac Echo Lab at the Children's Hospital of Philadelphia stands as one of the largest and most advanced pediatric echo labs in the United States, conducting over 40,000 exams annually. A vital part of the Cardiac Center, it also supports a broad array of specialties across the Departments of Pediatrics and Surgery, including Oncology, Pulmonology, Neurology, Nephrology, and General Surgery. At its main campus, the lab provides comprehensive inpatient and outpatient services, offering cutting-edge transthoracic, transesophageal (24/7 service for cardiac OR's, cath labs and other interventional procedures), and sedated echo exams. Its reach extends far beyond the hospital, delivering essential echo services across the region and throughout New Jersey.
In August 2024, the Cardiac Echo Lab further broadened its impact by forming a novel affiliation with Cooper University Healthcare in Camden, NJ. This partnership not only bolstered new outpatient clinics but also introduced after-hours and weekend pediatric echo services. In addition, Virtua Health also contracted 24/7 pediatric echo services for their three Virtua Health campuses in south New Jersey.

With two expansive reading rooms and a network of 15 specialty care centers and 11 affiliated nurseries, the Cardiac Echo Enterprise processaes echocardiograms through its centralized system, ensuring unparalleled care. The lab collaborates closely with the Hospital of the University of Pennsylvania, providing vital support for inpatient neonatal services and outpatient care for the Philadelphia Adult Congenital Heart Center. Committed to advancing the field, the Cardiac Echo Lab is at the forefront of research, driving numerous studies in partnership with the Cardiac Core at the Center for Human Phenomic Science (CHPS).

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 2024 (JULY 2023-JULY 2024):



Main
23,490

Satellites
5,103

Extramural Studies
833

KOPH/MLH
452

Overall Total
39,878

RESEARCH ACTIVITIES

The Cardiac Echo Lab Research Unit has made significant progress in 2024 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 at the Main Campus, 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, and implementation of new imaging protocols. 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, titled ICU-RESUS-Echo. Nine institutions have submitted images to CHOP and data analysis is ongoing in collaboration with the division of critical care. These data will be used for a multi-center grant submission planned for June 2025. We continue to serve as 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.
Dr. Matthew Jolley continues to successfully run the Jolley Lab, and serves as a mentor to several research trainees, some of whom funded under the T32 training grant. The Jolley Lab has successfully graduated post-graduate students now on faculty positions and trainees that have obtained K awards. The Jolley Lab is a collaborative endeavor by Dr. Jolley which has now gained national international reputation, with several sources of research funding, including federal and institutional grants. Dr. Jolley is a key member of the echo lab and echo lab Research Unit and contributes his clinical and research expertise to our colleagues and trainees.

In 2014, Dr. Anirban Baneree initiated an international fellowship program in imaging research, having received 9 international cardiologists to date who relocate to Philadelphia and spend time dedicated to imaging research. This has resulted in several presentations at National meetings and publications. Importantly, two international physicians (Drs. Montero and Sato) were recipients of the TomTec research award from the American Society of Echocardiography Starting in 2023, Dr. Mercer-Rosa hosted Dr. Jose Galan from Colombia, now a first-year Pediatrics resident at Levine Children's. Dr. Galan has submitted 2 manuscripts and a third is in preparation. Further, he was involved in other projects from the Echo lab. In July of 2024, Dr. Ariel Vargas joined our Echo lab from Ecuador, referred to us by Dr. Lizano. To date, Dr. Vargas has produced 3 manuscripts, has presented at Cardiology 2025, and will present his work at the upcoming ACC. He has 3 additional manuscripts in preparation, working collaboratively with other members of the Echo lab (Dr. Banerjee, Dr. Jones, Dr. Bhatt) and the Cardiac Center (Dr. Shustak and Dr. Elias). Dr. Vargas just matched for residency at Cincinnati Children's Hospital where he will start in July of 2025.

The Echo lab continues to be well-represented at the Scientific Sessions of the American Society of Echocardiography (ASE). In 2024, speakers included Melissa Wasserman, Matthew Jolley, Anirban Banerjee, Laura Mercer-Rosa, and Meryl Cohen. Several members of the Echo lab attended the meeting. Dr. Mercer-Rosa was nominated as the 2025 Scientific Sessions co-chair, and will chair the 2026 Scientific Sessions. The Echo lab members just submitted more than 6 abstracts for the 2025 meeting, which will be held in Nashville in September 2025.

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. Please note that this report does not include prospective studies that are conducted in the Cardiac Echo Lab which are funded through CHPS, 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.

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 mornings. 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. In addition, each first year fellow gives a talk during their echo rotation outlining echocardiographic diagnosis of a particular form of heart disease.

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 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 reinstate the echo didactic lecture series, with 45 min sessions twice per month given by echo faculty and attended by sonographers, cardiology fellows and echo faculty. In addition, she obtained approval for sonographers to receive continuing educational credit for these lectures. Karen and Mike Convery presented a poster outlining this work at the CHOP interprofessional education in January 2025.

In addition, there is a sonographer specific teaching session on Friday mornings specifically for sonographer learning, given by faculty and senior sonographers.

Echo lab faculty participate in clinical teaching daily with both categorical cardiology fellows, advanced imaging fellows and fellows from cardiac anesthesia and critical care. This teaching includes performing and interpretation of transthoracic echo, transesophageal echocardiography and advanced imaging in 3D, contrast and strain.

QUALITY IMPROVEMENT INITIATIVES

The CHOP echo lab continues to have a well-developed quality improvement program. The lab 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. There is a robust way to collect pre-operative diagnostic discrepancies in an automated way. All diagnostic discrepancies between pre-operative echo and surgical inspection, are reviewed by the group quarterly. This process 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 QI initiative. With the collaboration of 13 other participating centers, we have just published a paper about the baseline data around pre-operative diagnostic discrepancies for a cohort of heart defects and examined associations between diagnostic errors and patient, center and systems factors. We are now in the process of developing change ideas that we can put in place to decrease the error rate. Due to this project, which is under the auspice of the Society of Pediatric Echocardiography, we are now in discussions about building a formal QI/research committee in that organization so that other projects can be supported.

The Echo lab QI subcommittee is also part of a multi-disciplinary QI initiative (including cardiac surgery, intensive care, cardiology, anesthesia, and cardiac nursing divisions within the Cardiac Center) on early recognition and management of important residual lesions after cardiac surgery. For the initial cohort of patients after Norwood and Glenn operations, our team has created a standard imaging checklists for the operating room to ensure we obtain all the relevant TEE and epicardial views to evaluate the surgical repair and discuss the findings with the surgeon so the important information is presented to help the surgeons manage the patient. We are also developing imaging and reporting protocols for early post-operative echocardiograms ti uncover residual lesions earlier. These interventions are in addition to other efforts to discuss patients earlier in the post-operative period so that course corrections can be made, whether it be further diagnostic information, re-intervention, or medical management.

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. Theses projects also give maintenance of certification credits to the people involved.

GOALS AND OUTLOOK FOR FISCAL YEAR 2024

The Cardiac Echo Enterprise is rapidly growing, expanding its services across the region with a strong focus on innovation and excellence. The successful implementation of EPIC CUPID and the modernization of Syngo reporting templates have already enhanced workflows, and the enterprise is committed to continually identifying opportunities for improvement.

Currently, efforts are underway to optimize scheduling and align access with patient volume at the Buerger Center. As the center settles into a normal operational pace, attention will shift to formalizing plans for the New Patient Tower. This expansion is fueling momentum for the creation of a novel Pathway Program, designed to align with the workforce needs generated by the tower. The Pathway Program will set a new standard for pediatric sonographer education in the region. To support this initiative, the Echo Lab will host its first annual Sonographer Conference, providing an invaluable learning opportunity for professionals seeking specialized education in congenital heart disease.

As the cardiac echo lab continues to grow and advance the enterprise's mission, it is crucial to remain committed to these transformative initiatives. With several successful projects completed in recent years, the echo lab is well equipped and ready to take on these endeavors.

QI PROJECTS, INVITED LECTURES, ABSTRACTS AND PUBLICATIONS

- Shobha Natarajan: Focused Outpatient Echocardiograms in Repaired Congenital Heart Disease
- Chris Pascua and Mike Convery: Standardizing Sonographer Workflow in the Outpatient Echo Lab
- Meghan Metcalf and Jenna DiFrancesco: QI Initiative-Echocardiograms for Patients after Norwood operation in the interstage period
- QI Initiative - Inpatient Echocardiograms for Patients with Kawasaki Disease
- Shobha Natarajan: Director For the Biweekly Neonatal Review: a multi-disciplinary patient review of all postoperative neonates to engage staff in team learning
- Shobha Natarajan: "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.
- 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
- Natarajan SS, Chaszczewski K, Penney C, Ampah S, Ryba D, Kennedy AT, Olsen R, Srivastava S, Campbell MJ, Carney M, Prospero C, Elliott L, Brewer C, DiMaria M, Madan N, Tierney S, Beattie M, Sachdeva R, Lipinski J, Stern KWD, Kong G, Dhanantwari P, Kwon EN, Rajagopal H, Taylor C, Churchill T, Sanchez Mejia AA, Abenlah Ansah D, Parthiban A, Sanandajifar H, Balasubramanian S, Parra DA, Crum K, Stiver C, Bhat AH, Jone PN, Samples S, Van't Hof K, DeGroff C, Lopez-Colon D, Cohen MS. Diagnostic Accuracy Prior to Congenital Heart Defect Surgery: A Multicenter Collaboration. JACC Adv. Feb 2025.

EXERCISE PHYSIOLOGY

KEY LEADERS & STAFF

MEDICAL DIRECTOR
Stephen M. Paridon, M.D.

ATTENDING PHYSICIANS
- Julie A. Brothers M.D.
- Paul Stephens, Jr., M.D.
- Alexa Hogarty, M.D.
- Matthew Elias, M.D.
- Jonathan Edelson, M.D.
- Emmanuel Favilla, M.D.
- Imran Masood, DO (4th year fellow)

LABORATORY EXERCISE PHYSIOLOGISTS
- Elizabeth Ford, M.Ed.
- Shannon O'Malley, M.S., CEP
- Andrea Linton, M.Ed.
- Christine Giovinazzo, B.S.
- Declan McDonald, M.S.

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 and Mitochondrial 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 concern 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.

In addition to exercise testing, the laboratory maintains an active cardiovascular rehabilitation program. This program serves the needs of both inpatients and outpatients. These patients include many of the sickest children in the institution including children awaiting heart or lung transplantation. Many of these children have received implantable ventricular assist devices. This program monitors heart rate, rhythm, blood pressure, and arterial oxygen saturation throughout each hourly exercise session. Non-cardiac inpatients with chronic pulmonary disease are also frequently served by this program. Selected outpatients also use this program. These are frequently children who are too ill or have complicating medical conditions that prohibit enrollment in community-based rehabilitation.

In March 2024 with the launch of CUPID, there is now a streamlined approach to report turnover and a more efficient and direct means of communicating results to providers.

EXERCISE LABORATORY VOLUME FOR 2024:

Exercise Testing: A total of 1902 exercise tests were performed in year 2024 (see Fig. 1). This number includes the exercise testing performed at Buerger and King of Prussia. There were 93 six-minute walk tests performed at Buerger. Figure 2 shows exercise lab volume over the y

Cardiovascular Rehabilitation: A total of 84 outpatient rehabilitation sessions were performed in 2024.

Figure 1. Volume by Diagnostic Service 2024

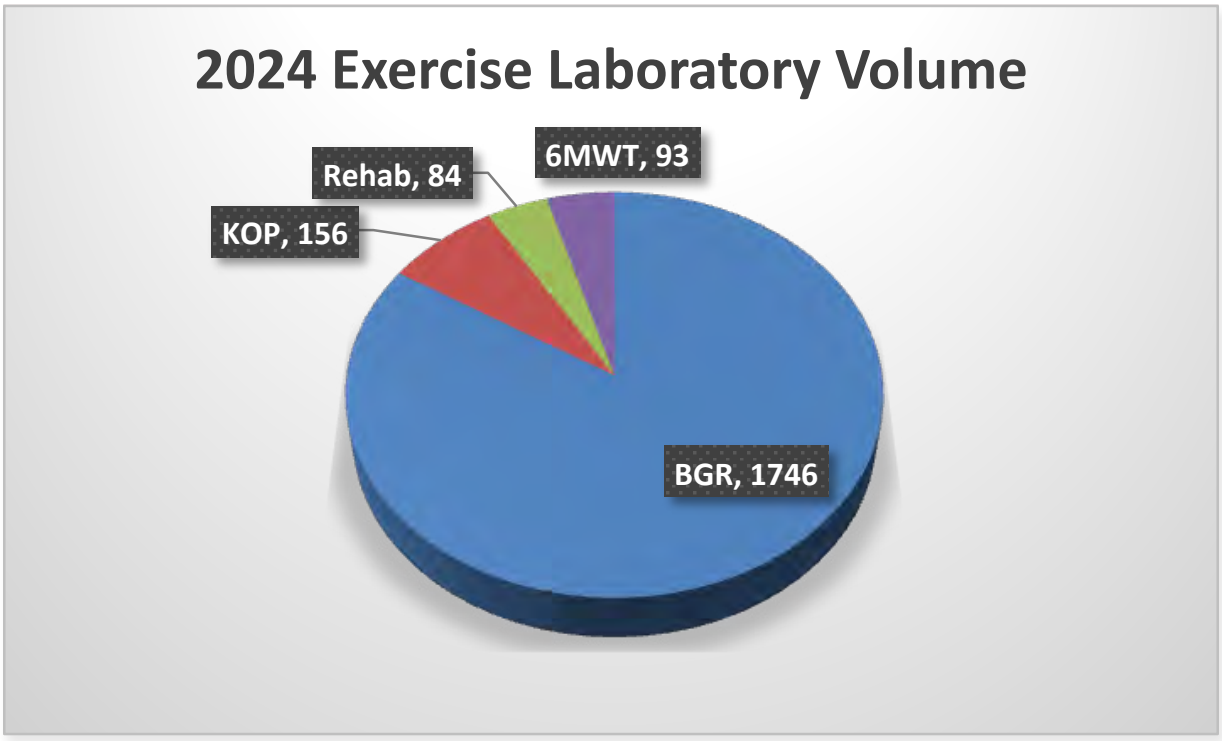
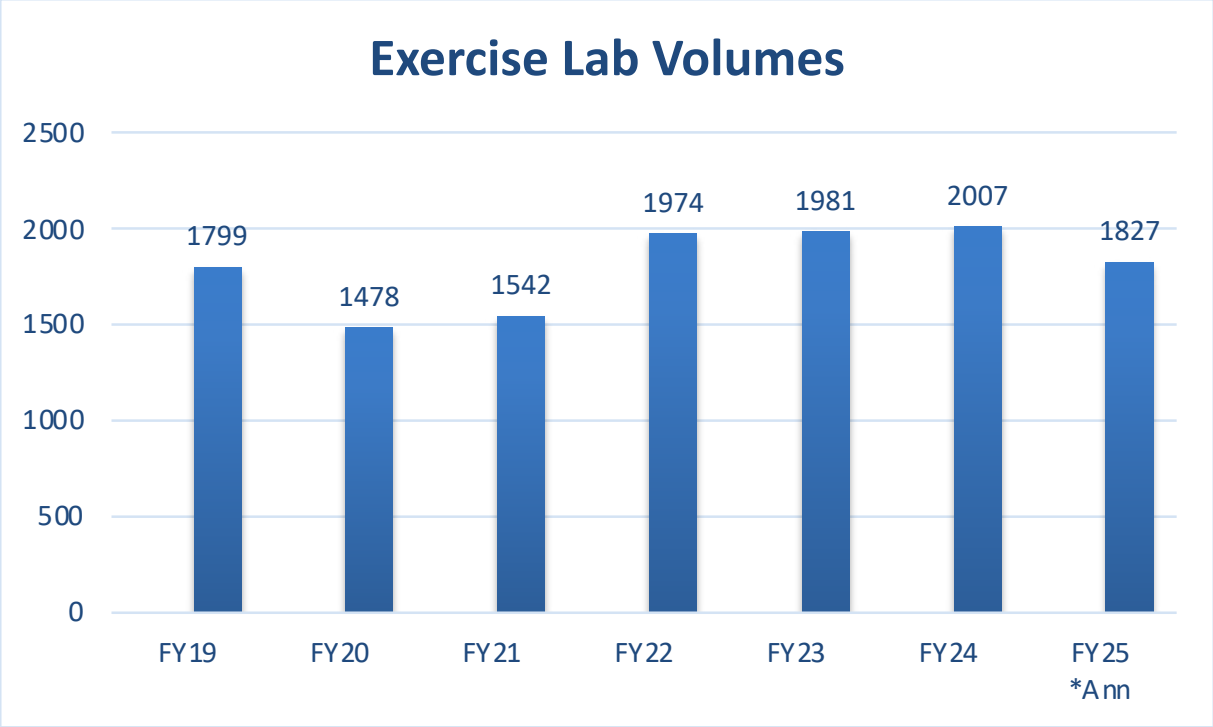


Figure 2. Volume by Year Since 2019



EXERCISE LABORATORY RESEARCH ACTIVITIES

The laboratory continues to be productive in research related to cardiovascular exercise physiology. The following are research projects that were active in year 2024.

Cardiology

- MIGHTEE: Motivational Interaction Group Heart Transplant Exercise and Education, A Pilot Study
- Fontan Udenafil Exercise Longitudinal Assessment Trial - 2 (FUEL-2)
- iTONE Trial (exercIse Training in pulmONary hypertEnsion) Exercise Program for Pediatric PH (iTONE)
- A Gene Therapy Study of RP-A501 in Male Patients With Danon Disease
- A Study to Evaluate Mavacamten in Adolescents With Symptomatic Obstructive Hypertrophic Cardiomyopathy
- Sodium Glucose Co-transporter (SGLT) Inhibitors in Nonobstructive Hypertrophic Cardiomyopathy (SOTA-CROSS HCM)
- Study to Evaluate Sotatercept (MK-7962) in Children With Pulmonary Arterial Hypertension (PAH)
- Right Ventricular Function and Right Ventricular to Pulmonary Arterial Coupling with Exercise in Pulmonary Hypertension

Cardiology and Oncology

- Exercise Training and NR Supplementation Trial to Improve Fitness in AYA HCT Survivors (IAMFIT)

Cardiology and Endocrinology

- NAD+ and Exercise in FA (ExRx in FA)

Mitochondrial Program

- Applying pGz in Mitochondrial Disease
- Validation of Nanosensor Oxygen Measurement

LISTED BELOW ARE THE PUBLICATIONS AND PRESENTATIONS FROM THE EXERCISE LABORATORY FOR YEAR 2024.

PEER REVIEWED PUBLICATIONS

1. 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. 2024 Jan 1.
2. Cilenti NA, Tamaroff JG, Capiola CJ, Faig W, **McBride MG, Paridon SM, O'Malley S, Edelson JB**, Lynch DR, McCormack SE, Lin KY. Cardiopulmonary exercise testing on adaptive equipment in children and adults with Friedreich ataxia. Muscle Nerve. 2024 May;69(5):613-619.
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4. Seivert, N. P., Dodds, K. M., **O'Malley, S**., Goldberg, D.J., **Paridon, S., McBride, M.**, and Rychik, J. Associations Between Exercise Capacity and Psychological Functioning in Children and Adolescents with Fontan Circulation. Pediatric Cardiology. 2024 Nov.
5. Jones AL, Xiao R, Williamson AA, Benn H, **Stephens P**, Bhatt SM, Mercer-Rosa L, Weiss PF. Health Disparities in Exercise Performance in Patients with Repaired Tetralogy of Fallot. Pediatr Cardiol. 2024 Nov 7.
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ABSTRACTS

1. **Masood IR**,Wang L, Roberts A, Stanley HM, Rossano J, O'Connor M, Lin K, Wittlieb-Weber C, Ahmed H, Edwards J, **O'Malley S, Paridon S**, Tam V, Edelson J.The Impact of Neighborhood Factors on Exercise Capacity in Children with Hypertrophic Cardiomyopathy. Poster presentation at Cardiology 2024. Scottsdale, AZ. February 2024.
2. **Masood IR**,Wang L, Roberts A, Stanley HM, Rossano J, O'Connor M, Lin K, Wittlieb-Weber C, Ahmed H, Edwards J, **O'Malley S, Paridon S**, Tam V, Edelson J.The Impact of Neighborhood Factors on Exercise Capacity in Children with Hypertrophic Cardiomyopathy. Poster presentation at ISHLT 2024. Prague, CZechia. April 2024
3. Fortin-Moore C-O, Jeewa A, Power A, Khoury M, Lin K, Edelson J, Ball G, Attalah J, Cifra B, **O'Malley S,** Pidborochynski T, Conway J. Home-based Exercise Intervention for Children and Adolescents with Hypertrophic Cardiomyopathy: A Consensus of Experts on a Safe and Acceptable Exercise Protocol. Poster presentation at American Heart Association 2024. Chicago, IL, November 2024.
4. Carter E, Moore R, Harris MA, **Brothers JA**. Exercise Stress Perfusion Cardiac MRI in Pediatric Patients with Coronary Anomalies. Circulation suppl 1, November 2024, abstract

INVITED LECTURES:

1. **Paridon S.** "Exercise Testing: Is it the Gold Standard for Assessing Outcomes in Congenital Heart Care?" Cardiology 2024, Scottsdale, AZ, February 2024.
2. **Stephens Jr, P.** "The Role of Exercise Testing in CHD Surgical Intervention, Planning and Post-Surgical Assessment", American Academy of Pediatrics National Conference, Orlando, FL, September 2024.
3. **Brothers JA**. "Non-operative Management of AAOCA", American College of Cardiology Scientific Sessions, Atlanta, GA, April 2024
4. **Brothers JA.** "Interarterial Anomalous Left Coronary Artery: Observation, Restriction, Exercise," 6th Coronary Anomaly Symposium, Houston, TX, December 2024

EXERCISE COUNSELING

Staff in the exercise lab routinely attend and provide exercise counselling for patients attending the multi-disciplinary clinics. Shannon O'Malley, MS, CEP, routinely counsels patients in Preventive Cardiology (Cardiovascular Risk Assessment (CVRA), and Hypertension), Sports Cardiology, and Fontan Forward programs. These clinics are generally held 2 times per month. Our goal is to increase the frequency of visits and utilize telemedicine as a means of tracking patients' wellness and physical activity patterns. Shannon counselled 84 patients in Preventive Cardiology, 29 in Fontan Forward and 7 in Sports Cardiology.

The Lifestyle Medicine clinic is a multidisciplinary program to help patients with connective tissue disorders and dyslipidemia 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. Andrea Linton, M.Ed, is the Exercise and Health Coach for this program and saw 14 patients with 92 encounters in 2024.

EDUCATIONAL ACTIVITIES

The Exercise Laboratory continues to be an integrated part of the regular cardiology fellowship non-invasive rotation. Dr. Imran Masood completed his 4th year fellowship in Exercise Physiology and Heart Failure/Transplant in 2024. The yearly didactic lecture series on exercise physiology for the Cardiology and Pulmonary fellows continues.

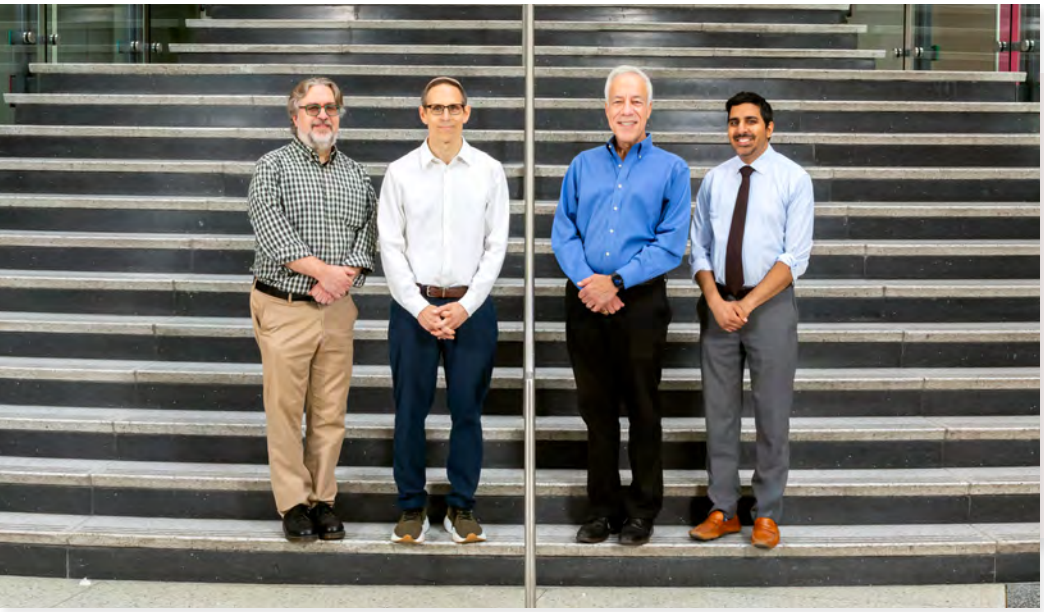
The Exercise Laboratory continues to be a competitive site for external training for undergraduate and graduate students from exercise physiology programs at regional universities. At the end of their time in the lab, these interns are highly sought after candidates for jobs in the exercise physiology field and others further their education in additional graduate medical studies. The exercise laboratory also hosts visiting physicians from national and international medical centers.

Several of the Exercise Physiology Lab staff serve as adjunct faculty at St Joseph's University providing didactic lectures and laboratory experiences to facilitate undergraduate learning.

GOALS AND OUTLOOK FOR FISCAL YEAR 2025

Early trends for clinical volume for FY 2025 are encouraging as the historical trends continue to stabilize or rise over the past several years. 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. We also hope to increase the volume at our King of Prussia satellite. The second major goal is to increase our cardiac rehabilitation services, both outpatient and inpatient. The third goal is to continue increasing our research activities in the laboratory.

CARDIAC MAGNETIC RESONANCE IMAGING



CARDIAC MRI TEAM

Mark Fogel, MD
Director of Cardiac MRI

Matthew Harris, MD

Kevin Whitehad, MD

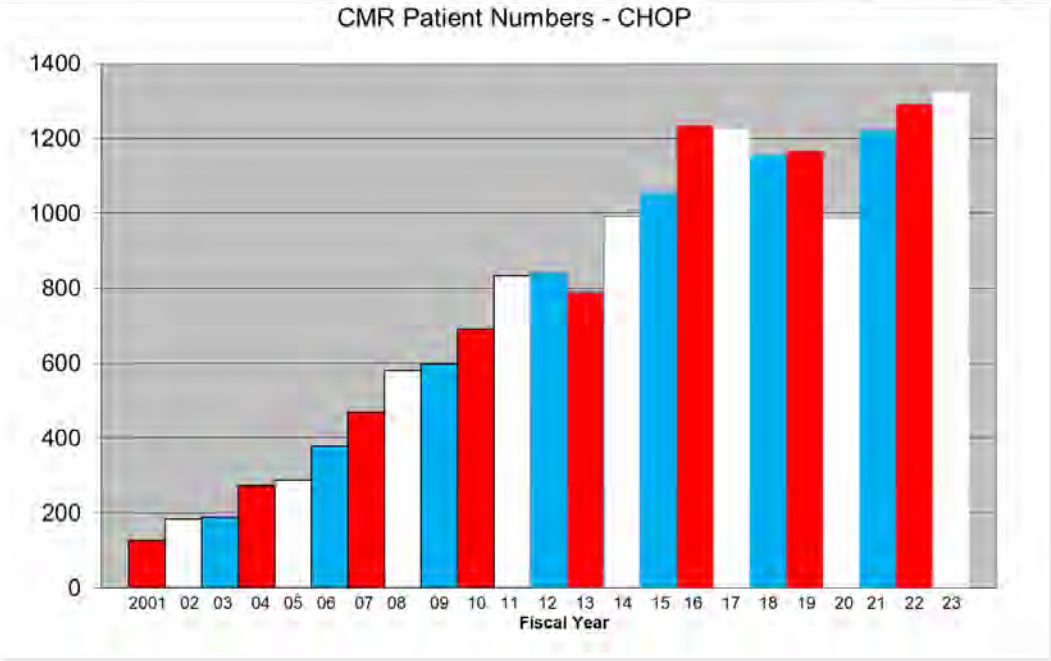
Sarah Partington, MD

David Biko, MD, MBA

Danish Vaiyani, MD

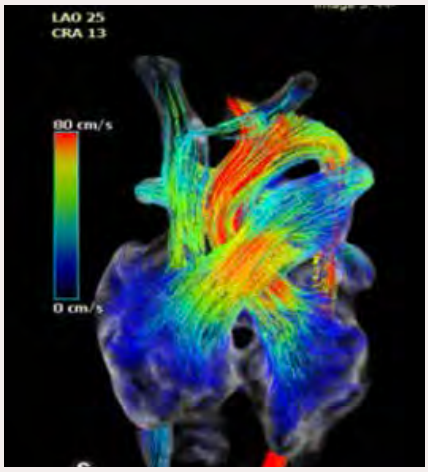
INTRODUCTION AND CLINICAL ACTIVITIES

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 2024, the program performed 1,304 CMRs despite limitations in cardiac anesthesia, 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.

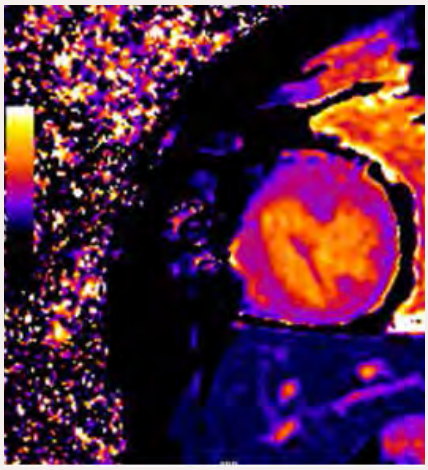


The section provides the highest quality and most advanced techniques for CMR imaging of anatomy, heart function, blood flow and tissue characterization (heart scarring, infarction, edema and myocardial iron) from fetus through and including adulthood. The program brings imaging quality and clinical care that only a few centers worldwide can perform with advanced imaging techniques only a few can 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 regadenoson or with a supine MRI-compatible bicycle, is used to assess heart blood perfusion or wall motion abnormalities. 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, the technique our institution pioneered and published in 2011, 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. We have also recently acquired an MRI-compatible Doppler probe for use in fetal CMR which holds the promise of unlocking advanced techniques in that area. Further, over the past year, we have obtained the ability to perform high spatial, submillimeter resolution imaging of small vessels such as the coronary arteries and pulmonary veins without the need for contrast.

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, University of Virginia, The Center for Biomedical Imaging/Federal Institute of Technology in Switzerland and the University of Pennsylvania to develop and test new and novel ways to image heart anatomy, function and blood flow. Advanced techniques such as ultra short TE, high resolution 5D cine and flow (which includes the respiratory cycle) as well as characterization of epicardial fat by CMR are in the works.

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

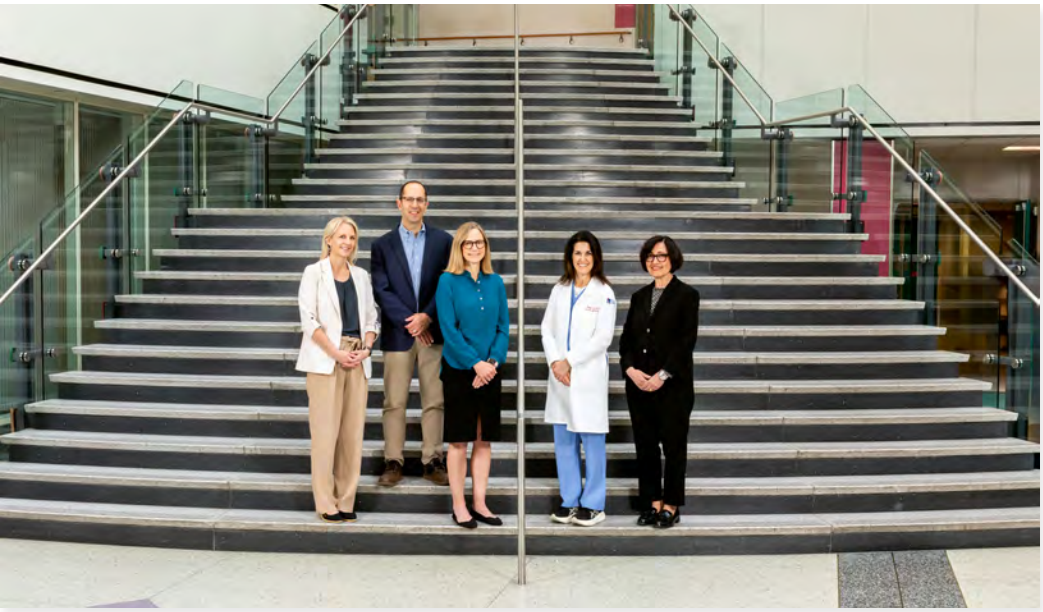
by Dr Fogel to determine CMR predictors of clinical outcomes including global heart function, strain and hemodynamics of from which 5 abstracts have been presented at national and international meetings and the first paper will be published in the Journal of the American Heart Association with over 750 patients. The team published 12 manuscripts this year in prestigious journals such as the Journal of the American Heart Association, the Journal of the American College of Cardiology: Advances, the Annals of Thoracic Surgery, Radiology: Artificial Intelligence, Journal of Cardiovascular Magnetic Resonance, Journal of the American Medical Association: Cardiology and PLOS to name a few. There are 2 papers submitted and being reviewed and 4 that are currently being written. Sixteen (16) 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.

SELECTED RESEARCH PUBLICATIONS

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

- 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. Radiol Artif Intell. 2024;6(1):e230132
- DiLorenzo MP, Lee S, Rathod RH, Raimondi F, Farooqi K, Jain SS, Samyn MM, Johnson TR, Olivieri, LJ, Fogel MA, Lai WW, Renella P, Powell AJ, Buddhe S, Johnson JN, Morris SA, Soslow JH, Grosse-Wortmann L, Beroukhim RS, Grotenhuis JB. Big data in smaller bodies: Design and Implementation of Multicenter Pediatric and Congenital Studies with Cardiac Magnetic Resonance. J Cardiovasc Magn Reson. . 2024;26(1):101041.
- 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.
- De Leon-Benedetti LS; Ramirez-Suarez KI; Otero HJ; Rapp JB; Biko DM; Smith C; Serai SD; Janson C; Shah M; Englehardt G; Fogel M; White AM. How we do it: Cardiac implantable devices are not a contraindication to MRI: time for a paradigm shift. Pediatr Radiol. 2024;54(6):863-875
- Peverell RE, Lin KY, Fogel MA, Cheung M, Moir WS, Corbin LA, Cahoon G, Delatycki M. Insights into the effects of Friedreich ataxia on the left ventricle using T1 mapping and late gadolinium enhancement. PLoS ONE. 2024;19(5):e0303969

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 Courtney Bloss, RN, MSN, 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 Meghan Long) 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.

EDUCATION

Education on the CCU includes training of cardiology fellows, residents, and nurses to recognize acute cardiac decompensation and to provide ongoing excellent cardiac care. We also have an intense focus on education of families to ensure comfort with their child's care needs prior to hospital discharge.

Pediatric residents receive 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 continues to optimize the curriculum to ensure education goals are achieved.

In addition to cardiac education, the Cardiology inpatient service provides a critical opportunity for each of the six first year pediatric cardiology fellows to learn leadership skills coordinating 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 2000 learners were taught in the Education Room over the past calendar year.

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 several active projects focused on supporting evidenced-based, high-quality care in the cardiac inpatient setting. Current Quality Improvement work within the Cardiac Care Units include supporting neurodevelopmental care of our infant population, weaning of tube feedings prior to discharge, improving communication between the care team and ongoing work to support discharge optimization.

As the unit continues to care for an unprecedented number of ventricular assist devices (VADs), we continue to explore optimizing a care model that support their care and development. A tremendous amount of work has gone into ensuring that our nursing teams are equipped and trained to care for these complex, long term patients.

CARDIAC PREPARATION & RECOVERY UNIT

KEY LEADERS

Donna Calfin MHL, BSN, RN, CPN
Nurse Manager

Edith Ryan BSN
Clinical Supervisor

Andrea Steele BSN
Clinical Nurse Expert

Lisa Brogan MBA-HM, RN, CPN, CPHQ, LSSGB
SQS

Ashley McCarthy MSN, RN
ENS

Lisa Balsama CVT, Ginene Travia RT, and Rita Urbanski RT
Tech 3s

The Cardiac Prep and Recovery Unit consists of Registered Nurses, cath lab technicians, an electrophysiology technician, and an electrophysiology specialist who 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, a billing analyst, IS, biomed, and a Business Resource Manager.

Our Educational Nurse Specialist along with the leadership team is continuing to improve the orientation and ongoing education program. Leaders are continuing to work on leadership development and professional development for the staff. The cross-training program with the CPRU is thriving. Five techs are certified as either a Cardiac Interventional (CI) Radiographer or as a Registered Cardiac Invasive Specialist (RCIS). 10 nurses are certified. A total of 16 staff members have achieved PEAK status.

HIGHLIGHTS AND ACCOMPLISHMENTS

The team successfully launched EPIC CUPID last March. Those efforts were led by the clinical nurse expert and several staff members who partnered with the EPIC Cupid team, IS, revenue cycle, and the par visions teams to develop processes and the roll out plan. EPIC CUPID has resulted in improved documentation, charge capture, and billing processes. Additionally, the improved supply management processes implemented with this project has resulted in a significant reduction in expired supplies, improved inventory management and financial stewardship.

This year the team has partnered with IR and a neuroradiology to support some of their cases while their space is upgraded. The lab is also supporting some vascular cases.

ON THE HORIZON

working with the revenue cycle team to convert to time-based billing for next fiscal year. Partnering with the anesthesia team on improving communication, code role identification, and handoffs between the Cath Lab, Anesthesia, and the CPRU.

A few members of the team are now members of the Pediatric and Congenital Interventional Cardiovascular Society (PICS) Nursing and Allied Health Professionals committee (NAHP) which offers the ability to network with other professionals globally, continuing education opportunities, and professional growth opportunities. The team is looking forward to increasing membership amongst the staff.

ADULT CONGENITAL CARDIOLOGY PROGRAM

KEY LEADERS & STAFF

Yuli Kim, MD
Medical Director

Stephanie Fuller MD, MS
Surgical Director

Desuana Dubose
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

ACHD FELLOWS
Bruke Tedla, MD
Rebecca Moore, MD

NURSE PRACTICTIONERS
Lynda Tobin, CRNP
Kirby Bate, CRNP

NURSING
Robert Karvell, RN
Christian Reda, RN
Matthew Nace, RN
Zack Post, RN

SOCIAL WORK
Teresa Salinas, LCW

DIVISION & PROGRAM OVERVIEW

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. We are dedicated to ensuring that our patients thrive into young adulthood and beyond.

HIGHLIGHTS AND ACCOMPLISHMENTS

TRANSITION READINESS AND AWARENESS FOR CARDIAC KIDS

Director- Emily Ruckdeschel, MD
Nurse Navigator- MJ Wexler, RN

The Transition Readiness and Awareness for Cardiac Kids (TRACK) program is a comprehensive support system to help adolescents and young adults with congenital heart disease safely and effectively transition from pediatric to adult-oriented care. The goal of TRACK is the successful transition of all patients with congenital and acquired heart disease to an Adult Congenital Heart Disease program through a comprehensive informed and personalized care model. The TRACK program consists of several elements including the transition clinic (TRACK clinic) and a peer support mentor program called Hearts in Tranition (HIT program).

The TRACK clinic is a telemedicine educational program geared towards adolescents and young adults to educate and support through the process of transition. Visits may occur once or several times over a period of years to assess the readiness for transition and assist in developing skills needed to function as an adult with congenital heart disease. The transition clinic is currently entirely telemedicine based making it easier to reach patients at satellite clinics in addition to allow for flexible scheduling after school or work.

Hearts in Transition (HIT) has been developed as an addition support mechanism for teens and young adults who might be struggling with the process of transition. It provides an opportunity for pediatric patients to meet with young adults who have already gone through the process of transition. Being a patient with congenital heart disease can be a unique and, at times, difficult experience. It is our hope that a peer mentor can provide guidance, reassurance and support that providers and family members are not able to provide.

RELEVANT DATA & METRICS

- 3258 total patient visits
- 588 new patient visits
- 2,404 echocardiograms
- 63 surgeries
- 183 cardiac catheterizations
- 544 CMR Studies (18 and older)

RESEARCH HIGHLIGHTS

Yuli Kim, MD was awarded the 2024 Mend a Heart/Children's Heart Foundation Award. This is a $200,000 award over 2 years will fund research into a development of a reliable means of measuring liver function in Fontan Associated Liver Disease. Co-investigators include Dr. Jack Rychik and Dr. Mark Fogel.
2024 Children's Hospital of Philadelphia — Mend A Heart Foundation

Lifetime Management of Adolescents and Young Adults with Congenital Aortic Valve Disease.
Frankel WC, Robinson JA, Roselli EE, Unai S, Tretter JT, **Fuller S**, Nelson JS, Ghobrial J, Svensson LG, Pettersson GB, Najm HK, Karamlou T. Ann Thorac Surg. 2025 Jan;119(1):59-69. doi: 10.1016/j.athoracsur.2024.04.038. Epub 2024 Jun 11. PMID: 38871162

Mortality and morbidity after combined heart and liver transplantation in the failing Fontan: An updated dual center retrospective study.
Vaikunth SS, Ortega-Legaspi JM, Conrad DR, Chen S, Daugherty T, Haeffele CL, Teuteberg J, Mclean R, MacArthur JW, Woo YJ, Maeda K, Ma M, Nasirov T, Hoteit M, Hilscher MB, Wald J, Mandelbaum T, Olthoff KM, Abt PL, Atluri P, Cevasco M, Mavroudis CD, **Fuller S**, Lui GK, **Kim YY**. Clin Transplant. 2024 Apr;38(4):e15302. doi: 10.1111/ctr.15302. PMID: 38567883

Hepatocellular carcinoma in survivors after Fontan operation: a case-control study.
Kim YY, Lluri G, Haeffee C, et al. Eur Heart J. 2024 Apr 21;45(16):1477-1480. doi: 10.1093/eurheartj/ehad788.

CORONARY ANOMALY MANAGEMENT PROGRAM (CAMP)

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, Shustak, Harris, Callahan, Maeda, Partington, Shah, and our Nurse Practitioner, Giordana (Jordy) Martino. Christine Williams is our Program Coordinator. Due to Dr Brothers' sabbatical and Dr Paridon stepping back from seeing clinic patients, there was a decrease in overall number of coronary patients seen this year; Dr Shustak and Ms. Martino did see patients in Dr Brothers' absence. Combined, Drs. Brothers, Shustak and Ms. Martino saw over 20 new patients and over 43 follow-up patients. The team serves as a national resource for second opinions from other doctors as well as directly to patients/families. Together, the CAMP team has provided approximately 30-40 expert opinions and record reviews this year. There have been several patients referred to cardiac catheterization performed by Dr. Callahan, with data that have helped with surgical or non-surgical management decision making. Dr. Maeda has performed 5 coronary surgeries in 2024. The team in 2024 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 continued to meet 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 American College of Cardiology 2024 Annual Meeting in Atlanta, GA, on a talk entitled, "Non-operative Management of AAOCA." She also spoke at the 6th Coronary Anomaly Conference in Houston, TX, on "Congenital Coronary Anomalies: the Current Landscape" and "Interarterial Anomalous Left Coronary Artery." Dr Brothers also submitted a PCORI grant in 2024, which unfortunately did not get funded. From a research perspective, 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" that was published in the Annals of Thoracic Surgery. She is senior author on a manuscript entitled, "Isolated Single Right Coronary Artery in a Young Patient: A Rare Shirani-Roberts Type IIC3" that is pending publication in JACC: Case Reports. Along with Drs. Carter and Moore (both Cardiology fellows), Dr Harris, and others CHOP colleagues, Dr Carter presented a poster entitled, "Exercise Stress Perfusion Cardiac MRI in Pediatric Patients with Coronary Anomalies" at the 2024 American Heart Association Meeting. This manuscript has been written and is submitted to a journal for publication. Dr Brothers was co-author with several CHOP colleagues on the paper entitled, "Outcomes Associated with Giant Coronary Artery Aneurysms After Kawasaki Disease: A Single-Center United States Experience" published in Journal of Pediatrics. Dr Brothers is 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 has been submitted and more are in progress.

In the next year, our program looks to expand, bringing in another physician to help see patients and to increase the frequency of our coronary clinics. We are also looking forward to performing more fellow-led research projects.

One patient's story exemplifies what the journey can be like for patients with AAOCA and how our evaluation helps with decision-making, especially in patients who are asymptomatic. Patient LB presented to CAMP clinic at age 5 years for a second opinion after an echocardiogram was performed as a toddler due to a heart murmur. A CTA was performed which showed an interarterial anomalous left coronary artery (L-AAOCA). A cardiac MRI was completed at CHOP after he was seen by Dr Brothers in 2019, which confirmed the diagnosis, but there did not appear an intramural course as there was minimal proximal narrowing and the ostium was not slit-like or elliptical. He returned to see Dr Brothers in 2023, where he was asymptomatic but he had been limited in his exercise due to the diagnosis. A repeat cardiac MRI was performed in 2023 and showed no evidence of intramural course but flattening of the left main coronary artery as it coursed interarterially. He had a stress test with no evidence of ischemia and no arrhythmias and a stress echocardiogram which had normal function at rest and stress without wall motion abnormalities. As part of our algorithm in patients with interarterial L-AAOCA, we recommended a cardiac catheterization with dobutamine iFR (instantaneous wave-free ratio) and intravascular ultrasound. LB underwent cardiac catheterization, which was notable for no clear evidence of an intramural course of the left main coronary artery, but mild dynamic compression as it coursed between the great arteries. There was a normal iFR at rest but with dobutamine, at a heart rate of 146 bpm, the iFR decreased to 0.84 and decreased to 0.81 as his heart rate increased further with the addition of atropine, indicative of a hemodynamically significant reduction in coronary blood flow.

He underwent surgical repair. On inspection, the LCMA ostium was found to be near the RCA ostium, with ~1.5cm of an interarterial course without an intramural course. However, more distally just past the intercoronary commissure, the LMCA appeared to attach to the aortic wall and a neo-ostium was created at this site, also keeping the ostium open from the right coronary sinus. He has done well post-operatively, with normal biventricular function and no aortic valve insufficiency post-operatively. He underwent a 3 month cardiac MRI as well as stress echocardiogram with stress test. All of these studies were reassuring and he was cleared for slow progression to start back to physical activity and sports.

PULMONARY HYPERTENSION

KEY LEADERS & FACULTY

Alexander Davidson, MD, FACC
Medical Director
Catherine Avitabile, MD
David Frank, MD, PhD
Jennifer Tingo, MD
Andrea Jones, MD, MSCE

NURSE PRACTITIONERS
Kerri Cram, CRNP
Sarah Bakke, CRNP

NURSE COORDINATOR
Kimberly Butler, RN

The Pulmonary Hypertension (PH) Program at the Children's Hospital of Philadelphia is one of the largest PH centers in the country. The PH Program provides 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 is a top referral center from across the country and overseas. Faculty and nursing team members 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.

Dr. Avitabile is one of the country's leading experts on the use of wearable sensors to estimate physical activity as a surrogate marker of hemodynamic status in pediatric PH. Funded by an NIH/NHLBI K23 Mentored Patient Oriented Research Career Development Award, she has successfully launched a home physical activity program, guided by wearable technology, that aims to improve functional capacity and quality of life in youth with PH (iTONE trial, NCT05442671). She is CHOP site-PI for the North American Pediatric PH Network (PPHNet), manages CHOP's enrollments in the PPHNet Registry, and collaborates on multiple Registry studies. Dr. Avitabile is also the CHOP site-PI for clinical trials including the Phase 2 pediatric trial studying the new mechanism-directed PAH therapy, sotatercept (MOONBEAM trial, NCT05587712). Dr. Avitabile has been funded by the NHLBI, Pediatric Heart Network, Actelion Pharmaceuticals, and United Therapeutics. She has more than 50 publications and is a co-investigator on an R01 and an R61/R33.

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 over 60 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.

RESEARCH HIGHLIGHTS

- Enrollment to Dr. Avitabile's iTONE home physical activity trial has continued with more than 40% recruitment complete to date
- Dr. Avitabile established a novel collaboration with the CHOP ARCUS team and developers of the Modular Actigraphy Platform to analyze wearable sensor data from PH participants in both observational and interventional studies
- The CHOP PH Program is one of very few North American sites to enroll a participant in the Phase II Study to Evaluate Sotatercept in Children with Pulmonary Arterial Hypertension (MOONBEAM)
- Dr. Frank and colleagues at Penn Vet developed a novel tool to study pulmonary veins and demonstrated their unique ability to regenerate lung capillary endothelium
- Dr. Frank's group have published a manuscript in Cell Report revealing how mesoderm lineages of the lung and cardiac inflow tract develop over time
- Dr. Frank and Dr. Jake Brenner at UPenn have been awarded the Penn CVI Dream Team grant to study delivery of target DNA via lipid nanoparticles for treatment of pulmonary arterial hypertension and pulmonary hypoplasia

NEW DEVELOPMENTS ON THE HORIZON

- Dr. Avitabile established a collaboration with 5 other PPHNet sites to merge the CHOP team's methodology in analyzing physical activity data from wearable sensors with rich clinical data from a large PPHNet registry population. An R01 application was submitted.
- Dr. Frank and Dr. Jake Brenner at UPenn have been awarded the Penn CVI Dream Team grant to study delivery of target DNA via lipid nanoparticles for treatment of pulmonary arterial hypertension and pulmonary hypoplasia
- Dr. Frank has collaborated with multiple investigators at CHOP to develop a large animal model of pulmonary vein stenosis that has identified several targets for therapy
- Dr. Frank has identified polyamine biosynthesis as critical regulators of distal vascular growth, providing a potential target for pulmonary hypoplasia

PREVENTIVE CARDIOVASCULAR PROGRAM

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 2024, 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 Adams 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, Exton, 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. Our Lipid Heart dietitians include: Brooke Thompson, Janel Steinhoff, and Danielle Campbell. They see our new lipid patients as well as follow-up patients who need or desire further dietary management and support. For calendar year 2024, the numbers presented are those seen at Buerger, Brandywine Valley, and Voorhees (Brothers, Shustak, Martino, Bamba, Prout, Lee, and Barsky) and are somewhat lower than 2023 due to Dr. Brothers' sabbatical. The LHC team saw 850 patients with 216 new in person visits, 224 follow up in person visits, 147 new telemedicine and 263 follow-up telemedicine visits for a total of ~ 1/2 of visits as telemedicine. For the telemedicine patients, there was a 2% no show rate, 2% 48-hour cancellation rate and 2% 24-hour cancellation rate compared to the in-person visits with a 2% no show rate, 6% 48-hour cancellation rate and 6% 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. We are utilizing a Qlik Sense dashboard so we can continue to track our progress.

The team has continued to be involved with research publications as well as speaking locally, regionally, and nationally about pediatric dyslipidemia. Dr. Shustak spoke on "Screening, Evaluation & Management of High Cholesterol in Children and Adolescents" at the CHOP Online Pediatric Education Network Seminar and on "Screening, Evaluation & Management of High Cholesterol in Children and Adolescents" at the CHOP Primary Care Conference. She gave virtual grand rounds through CS Mott Children's Hospital Division of Nephrology on "Dyslipidemia in Youth with Chronic Kidney Disease". Dr. Shustak presented a moderated poster presentation entitled "Disparities in Diagnosis and Treatment of Heterozygous Familial Hypercholesterolemia" at the 2024 American Heart Association Scientific Sessions. She also contributed to a Lifestyle Medicine book chapter entitled, "Identification and Management of Children with Dyslipidemia." Dr Shustak and Ms Martino also recently published the CHOP pathway for "Primary Care Clinical Pathway for Lipid Screening in Children."

Dr. Brothers published in Circulation a manuscript entitled "Evinacumab for pediatric patients with homozygous familial hypercholesterolemia" and in JAMA Cardiology, "Diagnosis, treatment, and cardiovascular outcomes in homozygous familial hypercholesterolemia: a sex-specific analysis." Dr Brothers was a co-author on a poster presented at the American Heart Association EPI Lifestyle Meeting entitled, "Randomized Placebo-controlled Trial of Pitavastatin Calcium to Treat Combined Dyslipidemia Of Obesity In Adolescents - The Pediatric Heart Network Dyslipidemia Of Obesity Intervention In Teens (do It!) Trial." Dr. Brothers spoke at the Morristown Pediatric Cardiology Symposium, entitled "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 sisters, EP and CP, presented to the Lipid Heart Clinic at age 12 and 10 years, respectively. At age 10, CP had her lipid panel checked before starting medication related to attention deficit disorder. This showed a total cholesterol of 247 mg/dL, HDL-c 69 mg/dL, LDL-c 157 mg/dL, TG 99 mg/dL, non-HDL-c 178 mg/dL. Her older sister, EP, then had her lipids checked and had similar results. They were referred to lipid clinic. Family history was significant for their dad with hypercholesterolemia on statin and paternal grandfather with heart attack at age 43 years. We discussed that they were on the border of needing medication based on the LDL-c and family history, but to return in 1 year with repeat labs, including a lipoprotein (a). They returned 2.5 years later and their LDL-c levels were slightly higher but their lipoprotein (a) levels were both ~ 4 times the upper limit of normal. We discussed that based on these findings and the family history, we would recommend starting a low dose statin, which they agreed. Their diet and exercise were already excellent. On 10 mg of atorvastatin, their LDL-c levels decreased to ~ 100 mg/dL and we did not make any other changes.

Cardiovascular Risk Assessment Clinic: The Cardiovascular Risk Assessment Clinic (CVRA) has continued to see patients approximately two times per month. We saw 18 patients total, somewhat decreased from previous due to Dr Brothers' sabbatical. The physicians in this clinic for 2024 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. We hope to start seeing our post-operative bariatric patients throughout 2025 and 2026 to re-evaluate their cardiometabolic risk.

One patient exemplifies how our clinic functions. An 18-year-old young lady, TB, was referred to CVRA clinic by her cardiologist due to severe obesity and pre-diabetes, concern for elevated systolic blood pressure, in the setting of a small conoventricular VSD, that did not need repair or medication. Her family history was not remarkable for any early coronary or peripheral vascular disease, congenital heart disease, or sudden cardiac death. There were multiple family members on both the mother's and the father's side of the family with type 2 diabetes mellitus and hypertension. She was asymptomatic from a cardiac perspective. At the CVRA clinic visit, her systolic blood pressure was not elevated. Her BMI was at the 161% of the 95th percentile. We performed vascular testing, including carotid IMT and pulse wave velocity. The CIMT was 0.51 mm on both the left and right common carotid arteries, which was the 50th%. Her pulse wave velocity was 5.2 m/s which was the 25-50th% for age, gender and height. We reviewed her laboratory data, which was significant for normal lipids, mildly elevated hemoglobin a1c of 5.8% and a markedly low Vitamin D of 8 ng/mL; she had been started on high dose weekly Vitamin D supplements by her primary care provider. She met with our dietitian and exercise specialist, who followed her as an outpatient as well.

Hypertension Clinic: The Hypertension 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 and Palermo along with our nurse practitioner, Jordy Martino) and one of our nephrologists who specializes in hypertension (Dr. Meyers). We also have a cardiac 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 scheduled 81 patients in 2024. Fifty-one patients completed the visit. There were 24 cancelations, and 6 patients did not show to the visit. 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.
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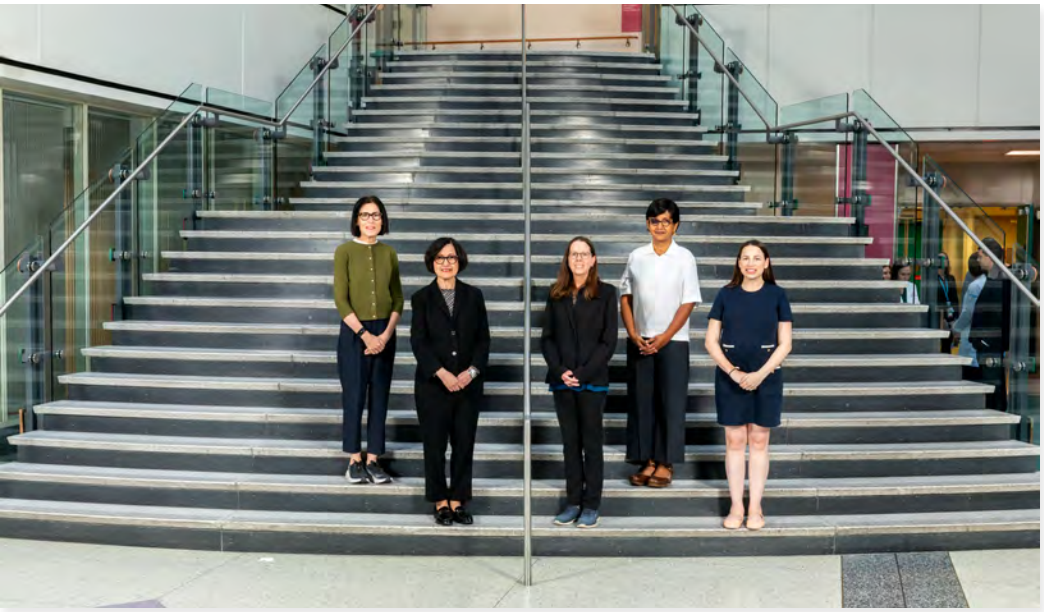
- Kaplinski M, et al. "Left ventricular measurements and strain in pediatric patients evaluated for systemic hypertension and the effect of adequate anti-hypertensive treatment". Pediatric Cardiology Page: doi: 10.1007, Aug 2021.
- Kaplinski M, et al. "Left Ventricular Measurements and Strain in Pediatric Patients Evaluated for Systemic Hypertension and the Effect of Adequate Anti-hypertensive Treatment". Pediatr Cardiol, Jan 2022.
- Hooper SR, Lande M, Flynn JT, Hanevold C, Meyers KE, Samuels J, Becker RC, Daniels SR, Bonita E. Falkner, Ferguson M, Ingelfinger JR, Martin LJ, Mitsnefes M, Khoury P, and Elaine M. Urbina EM. Systolic Blood Pressure, Cardiovascular Health, and Neurocognitive Functioning in Adolescents. Hypertension. 2024 Dec;81(12):2444-2453. PMID: 39291378.
- Sethna J, Wong K, Meyers KE. Cardiometabolic Health in Asian American Children. J Racial Ethnic Health Disparities. 2023 Dec 26. PMID: 38147200.
- Kogon AJ, Maqsood AM, LoGuidice J, Amaral S, Meyers KE, Mitchell JA. Sleep Duration and Blood Pressure in Youth Referred for Elevated Blood Pressure Evaluation. Pediatrics. 2024 Jul 1;154(1):e2023062940. doi: 10.1542/peds.2023-062940.PMID: 38887814
- Ananthamohan K, Brady TM, Arif M, Daniels S, Falkner B, Ferguson M, Flynn JT, Hanevold C, Hooper SR, Ingelfinger J, Lande M, Martin LJ, Meyers KE, Mitsnefes M, Rosner B, Samuels JA, Kuffel G, Zilliox MJ, Becker RC, Urbina EM, Sadayappan SA. Multi-Omics Approach to Defining Target Organ Injury in Youth with Primary Hypertension. . bioRxiv [Preprint]. 2024 Jun 18:2024. PMID: 38948714.
- Hamdani G, Urbina EM, Daniels SR, Falkner BE, Ferguson MA, Flynn JT, Hanevold CD, Ingelfinger JR, Khoury PR, Lande MB, Meyers KE, Samuels J, Mitsnefes M. Youth Blood Pressure and Target Organ Injury Markers: The SHIP AHOY Study. Hypertension. 2025 Feb 27. Online ahead of print. PMID: 40013356

Ms. Martino, our nurse practitioner, is leading a study investigating medium to long-term outcomes after coarctation repair, particularly related to hypertension and other cardiovascular risk factors.

A patient story that exemplifies the Hypertension (HAVE) clinic is pt LBR. He is now 20 years old and presented at 6 years of age to the emergency room after the school nurse noticed a high blood pressure. In the ER, an echocardiogram noted a bicuspid aortic valve and mild aortic arch hypoplasia and coarctation of the aorta, dilated ascending aorta and mild concentric hypertrophy of the left ventricle. Prior to surgical repair, he was sent to the ER again for hypertensive encephalopathy, including visual changes and dizziness which resolved quickly with no changes on head CT. He proceeded with end-to-end coarctation repair at the Children's Hospital of Philadelphia and post-op course was notable for hypertension. He was discharged on enalapril, amlodipine, and labetalol. Since that time, he has benefited from the collaboration of this multi-disciplinary Hypertension Clinic. The nephrologist has been managing the hypertension with. Clinic visits, serial ambulatory blood pressure monitors and changes to blood pressure medications. Cardiology has managed residual aortic arch obstruction (he has had serial clinic visits with echocardiograms, cardiac MRIs to define LV hypertrophy and residual aortic arch obstruction, exercise tests to assess exercise capacity and blood pressure gradients, and serial cardiac catheterizations to assess hemodynamics and balloon dilate/stent the residual coarctation). The cardiac nutritionist has managed his diet, and the exercise physiologist has managed his activity levels and types of exercise, both of which have led to some weight loss and decreased anxiety levels. Hypertension is a known, long-term co-morbidity after coarctation repair, particularly in those repaired later in childhood and those with concurrent aortic arch hypoplasia. A multi-disciplinary, wholistic approach can help to manage secondary hypertension related to this heart defect. LBR and his family continue to be grateful for the care they have received in the Hypertension (HAVE) 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.

INFANT SINGLE VENTRICLE MONITORING PROGRAM



LEADERSHIP

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Director

Alyson Stagg, CRNP
Program coordinator

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Cardiac Critical Care

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Amita Szwast, MD
Cardiology

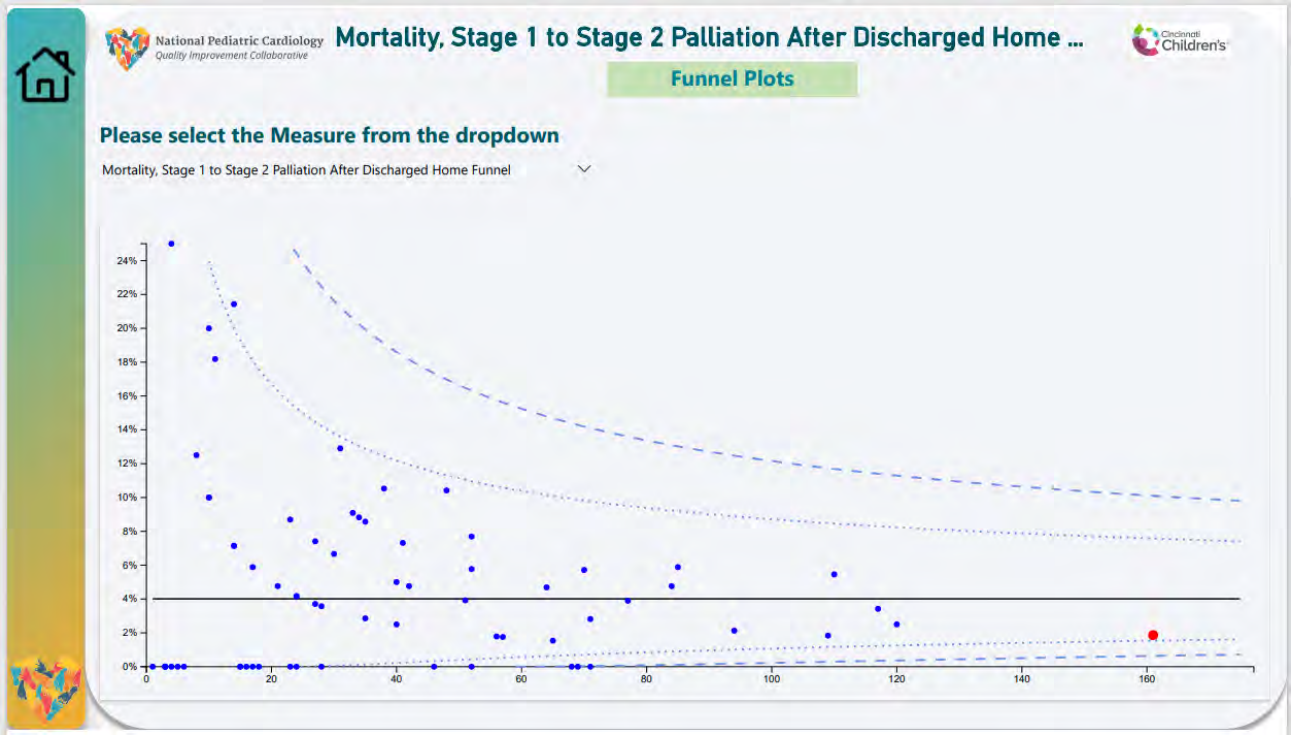
INTRODUCTION

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 5 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 and this year we included single ventricle patients with pulmonary artery bands. This year we also instituted a tube weaning project, an initiative to facilitate NG tube-dependent infants back to feeding normally by mouth.

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

PROGRAMMATIC HIGHLIGHTS

- Since the inception of program, we have enrolled 966 patients
- All Interstage death rate 1%, HLHS interstage death rate 2%
- Monthly telemedicine visits are our standard of care often with digital stethoscopes. 750 telemedicine visits to date since 2019, > 400 with Eko digital stethoscopes
- Care Companion Module in EPIC MyCHOP allows families to enter home data directly into the EMR
- Discharge consults 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)
- Instituted a NG tube weaning program this year and have successfully weaned 9 infants to all oral feeding

STATS

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

RESENT 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 2023
- Ilana T. Schwartz, Jan Leonard, Alexis Zavez, Luma Essaid, Alyson Stagg, Chitra Ravishankar, Therese M. Giglia, Monique M. Gardner, Rachel J. Shustak: Brain natriuretic Peptide is Not Predictive of Days Alive and Out of Hospital During the Interstage Period in Infants with Hypoplastic Left Heart Syndrome American Heart Association Scientific Sessions 2024, Chicago, IL, Poster: 2024

ON THE HORIZON

With additional nurse practitioner support we plan on expanding our program beyond the stage I interstage to after the stage II palliation and through to the Fontan.

CARDIAC KIDS NEURODEVELOPMENT PROGRAM

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Amanda J. Shillingford, MD
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Laura Mazza, RN, MSN, CRNP-PC
Developmental Pediatrics

Kate E. Wallis, MD, MPH
Developmental Pediatrics

OVERVIEW

The Cardiac Kids Developmental Follow-up Program (CKDP) is dedicated to improving the neurodevelopmental and behavioral outcomes for children with congenital heart disease (CHD). CKDP delivers neurodevelopmental care through equitable clinical services, family and patient education, multidisciplinary collaboration, and community outreach. The program has been a leader in developmental care for children with CHD since the inception of the NeuroCardiac Care Program in 2009. CKDP seeks to address the long-term developmental effects children with CHD may experience after cardiac surgery, recognizing that early interventions and ongoing evaluations are essential in promoting positive outcomes.

EVALUATION: EARLY CHILDHOOD, BIRTH TO 5 YEARS

CKDP operates within a collaborative, multidisciplinary model, providing consistent and comprehensive care to children from infancy through school age. Beginning at three months, children are evaluated by our pediatrician and specialized therapists in areas such as occupational, physical, and speech-language development. Additionally, psychologists conduct developmental and behavioral assessments from early childhood to age five, with ongoing consultations available from social work, nutrition, and education services. This early assessment and intervention strategy ensures that children with CHD receive the necessary resources to foster development and optimize longer term outcomes.

CKDP evaluates children with CHD who have undergone a catheter based or surgical interventions or have had a prolonged hospitalization for a cardiac related problem before the age of 12 months. By collaborating with the inpatient INFANT program, eligible patients are identified prior to hospital discharge and potential barriers to scheduling are addressed with the overall goal of expanding access and increasing participation in the program. Families are also encouraged to reach out directly to the CKDP team with inquiries, and the program collaborates closely with the financial clearance team to obtain insurance authorization for the visits. Once children reach school age, they transition out of the early childhood program, but ongoing support is available through the psychology team and developmental and behavioral pediatrics to address cognitive and behavioral challenges.

EVALUATION: SCHOOL-AGE, 5 YEARS TO 15 YEARS

In a partnership with developmental and behavioral pediatrics (DBP), CKDP continues to focus on developmental needs, providing care for school-age children with CHD and co-occurring developmental disabilities and mental health concerns, such as ADHD, autism, anxiety, and other behavioral disorders. Children with CHD face a significantly higher risk of developing ADHD and learning challenges, with these conditions often becoming more apparent as school demands increase. CKDP visits for this age group involve detailed assessments, including medical history reviews, behavioral rating scales from parents and teachers, in-person testing, and coordination with neuropsychology.

The DBP and psychology teams often collaborate with the patient's cardiologist, addressing issues such as ADHD, learning disabilities, and anxiety. By supporting these developmental and behavioral needs, the CKDP plays a critical role in enhancing a child's educational, social, and personal development.

PROGRAM DEVELOPMENT: CARDIAC EDUCATION COORDINATOR INITIATIVE

Education Coordinators are increasingly being imbedded into Cardiac Center Neurodevelopmental Follow-up Programs and serve as experts who support children with CHD and their families as they navigate access to appropriate school programing. In 2023, Roberta Rossman joined CKDP as an Education Coordinator. She immediately began reaching out to other Pediatric Cardiac Center Educators and it became clear that there was a need for Cardiac Education Liaisons to share experiences, information, and

create research-based strategies to support patients and families. In response, Roberta engaged Cardiac Educators from other institutions to launch the Cardiac Education Liaison Special Interest Group (SIG) within the Cardiac Neurodevelopmental Outcome Collaborative (CNOC) in August 2024. The mission of this SIG is to support Cardiac Education Liaisons and Coordinators by bridging gaps in knowledge, clinical practice, education, policy, and advocacy, ensuring quality educational support for children with CHD. The Cardiac Education Liaison SIG held their first meeting in January 2025 and plans to meet monthly.

RESEARCH CONTRIBUTIONS

The CKDP continues to play a role in neurodevelopmental care and congenital heart disease research.
Kathleen Campbell^, Wallis, K. E.^ (^contributed equally), El-Messidi Hampton, L., Burnham, A., Mercer-Rosa, L., Miller, O., Laura Mazza, L., Fogler, J. (2024) Complex Attention-Deficit Hyperactivity Disorder in a 4-Year-Old with Repaired Critical Congenital Heart Disease. Journal of Developmental & Behavioral Pediatrics.

O'Byrne ML, Baxelbaum K, Tam V, Griffis H, Pennington ML, Hagerty A, Naim MY, Nicolson SC, Shillingford AJ, Sutherland TN, Hampton LE, Gebregiorgis NG, Nguyen T, Ramos E, Rossano JW. Association of Postnatal Opioid Exposure and 2-Year Neurodevelopmental Outcomes in Infants Undergoing Cardiac Surgery. J Am Coll Cardiol. 2024 Sep 10;84(11):1010-1021. doi: 10.1016/j.jacc.2024.06.033. PMID: 39232628.

Essaid L, Haque K, Shillingford A, Zimmerman L, Burnham A, Hampton L, Okunowo O, Gaynor JW, Abend NS, Naim MY, Gardner MM. Medical & Socioeconomic Risk Factors Associated with Lack of Neurodevelopmental Evaluation Following Neonatal Cardiac Surgery. Pediatr Cardiol. 2025 Jan 4. doi: 10.1007/s00246-024-03761-w. Epub ahead of print. PMID: 39755847.

The CKDP is also a leader in contributions to the CNOC data registry and with the support of Cardiology, hopes to ensure that our robust patient volume and testing data is available for collaborative research and quality improvement activities as we continue to make advancements in cardiac neurodevelopmental care.

As the CKDP program continues to expand and evolve, we remain committed to providing exceptional care and support for children with CHD and their families, ensuring the best possible developmental and behavioral outcomes for the children we serve.

CARDIAC CONSULT SERVICE

TEAM

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. Matthew Elias
Dr. Alexa Hogarty
Dr. Ramiro Lizano
Dr. Meghan Metcalf
Dr. Tamar Preminger
Dr. Paul Stephens *(lifetime member)*
Dr. James Starc
Dr. Mudit Gupta *(4th year fellow)*
Dr. Helen Stanley *(4th year fellow)*

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 team manages babies in the NICU with complex CHD with co-morbidities such as prematurity and multiple congenital anomalies with known genetic syndromes and those not specified. A significant proportion of these babies are referred by the consult team for cardiac surgical procedures, diagnostic and interventional cardiac catheterizations. In addition, the consult team manages patients with acquired heart disease such as Kawasaki Disease, pericarditis, and rare conditions such as conjoined twins in collaboration with other medical and surgical specialties. Premature infants with PDA are referred to the NICU at CHOP and HUP for device closure in the cath lab. These patients are managed by the consult team in collaboration with Interventional Cardiologists and Neonatologists. During the fiscal year of 2024, the consult team staffed nearly 2000 inpatient encounters.

Many attendings on the consult service were named as Top Doctors in Philadelphia magazine or Mainline Health in 2024.

CARDIAC ANTICOAGULATION & THROMBOSIS PROGRAM

TEAM

ADVANCED PRACTICE PROVIDERS:
Susan Maeder-Chieffo, CRNP
Lauren Sewter, CRNP

CARDIOLOGISTS:
Therese Giglia, MD (Program Director)
Matthew O'Connor, MD
Chitra Ravishankar, MD

CARDIAC INTENSIVE CARE:
Jamie Weller, MD

HEMATOLOGISTS:
Leslie Raffini, MD (Hematology Lead)
Nihal Bakeer, MD
Bhavya Doshi, MD
Abraham Haimed, MD
Michele Lambert, MD
Ben Samelson-Jones, MD
Hilary Whitworth, MD
Char Witmer, MD

CT SURGERY:
Mohammed Nuri, MD

CLINICAL PHARMACY:
Andrew Sweigart, PharmD
Madeline Abbott, PharmD
Brendan Homanick, PharmD

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 an extraordinary, 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.

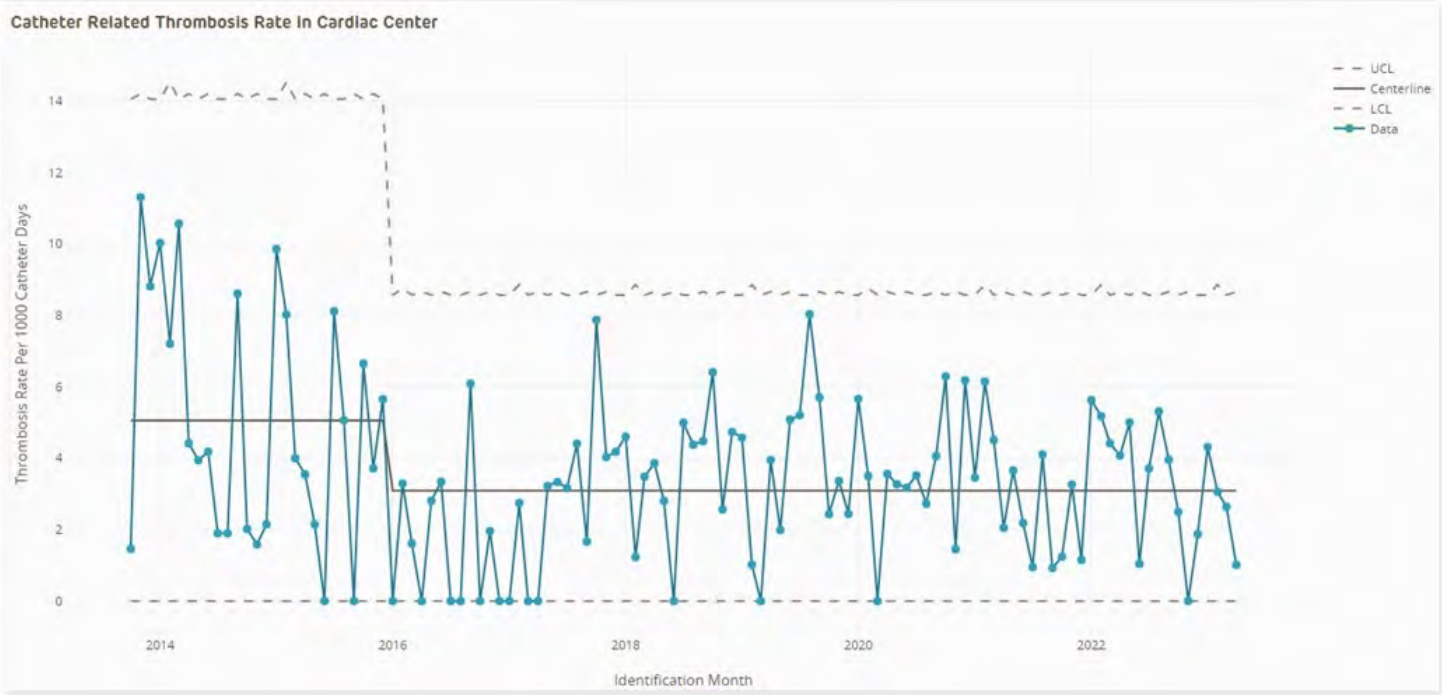
In July 2013 the Divisions of Cardiology (Dr. Giglia) and Hematology (Dr. Raffini) were awarded a competitive 2-year internal grant (Chair's Initiative) to pilot the program. To our knowledge, our team is the only dedicated, multidisciplinary pediatric cardiac thrombosis team in the US, and is now comprised of 2 full time nurse practitioners, 3 cardiologists, 8 hematologists, and 2 PharmDs. Recently a dedicated CT surgeon joined the team enhancing collaboration both pre and post operatively. Our advanced practice providers and attending physician on service perform an initial consult on all patients in the cardiac center with clots or in need of anticoagulation management and follow them through hospitalization until discharge. This includes follow-up consultations and discussion with the care team and subspecialties as needed. Upon discharge, patients are seen and a plan for imaging and anticoagulation follow up is entered into the 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 team saw approximately 300 new inpatient consults not including discharge management consults last year. We are growing our outpatient clinic and saw 160 outpatient last year both in-person and via video visits and continue to increase. Additionally, there are approximately 350 outpatients managed on warfarin, enoxaparin or direct oral anticoagulation that are actively managed remotely 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 trending outpatient labs and medication dosages which is managed by the NPs and is available to all care teams
- Established a comprehensive working patient database for all active anticoagulation outpatients.
- Consulted on nearly 1500 inpatients with thrombosis or on prophylactic anticoagulation since the program inception and currently manage over 350 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.
- Built and utilize Post Catheterization Pulse Loss Pathway which has standardized care as well https://pathways.chop.edu/clinical-pathway/post-cath-pulse-loss-clinical-pathway?utm_source=epic&utm_medium=link&utm_campaign=cardiac_dashboard.
- 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.



RESEARCH HIGHLIGHTS

We have partnered with colleagues locally and around the globe to better understand the problems of thrombosis in infants and children with cardiac disease:

Incidence, Management, and Outcomes of Pulmonary Embolism at Tertiary Pediatric Hospitals in the United States. Rastogi R, Okunowo O, Faerber JA, Mavroudis CD, Whitworth H, Giglia TM, Witmer C, Raffini LJ, O'Byrne ML. JACC Adv. 2024 Mar 19;3(4):100895

Recurrent Thromboembolism in Pediatric Congenital Heart Disease: Cumulative Incidence and Prognostic Factors. Kiskaddon AL, Giglia TM, Betensky M, Do NL, Witt DM, Stock AC, Amankwah EK, Fierstein JL, Ashour D, Ignjatovic V, Quintessenza JA, Goldenberg NA.Semin Thromb Hemost. 2024 Dec 18.

Arterial thromboembolism, antithrombotic therapy, and risk of recurrent thromboembolism in children with CHD undergoing cardiac surgery. Kiskaddon AL, Do NL, Amankwah EK, Witt DM, Ignjatovic V, Giglia TM, Woods GM, Whitworth HB, Stock AC, Goldenberg NA. Cardiol Young. 2025 Feb 27:1-4.
3 additional manuscripts in preparation

ON THE HORIZON

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.

DIVISION OF CARDIAC CRITICAL CARE

LEADERSHIP

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

David Hehir, MD, MS
Associate Chief, Quality Improvement
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

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

Rebecca Cardoso, MHA

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

OVERVIEW

The Division of Cardiac Critical Care Medicine at the CHOP is one of four divisions of the Department of Anesthesia and Critical Care Medicine and is, at the same time, one of the five governing groups that direct the work of the CHOP Cardiac Center. Twenty faculty work together to accomplish Division missions to care for patients and create a learning environment. The learning environment encompasses the Safety/CQI program, educational programs, and research.

CLINICAL CARE

The primary mission of the Division is to lead the multi-professional team that provides specialized care to patients with congenital and acquired heart conditions in the 32 bed CICU. In the most recent year CICU patient days were 11,929 supporting, 828 cardiac surgeries, 1,558 diagnostic and treatment catheter procedures and 175 newborn admissions from the Special Delivery Unit (SDU). These numbers reflect 6% increase in catheterization procedural volume and 5 day CICU length of stay. The number of cardiac surgeries and SDU admissions were unchanged. To accommodate this demand and allow for growth the CICU 1) increased capacity by regularly surging to 38 beds, 2) added a third critical care rounding team and providers to facilitate unscheduled diagnostics and/or procedures.

LEARNING ENVIRONMENT

QUALITY/SAFETY

In 2024 Division Faculty played key leadership roles in the CHOP Cardiac Center QI/Safety Steering Committee and have led quality and safety improvement initiatives across the Cardiac Center and CHOP. Several initiatives stand out among many, for example, the Cardiac Watcher and Critical Assessment processes in 2024 expanded, and made consistent, emergency response protocols in all inpatient areas. The Harm prevention program, led by Dr. Brunetti enjoyed sustained improvement in central line infection rates. She implemented a novel CLABSI risk score to improve identification of patients at CLABSI risk. The cardiac arrest analysis program (CAPER) led by Drs. Diddle and Gardner identified components of our arrest response processes that can be targets for improvement including expanded cardiac arrest prevention huddles and a post-arrest care team. At the enterprise level two items deserve mention. First, Dr. Hehir is medical lead of the CHOP's physiologic monitoring committee, second Dr. Goldsmith led the enterprise-wide implementation of Sickbay, a platform for viewing and analyzing health information and physiologic data.

EDUCATION AND TRAINING

The work of the CICU is rich with opportunities for education and training and the Critical Care Faculty physicians are skilled educators. The scope of educational offerings span a spectrum from short observerships for high school or undergraduate students and international physicians, to month long clerkships for medical students and resident physicians to our one-year advanced fellowship (PGY-7). A very important piece of our educational effort is the simulation program for our multidisciplinary CICU staff providers led by Dr. Marrisa Brunetti. The program is comprised of regular case-based scenarios using high fidelity mannequins and monitors to reenforce response to common emergencies and standardize procedure. In 2024, the simulation program added scenarios for initiation of ECMO support during CPR (E-CPR). Another key education responsibility for the Division faculty is the training of categorical physician trainees in Pediatric Cardiology and Critical Care Medicine fellowships (24 months of trainee rotations in the CICU for each categorical program). The core of the Division's Educational effort is the advanced physician fellowship (PGY 7 level) Cardiac Critical Care. The advanced fellowship (PGY-7) in Cardiac Critical Care in its 30th year. (See section on education).

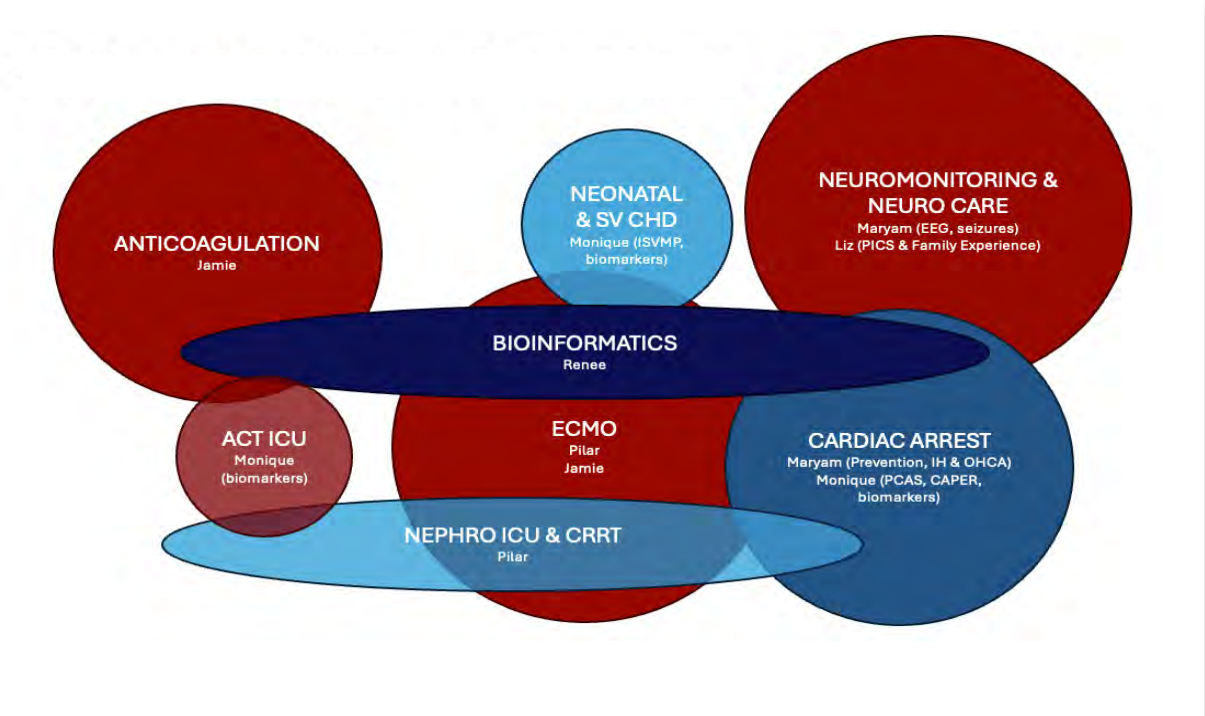
Several of the 2024 education efforts deserve highlight. The Divisions of Cardiac Critical Care and General Critical Care collaborated (Drs. Brunetti and Himebauch) to develop a one-year ECMO fellowship targeting physicians trained in Critical Care, Cardiology and/or Neonatology. This fellowship was awarded full funding by the CHOP GME office.

2024 marked the 5th annual Cardiac Critical Care bootcamp for fellows interested in Cardiac Critical Care. The weekend program drew its student body from 12 institutions spanning the I-95 corridor from Boston to St. Petersburg Fla. Twelve faculty from 7 institutions joined as the instructors.

RESEARCH AND INNOVATION

All Cardiac Critical Care faculty participate research to various degrees and the research focus of faculty members is represented in the overlapping ven diagram below reflecting both varied interests and opportunity for collaboration. Of note, in the last academic year 48 papers were published by the twenty Division faculty.

Other 2024 research events to note include the addition to our faculty of Dr. George Spyropoilous, from Washington University St. Louis. He will be working in the lab of Dr. Dan Kelly, the CHOP Cardiac Center Research Institute Director. His area of research is Cardiomyocyte metabolism in heart failure. Another important accomplishment is the NIH K23 career development award received by Dr. Monique Gardner. Her grant is entitled "Assessment of Myocardial Dysfunction and Inflammation after Cardiac Arrest". This is the next phase of Dr. Gardner's work with Dr. Nadir Yehya from our Division of General Critical Care.



CICU NURSING

OVERVIEW

The CICU is a 32-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.
- Expansion of the nursing leadership team to hire and onboard 2 new clinical supervisors and 1 additional clinical nurse expert to support staff support, development and engagement.
- Achieved 85% participation and marked improvement across all domains of nursing engagement for 2024 Employee Engagement Survey. Key drivers of improved engagement included improved staffing, communication with leadership, culture of safety, and interdisciplinary collaboration.
- 96% of nurses hold a BSN or higher-level degree and 24% are certified in critical care.
- Reached harm prevention milestones including 190 days Central Line Associated Bloodstream Infection (CLABSI) free, over 250 days Hospital Acquired Pressure Injury (HAPI) free, 155 days Catheter Associated Urinary Tract Infection (CAUTI) free, 77 days unplanned extubation free and greater than 430 days PIVIE free
- Continued robust collaboration with central VAS leaders and teams to meet the complex needs of CICU patients with central lines. This work included establishing a clear and standardized training program for CICU VAS rounding team followed by completion of training

- Advanced evidence-based care by implementing the VAMP Jr closed blood draw system and streamlining VAD dressing changes to eliminate unnecessary steps and focus on value-added practices. The Atriamp device was adopted to improve detection and treatment of post-op atrial arrhythmias. Developmental care was integrated into weekly interprofessional rounds. The monthly Nursing Journal Club fostered clinical inquiry through journal article discussion on pertinent topics to support learning and practice improvement.
- Successfully implemented new structured orientation program designed to successfully onboard both clinical nurses with prior experience and novice nurses entering practice. The Tiered Skills Acquisition Model (TSAM) program is an evidence-based structure that allows for individualized learning progression, enhanced skill acquisition, and support for safe clinical practice.
- Implemented a Quarterly Education and Competency Program designed to reinforce critical skills and ensure high-quality, evidence-based care for nursing staff. Each quarter has consisted of focused high priority/high impact clinical topics relevant to CICU patient population and nursing practice needs.
- As overall CICU nursing turnover and vacancy have stabilized, we have been able to elevate our support of professional advancement of nursing staff through robust ongoing education series providing Continuing Education (CE) credits and supporting lifelong learning and professional growth.

DIVISION OF CARDIAC ANESTHESIOLOGY

FACULTY

Andreas Loepke, MD, PhD, FAAP
Division Chief

Molly F. Deacutis, MD

Eduardo Goenaga Diaz, MD

Matthew A. Jolley, MD

Lindsey M. Loveland, MD

Jennifer M. Lynch, MD

Lea Matthews, MD

John McCloskey, MD

Manal Mirreh, MD

Reese Murray-Torres, MD

Susan C. Nicolson, MD

Asif Padiyath, MBBS

Jayant (Nick) Pratap, MB, BChir, MRCPCH, FRCA

Lindsey Weidmann, DO, MS

Deborah Romeo, MD, ScM

ADMINISTRATION

Rebecca Cardoso
Director, Physician Practice Administration

Cassandra Barbetti
Practice Operations Manager

Maxine Abrams
Office Administrator

Jessica Ross
Administrative & Clinical Services Coordinator

CARDIAC CRNAs

Lisa Jones, MSN, CRNA
Chief CRNA

Lauren Brown, DNP, CRNA

Peter Caruso, DNP, CRNA

Therese Brady, MSN, CRNA

Hannah Kuhn, MSN, CRNA

Deirdre Mcfillin, MSN, CRNA

Christopher McMichael, CRNA

Amy O'Donnell, CRNA

Jamie L. Sloan, MSN, CRNA

Lapio Tkzach, DNP, CRNA

CARDIAC CRNP

Shweta David, MSN, CRNP

INTRODUCTION

The Division of Cardiothoracic Anesthesiology experienced another year of transformative change. While advancing our mission of providing world-class clinical care for critically ill children with congenital heart disease, driving groundbreaking clinical and basic science research, and training the next generation of Pediatric Cardiac Anesthesiologists, Pediatric Anesthesiologists, and Certified Registered Nurse Anesthetists (CRNAs), we also welcomed an unprecedented number of new team members into our group.

Our highly successful recruitment efforts over the past two years, including our current recruitment targets, will more than double our faculty numbers compared to just two years ago. We now have 15 attending anesthesiologists as part of our group. Additionally, our CRNA recruitment campaign brought 3 new colleagues to our division, increasing our total to 10 CRNAs and strengthening our capacity for exceptional patient care.

Our team provided comprehensive peri-procedural care for over 3,100 patients. We manage some of the highest acuity patients in the hospital, including the largest number of neonates (> 300 per year) with congenital heart disease in the nation. We deliver life-saving care in the cardiac ORs and catheterization labs, including Immediate Postpartum Access to Cardiac Therapies (IMPACT) procedures, offering expectant parents with a severe prenatal cardiac diagnosis a chance for life-saving treatment for their unborn child.

CORE VALUES

Our work is guided by our CARDIAC values, thoughtfully developed by the entire team and championed by the Cheer Committee— Lea Matthews, Lindsey Weidmann, and Manal Mirreh. Living these core values requires daily dedication. We will lead by example and inspire every member of the health-care team to uphold these principles. Together, these values empower us to delivery exceptional care, build stronger teams, and keep our patients at the heart of everything we do.

WELLBEING INITIATIVES

In 2024, the Division of Cardiothoracic Anesthesiology prioritized wellbeing and team-building initiatives to foster a supportive and collegial environment. We hosted our first holiday party in recent history, bringing together faculty, staff, and trainees to celebrate our collective achievements. Our division also participated in CHOP's Cardiac Center's Philly Spin-In, raising funds for critical cardiac research while promoting teamwork and wellness. Additionally, we organized team-building activities such as potlucks and a holiday door decorating contest, strengthening camaraderie within the division.

QUALITY IMPROVEMENT AND PATIENT SAFETY

The Cardiac Anesthesiology division is continuously involved in projects to improve quality, safety, and outcomes in the Cardiac Center perioperative space. These initiatives are undertaken with a focus on multidisciplinary stakeholder input and sustainability. Projects conducted this year include:

- Creation of an emergency drug cognitive aid for anesthesia workstations
- Anesthesia workstation redesign for radiation safety and improved ergonomics
- Development of a cardiac OR to CICU handoff tool
- Revision of CODE emergency alert system in the procedural space
- Creation of a new "Anesthesia NOW" emergency alert system for the COIC
- Implementation of end-tidal CO2 monitoring for postoperative patients in the CPRU
- Standardization of code cart/defibrillator use in the catheterization labs

In addition to participation in Cardiac Center-wide multidisciplinary conferences, the division holds bimonthly quality and safety conferences that include continuous education, MMI and case reviews, and safety reporting event reviews.

The CRNA team in the Cardiac Center consists of nine CRNAs dedicated to Cardiac Anesthesiology, led by Lisa Jones, MSN, CRNA. Working in close collaboration with the cardiac anesthesiologists, this highly-skilled team ensures the safe and effective delivery of anesthesia care for children with congenital and acquired cardiac disease undergoing a full spectrum of procedures at CHOP's Cardiac Center. Their expertise spans cardiopulmonary bypass cases, interventional procedures, lymphatic interventions, and Cardiac MRIs.

PROFESSIONAL LEADERSHIP & EDUCATION INITIATIVES

- In 2024, Lisa Jones, CRNA served as Co-Moderator for the Advanced Practice Provider Symposium at SPA-AAP Pediatric Anesthesiology 2025.
- Therese Brady, CRNA delivered an inclusive Cardiac Basics lecture—a foundational session designed for new fellows, new CRNAs, and SRNAs, with a focus on lymphatic procedures.
- Chris McMichael, CRNA has stepped into the role of Student Clinical Coordinator, leading a structured Cardiac Rotation that accommodates two SRNA students per month, ensuring a comprehensive clinical experience.

QUALITY IMPROVEMENT & RECRUITMENT INITIATIVES

- The cardiac anesthesia CRNAs remain actively engaged in quality improvement. Jamie Sloan, CRNA, MSN contributed to a project aiming to reduce eye injury in anesthetized patients.
- Jamie Sloan, Chris McMichael, and Lisa Jones played a pivotal role in the "A Day in the Life of a CRNA" recruitment initiative. This program, in collaboration with Human Resources, educates ICU nurses on accredited anesthesia programs, financial considerations, and provides hands-on simulation training in intubation and ultrasound-guided IV placement.

RESEARCH HIGHLIGHTS

The Division of Cardiac Anesthesia continues to drive innovation in pediatric cardiac anesthesiology through translational and clinical research. Our faculty lead multi-institutional collaborations and novel investigations aimed at improving outcomes for children with congenital heart disease (CHD). In 2024, our group disseminated its work through peer-reviewed publications (listed below) and highprofile presentations at national and international conferences. Highlights of our ongoing research include:

- **Multi-Center Clinical Trials:** Dr. Susan Nicolson serves as the site Principal Investigator for CHOP in several multi-center trials addressing critical perioperative questions, including the optimal laryngoscopy technique for nasal intubation in infants and determining if platelet stored cold at varying storage durations are non-inferior in hemostatic efficiency compared to standard room temperature stored platelets.
- **Non-Invasive Venous Waveform Analysis:** Dr. Asif Padiyath initiated a collaboration with researchers from Vanderbilt University to explore the potential of non-invasive venous waveform analysis in pediatric cardiac patients. This research aims to improve bedside assessment of hemodynamics and guide individualized management strategies.
- **Advancing Medical Informatics in CHD:** Dr. Nick Pratap was awarded the prestigious Cardiac Center Innovation Award to lead the CHD Panorama project, which seeks to develop and validate a digital platform integrating multisource patient data into a streamlined interface for cardiac patient management.

- **3D Imaging and Computational Modeling**: The Jolley Laboratory continues to explore application of image-derived modeling and computational simulations to inform the design of the optimal intervention for an individual child. The team recently created a clinical modeling 3D core lab to ensure modeling can be performed for all children in the CHOP Cardiac Center who would benefit.
- **Neuromonitoring in CHD**: The Lynch Lab for Novel Biomedical Optics, led by Dr. Jennifer Lynch, develops and applies advanced optical technologies to study neurologic injury risk in children with cardiac disease. Dr. Lynch was awarded a Cardiac Center Innovation Award renewal for her project on developing advanced biomedical optical devices to enhance neuromonitoring during neonatal cardiac surgery. Graduate student Nicolina Ranieri was awarded Best Poster at the CCAS Annual Meeting this year for her work on this project.

Our division was well-represented at major scientific meetings in 2024. Faculty members, including Drs. Jolley, Loepke, Lynch, Padiyath, and Pratap, were invited speakers at CHOP's Annual Cardiology Conference. At the Congenital Cardiac Anesthesia Society (CCAS) Annual Meeting, Dr. Andreas Loepke served as an expert panelist, Dr. Reese Murray-Torres delivered an invited lecture, Dr. Asif Padiyath led a Problem-Based Learning Discussion (PBLD), and Dr. Eduardo Goenaga Diaz directed a hands-on workshop. Additionally, five students and trainees presented research posters. Members of the Jolley Lab presented at the Additional Ventures Single Ventricle Investigator Meeting and the American Heart Association's Scientific Sessions. The Lynch Lab was invited to present at the Optica Biophotonics Congress on Biomedical Optics, further highlighting our division's impact at the intersection of engineering, optics, and pediatric cardiac anesthesia research.

Our division remains at the forefront of research in pediatric cardiac anesthesiology, with ongoing efforts focused on neuromonitoring, perioperative hemodynamic optimization, medical informatics, and the integration of advanced imaging technologies to improve patient outcomes.

Through education, quality improvement, and recruitment, the CRNA team continues to make a significant impact on patient care and the future of Pediatric Cardiac Anesthesiology.

EDUCATIONAL PROGRAM

This year, 2024, we proudly graduated our second class of Accreditation Council for Graduate Medical Education (ACGME)-certified Pediatric Cardiac Anesthesiology fellows and are currently training three Advanced Cardiac Anesthesiology fellows who will graduate in 2025. They contribute enormously to the clinical mission at CHOP, and to education and research at local and national levels. All three will present at the only national meeting dedicated to pediatric cardiac anesthesiology each year – CCAS – The Congenital Cardiac Anesthesia Society Annual Meeting. Only 19 advanced peds cardiac fellows are in training in the entire country, making our division's contribution especially notable! Our fellowship program continues to shape the future leaders of our specialty, combining world-class clinical experience with cutting-edge research opportunities.

FELLOWS IN THE DIVISION OF CARDIAC ANESTHESIOLOGY

This year, in addition to the 11 Pediatric Anesthesiology fellows who each have been training with us for two months, we are proud to be training our largest-ever class of 1-year Pediatric Cardiac Anesthesiology fellows. This cohort represents nearly 10% of the 2024/25 national class, underscoring our program's impact and commitment to excellence in the field:

Mali Hetmaniuk, MD completed her anesthesiology residency at the University of Washington, her pediatric anesthesia fellowship at Boston Children's Hospital, and has spent the last 11 years working at Seattle Children's Hospital and Children's Hospital of Colorado. She's enjoying her fellow-batical year.

Divya Madhusudhan, MD completed a five-year dual residency in pediatrics and anesthesiology and critical care medicine at Johns Hopkins, followed by a one-year fellowship in pediatric anesthesiology at the Children's Hospital of Philadelphia (CHOP).

Yelin Lee, MD graduated medical school from the University of Queensland / Ochsner Clinical School in 2018, spending her first two didactic years in Brisbane, Australia, followed by two clinical years in New Orleans, LA. She subsequently completed her anesthesiology residency at the Ochsner Clinic Foundation in New Orleans from 2019-2023. Yelin then further specialized her training in pediatric and pediatric cardiac anesthesiology at the Children's Hospital of Philadelphia.

CARDIAC NURSING

LEADERSHIP

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

Amanda Seelhorst, MSN, RN, CICU
Nurse Manager

Jamie Fitzgerald, MSN, RN, CICU
Nurse Manager

Natalie Bernard, MHL, BSN, RN, 6E
CCU Nurse Manager

Courtney Bloss, MSN, RN, CPN, 5E
ITCU Nurse Manager

Donna Calfin, MHL, BSN, RN, CPN
Cath Lab and CPRU Nurse Manager

Tami Rosenthal, MBA, CCP, FPP
Perfusion Nurse Manager

Jill Bacher, MSN, RN, CT
OR Nurse Manager

INTRODUCTION

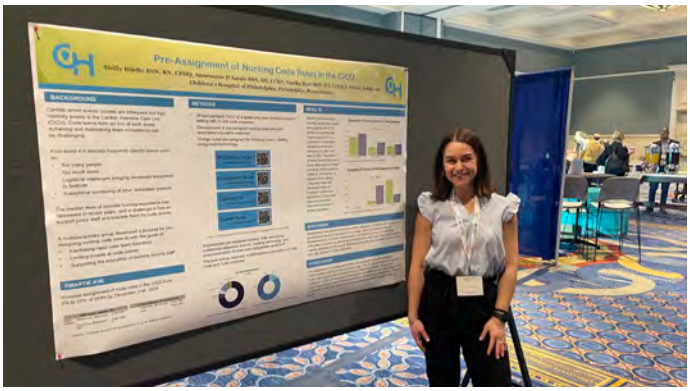
Sherri Kubis, MSN, RN, CCRN, Director of Cardiac Nursing, leads a team of over 350 nurses and 50 interdisciplinary specialists who partner with surgeons, physicians, and many others to ensure that all Cardiac Center patients and their families receive the safest, highest-quality care. This team continually strives for the highest quality of care and develops evidence-based standards of care for children with heart disease.

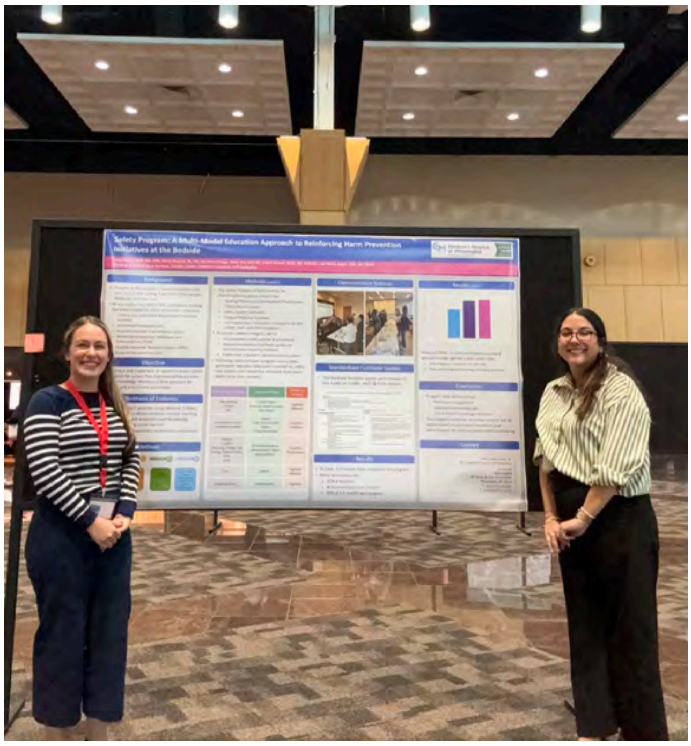
The entire nursing leadership teams consists of eight managers overseeing unit staff and operations. Additionally, a team of specially trained Safety Quality Specialists, Clinical Nurse Specialists and Nursing Professional Development Specialists support clinical practice, harm and safety prevention and educational needs for all Cardiac Center nursing and advanced practice staff. They have established highly successfully onboarding programs to maintain appropriate staffing levels across all specialized areas. Through strong retention and wellness efforts they are maintaining a 11.6% average turn-over rate which is much lower than the national average of 18%. 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 evidencebased practice in the pediatric cardiac field.

THE CARDIAC CENTER NURSING TEAM'S RECENT NOTABLE ACHIEVEMENTS INCLUDE:

- Implemented a targeted educational curriculum to ensure ongoing competency development in foundational nursing practices. This quarterly program leverages multiple asynchronous modalities including online interactive learning modules combined with in person hands-on practice and discussion. The program is provided by both experienced educators and peers within the work environment to reinforce team learning and mentoring relationships. The program has seen a vast improvement in knowledge transfer and retainment scores compared to prior approaches.

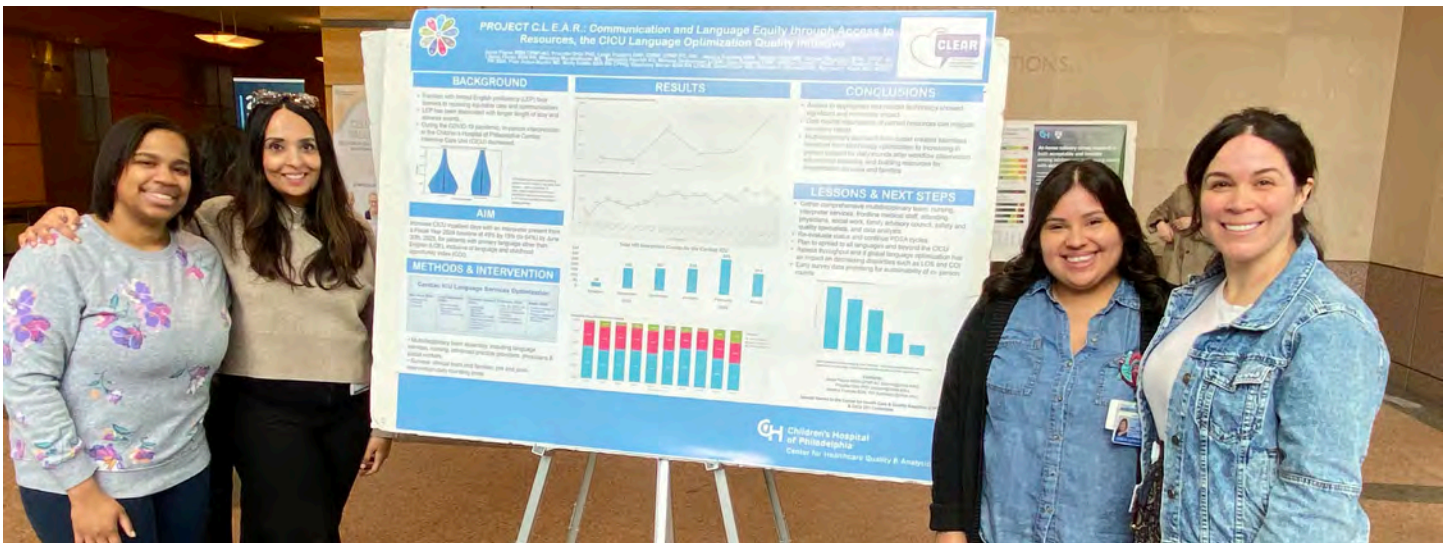
- Most units scored significantly higher in the 2024 Staff Engagement Survey, reflective of increasing employee engagement and improved work environment. Notably, four nursing teams were recognized for outstanding safety performance. The CPRU and Cardiac OR nursing staff were both recognized as top performers out of all other units within the CHOP Enterprise. Staff from the Cardiac Care Units (5 East & 6 East) were also recognized a one of the most improved units regarding culture of safety responses. All cardiac units have seen drastic improvements in preventable harm outcomes, with notable improvements in preventing hospital acquired viral infections and vascular access related harm (CLABSI & PIVIs).


Pre-Assignment of Nursing Code Roles in the CICU
BACKGROUND
METHODS
RESULTS


Safety Program: A Multi-Modal Education Approach to Reinforcing Harm Prevention Initiatives at the Bedside


The DAISY Team Award
Congratulate our DAISY Team Award Honorees!


Pre-Assignment of Nursing Code Roles


PROJECT C.L.E.A.R.: Communication and Language Equity through Access to Resources, the CICU Language Optimization Quality Initiative
CLEAR
BACKGROUND
RESULTS
CONCLUSIONS
AIM
METHODS & INTERVENTION
LESSONS & NEXT STEPS
Children's Hospital of Philadelphia

NURSING EDUCATION

FACULTY

Michelle Pileggi, RN
Julie Dunn, RN
Karen Brown, RN
Ashley Mccarthy, RN

ONBOARDING & ORIENTATION

CICU: 36 RNs successfully onboarded
CCU/5E: 8 RN's successfully onboarded

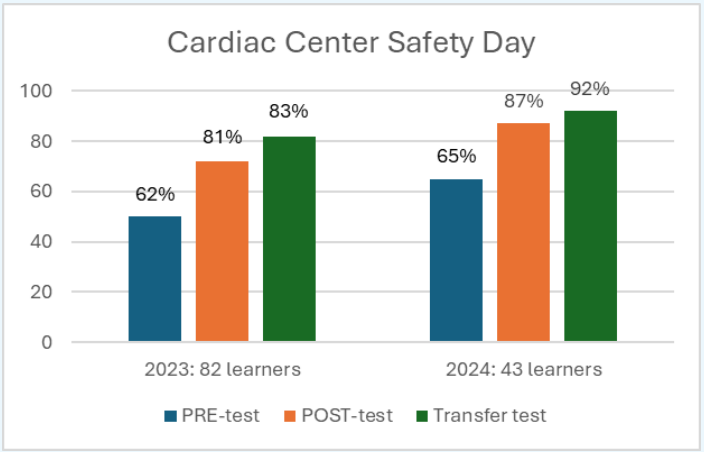
PROFESSIONAL DEVELOPMENT & CONTINUING EDUCATION

CARDIAC CENTER SAFETY DAY

The Cardiac Center Safety Day is a dedicated class for new Cardiac Center hires at CHOP, emphasizing harm prevention strategies (e.g., CLABSI, PIVIE, HAVI) and cardiac-specific safety measures, including SSI, MSI care, and HAPI prevention. This multidisciplinary initiative involves SQS, NPDS, CT Surgical PAs, CNSs, and harm prevention champions from all Cardiac Center units.

2024 OUTCOMES:

- 5 sessions conducted
- 43 participants
- Participant feedback:
  - 100% strongly agreed/agreed that the program is relevant to their role.
  - 100% strongly agreed/agreed that they will integrate learning into daily practice.



QUARTERLY COMPETENCIES FOR NURSING STAFF

Goal: Achieve 100% completion across inpatient units (~300 nurses). Topics are selected based on Knowledge, Attitudes, and Practices (KAP) assessments and error data analysis to address practice gaps.

- **Q1**: G/J Tube Safety & Care
- **Q2**: Medication Safety
- **Q3**: Central Line Maintenance
- **Q4** (Upcoming): Developmental Care & Feeding

ICU LECTURE SERIES 2025

With help from **Erin Pinto, MSN, CRNP,** this collaborative education series brings together all ICUs (**PICU, NICU, CICU, stepdown units 5E, 6E, PCU, and KOP ED & PICU**) for in-person or virtual learning on shared critical care topics. Continuing education credits are offered, and lectures are archived in the **Cardiac Center Library** for ongoing access.

2025 LECTURE SCHEDULE

CARDIAC CENTER VAD EDUCATION EXPANSION

The VAD education program has grown to include all disciplines beyond nursing, ensuring comprehensive team competency.

2023-2024 OUTCOMES:

- **331 total participants**
- Expanded to include: APPs, PAs, Hospitalists, CTOR, CPRU, Cath Lab RNs, PT/OT, and Rehab Physicians

MULTIDISCIPLINARY SIMULATIONS ACROSS THE CARDIAC CENTER

Simulations are led by a dedicated team, including a simulation attending, simulation educator, and NPDS educator. The team also facilitates bi-monthly multidisciplinary **ECPR simulations.**

2024 OUTCOMES:

- 57 simulation sessions conducted
- Participants:
  - 236 RNs (including NODs), 9 nursing students
  - 4 RRTs
  - 134 FLOC participants (PAs, APPs, Hospitalists)

2024 AWARDS, RECOGNITION & PRESENTATIONS

ACCEPTED & PRESENTED POSTERS/ABSTRACTS

- NICU Symposium (Feb 2024): Speaker on PDA management
- ANPD Conference (May 2024): ITCU Immersion (Poster Presentation)
- NCN Conference (Oct 2024): Cardiac Center Safety Day (Poster Presentation)
  - Awarded “Poster of the Day”
- PCICS Conference (Nov 2024): Comprehensive VAD Class (Poster Presentation)
- CHOP IPE Conference (Jan 2025)
- MSI Workgroup
- CRRT Competency Workgroup
  - Awarded “Poster of the Day”
- Cardiology 2025: SSI Workgroup

PUBLICATIONS

- ANPD Editorial: “Medication Safety: A Multimodal Approach to Education”
  - Publication Date: March 2025

COMING SOON:

- MyHeartArt – diagram application rolling out to the entire Cardiac Cetner!
- QI: Multidisciplinary Oral Optimization feeding workgroup in the Cardiac Center

ADVANCED PRACTICE TEAM

CICU APPs

CCU APPs

OUTPATIENT APPs

LEADERSHIP

Kerri Lombardi MSN, CRNP, MJ, MBA
APP Manager (CICU, CCU, CTOR and CPRU/Intake

Erin Pinto MSN, FNP
APP Manager (Outpatient Cardiology Subspecialties and Consult Services)

TEAM LEADS

Jarae Payne MSN, APRN CICU

Meghan Long MSN, APRN CCU

Christine Welch PA-C CT Surgery

Sharna Basu, MSN FNP CPRU-Intake

EXECUTIVE SUMMARY

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 the 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. The Cardiac Center Advanced Practice Teams support the Cardiac Center vision of promoting 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 partnership in research and ongoing dissemination of knowledge. We aim to contribute to the vision of the Cardiac Center to be the premier Cardiac Center that transforms the lives of children with heart disease and their families.

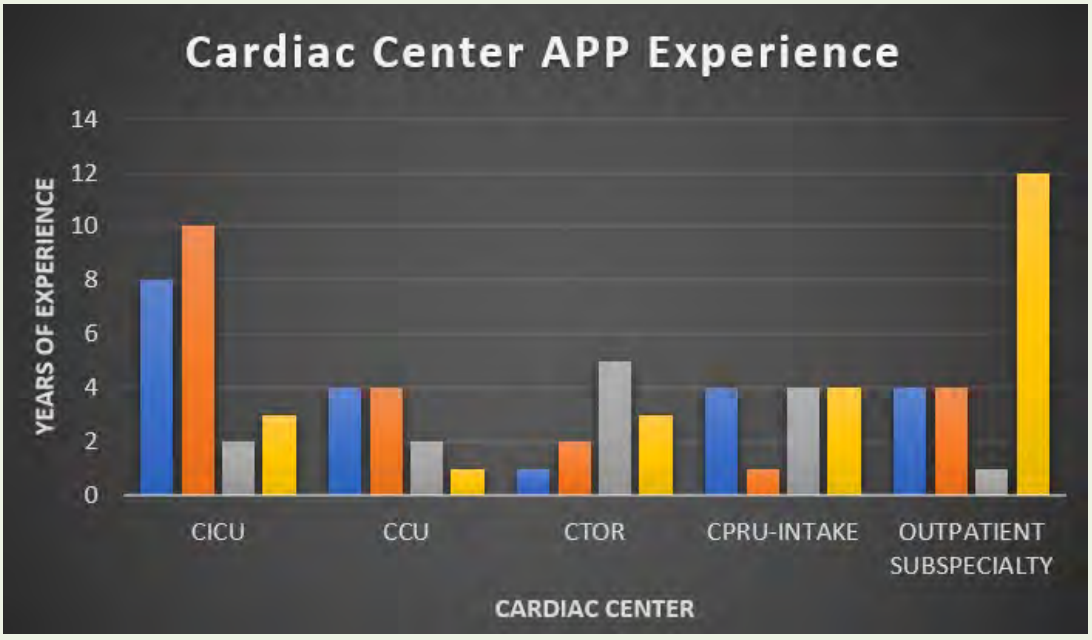
Key accomplishments by the APPs in support of our Cardiac Center Mission and Vision.

- CICU: Project C.L.E.A.R. (Communication and Language Equity through Access to Resources) is a process that increase in-person interpretation in the CICU, with interpretation during rounds for our Spanish-speaking families. This project went live in February 2025.
- CPRU/Intake: Flat time initiative in the CPRU post-cardiac catheterization and Reducing Unnecessary Blood Orders in the Cardiac Catheterization Lab
- CCU: Medical Readiness and Discharge Optimization
- CT Surgery: Wound management

NUMBER OF CARDIAC CENTER APPS: 81 APPS

- Pediatric Nurse Practitioners (pediatric and family) 54
- Family Nurse Practitioners: 3
- Physician Assistants: 24

APP EXPERIENCE BY AREA



APP EXCELLENCE AWARDS - PAST AND CURRENT

APP Leader Award - 2022

APP Rising Star Award - 2023

APP Educator Award - 2024

APP EXCELLENCE AWARD NOMINEES

APP LEADER AWARD

Christine Welch
Kerri Lombardi
Erin Pinto
Jarae Payne
Teresa Stegmann

APP INNOVATOR AWARD

Jessica Eichner
Sarah Bakke

APP CLINICIAN AWARD

Jessica Eichner
Stephanie Braun
Erin Pinto

APP EDUCATOR AWARD

Carley Boyle
Lynne Ha
Jenna Heichel

RISING STAR AWARD

Meghan Long
Teresa Stegmann

EMERGING LEADE'R

Becky Westdorp

PHYSICIAN PARTNER AWARD

Matthew Elias
Mahsun Yuerek
Venkat Shankar
Monique Gardner

APP OF THE YEAR

Teresa Stegmann

CLINICAL EXPERT

Sharna Basu
Christy Bosler
Stephanie Braun
Lisa Gervasi
Diana Holbein
Rachel Keashen
Alyssa Tani (pending)
Erica Reighard
Laura Murphy
Sara Bond
Christine Welch
Taylor Zulli
Farzana Shah
Alyson Stagg
Monica Giannopoulos
Meghan Long
Rachel Pancoe (pending)
Katlyn Rubnitz (pending)

MASTER CLINICIAN

Megan Yowell Scott
Jessica Eichner
Emily Schwartz
Liz Trovato
Katie Dodds
Jenna Heichel
Erin Pinto
Sarah Bond
Kat Spivak
Lynne Ha
Teresa Stegmann (pending)
Jarae Payne (pending)

QUALITY IMPROVEMENT

(APP names listed but all projects are interdisciplinary)

- **Project CLEAR**
  - Jarae Payne
- **Discharge Optimization (partnership with PAC3)**
  - Sarah Bakke and Jordyn Farragher
- **Remote Monitoring**
  - Kat Spivak
- **Flat time initiative in the CPRU**
  - Sharna Basu and Lisa Gervasi
- **Oral feeding optimization**
  - Emily Stevenson
- **Enterprise Sepsis work**
  - Jordyn Farragher
- **Target based outcomes: Weight Adjust Wednesday**
  - Stephanie Braun
- **SSI prevention**
  - Liz Trovato
- **Unplanned Extubation in the CICU**
  - Erica Reighard
- **Clinical Communications**
  - Diana Holbein
- **CCU QI led daily rounding project.**
  - Becky Westdorp
- **Medical Readiness**
  - Becky Westdorp
- **Reducing unnecessary blood orders in the cath lab**
  - Sharna Basu and Lisa Gervasi
- **CICU Early Mobility**
  - Emily Stevenson
- **Infant Program**
  - Emily Stevenson
- **CCU Throughput/ New Patient Tower**
  - Meghan Long
- **CICU Throughput/ New Patient Tower**
  - Jarae Payne

APP HUMANITARIAN AND VOLUNTEER WORK

Meghan Long (Lead Coordinator), Jessica Eichner, & Jarae Payne
- Annual Heart Camp at Echo Hill Outdoor School (EHOS)

Teresa Stegmann
- India: New Pediatric CICU

Farzana Shah
- Outreach Mission: Rwanda

Erin Pinto, Carley Boyle, Lynne Ha, Kaitlin Lewis
- Gift of Life house

PROFESSIONAL DEVELOPMENT (ABSTRACTS, POSTERS, PUBLICATIONS AND PRESENTATIONS)

- Extracorporeal membrane oxygenation in pediatric patients with Fontan circulation: epidemiology and outcomes (Abstract) 2024
  - Authors: **Jessica R. Eichner, CRNP**, Rachel Sanderlin, Keith Baxelbaum, Aaron G. DeWitt, MD, Chitra Ravishankar, MD, Katsuhide Maeda, MD, Joseph Rossano, MD, Benjamin W. Kozyak, MD, Jonathan B. Edelson, MD MSCE
- Creating an Intensive Care Unit for Pediatric Patients with Advanced Heart Failure: A Team Focused Approach (Abstract) 2024
  - Authors: **Jessica Eichner, CRNP**, Benjamin W. Kozyak, MD, Matthew J. O'Connor, MD, Joseph Rossano, MD, Katsuhide Maeda, MD, Venkat Shankar, MD, Farrell Weiss, CRNP, Lynne Ha, CRNP, Carley Boyle, CRNP, Catherine Montgomery, RN, Jonathan B. Edelson, MD, Sally Evans, MD, Amanda Seelhorst, RN, Amanda Waples, DPT, Sherri Kubis, RN, Margaret Cates, CNS, Natalie Bernard, RN, Joye Bricker, RN, Meghan Long, CRNP, Monique Gardner, MD, Aaron G. DeWitt, MD
- Single Center Rates and Trends in Diagnosis of Necrotizing Enterocolitis in Pediatric Shunt Dependent Congenital Heart Disease (Poster presented at AHA & PCICS 2024)
  - Authors: **Jarae Payne MSN**, Keith Baxelbaum PhD, Robert Olsen BA, Deepthi Gunturi MS, Svetlana Ostapenko MA, Melanie Savoca MS, Erin Sullivan Ms, J., William Gaynor MD, Benjamin Kozyak MD, Monique Gardener MD
- Congenital Topic: The Fontan Patient and Fontan Failure. (2025).
  - **Melissa Damiano**. Presentation at the 61st Annual Meeting of The Society of Thoracic Surgeons; APP Pre-Conference: Clinical Session 1 Current Practices for Cardiothoracic Intraoperative Care. (2025)
- Creating an Intensive Care Unit for Pediatric Patients with Advanced Heart Failure: A Team Focused Approach. Pediatric Cardiac Intensive Care Society International Meeting, San Diego, CA (2024).
  - Authors: **Jessica Eichner CRNP**, Kozyak, BW, O'Connor MJ, Rossano, J, Maeda, K, Shankar, V, Weiss, F, Ha, L, Boyle, C, Montgomery, C, Edelson, JB, Evans, S, Seelhorst, A, Waples, A, Kubis, S, Cates, M, Bernard, N, Bricker, J, Long, M, Gardner, MM, DeWitt, AG.
- Laje P, Dori Y, Smith C, **Pinto, E**, Taha D, Maeda K. Surgical Management of Central Lymphatic Conduction Disorders: A Review. J Pediatr Surg. 2024 Feb;59(2):281-289. doi: 10.1016/j.jpedsurg.2023.10.039. Epub 2023 Oct 21. PMID: 37953163.
- **Pinto E**, Smith C, DeWitt A, Laje P, Dori Y. Multidisciplinary approach to patients with lymphatic conduction disorders. Semin Pediatr Surg. 2024 May 22;33(3):151416. doi: 10.1016/j.sempedsurg.2024.151416. Epub ahead of print. PMID: 38830310.
- Kelly B, Mohanakumar S, Ford B, Smith CL, **Pinto E**, Biko DM, Hjortdal VE, Dori Y. Sequential MRI Evaluation of Lymphatic Abnormalities over the Course of Fontan Completion. Radiol Cardiothorac Imaging. 2024 Jun;6(3): e230315. doi: 10.1148/ryct.230315. PMID: 38814187.
- DeWitt A, **Pinto E, Biroc L, Scott M**, Mille F, Favilla E, Vaiyani D, Rosenblatt S. Critical care management of patients with lymphatic conduction disorders. Semin Pediatr Surg. 2024 May 23;33(3):151423. doi: 10.1016/j.sempedsurg.2024.151423. Epub ahead of print. PMID: 38796974.
- **Pinto, E**. (2024). International- Copenhagen, Denmark. Lymphatics.
- **Keashen, R** and O'Connor Prange, E (December 2024). Syncope: Vasovagal, Mimic or Malignant? Oral presentation at Children Hospital of Philadelphia's Current Concepts in Advanced Practice Conference.
- **Keashen, R** (November 2024). Cardiology 101. Invited Speaker for Gloucester Township School Nurses. Presented at the Glen Landing Middle School, Blackwood, NJ.
- **Keashen, R** and O'Connor Prange, E (May 2024). Syncope: Vasovagal, Mimic or Malignant? Oral presentation at Connecticut Children's Fourth Annual Advanced Practice Provider Summit.
- **Keashen, R** and Dorfman, A (April 2024). Cardiac Conditions in Youth. Invited Speaker for the AtlantiCare Healthy Schools, Healthy Children Lecture Series for school nurses.
- **Keashen, R** (March 2024). General Cardiology. Invited Speaker for Haddon Township School Nurse Professional Development. Presented at the William G. Rohrer School, Haddon Twp, NJ.
- 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.
- Use of Bupivacaine liposomal injectable suspension in children aged 2 to 6 years undergoing cardiac surgery does not accelerate recovery. *JTCVS Open*. https://doi.org/10.1016/j.xjon.2024.11.013
  - Authors: Nitsche, L. J., Devlin, P. J., **Bond, S.** J., Friedman, J. A., **Rubnitz, K**. R., Schwartz, E., Bontrager, C. E., Karel, L. I., Nicolson, S. C., & Fuller, S. M. (2024).

- Jennifer Jacob-Freese MSN ACCNS-P; **Elizabeth Trovato MS PA-C**; Stephany Moran BSN LSSGB. *Caring for Incisions through Close Collaboration: Incision Care after Cardiac Surgery Initiative (INCCSN)*. PCICS 11/2024 and accepted for CHOP Cardiology 2/2025.
- **Elizabeth Trovato, MS, PA-C; Julie Dunn, MSN, RN, NPD-BC, CPN; Jenn Jacob-Freese, MSN, CNS, ACCNS-P, CCRN, RNC-NIC**, Kerri Crowley, MST, ALM; Stephany Moran, BSN, RN, LSSGB, Michelle Pileggi, MSN, RN, CCRN, NPD-BC; Karen Brown, MSN, RN, NPD-BC, **Marissa Bremer,** MSN, CNS, ACCNS-P, CV-BC, Rebecca Reid, MSN, RN, NPD-BC, CCRN-K, CPN, and Jeanette Palermo, DNP, RN, NPD-BC, EBP-C, PCCN; *Cardiothoracic Surgical Incision Care: An Interdisciplinary Approach to Improving Post-Operative Care.*CHOP Education Day 1/2025 and accepted for CHOP Cardiology 2/2025.
- Surgical resection of diffuse pulmonary arteriovenous malformations (pavms). *JTCVS Open*. https://doi.org/10.1016/j.xjon.2024.11.002
  - Authors: Falk, A. R., Nitsche, L. J., Bontrager, C. E., **Bond, S.**, Beslow, L. A., Borst, A. J., Pogoriler, J., Devlin, P. J., Goldmuntz, E., Singhal, S., Trerotola, S. O., & Fuller, S. M. (2024).

PRESENTATIONS:

- Cardiology 2025 Presentations
  - **Jenna Heichel:** Plenary Session: I've Intensely Cared for This Child but Things Did Not Turn Out Well: How Do I Manage? What Do I Do Next? The Nurse Perspective
  - **Christy Bosler:** Open Heart Surgery: What is CPB, X Clamp, Circulatory Arrest? / MCS: The Path to Explant.
  - **Carley Boyle:** A case based cardiac medication review panel / Heart to Heart: Navigating Challenges in Adolescent Transplant
  - **Erin Pinto:** Lessons from Lymphatics
- Pulmonary Vein Conference/Case Presentation. (2025). **Heather Meluskey**. AHA Scientific Faculty.
- Cardiac Center Lectures for the CICU/CCU nurses
  - Presenters: Carley Boyle, Lynne Ha, Lauren Biroc, Erin Pinto, Kerri Cram, Sarah Bakke, Heather Meluskey, Bree Kyncl, Fiona Halloran
- Lectures outside of the Cardiac Center:
  - Emergency room: Teresa Stegmann
  - CHOP specialty teams: Jordy Martino
  - CHOP resident lectures: Heather Meluskey
  - University of Pennsylvania: School of Nursing: Carley Boyle, Lynne Ha, and Deb Torowicz
- Skills Days
  - Teresa Stegmann and Megan Scott
- Conference Planning Committee
  - CHOP APP Annual Conference: Sara Bond
  - CHOP Lymphatic Conference: Erin Pinto
  - World Congress of Lymphology: Erin Pinto
  - PCICS APP Core Curriculum, Faculty: Jenna Heichel
  - Vital Talk Faculty: Jessica Eichner

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

PATIENT AND FAMILY-CENTERED CARE

- Patient Family Officer
  - Rachel Keashen, CRNP
- **Patient Satisfaction:** Key feedback from patients about their care experience with APPs.
- **Initiatives:** Special initiatives for improving communication, education, and overall patient experience.
- **Feedback Mechanisms:** Description of any formal processes for patient feedback or improvement (e.g., patient surveys, focus groups).

APP DIRECT BILLING- OUTPATIENT

- **Voorhees:** Rachel Keashen
- **Lancaster:** Lou Ann Fromuth **First APP in outpatient cardiology to direct bill and have her own schedule**.
- **PHL Campus:** Monica Giannopolous, Kaitlin Lewis, Jordy Martino, Erin Pinto, Lauren Biroc, Lynne Ha, Carley Boyle, Kerri Cram, Sara Mylett, Kelley Miller

STRATEGIC GOALS FOR NEXT YEAR

- Wellness & Work-Life Balance
  - April 2024-First Annual Cardiac Center APP Wellness Retreat
  - April 2025-Second Annual Cardiac Center APP Wellness Retreat
- Expansion of Services:
  - Expand APP roles in certain areas of cardiology.
  - Continued recruitment & retention of APPs in the Cardiac Center
- Training and Development:
  - **Leadership series:** OWN and LAUNCH
  - PCICS Bootcamp for all CICU APPs

CLINICAL & ANCILLARY DEPARTMENTS

PSYCHOLOGY

DEBRA LEFKOWITZ, PSY.D.

Debra Lefkowitz, PsyD is the Clinical Director of Cardiology Psychology. She specializes in providing services to patients undergoing heart transplantation and their families. Her focus is on optimizing child and family long-term health and well-being, which includes 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 a 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 at CHOP. In 2024, 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, and sits on the Ethics Committees of both CHOP and the International Pediatric Transplant Association. Dr. Lefkowitz led an international group of heart and lung transplant professionals to develop a consensus framework for best practices in the pediatric cardiothoracic transplant and VAD psychosocial evaluation, which will be published in the International Journal of Heart Lung Transplantation.

COLLEEN DRISCOLL, PH.D.

Colleen Driscoll, Ph.D. works with patients and families across the Cardiac Center's inpatient and outpatient settings, with a special focus on early childhood. She provides consultation and treatment services, and 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 currently serves as the Program Director for the Inpatient Family-Centered Neurodevelopmental (INFANT) Program, which was funded by a Cardiac Center Innovation Award. In this role, she is leading program development and implementation efforts to improve the provision of equitable neuroprotective care to infants in the inpatient units and to ensure appropriate outpatient developmental follow-up. She is also engaged in program development and quality improvement projects through the Developmental Care Steering Committee. Dr. Driscoll is an Assistant Professor of Clinical Psychology at the University of Pennsylvania Perelman School of Medicine. She participates in training activities, supervising Psychology interns and fellows and organizing a monthly seminar for Pediatric Psychology fellows. In 2024, she collaborated on 3 peer-reviewed publications related to family-centered care in pediatric populations, and was awarded the Diane Willis Award for outstanding research article published in the Journal of Pediatric Psychology.

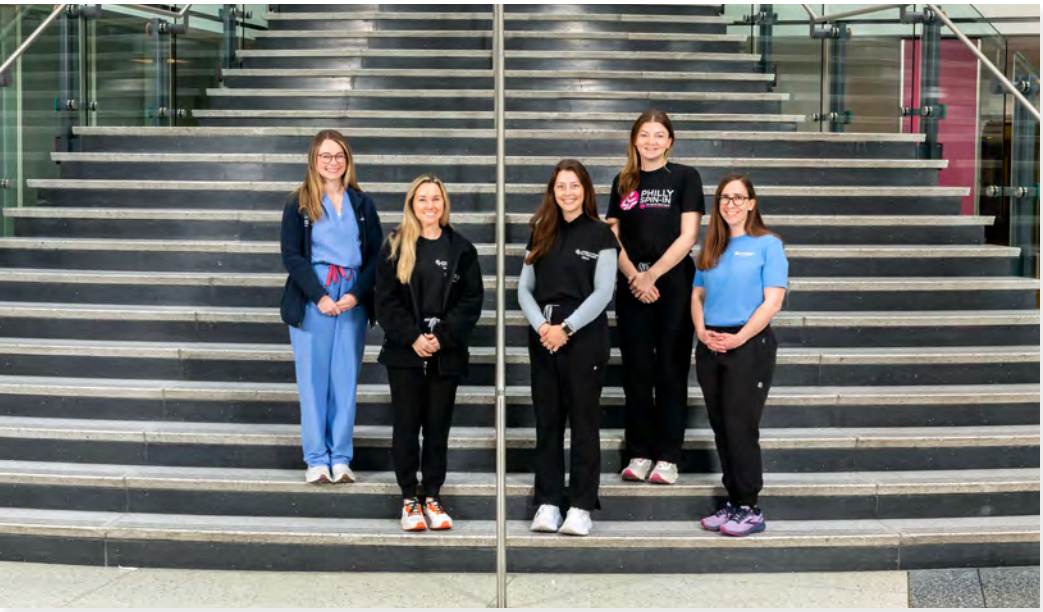
NICK SEIVERT, PH.D.

Nick Seivert, PhD is a pediatric psychologist in the Cardiac Center. Dr. Seivert's clinical interests include child and parent adjustment to illness, particularly congenital heart disease, as well as children with comorbid medical and psychiatric disorders. Dr. Seivert provides both inpatient and outpatient services to cardiology patients 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. In 2024, Dr. Seivert published a first-author paper, along with his FORWARD Program colleagues, on the impact of mental health on exercise capacity in pediatric patients with Fontan circulation. He also presented his work at local and national academic conferences. Dr. Seivert is involved in DEI work across CHOP, including the Cardiac Center Diversity, Equity, and Inclusion Committee. He is also an 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.

KARA WEST, PH.D.

Kara West, PhD joined CHOP as a psychologist in the Heart Failure Program in August 2024 after completing three years of training within CHOP's Solid Organ Transplant Program. She provides care to patients experiencing heart failure, including those who are being considered for ventricular assist devices. She engages in consultation and treatment with patients and families in both outpatient and inpatient settings to support coping with diagnosis and medical treatments, adherence to medical regimens, pain management, and transition to adult healthcare. In addition to clinical services, she is actively engaged in program development initiatives that seek to increase patient and family engagement and support opportunities. Dr. West also conducts research activities with a focus on psychosocial risk and resilience, and health disparities. She is a member of both national and international pediatric heart failure organizations.

CHILD LIFE



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. With the expansion of child life coverage in inpatient areas on the 6th floor and 5 East and outpatient areas, an additional child life team member was added as a Child Life Clinical Supervisor. Kaylee O'Brien stepped into this roll in early fall-2024. Olivia Humphrey was recruited for the open child life specialist position and joined the team in January 2025. 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, Sam Flick, and Olivia Humphrey. 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.

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.

HIGHLIGHTS FOR 2024 INCLUDE:

- Megan Fogerty presented with the CPRU team their poster "Improving Behavioral Health Planning in The Cardiac Prep and Recovery Unit (CPRU)" at CHOP's 2024 Quality and Safety Day.
- Supporting Fetal Heart patients and families during CFDT appointments to support continuity of care for these families.
- Active participation in the Infant Neurodevelopment Project.
- Weekly Tuesday evening and Sunday programming by our Child Activity Coordinator.
- Integration of Facility Dog, Nettle, with Child Life Specialists handler, Sammi Bachrach, routinely co-treating with Occupational and Physical Therapies.
- Presenting at the CHOP Cardiac Center Infant Development Conference.
- An increase in child life referrals for Cardiac Center outpatients. Between August – December 2024, 21 patients were seen in the Buerger Center Cardiac Clinic and supported through their cardiac testing (EKG's/Ultrasounds).
- Advocacy around safe sleep practices and minimized screen time for our young inpatients.
- Hosting shadow experiences highlight child life's work with the patients, families and team
- Involvement in the following Cardiac Center Committees
  - CICU Mobility and Sleep Hygiene Committee
  - Developmental Care Steering Committee
  - Patient and Family Experience Committee
  - Cardiac Center Bereavement Committee
- Continuing annual Cardiac Center traditions of Heart Dance, CHOP Prom, Camp Week

SOCIAL WORK

TEAM

Gino Poliziani, LSW CICU

Melissa Greberman, LSW CICU

Taylor Goldberg, LSW
Heart Failure/VAD

Charisse Rhone, MSW
Heart Failure/Transplant

Lynn Callaway, MSW
Fontan Foward & Cardiac Kids

Sue White, LCSW
Outpatient Cardiology

Lucia Figueroa, LSW Fetal Heart

Sasha Rose, LCSW Fetal Heart

Sydney Smith, LSW CCU/CPRU

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.

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

- Many 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.
- Securing lodging for the parents or caretakers, sometimes siblings as well, can be very challenging. This is another area where Social Work can support the families by 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 plays a pivotal role in responding to enterprise-wide screening, including the Ambulatory Abuse Screening work that is completed in all ambulatory spaces. Additionally, on the horizon for 2025, our Social Work team be engaged in responding to the Health-Related Social Needs Screening tool both in ambulatory and inpatient spaces

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

PHYSICAL THERAPY/ OCCUPATIONAL THERAPY

KEY LEADERS & STAFF

PHYSICAL THERAPY

Amanda Waples, PT, DPT, SSGBC
Rebecca Hoffritz, PT, DPT
Kristin Caputo, PT, DPT

OCCUPATIONAL THERAPY

Tabatha Rudzinski, MS, OTR/L, BCP
Jennifer Brennan, COTA
Eileen Kelleher, MS, OTR/L
Abigail Brundage, MS, OTR/L

OVERVIEW

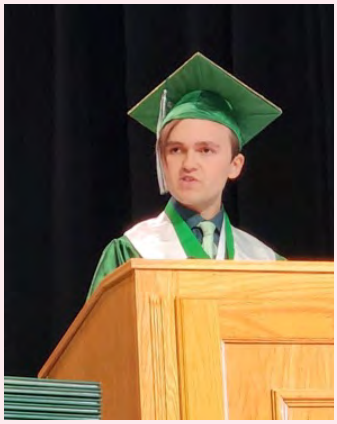
Our team of physical and occupational therapists work together to support patient's developmental and functional needs across the Cardiac Center including inpatient on the CICU and CCU and outpatient in the Cardiac Kids Developmental Program. In 2024, the physical therapy and occupational therapy teams provided high level care to over 800 patients in the inpatient setting alone, many with high complexity requiring novel interventions.

ADVANCED CARDIAC THERAPIES PROGRAM

In 2024, we had 21 participants in the ACT intensive rehab program, bringing the total since the start of the program to 49 participants. Despite increased volumes and complexity, we have continued to see remarkable functional outcomes in the infant, school aged, and adolescent populations. We presented on the national and international stages with poster presentations at the American Physical Therapy Association Combined Sections Meeting, American Occupational Therapy Association, and Pediatric Cardiac Intensive Care Society Annual Meeting as well as a platform presentation at Pediatric Cardiac Intensive Care Society Annual Meeting.

ACT Patients – Just A Few of Our Success Stories from 2024






NEURODEVELOPMENTAL CARE/INFANT PROGRAM

Our work on the Developmental Steering Committee this past year aimed to identify current gaps in our developmental care practices on the cardiac unit. As experts in development, we are able to help contribute best practices based on the pillars of developmental care, including family-centered care, cue-based care, a supportive environment, and positioning. Through our work this past year, we were able to identify a number of areas that would benefit from practice updates, and opportunities for education for our nursing and other clinical staff.

As part of the INFANT program, we partnered with nursing leadership for the Developmental Care in Congenital Heart Disease: The INFANT Program Conference in which we presented on Infant Behaviors and Cues and instructed in multiple breakout sessions for Positioning of the Infant, Holding and Skin-to-Skin Care and help to provide individualized activity and discharge recommendations for identified high risk infants during weekly INFANT rounds.

CICU MOVE PROGRAM

The CICU mobility project, CICU Move, has taken shape this year with a goal of promoting a culture of mobility for all patients. A collaboration amongst team members on this project from a variety of disciplines on the CICU have come together to address this goal for implementation of initiatives in 2025. This includes items such as creation of the cardiac critical care illness levels and staff education, ready for roll out in March 2025.

CARDIAC KIDS DEVELOPMENTAL FOLLOW-UP PROGRAM (CKDP)

Through the Cardiac Kids Developmental Follow-up Program QI Tummy Time study we have updated the Patient Family Education documents for sternal precautions to differentiate into specific age groups (infants 0-12 months, toddlers 13-36 months, school aged 4-12 years, and adolescent/adult > 13 years). By separating the age ranges we were able to be more specific about the activities patients are able to complete during the time of sternal precautions. This was especially important in the infant population as historically patients were not being placed in prone or participating in tummy time activities until 6-8 weeks after sternal closure, leading to increased incidence of cranial asymmetry, head preference and delayed milestones.

RESEARCH HIGHLIGHTS

The ACT Rehab team is exploring the use of the Segmental Assessment of Trunk Control, an outcome measure utilized to objective measure and track acquisition of trunk control at a segmental level, in infants with paracorporeal VADs and is working on feasibility manuscript for publication at this time. Simultaneously, they are exploring the use of the AM-PAC 6 Clicks as a measure of functional change in the pediatric heart failure population.

ON THE HORIZON

From an ACT Rehab programmatic perspective, we are looking forward to presenting at the International Society of Heart and Lung Transplantation in Boston in April of 2025. We are piloting an initiative for therapists to modify and pend activity orders to facilitate carry over of mobility outside of directed therapy sessions with our ACT intensive patients on the CICU in March 2025.
We will continue to assess our standard of care for our neurodevelopmental population to determine the most effective frequency, intensity, and duration of services in addition to supporting the neurodevelopmental care initiative, the INFANT program, with the implementation of more formalized assessments for high-risk infants. We plan to use the identified areas that would benefit from practice updates to create and roll out robust education to our cardiac unit staff.

We are eager to continue to partner with our colleagues across the Cardiac Center as we roll out the CICU Move initiative in March 2025 to support an interdisciplinary mindset regarding mobility in the CICU.

ADMINISTRATIVE & SUPPORT SERVICES

CARDIAC CENTER ADMINISTRATION

FACULTY

Mark Schwartz, MBA, M.Ed

Sara Baumgarten, BA
Heather Meldrum, BSN, RN
Jennifer Osborne, MSN, RN, CPHQ
Emily Schwartz, MSN, CRNP
Katelyn Zeoli, BSN, RN

Mary Kay Avington, RN
Susan Ferry, MHL, RRT-NPS, CCRC, CPHQ, CLSSBG
Ashley Ferstermann
Christine Gossard, RN
Brianna Heidenreich
Katie Kennedy, MPH, CPHQ, LSSGB
Shaylyn Leahy, BSN, RN
Hollis McLaughlin, BSN, RN
Samirah Nadar
Jennifer O'Neill, RN
Shannon Paoletti, BSN, RN, CCRN
Christa Piccininni
Bethany Seidel, BSN, RN
Kristen Skrobanek, BSN, RN
Amanda Thaler
Kelly Thomas
Michael Tumolo
Stephanie Valadez, RN, MSN
MarlaJan Wexler, BSN, RN, CPN-BC
Jackie Whittle, BSN, RN, CPN

In 2024, the Cardiac Center Operations Team continued to drive operational excellence by focusing on five domains: strategic planning, throughput, utilization, new patient tower planning, sustainability and financial stewardship. The Executive Operations Team worked closely with division and hospital leadership to ensure strategic collaboration for resource alignment and programmatic planning for the coming year. Below are several key highlights from 2024:

STRATEGIC PLANNING

In Fall 2024, under the leadership of the Cardiac Center Operations Team, Cardiac Center leadership initiated the next strategic planning process in collaboration with key stakeholders across the center. This effort began with six dedicated workgroups conducting a current state analysis and identifying recommended goals and initiatives to propel the center forward. In 2025, the strategic plan will be finalized and its initial implementation will begin, shaping the center's growth for the next five to ten years. Additionally, efforts to formalize the Cardiac Center service line within the CHOP enterprise are underway, aligning with the broader strategic plan.

PROCEDURAL SCORECARD OPTIMIZATION, UTILIZATION, AND THROUGHPUT

Collaborated with clinical operational leaders to develop a procedural scorecard series aimed at enhancing operational effectiveness across the Cath lab, CT surgery, Anesthesia, and Scheduling teams. These user-friendly, precise data visualization tools support informed decision-making and improve overall operational efficiency.

NEW PATIENT TOWER OPERATIONAL PLANNING

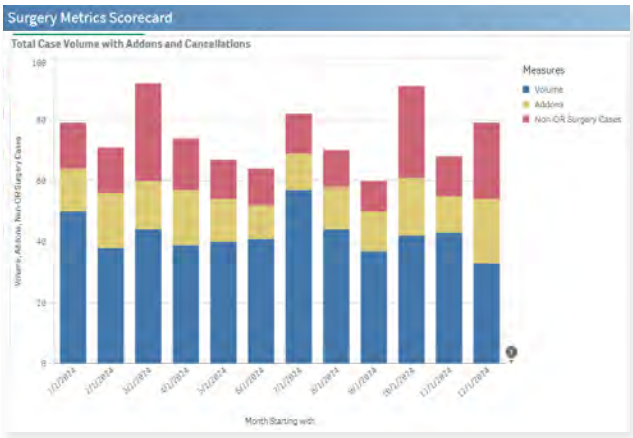
New Patient Tower [NPT] is rapidly taking shape as its steel infrastructure rises, with a planned opening date in May 2028.

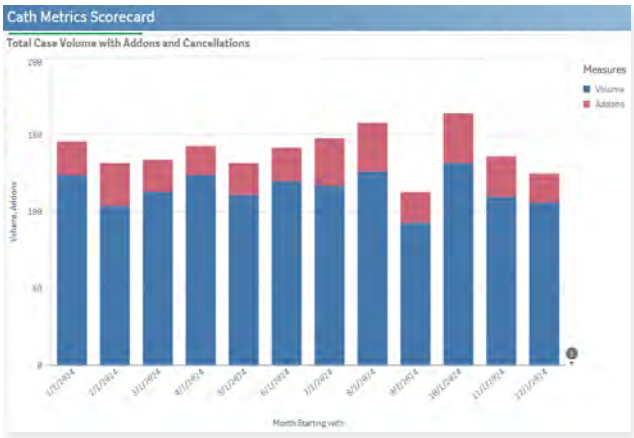
As the project advances, teams across the enterprise have transitioned from structural design planning to operational and logistics planning to ensure a seamless launch.

To support this effort, the Cardiac Center has established an Executive NPT Leadership Team, dedicated to maintaining strategic alignment and vision throughout the planning and coordination process.

As a result of the Cath and CT surgery scorecard work, the operations team, in partnership with frontline staff, has begun process mapping the throughput of procedural spaces. This collaborative effort, made possible by the contributions of the entire team, helps establish a shared understanding of operational terminology, identify areas for improvement, and maintain a strong focus on a culture of safety.

Ongoing quality improvement efforts remain focused on patient throughput, aligning care with patients' clinical needs and reducing length of stay through projects such as extubation readiness, sedation pathway optimization, early mobility and sleep hygiene, medical readiness and oral feeding optimization.





critical component of these throughput efforts is the Flow Facilitator role, which serves as a central communication hub. This role provides a single point of contact for inpatient disciplines, bridging procedural, scheduling, and anesthesia teams to create a balanced, efficient procedure schedule that supports safe and timely patient care.

SUSTAINABILITY AND FINANCIAL STEWARDSHIP

We have partnered with the Enterprise Climate and Sustainability Sub-Committee to establish a dedicated Cardiac Center Sustainability Team. Moving forward, we aim to expand successful projects from other areas while implementing new sustainability initiatives driven by frontline teams.

With the appointment of Emily Schwartz as Business Manager, we have launched several initiatives to support the Cardiac Center's efforts to optimize resource allocation, utilization and financial stewardship.

SUMMARY OF EFFORTS FOR 2024

- Cardiac procedural financial savings: $99,824.82
- Created design and implementation of non-cardiac procedure billing in the catheterization lab leading to greater than $140,000 in additional revenue capture
- Established Cardiac Operative and Imaging Complex steering committee:
  - Developed process for potential Extracorporeal Cardiopulmonary Resuscitation [ECPR]
  - Created and implemented cardiac surgery severity score
- Completed Emergency Care Research Institute [ECRI] analysis of cardiac procedural biomedical equipment

Continue to collaborate closely with CHOP Finance and Revenue Integrity to uphold the financial well-being of the Cardiac Center, ensuring our ability to achieve operational efficiency, financial stewardship, and strategic planning goals.

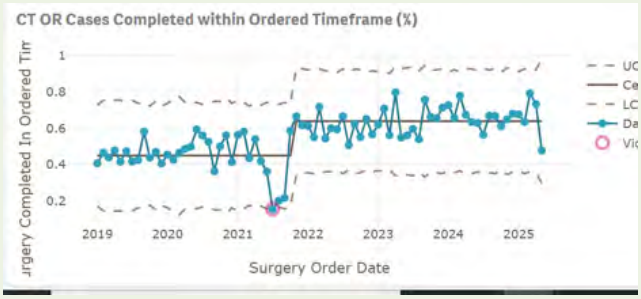
CARDIAC SCHEDULING & CARE COORDINATION

Manager – Heather Meldrum

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.

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.

- Partnering with EPIC team to improve Cardiac Center Status Board functionality.
- Block schedule utilization.
- Collaboration with revenue integrity team to reduce denials and improve reimbursement for procedures completed.
- Dental clearance-building tools to include in after visit summary at cardiology visit, and awareness of resources available.
- Collaborating with Penn Dental team to improve access for cardiac patients and develop family education on dental care.
- Cyber security- project to decrease impact on patient care in the event of a cyber attack.

REFERRAL & NURSE NAVIGATOR PROGRAM

TEAM

MANAGER

- Katelyn Zeoli, BSN, RN

NURSE NAVIGATORS

- Shaylyn Leahy, BSN, RN
- Shannon Paoletti, BSN, RN, CCRN
- Kristen Skrobanek, BSN, RN
- Bethany Seidel, BSN, RN
- MarlaJan Wexler, BSN, RN, CPN-BC

ACCESS COORDINATOR

- Kelly D. Thomas

The Cardiac Referral Team is dedicated to supporting patients seeking care at CHOP who have previously been diagnosed or treated by a cardiologist at another facility. Whether a patient is referred by their physician or is seeking to transfer care, the nurse navigators on the referral team are committed to guiding families through every step of the process. Our dedicated team of nurse navigators, in collaboration with our access coordinator, supports referring physicians and families nationwide, guiding them through the process from start to finish. This year alone, we have assisted patients from 47 states across the country.

Patients are often referred to our Cardiac Center for expert second opinions, diagnostic testing, advanced imaging, cardiac catheterizations, surgical procedures, or to participate in one of our specialty programs. We also help connect patients to our flagship programs, such as the Jill and Mark Fishman Center for Lymphatic Imaging and Intervention and the Topolewski Pediatric Heart Valve Center. Among our specialty clinics, the Electrophysiology (EP) and Heart Failure programs are the most frequently referred. Throughout the process, our team maintains open communication with referring physicians, fostering a strong, collaborative relationship with practices across the region. Additionally, our team works closely with the Cardiac Care Coordination Counselors to ensure that each patient's individual needs are addressed when seeking care at CHOP. Our team manages approximately 200 referrals per month, with about 65-70% being new patients to the Cardiac Center. While we do see many repeat patients, particularly from our long-established referring practices in the region, many return for diagnostic and procedural care.

The referral team collaborates closely with our Global Medicine Program to assist patients and families in navigating the complex process of seeking cardiac care at CHOP from outside the United States. This partnership is dedicated to facilitating access and overcoming the unique challenges that may arise when international patients seek the specialized services offered at our Cardiac Center. By working together, we ensure that all patients, regardless of their location, have the support they need to access world-class cardiac care at CHOP.

MARKETING & PUBLIC RELATIONS

LEADERSHIP

Alicia Callahan
Digital Strategist

Jennifer Mitloff
Senior Account Manager

Tony Popowski
Digital Marketing Manager

Natalie Solimeo
Public Relations Manager

SUPPORTING ENTERPRISE GROWTH

Leveraging insights, analytics, strategic planning and communications to drive business growth, defend and grow the CHOP brand and enhance the patient experience.

Our team ensures that the right message reaches the right audience at the right time to support the Cardiac Center's goals. Through a comprehensive digital strategy—including CHOP.edu, paid search, digital advertising, and email marketing—we strengthen visibility and engagement. Our public relations efforts leverage social and traditional media to amplify high impact research, patient stories and other breakthrough Cardiac Center news. We also lead the creative development and production of multimedia assets designed to connect with patient families, professionals, and the broader community, ultimately advancing the mission of CHOP's Cardiac Center.

BUILDING THE BRAND

1,200+
Local and National
News Media Mentions*

1.8M
People Reached*
via CHOP and Cardiac Center
social media **In 2024*

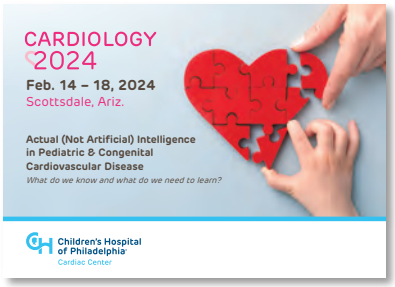
Nearly **5,500** National and International contacts for professional newsletters

DRIVING VOLUMES

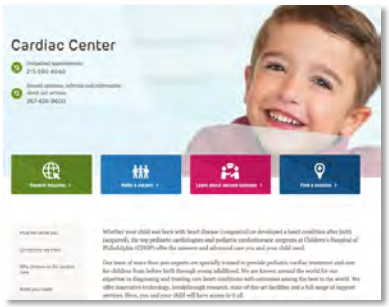
1,000 CALLS
to Cardiac Center from chop.edu

308K VISITS
to priority Cardiac Center chop.edu pages (+4% YoY)

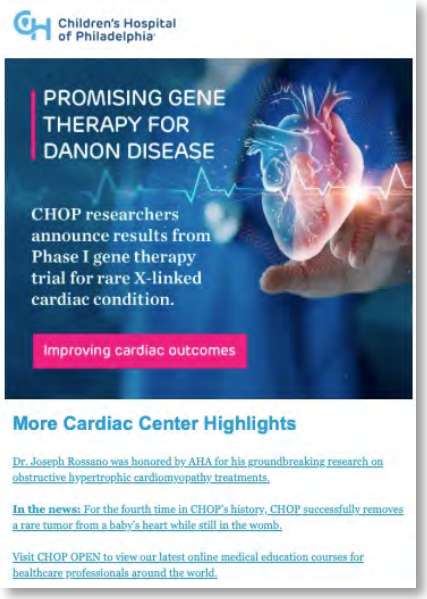
Annual Conference promotion and material development



Newly redesigned chop.edu



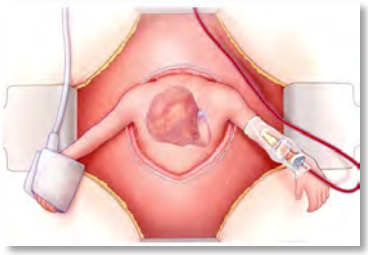
Cardiac Connections e-Newsletters



ARLEY'S STORY:

Fetal Surgery for Pericardial Teratoma

See video here



CARDIOLOGY CONFERENCE

CARDIOLOGY CONFERENCE 2024

The 28th Annual Update on Pediatric and Congenital Cardiovascular Disorders - sponsored annually by the CHOP Cardiac Center, was held from February 19th to February 23rd at the Disney Yacht and Beach Club Resort in Lake Buena Vista, Florida. Over 800 attendees came to the conference from around the country and internationally. The theme of the conference this year was “Hope, Heal, Learn”.

PHILANTHROPY

PHILANTHROPY

OVERVIEW OF THE FOUNDATION

The CHOP Foundation has achieved remarkable growth in its fundraising efforts, marking another record-breaking year. Within the Cardiac Center, a multi-faceted and highly collaborative strategy has been a key driver of success. The Foundation works closely with cardiac leadership, faculty, and staff to advocate for the Cardiac Center's needs, including clinical care, patient and family experience, training, education, and innovative research. This progress is built on a solid foundation of trust and a shared commitment to advancing the Cardiac Center's vision and goals through external partnerships.

In the past fiscal year, the Foundation utilized an integrated infrastructure that brings together various fundraising streams. This infrastructure has allowed the team to expand their efforts and continue supporting the excellence in care, training, and research that is happening within the Cardiac Center.

FOUNDATION TEAM DEDICATED TO THE CARDIAC CENTER

A dedicated team supports the fundraising strategies that aim to increase philanthropic support for the Cardiac Center. Alongside the Individual Giving team, other partner teams collaborate to generate revenue from multiple charitable sources, all directed toward supporting the strategic goals and priorities of the Cardiac Center. Below is the integrated structure of the Foundation partners supporting this effort.

SUMMARY OF FUNDRAISING PERFORMANCE FY24

- Total Giving: $7,401,166
- Total Unique Donors: 7,701
- Total Number of Gifts: 20,864
- Total Number of Fund Allocations: 41
- Average Gift Size: $355

BOARD OF VISITORS

The Cardiac Board of Visitors (BOV) remains a dedicated and integral group in supporting the Cardiac Center's goals and vision. This multigenerational group of donors includes parents, grandparents, and adult former pediatric patients, all united by their shared commitment to advancing cardiac care, research, and training through philanthropy. Their efforts have had a significant impact on the Center, as they contribute not only financially but also through their deep engagement and advocacy.

The Board consists of philanthropists both from Philadelphia and beyond who are deeply aware of CHOP's leadership in pediatric cardiac care. The members gather twice a year to stay informed about the progress and challenges facing the Cardiac Center, discussing how best to support initiatives like groundbreaking research, clinical care improvements, recruitment of top talent, and training the next generation of medical professionals. Additionally, they focus on emerging priorities, such as providing psychosocial support to patients and families—an essential aspect of holistic care.

The Cardiac Center is fortunate to have such a highly engaged and passionate support system in the Cardiac BOV, whose members continue to play a pivotal role in driving forward its mission and priorities.

2025 PHILLY SPIN IN

HIGHLIGHTS AND ACCOMPLISHMENTS

Over 1,800 people danced on bikes for the little hearts at CHOP the weekend of March 8th and 9th. In its 9th year Philly Spin-In raised a record breaking $1,147,752 and counting - bringing the cumulative event total to over $6.6 million in 9 years.

SAVE THE DATE

2026 PHILLY SPIN-IN, MARCH 7TH & 8TH
AT THELIVE! CASINO & HOTEL PHILADELPHIA

RESEARCH

CARDIOVASCULAR RESEARCH INSTITUTE

LEADERSHIP

Daniel P. Kelly, MD
Rachel Ash Presidential Chair;
Director, Cardiovascular Institute

OVERVIEW

The CHOP Cardiac Center is internationally recognized as a leader in the care of children with congenital forms of heart and vascular disease, and in the development of breakthrough therapeutics and diagnostics. To develop a world-class comprehensive cardiovascular research enterprise at CHOP, the CHOP CVI was established in the spring of 2022 in partnership with the CHOP Cardiac Center and the Penn CVI, under the common leadership provided by Dr. Daniel Kelly (photo) with administrative assistance from Ms. Brittany Thomas (Administrative Coordinator) and Ms. Teresa Leone (Director, Research Administration and Operations). An overview of the early-stage progress and strategic long-term plans for the new CHOP CVI is provided here, with emphasis on collaborative linkage to the CHOP Cardiac Center.

CHOP CVI MISSION STATEMENT

Channeling the expertise of top basic, translational, and clinical 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. The objectives of the CVI are:

- **Fundamental discovery** to elucidate the pathophysiology of pediatric heart and vasculature.
- **Translation and clinical research** to rapidly move discovery to new paradigms in pediatric patient cardiovascular care and diagnosis using precision medicine approaches.
- **Train** the next generation of pediatric cardiovascular scientists.

PROGRESS UPDATE KEYED TO 5-YEAR PLAN.

1. Establish CHOP CVI membership and website. Since the opening of CHOP CVI membership in 2022, we now have 35 faculty members, most of whom also have membership in the Penn CVI. A website (https://www.research.chop.edu/chop-cardiovascular-institute) was launched to provide information about the faculty and to display 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 and funding opportunities.

   FY25 Plans: Continue to expand membership and enhance website commensurate with the faculty recruitment plans as outlined below.

2. Faculty recruitment and development of programs. As outlined in last year's annual report, we have endeavored to recruit a mid-to-senior level scientist with research interests in the area of pediatric cardiovascular disease as the first CVI Basic Science Director. The search is still ongoing because our first two choices did not materialize. We have several excellent outside and internal candidates for this position. Over the past year, we made a decision to also recruit a CVI Clinical Research Director in partnership with the Cardiac Center. A Search Committee has been established for the Clinical Research Director position and several outstanding candidates have been identified.

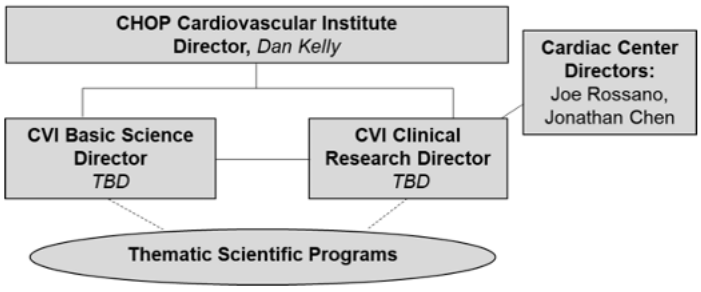


Figure 1. Plans for the development of a CHOP CVI comprehensive research enterprise.

This strategy will result in partnered leaders across the spectrum of basic discovery to clinical research; a comprehensive research enterprise as shown in Figure 1. Recruitment of new leaders will lead to development of thematic programs that span basic discovery to clinical research.

FY25 Plans: Recruit the Basic Science and Clinical Research Directors. In conjunction with Dr. Kelly, the new Directors will develop a plan to recruit junior faculty members in both the laboratory and clinical research areas to populate new thematic programs (Figure 1). The research space housing the evolving Basic Science unit will be located on the 6th floor of the Colket Translational Research Building.

3. **Develop a dedicated "through the door" biorepository for pediatric CV disease.** 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 Cardiac Center/CVI/ Birth Defects Biorepository (CC.CVI.BDB, Figure 2). This initiative is jointly supported by the CHOP CVI and 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. Disposable tissues are also being collected in the operating rooms for deep "omic" characterization. In addition, extensive de-identified clinical (phenotype) information is collected and stored in a database so that genotype-phenotype and outcome studies may be conducted. 982 patients with CHD (including 737 trios) have been enrolled to date which represent both previous BDB efforts together with the newly formed CC.CVI.BDB. Notably, this is one of the few such pediatric cardiac biobank efforts nationwide. Increasing numbers of Cardiac Center/CVI scientists are launching projects using the CC.CVI.BDB.

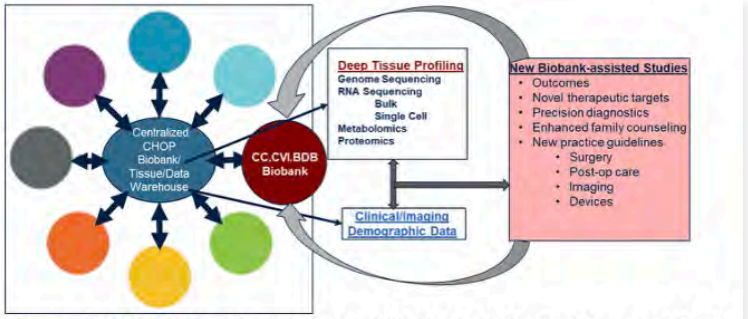


Figure 2. CHOP Cardiac Center-CVI-Birth Defects Biorepository

FY25 Plans: vContinue to develop and expand this important research resource over the next year. In addition, a business plan must be developed to ensure solvency over the years. This will require both institutional and philanthropic/grant support.

4. **In partnership with the Cardiac Center leadership, develop a strategic plan for clinical research from translational science to innovative trial design.** The research component of the Cardiac Center 5-year strategic plan is currently being developed by a team of faculty researchers together with the Cardiac Center leadership. This plan is largely focused on clinical research directions and resources but also to employ mechanisms to partner with the basic science component of the CVI. Within this effort, a collaborative interest group termed Imaging, Modeling, Mechanics and Materials (IM3) has been launched. IM3 involves a collaborative partnership between engineering- and imaging-oriented Cardiac Center faculty with faculty within the Penn School of Engineering and Applied Sciences. The first joint recruit has been accomplished, Dr. Wensi Wu (see announcement below). It is envisioned that IM3 will evolve into a formal program within the CVI.

NEW TEAM FACULTY MEMBER WENSI WU BRINGS INNOVATION TO CARDIOVASCULAR RESEARCH

Wensi Wu joined the Mechanical Engineering and Applied Mechanics (MEAM) faculty as a Research Assistant Professor. Wensi's research sits at the convergence of applied mechanics, scientific machine learning, and medicine, where she develops predictive virtual models of the heart, grounded in the in vivo principles of tissue mechanics, to tackle critical challenges in cardiovascular research. While completing her PhD in Structural Mechanics at Cornell in 2021, a time marked by the Covid-19 pandemic, Wensi was prompted to reflect on the broader significance of her work. These moments inspired her to direct her skills toward research that would both align with her intellectual interests and make a meaningful impact on human lives. Wensi is particularly energized by Penn's collaborative environment.

FY25 Plans: Finish and execute the Cardiac Center Strategic Plan for research.

5. **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.

   FY25 Plans: Secure the biobank gift along with other funds that could support the recruitment of the Cardiac Center/CVI Clinical Research Director and other new research efforts.

SELECTED 2024 PUBLICATIONS FROM CVI MEMBERS:

1. 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. *Circulation: Cardiovascular Interventions.* 2024 Jan;17(1):e013204. PMID: 38152881

2. Hu P, Rychik J, Zhao J, Bai H, Bauer A, Yu W, Rand EB, Dodds KM, Goldberg DJ, Tan K, Wilkins BL, **Pei L**. Single-cell multiomics guided mechanistic understanding of Fontan-associated liver disease. *Science Translational Medicine*. 2024 Apr 24;16(744):eadk6213. PMID: 38657025 PMCID: PMC11103255

3. **Berger J,** Matsuura TR, Bowman CE, Taing R, Patel J, Lai L, Leone TC, Reagan JD, Haldar SM, Arany Z, **Kelly DP**. Sodium-glucose co-transporter 2 Inhibitors Act Independently of SGLT2 to Confer Benefit for Heart Failure with Reduced Ejection Fraction in Mice. *Circulation Research*. 2024 Aug 16;135(5):632-634. PMID: 39041214 PMCID: PMC11326968.

4. **Berger JH**, Shi Y, Matsuura TR, Batmanov K, Chen X, Tam K, Marshall M, Kue R, Patel J, Taing R, Callaway R, Griffin J, Kovacs A, Shanthappa DH, Miller R, Zhang BB, Roth Flach RJ, **Kelly DP**. Two-hit mouse model of heart failure with preserved ejection fraction combining diet-induced obesity and renin-mediated hypertension. *Scientific Reports*. 2025 Jan 2;15(1):422. PMID: 39747575

SELECTED 2024 AWARDS/GRANTS AND HONORS OF CVI MEMBERS:

- **Justin Berger** was awarded a 3-year Career Development Award by the American Heart Association (AHA) for his project, "Probing the Mechanism of SGLT2 Inhibitors in Heart Failure".
- **Michael O'Byrne** was invited to give the Niland Memorial Lecture at Mott Children's, University of Michigan.
- **Jonathan Edwards** received a WW Smith Charitable Trust Grant.
- **Liming Pei (CHOP)** and Wenli Yang (Penn) received a multi-PI grant from the Department of Defense.
- **Daniel Kelly** delivered the Inaugural Conner Dunn Keynote Lecture at the 2024 UCLA Cardiovascular Theme Retreat.
- **Daniel Kelly** was selected to receive an NHLBI Outstanding Investigator Award (R35).
- **Rebecca Ahrens-Nicklas (CHOP)** and Kiran Musunuru (Penn) received a U01 Award from the NIH for gene editing in humans with inherited metabolic disorders.

ON THE HORIZON:

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

1. Continue to expand membership and enhance website commensurate with the faculty recruitment plans.
2. Recruit the Basic Science and Clinical Research Directors. In conjunction with Dr. Kelly, the new Directors will develop a plan to recruit junior faculty members in both the laboratory and clinical research areas to form thematic programs.
3. Continue to develop and expand the CC.CVI.BDB and develop a sustaining business plan for its support.
4. Finish and launch the research component of the Cardiac Center Strategic Plan for research.
5. Secure the CC.CCVI.BDB gift along with other funds that could support the recruitment of the Cardiac Center/CVI Clinical Research Director and ramp up efforts for other new research efforts.

CARDIAC BASIC RESEARCH
LEVY LAB

KEY LEADERS & STAFF

Ivan Alferiev, PhD
Research Associate Professor

Michael Chorny, PhD
Professor

Ilia Fishbein, PhD
Research Associate Professor

Robert Levy, MD, Professor
Director of Research and Research Training, Division of Cardiology

Stanley Stachelek, PhD
Research Associate Professor

Andrey Zakharchenko, PhD
Instructor

HIGHLIGHTS AND ACCOMPLISHMENTS

STUDENT ACHIEVEMENTS

The Levy lab has welcomed high school and undergraduate students to participate in our scientific work. This includes enthusiastic participation in the CHOP-RISES program for Philadelphia high school students.

- Kyle Tymes (CHOP Rises 2023 and 2024) is the most recent CHOP RISES participant. Kyle is completing his first year of college at Temple University as an Engineering Major. He plans to apply to the CHOP Research Institute Summer Scholars Program (CRISSP) program in his junior year.
- Mahady Rabbani, has joined the lab in 2024 for his Advanced Research elective course at Central High school, a public magnet school in Philadelphia. He is spending September to April of his junior year on a project in our lab concerned with the pathophysiology of biomaterials used in medicine.
- Drexel medical student, Trinity Hart, was a summer research intern in Dr. Robert Levy's laboratory in 2024. She received honorable mention for her Discovery Day poster at Drexel's School of Medicine, based on work performed in our lab.

FACULTY ACHIEVEMENTS

Research Associate Professor Stanley J. Stachlek, PhD, is co-investigator in a new program, R25GM155479: *Translating Medical Device Discoveries to the Bedside: The Academic Entrepreneurship Awareness to Action (AE2A) Curriculum to Promote Training of a Diverse Workforce* funded by the National Institute of General Medical Sciences (NIGMS). Along with PI Daria Ferro and other faculty, this program aims to grow a diverse, national biomedical research workforce adept in medical device innovation and entrepreneurship. The goal is to help participants embark on careers translating new research findings and technologies, including artificial intelligence, into market-ready medical devices for children and adults.

Robert J. Levy, MD, William J Rashkind Endowed Chair: Dr. Levy directs The FDA funded Pediatric Medical Device Consortium (PPDC). This past year in cooperation with Penn Health Tech, PPDC, has advised on 36 proposals for pediatric medical devices submitted by CHOP faculty. The PPDC directly supports two projects with FDA funds: 1) MENDing the Eardrum: Meniscus Decellularized Cartilage for Tympanoplasty from the Gottardi lab Division of Otolaryngology. More than one million children annually require tubes to drain ear infections, making myringotomy (tube placement) the most common pediatric surgery in the United States. However, in approximately 10% of patients, the tympanic membrane does not heal, requiring surgery. An autologous graft, which has longer surgical time and risk of morbidity, is the main treatment option to patch the defect. Meniscus decellularized (MEND) cartilage is a bioengineered material that structurally resembles the tympanic membrane, promotes repair, and provides mechanical strength matching and surpassing that of autologous grafts currently used in the clinic. The MEND technology is in development to improve the treatment for tympanic membrane repair and avoid patient morbidity.

2) The other pediatric medical device receiving PPDC support is the AMP-Vent: High-tech, Low-cost Ventilation for Austere Environments. The Autonomous, Modular, and Portable Ventilation system (AMP-Vent, patent pending) in development is suitable for austere environments, prolonged critical care, surgical applications, and mass casualty incidences. AMP-Vent's portability, coupled with telemedicine support and guidance from the neurometabolic optical monitoring module, can help ensure optimal trauma care in previously inaccessible medical scenarios. Rodrigo Menezes Forti, PhD, research associate, Division of Neurology; and Todd Kilbaugh, MD, anesthesiologist and pediatric intensivist in the Department of Anesthesiology and Critical Care Medicine, Director of the Resuscitation Science Center are leads on this project.

RELEVANT DATA & METRICS

Levy lab faculty were supported by twelve unique grants, averaging $630,950 for a total of $4,101,177 Annual Direct Costs received.

NAME	ROLE	PROJECT #	SOURCE	TITLE	ADC
Michael Chorny, PhD	PI	5R21HL159562	NIH/NHLBI	Multimeric prodrugs for pulmonary hypertension therapy	$125,000
Chorny	PI		(CHOP) Add-an-Aim (AAA)	2023 AAA Program NET-targeted prodrugs for treating chemoresistant neuroblastoma	50,000
Chorny	PI	5R01CA251883-05	NIH/NCI	Prodrugs targeting norepinephrine transporter for dual-selective therapy of refractory neuroblastoma	336,260
Chorny	CoI (Brodeur)	W81XWH2110536	DOD	Overcoming Drug Resistance to Treat High-Risk Neuroblastoma	$331,406
Robert J. Levy, MD	Contact PI	2T32HL007915	NIH/NHLBI	Training in Molecular Therapeutics for Pediatric Cardiology	$757,012
Levy	PI	3R01HL131872-07S1	NIH/NHLBI	Supplement to Serotonin Signaling in Mitral Valve Homeostasis, Maintenance and Restoration	$457,633
Levy	Contact PI (Ferrari)	5R01HL131872	NIH/NHLBI	Serotonin Signaling in Mitral Valve Homeostasis, Maintenance and Restoration	$571,713
Levy	PI	3P50FD006427-05S1	US Food and Drug Administration FDA	Medical Device Consortium Supplement	$136,364
Levy	PI	5P50FD006427	US Food and Drug Administration FDA	Medical Device Consortium	$702,370
Levy	MPI (Ferrari)	1R01HL170573-01A1	NIH/NHLBI	Mitigation Strategies for Metabolic Syndrome-induced Bioprosthetic Heart Valve Degeneration	$180,000
Stanley J. Stachelek, PhD	Co-I (Levy)	5R01HL131872	NIH/NHLBI	Serotonin Signaling in Mitral Valve Homeostasis, Maintenance and Restoration	See above
Stachelek	Co-I (Ferrari)	1R01HL170573-01A1	NIHv/NHLBI	Mitigation Strategies for Metabolic Syndrome-induced Bioprosthetic Heart Valve Degeneration	See above
Stachelek	Co-I (Ferro)	1R25GM155479	NIH/NIGMS	Translating Medical Device Discoveries to the Bedside: The Academic Entrepreneurship Awareness to Action (AE2A) Curriculum to Promote Training of a Diverse Workforce	$403,419
Stachelek	Contact PI (Laurence)		CHOP Cardiac Ctr Innovation grant	Progression of Mitral Valve Regurgitation in the Pediatric Population	$50,000
			12 unique grants	**Total ADC**	**$4,101,177**
				Average	**$630,950**

THE DIVISION OF CARDIOLOGY NIH RESEARCH TRAINING GRANT—YEAR 26

The NHLBI funded Research Training Grant at CHOP is now in its twenty-sixth year. This program, founded and continuously directed by Dr. Robert Levy, is the largest training grant at CHOP, with 8 training positions available for both bench researcher trainees and clinical research fellows. This year's annual Research Training Symposium for this NHLBI-T32 program is scheduled for June 26. The Keynote speaker will be Penn Associate Dean, Emma Meagher, PhD. In her roles as Associate Dean for the Perelman School of Medicine Masters and Certificate Programs, and as Director of Translational Research Education, Dr. Meagher is responsible for the rapidly growing portfolio of professional education opportunities provided by the Perelman School of Medicine.

T32 Trainees Joining the Faculty: Among recent T32 participants, Wensi Wu, PhD and Mudit Gupta, MD, PhD have joined the faculty at Penn and staff at CHOP. Dr. Gupta is Assistant Professor, in the Division of Cardiology, Department of Pediatrics, CHOP. Dr. Wu joins the Penn Mechanical Engineering and Applied Mechanics (MEAM) faculty as Assistant Research Professor. Former trainees Ivor Asztalos, MD, MBMi and Nikia Toomey are pursuing advanced clinical training.

PEDIATRIC CARDIOLOGY RESEARCH LECTURES (PCRL)

This year's PCRL lecture series was initiated with a talk from visiting scholar Asaf Ta-Shma, MD, PhD, Lecturer, The School of Medicine, Hebrew University of Jerusalem. The theme of this year's lecture series is: "Role models of research training and clinical research excellence".

RESEARCH HIGHLIGHTS

The 2nd Robert J. Levy, M.D. Lecturer at Cardiology 2025 (February, 2025): Annual Update on Pediatric and Congenital Cardiovascular Disease, was presented by Liming Pei, PhD, Associate Professor of Pathology and Laboratory Medicine, Perelman School of Medicine at the University of Pennsylvania

A Cardiac Center Innovation Grant was awarded to Dr. Stachelek, Associate Professor of Pediatrics (Research Track) & Dr. Devin Lawrence, CHOP Cardiology T32 Trainee (mentors Dr. Matthew Jolley, Dr. Stanley Stachelek, and Dr. Robert Levy), for the project entitled: Progression of Mitral Valve Regurgitation in the Pediatric Population: Biomechanics, cellular mechanisms and therapeutic targets physiology of mitral valve interstitial cells (MVICs).

ON THE HORIZON

Participation in a new national program entitled, the Heart Valve Collaboratory

CARDIOLOGY RESEARCH LABORATORY PUBLICATIONS FROM PUBMED JAN-DEC 2024

1. Castillero E, Camillo C, Levine D, D'Angelo AM, Kosuri Y, Grau JB, **Levy RJ,** Ferrari G. Serotonin transporter deficiency in mice results in an increased susceptibility to HTR2B-dependent pro-fibrotic mechanisms in the cardiac valves and left ventricular myocardium. *Cardiovasc Pathol*. 2025 Jan-Feb;74:107689. doi: 10.1016/j.carpath.2024.107689. Epub 2024 Sep 6. PMID: 39245153; PMC11585425.
2. Matsuoka M, Uchibe K, Tang N, Tian H, Suzuki A, Oichi T, Usami Y, **Alferiev I**, Otsuru S, Abzug JM, Herzenberg JE, Pacifici M, Enomoto-Iwamoto M, **Chorny M**, Iwamoto M. Retinoid-impregnated nanoparticles enable control of bone growth by site-specific modulation of endochondral ossification in mice. *bioRxiv* [Preprint]. 2024 Nov 11:2024.11.08.622655. doi: 10.1101/2024.11.08.622655.PMID: 396054977; PMC11601462.
3. **Dienstman J, Stachelek SJ,** Krieger AM, Eskandanian K, Espinoza JC, Harrison MR, Koh CJ, Peiris V, Torjusen E, **Levy RJ**. Pediatric Device Clinical Trials Activity: 1999-2022. *Pediatrics*. 2024 Aug 1;154(2):e2023063466. doi: 10.1542/peds.2023-063466. PMID: 38953121; PMC11277217.
4. Garcia SA, Wilson K, Tang N, Tian H, Oichi T, Gunawardena AT, **Chorny M**, **Alferiev IS,** Herzenberg JE, Ng VY, Iwamoto M, Enomoto-Iwamoto M. Analysis of the Actions of RARγ Agonists on Growing Osteochondromas in a Mouse Model. *Int J Mol Sci*. 2024 Jul 11;25(14):7610. doi: 10.3390/ijms25147610.PMID: 39062860; PMC11277217.

5. Fishbein I, Inamdar VV, Alferiev IS, Bratinov G, Zviman MM, Yekhilevsky A, Nagaswami C, Gardiner KL, Levy RJ, Stachelek SJ Hypercholesterolemia exacerbates in-stent restenosis in rabbits: Studies of the mitigating effect of stent surface modification with a CD47-derived peptide.. Atherosclerosis. 2024 Mar;390:117432. doi: 10.1016/j.atherosclerosis.2023.117432. Epub 2023 Dec 24. PMID: 38241977; PMC10939830.
6. **Alferiev IS**, Zhang K, **Folchman-Wagner Z, Adamo RF, Guerrero DT, Fishbein I, Soberman D, Levy RJ, Chorny M**. Nanocarrier Design for Dual-Targeted Therapy of In-Stent Restenosis. *Pharmaceutics*. 2024 Jan 29;16(2):188. doi: 10.3390/pharmaceutics16020188. PMID: 38399249; PMCID: PMC10892638.

Publications in review: Activation of PIEZO1 in human mitral valve interstitial cells upregulates collagen through serotonin receptor 2B signaling, Authors: Stanley Stachelek; Vitali Rusinkevich; Emily Hall; Nikia Toomey; Xiaoqiu Yang; Ilia Fishbein; Ephraim Jacobson; Dov Levine; Abba Krieger; Giovanni Ferrari; Robert Levy. *Circulation Research, Revisions under review.*

CARDIAC CENTER CLINICAL RESEARCH CORE (CCRC)

INTRODUCTION

In 2024, 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.

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 2024, the Research Core received 50 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 17 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 to research mentors and projects 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 that received notices of award or began enrolling in 2024.
Michael O'Byrne MD MSCE was awarded a National Heart Lung and Blood Institute (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 and to investigate the mechanisms for this disparity. He is the M-PI project with Halley Ruppel, a nurse investigator at CHOP and The University of Pennsylvania School of Nursing.

Elizabeth Goldmuntz MD (an attending physician in the Division of Cardiology) and Jonathan A Mitchell PhD (an investigator in CHOP's Division of Gastroenterology, Hepatology and Nutrition) were awarded an R61/R33 Phase 1 Exploratory/Developmental Grant from NHLBI supporting "Home-Based, Digital Intervention to Increase Physical Activity in Patients with the Fontan Circulation," which "aims to develop and test the efficacy of a mobile health technology platform for pediatric cardiology teams to promote physical activity in children with the Fontan circulation." Dr. Goldmuntz is also a M-PI with other investigators at CHOP for a National Cancer Institute U24 funded project "Uncovering the Shared Genetic Origins of Childhood Cancer and Structural Birth Defects Through Enhanced Data Integration and Analysis with the CFDE Distillery Knowledge Graph," which seeks to leverage machine learning to analyze genomic data to understand the biological mechanisms underlying both congenital defects and childhood cancers.

Monique Gardner MD MSCE (an attending physician in the Division of Cardiac Intensive Care) was awarded a K23 Mentored Career Development Award from the National Heart Lung and Blood Institute for the project "Assessment of Myocardial Dysfunction And Inflammation after Pediatric Cardiac Arrest" which seeks to evaluate the pathophysiological mechanisms of post-cardiac arrest syndrome using a combination of imaging and biomarkers.

Jonathan Edelson MD MSCE (an attending physician in the Division of Cardiology) was also awarded a K23 award for his project, "MIGHTIER: Movement in Heart Transplant patients: The Impact of Environmental factoRs [sic]," which "...seeks to use quantitative and qualitative methods to assess the macro- and micro-environmental determinants of moderate to vigorous physical activity in pediatric heart transplant patients and to evaluate a pilot study of longitudinal multi-component exercise intervention.

These awards are part of an increasing number of K-awardees in CHOP's Cardiac Center. Catherine Avitabile MD continued her K23 Mentored Career Development Award from NHLBI funding her project "Understanding Barriers to Physical Activity in Pediatric Pulmonary Hypertension in Order to Design Effective Home-based Exercise Programs. Brian White MD PhD continued his NHLBI-K08 funded research, titled "Optical Functional Neuroimaging of Acute and Chronic Hypoxia." Jonathan Edwards MD continued his own K08 (also funded by NHLBI) supporting research titled "Defining the Role of ROR2 in Right Ventricular Failure Pathogenesis."

Yuli Kim MD from the Section of Adult Congenital Heart Disease was awarded a Mend a Heart Foundation Research Award through The Children's Heart Foundation for the project "Hepatic Perfusion and Liver Health as Assessed by Dual Cholate Clearance Assay in Fontan-Associated Liver Disease,' funding a prospective cohort study that attempts to evaluate a novel method of evaluating hepatic clearance in recipients of the Fontan operation in comparison to patients with right heart disease and healthy controls. This research builds on a project initially funded through the CHOP Cardiac Center Intramural Grant program.

Radhika Rastogi, MD MPH (cardiology fellow) was awarded a Matthew's Hearts of Hope Award for an ongoing project evaluating the risks and benefits of cardiac catheterization in patients receiving mechanical circulatory support through ventricular assist devices. This project is co-mentored by Jonathan Edelson and Michael O'Byrne (both from the Division of Cardiology).

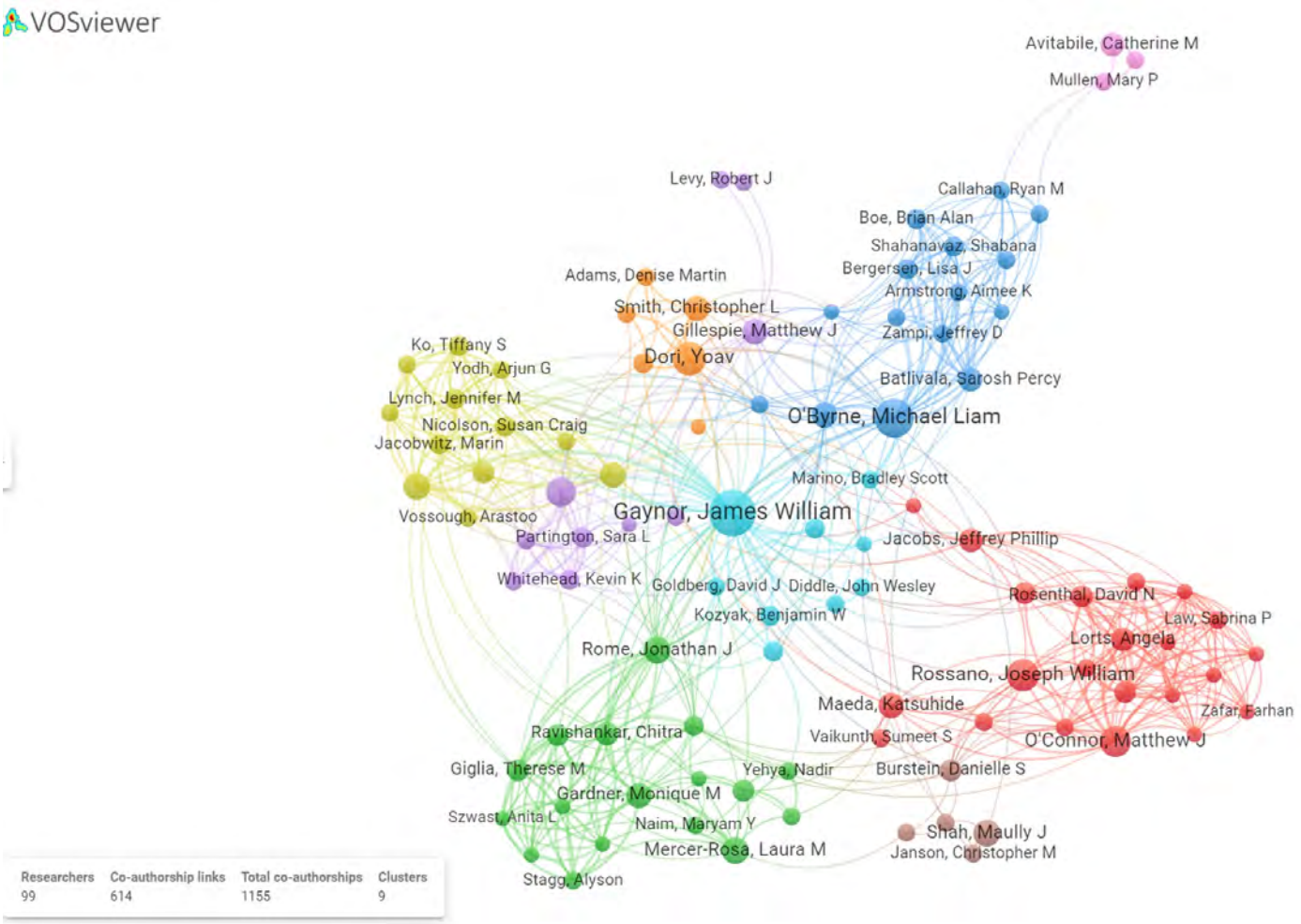
The Cardiac Center at CHOP maintains support for research training via an NHLBI-funded T32 training grant, which funds six advanced fellows or post-doctoral researchers with research interests (mentored by CHOP Cardiac Center Faculty) spanning the research continuum from discovery, translational, and clinical research focuses. This program celebrated its twenty-fourth year of support this year.

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 (11/2024) in Chicago IL, CHOP Cardiac Center faculty and trainees were prominently involved. In total cardiac center faculty, presented six invited lectures along with 21 abstracts from CHOP Cardiac Center authors (7 of which were supported by the CCRC), including 2 rapid-fire abstract presentations, as well as 9 invited presentations, and seven projects which included our fellow trainees. Dr. Joseph Rossano also received the PI award for excellence from the AHA/Heart Failure Collaboratory.

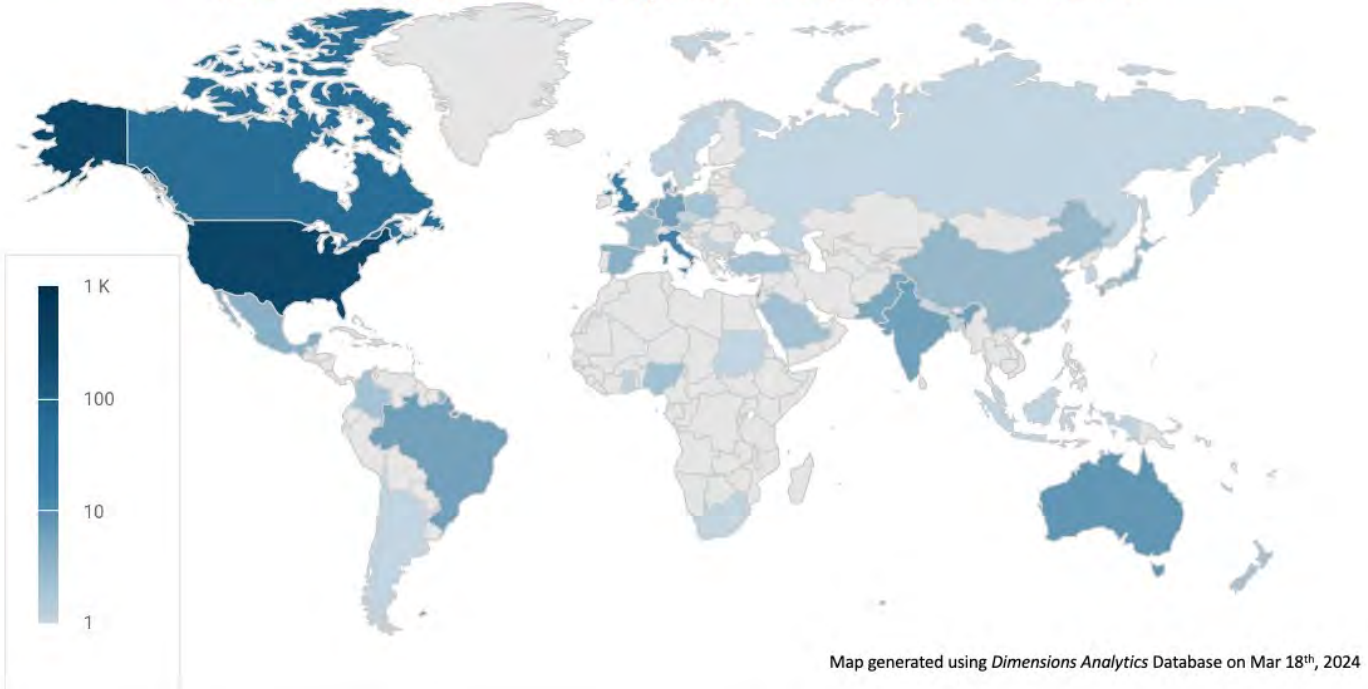
PUBLICATIONS IN MEDICAL JOURNALS

CHOP Cardiac Center faculty authored over 200 manuscripts in 2024. Of these, 58 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. Cardiac Center faculty and trainees are listed in red font. Publications with trainee authors are identified with an asterisk.



Countries of collaborators for 255 publications in 2023

Cardiac Center's global collaborations spanned over 356 institutions in 29 countries



Map generated using *Dimensions Analytics* Database on Mar 18th, 2024

CARDIAC CENTER PUBLICATIONS IN HIGH IMPACT JOURNALS

Amdani S, Auerbach SR, Bansal N, Chen S, Conway J, Silva JPD, Deshpande SR, Hoover J, Lin KY, Miyamoto SD, 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. 2024 Jan. 30(1):64-77. doi: 10.1016/j.cardfail.2023.08.026. PMID: 38065308

Amdani S, Shezad MF, Kroslowitz B, Townsend M, Joong A, Najm H, Marino BS, Rosenthal DN, Lorts A, O'Connor MJ. Outcomes for Children with Congenital Heart Disease Undergoing Ventricular Assist Device Implantation: An ACTION Registry Analysis. JACC. 2024, Dec. S0735-1097(24)10047-2. doi: 10.1016/j.jacc.2024.10.083. PMID: 39772369

Backer CL, Mavroudis CD. Vascular Ring Surgery: Past, Present, and Future. JACC. 2024, Oct. 84(14):1293-1294. doi: 10.1016/j.jacc.2024.06.043. PMID: 39322322

Balaji S, Rychik J, Moore JP. Fontan Junctional Rhythm-Innocent Bystander or Silent Killer? JAMA Cardiol. 2024, Apr. doi: 10.1001/jamacardio.2024.0689. PMID: 38656381

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 Jan; 17(1):e013204. doi: 10.1161/CIRCINTERVENTIONS.123.013204. PMID: 38152881

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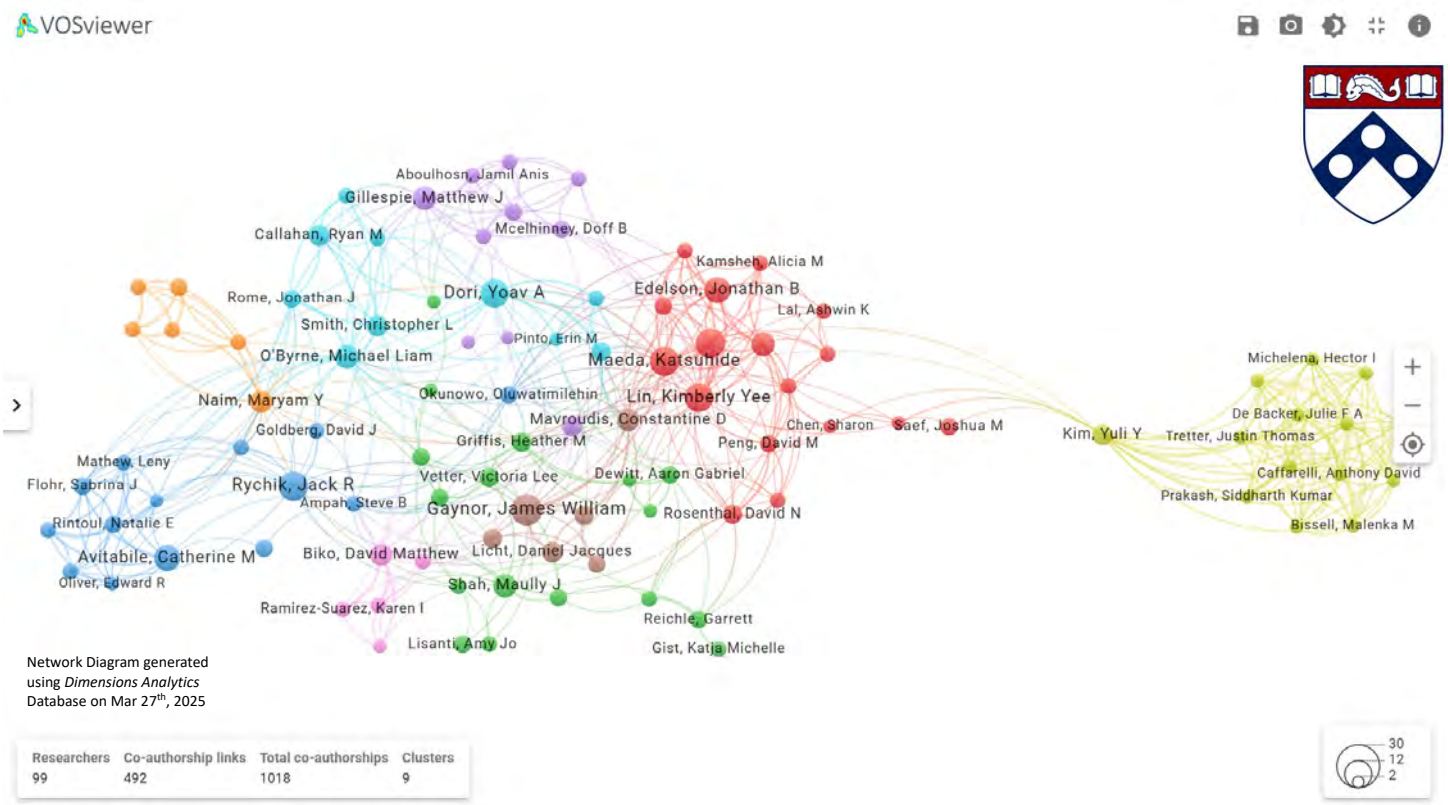
IMPACT METRICS AND COLLABORATIONS FOR YEAR 2024

Prepared on March 6th , 2025 by Neetu Rajpal, PhD
Holman Biotech Commons

CO-AUTHORSHIP NETWORK FOR 292 PUBLICATIONS IN 2024



Network Diagram generated using *Dimensions Analytics* Database on Mar 27th, 2025

BIBLIOMETRIC ANALYSIS

Prepared by: Neetu Rajpal., PhD.
University of Pennsylvania, Biomedical Holman Biotech Commons

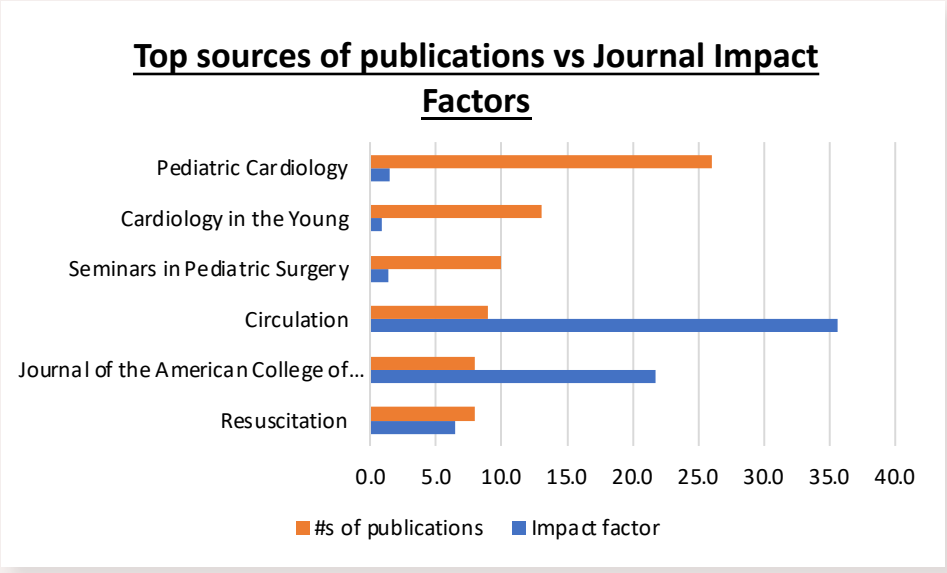
BIBLIOMETRIC ANALYSIS OF PUBLICATIONS BY THE FACULTY AND STAFF OF THE CARDIAC CENTER AT THE CHILDREN'S HOSPITAL OF PHILADELPHIA, 2024

Bibliometric Indicators 2024 (Cardiac Center-wide)	Value
Number of articles (Scopus)	292
Number of citations (WoS) Number of articles citing these works	378 259
Av. Citations (per cited article: articles received at least 1 citation) Av. Citations (overall)	2.8 1.5
Median citations (Articles with citations)	2.8
Portfolio H-index	9
# "Highly Cited" papers (top 1% for the field of Clinical Medicine in WoS) See Appendix A for a bibliography of "highly cited" papers.	2
# "Cited >=8" papers (Journal Impact Factor >6) See Appendix B for a bibliography of "Cited >=8" papers.	4

SUMMARY METRICS FOR CHOP CARDIAC CENTER (FROM SCOPUS)

Top 5 Sources:
Pediatric Cardiology: 26
Cardiology in the Young: 13
Seminars in Pediatric Surgery: 10
Circulation: 9
Journal of the American
College of Cardiology: 8
Resuscitation: 8

Articles: 292
Cited in 2024: 509
H-index: 9
Authors searched within the CHOP Cardiac Center: 199

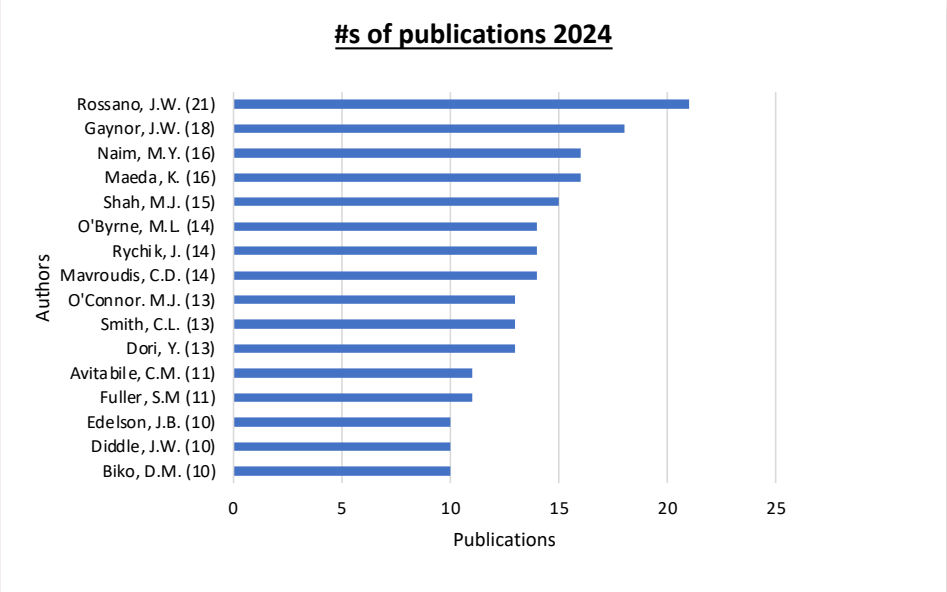


AUTHOR IMPACT -CARDIAC CENTER-WIDE (FROM SCOPUS)

Number of publications, top authors in 2024 (Source: Scopus) (limited to 10 or more publications)

Authors with the most publications in 2024

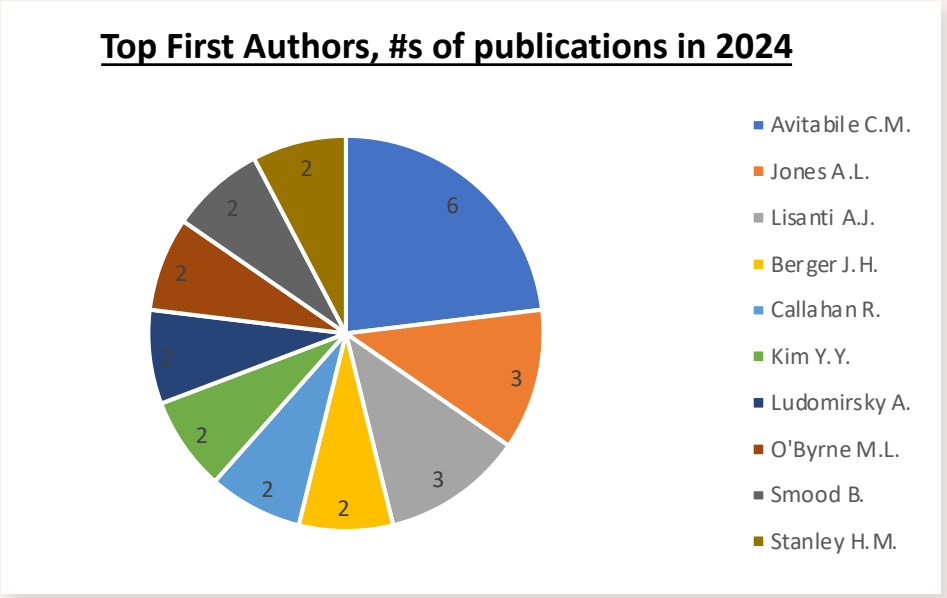
Rossano, J.W.....21
Gaynor, J.W.....18
Naim, M.Y. 16
Maeda, K. 16
Shah, M.J.....15
O'Byrne, M.L.....14
Rychik, J.....14
Mavroudis, C.D. 14
O'Connor, M.J. 13
Smith, C.L. 13
Dori, Y. 13
Avitabile, C.M. 11
Fuller, S.M. 11
Edelson, J.B. 10
Diddle, J.W.....10
Biko, D.M. 10



TOP FIRST AUTHORS IN 2024 PUBLISHED BY THE CHOP CARDIAC CENTER

Author	# of pubilcations in 2024
Avitabile C.M.	6
Jones A.L.	3
Lisanti A.J.	3
Berger J.H.	2
Callahan R.	2
Kim Y.Y.	2
Ludomirsky A.	2
O'Byrne M.L.	2
Smood B.	2
Stanley H.M.	2

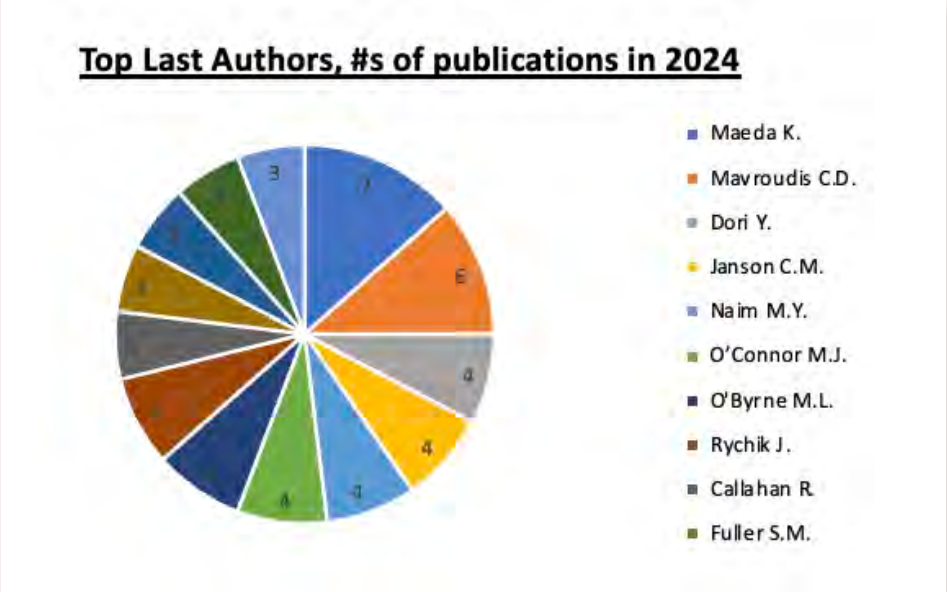
(Limited to 2 or more publications)



TOP LAST AUTHORS PUBLISHED IN 2024 BY THE CHOP CARDIAC CENTER

Author	# of pubilcations in 2024
Maeda K.	7
Mavroudis C.D.	6
Dori Y.	4
Janson C.M.	4
Naim M.Y.	4
O'Connor M.J.	4
O'Byrne M.L.	4
Rychik J.	4
Callahan R.	3
Fuller S.M.	3
Gillespie M.J.	3
Rossano J.W.	3
Shah M.J.	3

(Limited to 3 or more publications)

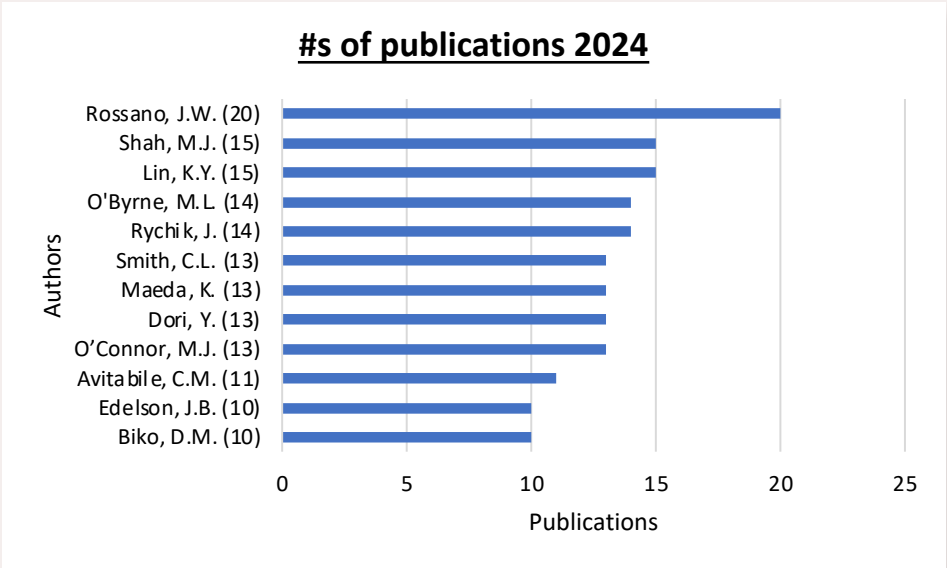


SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF CARDIOLOGY

Top 5 Sources:
Pediatric Cardiology: 20
Seminars in Pediatric Surgery: 9
Cardiology in the Young: 8
Circulation: 8
J. of the American College of Cardiology: 7
Heart Rhythm: 7
Journal of Pediatrics: 7

Articles: 197
Cited in 2024: 350
H-index: 8
Authors searched within the Division of Cardiology: 87
(Outpatient: 21, Echo: 21, Pulmonary Hypertension: 5, Heart Failure/Tx: 8, ACHD: 5, MRI: 5, Cath: 8, Exercise: 3, EP: 5, Research: 6)

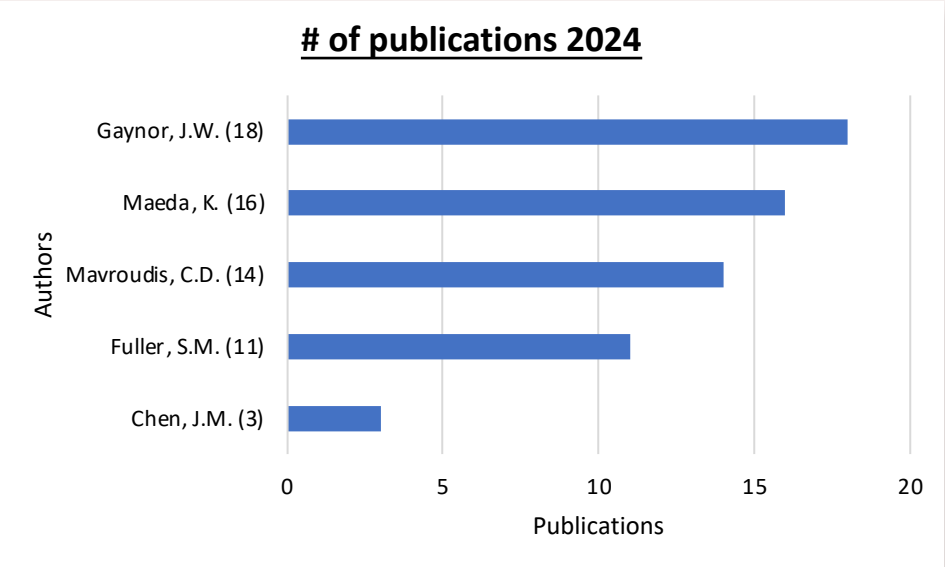


SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF SURGERY

Top 5 Sources:
Annals of Thoracic Surgery: 5
Cardiology in the Young: 4
Seminars in Pediatric Surgery: 4
Journal of the American Heart Association: 3
European Journal of Cardio-thoracic Surgery: 2

Articles: 42
Cited in 2024: 46
H-index: 3
Authors searched within the Division of Surgery: 6

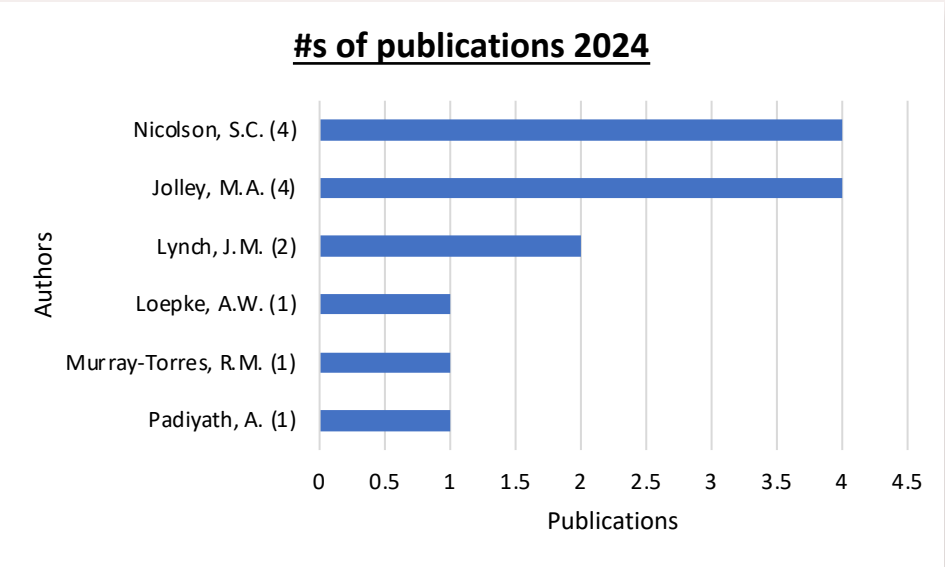


SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF ANESTHESIOLOGY

Top 5 Sources:
Paediatric Anaesthesia: 2
Biomedical Optics Express: 1
Cardiology in the Young: 1
Catheterization and Cardiovascular Interventions: 1
Circulation: Cardiovascular Interventions: 1

Articles: 12
Cited in 2024: 16
H-index: 2
Authors searched within the Division of Surgery: 15

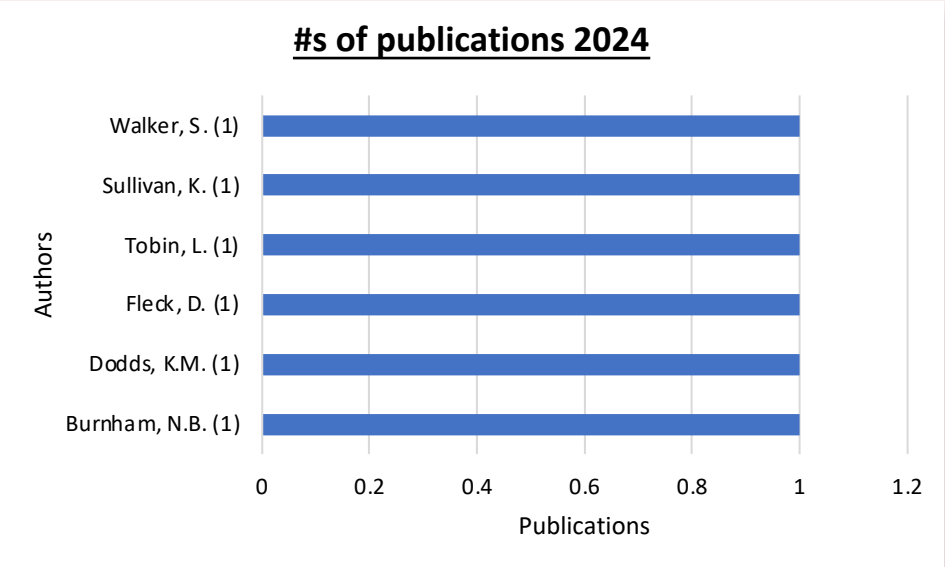


SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

DIVISION OF NURSING AND NUTRITION

Top 5 Sources:
Pediatric Cardiology: 4
JAMA Network Open: 1
Journal of Perianesthesia Nursing: 1

Articles: 6
Cited in 2024: 1
H-index: 1
Authors searched within the Division of Nursing & Nutrition: 66
(Nursing: 62, Nutrition (CICU): 2, Nutrition (CCU): 2)

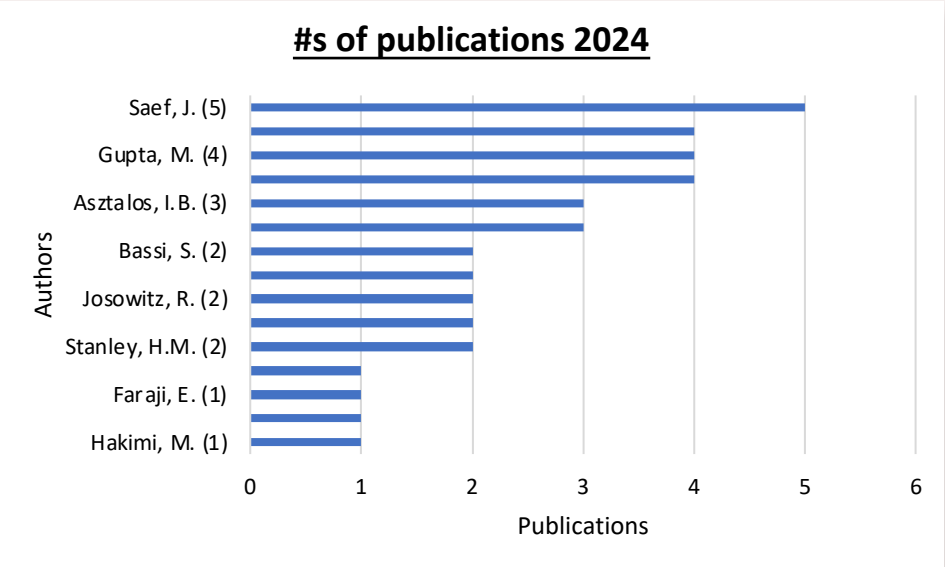


SUMMARY METRICS BY DIVISION WITHIN THE CHOP CARDIAC CENTER (FROM SCOPUS)

FELLOWS

Top 5 Sources:
Pediatric Cardiology: 9
Catheterization and Cardiovascular Interventions: 2
JACC: Advances: 2
JAMA Network Open: 2
Journal of Cardiac Failure: 2

Articles: 44
Cited in 2024: 35
H-index: 3
Authors searched within the Fellows: 41



APPENDIX A

BIBLIOGRAPHY OF "HIGHLY CITED" PAPERS

1) Neurodevelopmental Outcomes for Individuals With Congenital Heart Disease: Updates in Neuroprotection, Risk-Stratification, Evaluation, and Management: A Scientific Statement From the American Heart Association.
Sood, Erica; Newburger, Jane W.; Anixt, Julia S.; Cassidy, Adam R.; Jackson, Jamie L.; Jonas, Richard A.; Lisanti, Amy J.; Lopez, Keila N.; Peyvandi, Shabnam; Marino, Bradley S.; DOI: 10.1161/CIR.0000000000001211; Circulation., 2024, Vol.149(13), p. e997-e1022
2) Evinacumab for Pediatric Patients With Homozygous Familial Hypercholesterolemia.
Wiegman, Albert; Greber-Platzer, Susanne; Ali, Shazia; Reijman, M. Doortje; Brinton, Eliot A.; Charng, Min-Ji; Srinivasan, Shubha; Baker-Smith, Carissa; Baum, Seth; Brothers, Julie A.; Hartz, Jacob; Moriarty, Patrick M.; Mendell, Jeanne; Bihorel, Sebastien; Banerjee, Poulabi; George, Richard T.; Hirshberg, Boaz; Pordy, Robert.; DOI: 10.1161/CIRCULATIONAHA.123.065529; Circulation., 2024, Vol.149(5), p. 343-353

APPENDIX B

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

1) Neurodevelopmental Outcomes for Individuals With Congenital Heart Disease: Updates in Neuroprotection, Risk-Stratification, Evaluation, and Management: A Scientific Statement From the American Heart Association.
Sood, Erica; Newburger, Jane W.; Anixt, Julia S.; Cassidy, Adam R.; Jackson, Jamie L.; Jonas, Richard A.; Lisanti, Amy J.; Lopez, Keila N.; Peyvandi, Shabnam; Marino, Bradley S.; DOI: 10.1161/CIR.0000000000001211; Circulation., 2024, Vol.149(13), p. e997-e1022
2) Evinacumab for Pediatric Patients With Homozygous Familial Hypercholesterolemia.
Wiegman, Albert; Greber-Platzer, Susanne; Ali, Shazia; Reijman, M. Doortje; Brinton, Eliot A.; Charng, Min-Ji; Srinivasan, Shubha; Baker-Smith, Carissa; Baum, Seth; Brothers, Julie A.; Hartz, Jacob; Moriarty, Patrick M.; Mendell, Jeanne; Bihorel, Sebastien; Banerjee, Poulabi; George, Richard T.; Hirshberg, Boaz; Pordy, Robert.; DOI: 10.1161/CIRCULATIONAHA.123.065529; Circulation., 2024, Vol.149(5), p. 343-353
3) The genomic basis of childhood T-lineage acute lymphoblastic leukaemia.
Polonen, Petri; Di Giacomo, Danika; Seffernick, Anna Eames; Elsayed, Abdelrahman; Kimura, Shunsuke; Benini, Francesca; Montefiori, Lindsey E.; Wood, Brent L.; Xu, Jason; Chen, Changya; Cheng, Zhongshan; Newman, Haley; Myers, Jason; Iacobucci, Ilaria; Li, Elizabeth; Sussman, Jonathan; Hedges, Dale; Hui, Yawei; Diorio, Caroline; Uppuluri, Lahari; Frank, David; Fan, Yiping; Chang, Yunchao; Meshinchi, Soheil; Ries, Rhonda; Shraim, Rawan; Li, Alexander; Bernt, Kathrin M.; Devidas, Meenakshi; Winter, Stuart S.; Dunsmore, Kimberly P.; Inaba, Hiroto; Carroll, William L.; Ramirez, Nilsa C.; Phillips, Aaron H.; Kriwacki, Richard W.; Yang, Jun J.; Vincent, Tiffaney L.; Zhao, Yaqi; Ghate, Pankaj S.; Wang, Jian; Reilly, Colleen; Zhou, Xin; Sanders, Mathijs A.; Takita, Junko; Kato, Motohiro; Takasugi, Nao; Chang, Bill H.; Press, Richard D.; Loh, Mignon; Rampersaud, Evadnie; Raetz, Elizabeth; Hunger, Stephen P.; Tan, Kai; Chang, Ti-Cheng; Wu, Gang; Pounds, Stanley B.; Mullighan, Charles G.; Teachey, David T.; DOI: 10.1038/s41586-024-07807-0; Nature., 2024, Vol.632, p. 1082–1091.
4) Early Outcomes From a Multicenter Transcatheter Self-Expanding Pulmonary Valve Replacement Registry.
Goldstein, Bryan H.; McElhinney, Doff B.; Gillespie, Matthew J.; Aboulhosn, Jamil A.; Levi, Daniel S.; Morray, Brian H.; Cabalka, Allison K.; Love, Barry A.; Zampi, Jeffrey D.; Balzer, David T.; Law, Mark A.; Schiff, Mary D.; Hoskoppal, Arvind; Qureshi, Athar M.; DOI: 10.1016/j.jacc.2024.02.010; Journal of American College of Cardiology., Vol. 83(14), p. 1310-1321.

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Alsaied T, Li R, Christopher AB, Fogel MA, Slesnick TC, Krishnamurthy R, Muthurangu V, Dorfman AL, Lam CZ, Weigand JD, Robinson JD, Cordina R, Olivieri LJ, Rathod RH; FORCE Investigators. H**igh-Performing Fontan Patients: A Fontan Outcome Registry by Cardiac Magnetic Resonance Imaging Study**. *JACC Adv*. 2024, Sep. 3(10):101254. doi: 10.1016/j.jacadv.2024.101254. PMID: 39309667; PMCID: PMC11414658

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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**. 2024 Feb. 37(2):259-267. doi: 10.1016/j.echo.2023.11.011. PMID: 37995938; PMCID: PMC10872766

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