We offer the full spectrum of interventional services for children and young adults of all ages with congenital heart disease.
Cardiac catheterization (Interventional Cardiology) Program

Cardiac catheterization, or interventional cardiology, is a procedure used for the diagnosis and management of patients with congenital (and acquired) heart disease. A small tube is inserted into the groin and a long catheter advanced into the heart and blood vessels. X-ray equipment is used to monitor the course of the catheter, and to document specific images that are acquired during the procedure, such as angiograms (which is the injection of a contrast agent into the chambers of the heart and/or great vessels). This technique facilitates not only diagnostic procedures, but also therapeutic interventions, such as the closure of holes within the heart, closure of abnormal blood vessels, opening of narrowed blood vessels, and implantation of valves into the heart.

Procedures are performed in a dedicated state-of-the-art cardiac catheterization laboratory (including transcatheter valves and covered stents), and modern bi-plane imaging equipment. In many older patients, we perform the procedures as team of pediatric and adult congenital interventional cardiologists.

We offer the full spectrum of interventional cardiac catheterization procedures including (but not limited to) the following:

- **Closure of septal defects**
  - Atrial septal defects (ASDs)
  - Ventricular septal defects (VSDs)
  - Surgically created fenestrations (e.g. after Fontan procedure)

- **Closure of abnormal vascular communications**
  - Patent ductus arteriosus (PDA)
  - Collateral vessels
  - Pulmonary arterio-venous fistulas
  - Coronary fistulas

- **Transcatheter valve implantation**

- **Balloon angioplasty and/or stent implantation of stenotic blood vessels**
  - Coarctation of the aorta
  - Simple and complex stenosis of branch pulmonary arteries
  - Stenotic superior and inferior caval vein
  - Stenotic intracardiac baffles and Fontan

- **Recanalization or opening of completely occluded blood vessels**

- **Opening of atretic heart valves (valves that were not formed before birth)**

- **Creating and maintaining of communications within the heart**
  - Balloon atrial septostomy
  - Stenting of the atrial septum

In some cases, some procedures are performed outside the cardiac catheterization laboratory in the operating room, in close cooperation with our cardiac surgical colleagues led by Dr Emile Bacha (hybrid procedures).
Children and young adults who undergo cardiac catheterization in our cardiology practice will meet with the interventional cardiologist at a consultation prior to the day of the procedure. At that time, the procedure’s details, possible risks and adverse events specific to the procedure will be explained in detail. When possible, our team will use case examples and models to demonstrate the technical elements of the procedure.

In most cases, no blood tests are needed prior to the procedure with laboratory tests being taken once the child is under anesthesia, thereby avoiding unnecessary distress to patients and families.

In addition to the interventional cardiologist performing the procedure, we have a dedicated cardiac interventional nurse practitioner who will be a primary point of contact for patients and families, and who will provide detailed pre-procedural instructions and guidelines.

Most patients will be asked to arrive at our center in the morning of the procedure, when they will again meet the interventional cardiologist and nurse practitioner for any additional questions or concerns, as well as the anesthetists who will provide anesthesia during the procedure.

The length of the procedure varies, depending on the individual patient, and can last anywhere between one to six hours, or sometimes longer. Most procedures are performed under general
anesthesia. During the procedure, parents and families will be provided with regular progress updates. When the procedure is done, patients are brought briefly to a recovery area. They are then prior to being admitted to the pediatric (or adult) floor, or in some cases, to the pediatric (or adult) intensive care unit. The interventional cardiologist will speak to parents and family immediately following the procedure and explain the details of what was performed.

While some patients can be discharged home within 6 hours, most will be observed overnight.

After the Procedure (Post-Procedure)

The day after the procedure, some tests such as a chest X-Ray or echocardiogram may need to be performed. Prior to discharge, parents will meet with the interventional cardiologist one more time to discuss any additional questions or concerns. Families will be provided with detailed discharge instructions and a follow-up with the interventional nurse practitioner will be arranged for four weeks following the procedure. At the follow-up visit, the vascular entry site (usually the groin) will be inspected and the patient evaluated for any problems or concerns relating to the cardiac catheterization procedure. After this visit, further follow-up will be arranged with the patient’s original pediatric cardiologist.

Research

Quality and safety are the most important priorities when performing interventional cardiac procedures in patients with congenital heart disease. Dr Holzer is an internationally recognized leader when it comes to outcomes research, quality, and risk adjustment. We participate in important quality improvement efforts such as CRISP/CCISC, and IMPACT, and Dr. Holzer has held leadership positions within the IMPACT registry and the C3PO quality improvement initiative. Our program has a long track record of research focusing on outcomes, quality improvement, and risk adjustment.

Some of the manuscripts that we co-authored (often as primary or senior author) over the last five years relating to quality and outcomes are listed below (authors from Weill Cornell are highlighted in bold) for patient and provider reference:


What Sets us Apart

- Dr Ralf Holzer, chief of Pediatric Cardiology and Director of Pediatric Cardiac Catheterization, is an internationally recognized expert in the transcatheater treatment of patients with congenital heart disease. Dr. Holzer has been involved in many of the trials that led to approval of the devices presently used to treat children and young adults with heart disease. He has lectured at many international meetings and has demonstrated and taught interventional techniques through live case demonstrations.
- The Division of Pediatric Cardiology is affiliated with top-ranked NewYork-Presbyterian Komansky Children's Hospital at Weill Cornell Medical Center.

Videos

*(All Surgeries Performed by Dr. Ralf Holzer)*

**CASE 1**

This image (Figure 1) is from 17-year old girl who had a **narrowing of the distal main pulmonary artery** (the vessel going to the lungs) as well as an **incompetent (leaky) valve**, which was treated through transcatheter valve implantation. The procedure was transmitted live via satellite to the Pediatric Interventional Cardiac Symposium (PICS) in Chicago. Due to the specific location of the narrowing, the valve had to be implanted over two balloon catheters simultaneously, which was the first time this technique had ever been successfully performed anywhere. The top image documents the expansion with two balloons and the bottom image shows an angiography after valve implantation, documenting no residual leak or narrowing.
CASE 2:
This 6-year-old boy’s large atrial septal defect (hole between the two collecting chambers of the heart) was closed using an AMPLATZER septal occluder. Figure 2 documents a baseline angiography documenting a large ASD (top left image, arrows outlining the ASD), balloon sizing for device size determination (top right), device positioned across the ASD (bottom left), and final angiography after release of the device documenting no residual shunt (flow) across the ASD (bottom right).
CASE 3:
This 15-year old boy was born with a **tight coarctation** (a narrowing of the aorta), which was relieved through implantation of a covered stent. Figure 3 documents the narrowing (top left image, in between arrows), with positioning of a covered CP stent (top right image), and stent
expansion (bottom left image), and final angiography documenting complete relief of the narrowing with the vessel now wide open (bottom right image). The video documents the procedure's stages.
CASE 4:
This 2-day old infant was born with **pulmonary atresia** (the valve to the lungs was completely closed, requiring the blood to go to the lungs via a different route). This was treated through radiofrequency perforation of the valve, followed by balloon valvuloplasty (balloon dilation). Figure 4 shows the closed off valve without any flow to the lungs (top left), which then required RF perforation (top right), and balloon valvuloplasty (bottom left), leading to a wide-open valve to the lungs (bottom right). The video documents all procedural stages.

![Figure 4](image-url)
CASE 5:
This 3-year-old child was born with complex congenital heart disease and had undergone multiple cardiac surgeries and cardiac catheterization procedures. The child developed a **complete occlusion of the left pulmonary artery** (artery going to the left lung), which required recanalization (re-opening) using radiofrequency energy, followed by implantation of an endovascular stent. Figure 5 documents the occluded left pulmonary artery (top left, level of occlusion highlighted by arrow), the radiofrequency wire perforating through the occluded segment (top right, highlighted by arrow), the implantation of an additional stent (bottom left), as well as the final result with excellent flow to the re-opened left pulmonary artery (bottom right).

CASE 6:
This 6-week-old infant with a **large muscular ventricular septal defect (VSD)** (hole between the two pumping chambers), in whom a device was deployed to close the VSD using a Hybrid
approach through a small subxyphoid (below the sternum) incision performed by our surgical colleagues. The video initially documents the VSD (labelled as VSD) and then shows the device deployment with no residual flow across the hole at the end of the procedure.