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How I Do It: Tips, Tricks and Techniques – Percutaneous Carotid Artery Access in Congenital Cardiac Intervention

A PICS Society Education Series

R. Allen Ligon, MD & Christopher J. Petit, MD

An Introduction to PICS "Tips and Tricks"

Need a quick and handy review of a novel technique or rare intervention? Want to know how leaders in pediatric and congenital cardiac interventions would approach the case?

This new PICS "Tips & Tricks" section provides congenital interventional cardiologists with nuanced techniques from experienced leaders in the field. These high yield articles highlight their approaches to these challenges, with particular attention paid to practical aspects of procedural techniques, challenges, and potential pitfalls.

Each topic is authored by a key opinion leader with specific procedural expertise and written in an accessible and succinct format with illustrative case examples and suggested references to make this an impactful educational platform.

In this issue of CCT, we present Dr. Ligon and Dr. Petit's approach to carotid access. We are confident readers will find this duo's experience to be extremely informative in the cases where carotid access is crucial.

We hope you enjoy this issue. We are confident PICS Society members of all experience levels will find this series to be educational and insightful. For the full list of available articles, which will be updated monthly, please visit https://www.picsymposium.com/tips_and_tricks.html.

GURUMURTHY "GURU" HIREMATH, MD, FPICS
Editor, PICS Tips and Tricks

SAROSH "SHAWN" BATLIVALA, MD, MSCI, FPICS
Editor, PICS Tips and Tricks

KAMEL SHIBBANI, MD
Associate Editor, PICS Tips and Tricks

JACQUELINE KREUTZER, MD, FPICS
Consulting Editor, PICS Tips and Tricks & PICS Board Member

Percutaneous Carotid Artery Access in Congenital Cardiac Intervention

Introduction

Percutaneous carotid access (PCA) is a relatively new form of vascular access utilized for congenital cardiac catheterization. Due to the inherent advantages of approaching interventions from the carotid vessels, carotid artery access via surgical cut-down has been historically employed for

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neonatal interventions. However, PCA has a number of advantages over the cut-down approach, including a less-invasive approach, reduced reliance on surgical colleagues, and greater rate of vessel patency following the intervention.[1-3] Further, PCA has been shown to be an optimal approach (especially compared to femoral artery or vein) for specific high-risk procedures including placement of a ductal artery stent, balloon aortic valvuloplasty, and angioplasty/stent of an occluded systemic-to-pulmonary shunt.[2, 4, 5]

Anticipated Challenges of the Procedure

1. Equipment: ultrasound guidance, needle selection, hydrophilic radial sheath, guidewire selection
2. Approach: "flipping" neonate and cath lab setup, limiting sheath time in carotid
3. Procedure: heparinization, minimizing vessel trauma, securing sheath
4. Post-procedural: hemostasis, planned ICU admission, intubation overnight, prophylactic heparin drip, surveillance vascular ultrasound

Tip 1 – Planning and Preparation

1. Access – Performing arterial puncture during PCA can be quite challenging as the carotid artery is not confined in lateral space. Puncture, then, is best completed with a needle that is of small caliber (24-gauge Galt Medical™ or 30-gauge NeoMedical™ Neo-Magic Modified Seldinger Introducer kit) and is exceptionally sharp in order to puncture through the muscular layer of the vessel. Access can be performed with a standard 21-gauge needle perc needle, but improved efficiency with the aforementioned equipment can avoid vessel "rolling."
2. Imaging – Ultrasound guidance is a requirement during PCA, utilizing a vascular probe with depth set down to 2cm. Pre-procedural advanced cross-sectional imaging (i.e., CTA) is helpful in planning interventions such as ductal stenting, especially as selection of the right vs. left common carotid artery is critical to the success of stenting in these cases. Some centers have utilized such CTA images to help plan camera angulations during the catheterization procedure. Software applications (such as 3Mensio) allow for virtual implants of stents (outlining the ductal tortuosity index and predicting stent length). A decision regarding which carotid artery to access can be influenced greatly by the pre-procedural imaging better characterizing the ductal tortuosity and/or origin.
3. Guidewire selection – It is advisable to use a very floppy, nitinol-tipped 0.014" guidewire through the perc needle when accessing the common carotid artery. Oftentimes, the body of such wires is insufficient to safely advance a 4-French sheath. Therefore, we recommend using a micropuncture dilator to then swap out the 0.014" floppy guidewire for a traditional access guidewire (0.018" caliber) that will be less prone to bending in the percutaneous track. This extra step guards against the devastating vascular complication that can occur if the guidewire easily bends in the perivascular soft tissue with advancement of the sheath.
4. Other – Team preparation and comfort is crucial to limiting sheath time within the carotid artery. Staff familiarity with patient inversion (outlined below) and cath lab setup will improve efficiency. Having all tools/equipment pulled/ready for usage will help limit procedural time during "crucial steps."

Tip 2 – Tools Needed

1. Sheaths – Hydrophilic/radial access short sheaths are preferred for PCA in order to limit trauma to the arteriotomy site. Of note, be wary of the "thin-wall" sheaths (such as the Merit Medical Prelude Ideal™ sheath) if ductal stenting is planned. Some stent platforms will not come back into the thin-wall short sheath if the decision is to change stent size.
2. Catheters – The intended intervention will drive catheter selection, but this can be assisted by pre-procedural cross-sectional imaging. A carotid approach in neonates will significantly decrease the distance to intended intervention (e.g. aortic valvuloplasty or ductal stenting), therefore the utilization of short length catheters and wires will save time, if feasible. Additionally, having a "plan for approach" with regards to specific turns/angles, an operator will need to navigate from the pre-procedural imaging will guide catheter choice selection.
3. Devices – The intended intervention will dictate device selection, but having several options of balloons/stents readily available is crucial to limit sheath time with PCA. This is particularly prudent in ductal stenting, where numerous options for stent length(s) should be available for utilization in a timely fashion. Patients with high grade ductal tortuosity indices can lend to quite variable lengths after these ductus are straightened with a stiff wire system. Further, thorough consideration must be placed to the wire over which to perform the transcatheter intervention. For example, with ductal stenting and PCA, we commonly navigate through the ductus arteriosus with a floppy 0.014" wire to establish adequate wire position into the intended lung field. The wire is then exchanged via a microcatheter to a stiffer 0.014" wire platform in order to deliver the stent.
4. Others – Lengthened ventilator and medication line tubing is a must if the neonate "flipped" on the cath table. An inverted patient will take the head of the patient away from the Anesthesia team. Ensuring an adequate length of the ventilator tubing and adequate access to medication line(s) will prevent challenges once the patient is prepped and draped for the procedure.

> "Percutaneous carotid access is a team sport…involving the Anesthesia team and techs/nurses as much as the primary operator." *– Dr. R. Allen Ligon*

Tip 3 – How I Do It

1. Pre-procedural Imaging – The decision of which carotid artery (left/right) to perform PCA will be based on the intended intervention and the pre-procedural imaging. In the example of ductal stenting, consideration of ductal origin and tortuosity index will need to be taken into account as well. As mentioned above, deciding on optimal camera angles and postulating the intended ductal stent length (and diameter) can be greatly aided by CTA imaging. If there is concern for pulmonary artery coarctation, this may play into which lung bed the distal wire is place during intervention.

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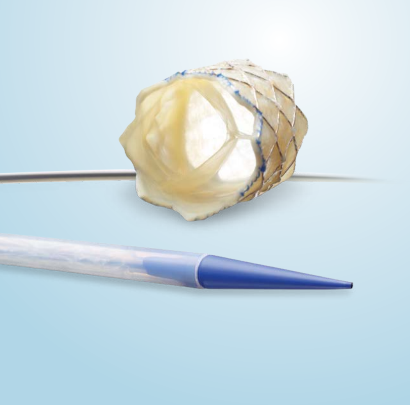

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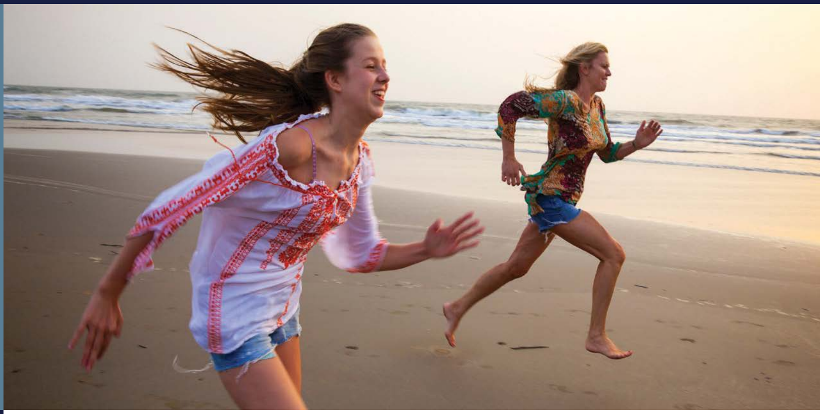

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Contraindications

- Venous anatomy unable to accommodate a 22 Fr size introducer sheath
- Implantation of the TPV in the left heart
- RVOT unfavorable for good stent anchorage
- Severe RVOT obstruction, which cannot be dilated by balloon
- Obstruction of the central veins
- Clinical or biological signs of infection
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- Known allergy to aspirin or heparin
- Pregnancy

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*The term "stent fracture" refers to the fracturing of the Melody TPV. However, in subjects with multiple stents in the RVOT it is difficult to definitively attribute stent fractures to the Melody frame versus another stent.

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2. Perform patient "flipping" (if a neonate):
    a. The goal is to invert the patient completely on the catheterization table prior to draping and performing PCA. Patients are transferred from the stretcher to the cath lab table in the "normal" orientation. The Anesthesia team then performs induction, airway stabilization (intubation), and line placement as per their standard routine **(Figure 1)**. Once completed (and tubing identified to be long enough as outlined above), the staff coordinates a patient flip so as to place the feet at the traditional head of the cath lab table **(Figure 2)**. Operators should consider which side of the table to perform the procedure, the camera boom is taken to the side opposite the cath team, and fluoroscopic (AP and lateral) images are inverted. The patient is then positioned for adequate access into the expected carotid artery with a shoulder roll and the anesthesia team ensures stable airway security as well as access to the lines for medications **(Figure 3)**. The patient is prepped and draped in a standard fashion. Ultrasound guidance is utilized during PCA and the hydrophilic short sheath is placed as above, the remaining portion of the cath table being dedicated to a working space for the operator and assistant(s) **(Figures 4 & 5)**.
3. Pitfalls to avoid:
    a. If flipping the patient:
        i. Make sure to invert the fluoroscopic images. Inversion needs to be done on the AP as well as the lateral camera planes.
        ii. Check the position of the endotracheal tube before prepping and draping the access site. It is much easier to address the tube prior to covering the patient – and in our experience it is quite easy to have a tube advance to the right mainstem, or pulled to the oropharynx, with the flip technique.
    b. Be very mindful of the depth of the short sheath upon gaining access. One might find themselves already within the ductus arteriosus solely with the distal tip of the short sheath!
    c. Post-procedure hemostasis should be performed by a very experienced staff member (or operator) to ensure direct pressure on the arteriotomy site. Consider the usage of the ultrasound to guide pressure location and pressure in order to prevent accumulation of a hematoma.

Tip 4 – What Complications to Expect and How to Deal with Them

- Inability to change stent platform through the thin wall short sheath. Prevented by utilizing a hydrophilic radial artery short sheath during PCA.
- Hematoma Formation – Post-procedure hemostasis should be performed by an experienced operator/staff member. Once hemostasis is achieved, consider another 10 minutes of "supportive" digital pressure on the access site to help prevent pseudoaneurysm. Utilize ultrasound imaging to guide point of pressure onto arteriotomy site and one finger, no gauze.
- Pseudoaneurysm or clot formation. Once hemostasis is established, transfer to ICU and keep patient intubated overnight with generous sedation. Ensure hemostasis and then provide prophylactic heparin drip overnight. Follow-up ultrasound imaging of the carotid is performed the following morning. If there is evidence of a clot within the vessel lumen, then place on therapeutic Lovenox dosing for at least 72 hours and repeat imaging to guide further management.

Summary

PCA has emerged as a new option for transcatheter access with improved efficacy for certain interventions and an encouraging safety profile as thus far outlined in mid-term follow-up. As the experience of operators with PCA increases, techniques particular to this form of access (such as patient flipping/inversion) and technologies have been identified that facilitate the procedure. The inherent benefits of PCA in certain transcatheter interventions have challenged the norm of that which is performed routinely within the congenital interventional catheterization laboratory.

FIGURE 1 **Pre-procedure** *The anesthesia team intubates and induces patient with the normal orientation on the cath lab table, having the head (red arrow) towards them.*

FIGURE 2 **Patient Inversion** *After flipping/inverting the patient, the patient's feet are now towards the anesthesia team and the boom is taken to the opposite side of the cath table.*

FIGURE 3 Patient Preparation *A shoulder roll is placed exposing the intended right carotid artery (red arrow) and endotracheal tube secured away from the field.*

FIGURE 4 Access *The primary operator works from the patient's head towards the intended carotid artery and the ultrasound on the opposite side of the table (white arrow). It is crucial to remember to invert the image on the AP and lateral cameras prior to performing fluoroscopy. The medication lines are lengthened to the feet of the patient for easy access by the anesthesia team (red arrow).*

FIGURE 5 Workspace *The operator is now able to have the sheath facing them and perform the intended intervention in a patient caudal direction (towards the anesthesia team). The remaining length of the cath table is utilized for wire/catheter/device manipulation.*

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R. ALLEN LIGON, MD

Assistant Professor in Pediatrics
Emory University School of Medicine
Pediatric and Adult Congenital Interventional Cardiology
Children's Healthcare of Atlanta
Atlanta, Georgia, USA

CHRISTOPHER J. PETIT, MD

Chief, Division of Cardiology
NewYork-Presbyterian Morgan Stanley Children's Hospital
Welton M. Gersony Professor of Pediatrics
Columbia Vagelos College of Physicians and Surgeons
New York, New York, USA

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A Tribute to Dr. Joseph deGiovanni (1949-2023)

On behalf of the Board and membership of The PICS Society, we would like to pay tribute to our friend and colleague Dr. Joseph ("Jo") deGiovanni, who passed away May 8, 2023, after a lengthy illness. Dr. deGiovanni was a dedicated pioneer in our profession, representing the highest principles of research, leadership, education and above all excellence in patient care. We extend our deepest sympathies to his family, colleagues and friends.

Since 1983 Dr. deGiovanni served as a consultant paediatric cardiologist at Birmingham Children's Hospital in the UK. In a moving announcement on the Association for European Paediatric and Congenital Cardiology (AEPC) website (https://www.aepc.org/news), Prof. Sir Shakeel Qureshi and Dr. Chetan Mehta observed he was at the forefront introducing many procedures in interventional cardiology, echo, arrhythmia treatment, adult CHD and other arenas.

Equally important was his dedication to the medically underserved. As Drs. Qureshi and Mehta noted, *"Jo was committed to help, teach and promote all the new techniques in many countries around the world, both in developing and developed countries… Dr. deGiovanni always gave his time selflessly in teaching practical interventional procedures, in particular in the developing countries, to bring their services up to modern levels. He made himself available to help them, whenever they asked for his help."*

Among many recent tributes was one by his colleague Prof. Victor Grech (Mater Dei Hospital, Malta), who observed in the *Malta Times* (May 15, 2023) that *"The world has lost a gentleman, and cardiology has lost a stalwart…. Jo could (incredibly) do anything in the cath lab safely, pioneering quite a few novel interventions, some of them in Malta."*

Dr. deGiovanni had a deep, long-standing commitment to the PICS Annual Symposium and the PICS Society. Over the years he chaired many educational sessions, as well as contributing to hundreds of similar events at scientific gatherings throughout the world. PICS President Dr. Ziyad M. Hijazi commented that *"we were so grateful for Jo's longstanding commitment to mentor the next generation of CHD interventionalists—no matter how full his schedule, he was always willing to provide his wise advice to anyone who sought it. We were honored that Jo chaired the annual PICS Achievement Award Committee for two years—selecting the best of the best in our profession. Although Jo was a modest man, those of us privileged to have known him would agree that Jo himself was the best of the best ! We will miss him terribly."*

In his own words. Perhaps the best way to honor Dr. deGiovanni's legacy is through his own words. Shortly after The PICS Society's formation, he committed to continuing mentoring and contributing in spite of his own personal challenges. He observed that *"I have personally learnt and gained so much from PICS and the many enthusiastic participants, my main role now is to pass on my knowledge and experience and support up-and-coming interventionists and electrophysiologists. It would be an honour and pleasure to further education, good clinical practice, support and respect for colleagues, training, keep up standards and lead by example…. I will continue to give younger colleagues opportunity to discuss any problem cases, even though the support will be remote. Very best wishes despite the unknowns we face."* – Dr. deGiovanni

Thank you, Jo! Rest in peace.

On behalf of The PICS Society Board, membership and staff,

ZIYAD M. HIJAZI, MD, MPH, FPICS, *President*
DAMIEN KENNY, MD, FPICS, *Vice President*
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George Dangas, MD, PhD, Named President of Society for Cardiovascular Angiography & Interventions

First Mount Sinai Cardiologist to Hold this Prestigious Position

The Society for Cardiovascular Angiography & Interventions (SCAI) has named George Dangas, MD, PhD, Professor of Medicine (Cardiology), and Surgery, at the Icahn School of Medicine at Mount Sinai as its new President. He was appointed on Saturday, May 20th, during the closing ceremonies at the SCAI 2023 Scientific Sessions in Phoenix. He is the first Mount Sinai cardiologist to hold this position and will serve as the 46th President of SCAI.

Dr. Dangas, also the Director of Cardiovascular Innovation at the Zena and Michael A. Wiener Cardiovascular Institute at Icahn Mount Sinai and Chief of Cardiology at Mount Sinai Queens, is an authoritative voice on the performance of nonsurgical cardiovascular and valve interventions using both established and novel techniques, and on preventing and dissolving endovascular thrombosis. In his work with SCAI, he has served as a key faculty and program committee member for various meetings and events and is a former SCAI Trustee.

"I am deeply honored to serve as SCAI president this year," said Dr. Dangas. "Our society is moving the interventional cardiology specialty forward in such impactful ways that are reflective of our current times and speak to the innovation required to advance patient care. I am excited to collaborate with our physician and associate members to address the needs of our profession and make an imprint on global health."

In this new role, Dr. Dangas will fulfill a number of important responsibilities including acting as the spokesperson for SCAI, supporting its development efforts, and helping manage its operations.

Dr. Dangas completed medical and postgraduate studies at the National and Capodistrian University of Athens, Greece, followed by his internship and residency in internal medicine at The Miriam Hospital and Brown University in Providence, Rhode Island. He completed his cardiovascular disease and interventional cardiology fellowships at The Mount Sinai Hospital in New York City and has been certified by the American Board of Internal Medicine in Cardiovascular Disease and Interventional Cardiology, and also elected Master of the American College of Cardiology.

Dr. Dangas began his one-year term on May 20th, 2023.

Mount Sinai

Vivalink's Biometrics Data Platform Supports UCSF Clinical Trial for Hypertrophic Cardiomyopathy (HCM)

The six-month EXCITE-HCM study of 70 patients will study the effects of exercise on electrical activity and blood flow using Vivalink's medical wearable ECG sensor and cloud data services.

UC San Francisco (UCSF) is conducting a six-month clinical trial on hypertrophic cardiomyopathy (HCM) using Vivalink's Biometrics Data Platform. The study, consisting of 70 patients, will evaluate if regimented moderate intensity exercise improves overall exercise capacity and cardiac blood flow.

HCM is thought to be the most common inherited heart condition, estimated to affect about 1 in 500 people. HCM can lead to heart failure and atrial fibrillation, and is cited as the most common cause of sudden death in young athletes, accounting for 35 to 50% of cases. The UCSF study, EXCITE-HCM, is funded by the National Heart Lung and Blood Institute of the National Institutes of Health, and led by Theodore Abraham, MD, FACC, FASE.

"In this study, we hope to identify ways to prevent adverse health events for these patients," said Theodore Abraham, MD, FACC, FASE, co-director of UCSF HCM Center of Excellence, and Director of the UCSF Adult Cardiac Echocardiography Laboratory. "Vivalink's medical-grade sensors and data services will help us find accurate endpoints during the trial."

Subjects in the research trial will be monitored using the Vivalink wearable ECG sensor and cloud data platform to track electrical activity throughout the study. The reusable sensor will continually capture ECG and heart rate data 24 hours a day which will be processed through Vivalink's Biometrics Data Platform. The platform ensures data is delivered successfully from any location for centralized analysis and processing in order to extract clinically relevant insights in real-time or retrospectively.

"We are thrilled to support UCSF in this clinical trial for HCM," said Jiang Li, CEO of Vivalink. "Our Biometrics Data Platform is a reliable and accurate way to study key cardiovascular and health conditions. We are excited to see the results from the study and continue to support UCSF throughout the trial."

In addition to capturing ECG rhythm and heart rate, the multi-function sensor can also monitor Heart rate variability, respiratory rate and offer accelerometer data. The sensor is used in other applications and studies, such as in-hospital patient monitoring, atrial fibrillation, remote patient monitoring, and chemo treatment event detection.

For more information, visit **www.vivalink.com.**

AUGUST

25TH - 27TH

3rd Annual PICS Fellows & Early Career Course
Washington, DC, USA
kimberly_ray@chdinterventions.org

27TH - SEPT 01ST

8th World Congress of Pediatric Cardiology and Cardiac Surgery
Washington, DC, USA
http://wcpccs2023.org/

SEPTEMBER

08TH - 09TH

2023WPC – 2023 World Pediatric Conference
Singapore
https://pediatrics.episirus.org/

25TH - 26TH

CME HeartCare and Cardiovascular Medicine Cardiac Surgery
Paris, France
https://heart.plenareno.com/

OCTOBER

06TH - 08TH

CSI Asia-Pacific 2023
Bangkok, Thailand
https://www.csi-congress.org/asia-pacific

28TH

13th Annual UCA Fetal Echocardiography Symposium
Westwood, California, USA
https://events.medschool.ucla.edu/event/fetalcardiac23

U.S. News & World Report's Best Children's Hospitals for Cardiology & Heart Surgery 2023-2024

To create the pediatric rankings, U.S. News & World Report gather key clinical data from nearly 200 medical centers through a detailed survey that looks at measures such as patient safety, infection prevention and adequacy of nurse staffing. In addition, part of each hospital's score is derived from surveys of more than 15,000 pediatric specialists who are asked where they would send the sickest children in their specialty. In 2023, only 89 children's hospitals were ranked in at least one of the 10 pediatric specialties evaluated. Ten hospitals ranked at the top of their class and were named to the 2023-2024 Honor Roll, https://health.usnews.com/health-news/best-childrens-hospitals/slideshows/best-childrens-hospitals-honor-roll.

Fifty centers were ranked in pediatric cardiology care. Survival after complex heart surgery, such as heart transplants and corrective surgery for congenital heart defects, specialized staff, services and technologies, commitment to best practices and ability to prevent infections accounted for most of each hospital's score.

Top 50 Children's Hospitals for Cardiology & Heart Surgery

1. Texas Children's Hospital
2. Duke Children's Hospital and Health Center
3. Rady Children's Hospital
4. MUSC Children's Heart Network of South Carolina
5. Nationwide Children's Hospital
6. Boston Children's Hospital
7. Cincinnati Children's and Kentucky Children's Hospital Joint Heart Program
8. Levine Children's Hospital
9. UPMC Children's Hospital of Pittsburgh
10. Cleveland Clinic Children's Hospital
11. University of Michigan Health C.S. Mott Children's Hospital
12. Children's Healthcare of Atlanta
13. Children's Hospital Los Angeles
14. Hassenfeld Children's Hospital at NYU Langone
15. Children's Hospital of Alabama at UAB
16. Children's Hospital Colorado
17. Children's Hospital of Philadelphia
18. Riley Hospital for Children at IU Health
19. Seattle Children's Hospital
20. New York-Presbyterian Children's Hospital-Columbia and Cornell
21. UCLA Mattel Children's Hospital
22. Loma Linda University Children's Hospital
23. Ann and Robert H. Lurie Children's Hospital of Chicago
24. Johns Hopkins Children's Center
25. Mayo Clinic-Children's Minnesota Cardiovascular Collaborative
26. UF Health Shands Children's Hospital
27. Intermountain Primary Children's Hospital-University of Utah
28. Rainbow Babies and Children's Hospital
29. Le Bonheur Children's Hospital
30. Children's Memorial Hermann Hospital
31. Monroe Carell Jr. Children's Hospital at Vanderbilt
32. Advocate Children's Heart Institute
33. Nemours Children's Hospital-Delaware
34. Ochsner Hospital for Children
35. Children's Medical Center Dallas
36. Virginia Congenital Cardiac Collaborative
37. Nicklaus Children's Hospital
38. Oklahoma Children's Hospital OU Health
39. SSM Health Cardinal Glennon Children's Hospital-St. Louis University
40. UCSF Benioff Children's Hospitals, San Francisco and Oakland
41. Norton Children's Hospital
42. Lucile Packard Children's Hospital Stanford
43. Children's Mercy Kansas City Hospital
44. Phoenix Children's Hospital
45. Arkansas Children's Hospital
46. Children's National Hospital
47. American Family Children's Hospital
48. Dell Children's Medical Center
49. CHOC Children's Hospital
50. Yale New Haven Children's Hospital

To see the entire list, visit: https://health.usnews.com/best-hospitals/pediatric-rankings/cardiology-and-heart-surgery

CONGENITAL CARDIOLOGY TODAY

CORPORATE OFFICE

PO Box 52316
Sarasota, FL 34232 USA

CORPORATE TEAM

PUBLISHER & EDITOR-IN-CHIEF
Kate Baldwin
kate.f.baldwin@gmail.com

CO-FOUNDER & MEDICAL EDITOR
John W. Moore, MD, MPH
jwmmoore1950@gmail.com

FOUNDER & SENIOR EDITOR
Tony Carlson
tcarlsonmd@gmail.com

STAFF EDITOR & WRITER
Virginia Dematatis

EDITOR-IN-CHIEF EMERITUS
Richard Koulbanis

STAFF EDITOR
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