NewYork-Presbyterian
Congenital Heart Center

HIGH VOLUMES

+

TOP DOCTORS

+

NOVEL TECHNIQUES

=

Pediatric & Adult
Congenital Heart Surgery

BEST OUTCOMES

ColumbiaDoctors
Children's Health

Weill Cornell Medicine
Pediatrics

NewYork-Presbyterian
Morgan Stanley Children's Hospital
Columbia University Medical Center

NewYork-Presbyterian
Phyllis and David Komansky
Center for Children's Health
Weill Cornell Medical Center

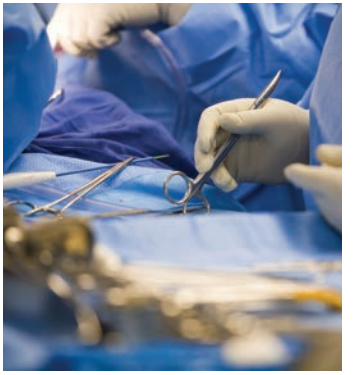
Affiliated with two of the nation's leading medical colleges – Columbia University College of Physicians and Surgeons and Weill Cornell Medical College – NewYork-Presbyterian is one of the top ten hospitals in the country.

We are comprised of two renowned medical centers: NewYork-Presbyterian/Columbia University Medical Center, which includes Morgan Stanley Children's Hospital and NewYork-Presbyterian/Weill Cornell Medical Center which encompasses the Phyllis and David Komansky Center for Children's Health. Our children's hospitals offer the best available care in every area of pediatrics in a compassionate, family-friendly and technologically-advanced setting.

We have built a reputation as a leading center for pediatric care, medical education, and scientific research. NewYork-Presbyterian Hospital ranks in all 10 pediatric specialties including cardiology and heart surgery – more than any other hospital in the metropolitan New York area – according to the 2015-2016 *U.S. News & World Report* "Best Children's Hospitals" rankings.

Contents

The most important measure of a center's experience & expertise in pediatric cardiovascular surgery is the quality of its outcomes.



Our Surgical Goals

- Make family-centered care a priority, involving parents in every step of the treatment process.
- Minimize "surgical trauma" by reducing length of surgery, time on the ventilator and recovery in ICU.
- Make this the first and last surgery the child will ever need.
- Use small incisions, with minimal scarring and cosmetically pleasing results.
- Practice blood transfusion-free surgery whenever possible.
- Share data to help practitioners and families make informed decisions.

Julie A. Vincent, MD and Emile A. Bacha, MD

Dear Colleague:

Each year, pediatric cardiac surgeons at the NewYork-Presbyterian Congenital Heart Center perform more than 700 cardiac operations, including some 25 heart transplants, 175 newborn heart repairs and 100 adult congenital heart repairs. Notably, the hospital ranks in the top ten in the nation in pediatric cardiology and heart surgery. We have the lowest mortality rate in New York State for pediatric heart surgery, and one of the lowest nationwide – even though our surgeons routinely treat some of the most complex cases, many referred from other institutions.

The Congenital Heart Center, a combined program of the pediatric centers of NewYork-Presbyterian/Morgan Stanley Children's Hospital at Columbia University Medical Center and NewYork-Presbyterian Hospital/Phyllis and David Komansky Center for Children's Health at Weill Cornell Medical Center, provides a fully integrated approach to the treatment of complex heart conditions in children of all ages – from neonates to adults. It is one of the first and most preeminent pediatric cardiology and cardiac surgery centers in the nation, and one of the nation's major pediatric transplant centers. We have been performing pediatric heart surgery at a high volume since the early 1970s, creating a culture of clinical excellence and demanding the best outcome for each and every patient. We performed the first successful pediatric heart transplant in the United States in 1984. In 2015, a team of surgeons at NYP/Morgan Stanley Children's made history when they used a 3-D printed model of a one-week-old baby's heart as a guide for surgery on the child, who was born with a complex and deadly form of congenital heart disease.

NewYork-Presbyterian has routinely ranked among the top ten U.S. hospitals for all pediatric specialties evaluated by *U.S. News and World Report,* including cardiology and heart surgery. We have a distinguished roster of highly-skilled and experienced cardiovascular surgeons, including four national leaders specializing in complex neonatal surgery, hybrid minimally invasive surgery and transplant/assist devices. We offer our young patients not only cardiovascular expertise, but all sub-specialties that may be needed when treating a complex heart problem – from fetal diagnosis to neonatal intensive care, non-invasive imaging and specialized pediatric cardiac anesthesia.

The seamless integration of our Pediatric Cardiology and Cardiac Surgery Divisions ensures that patients who require surgical intervention receive continuity of care throughout their treatment and recovery. As a major national and international referral center for children and adults with congenital heart disease, NewYork-Presbyterian offers a physician access transfer program – 1-800-NYP-STAT – to coordinate patient transfers when tertiary and quaternary care are required.

We strongly believe in transparency, allowing both practitioners and parents to have convenient access to data that helps them make their own informed decisions. On behalf of NewYork-Presbyterian Congenital Heart Center, we are pleased to provide a summary of outcomes for some of our most often performed pediatric and adult cardiac congenital surgical procedures for the years 2011-2014, the most recent period for which complete data are available. Data are presented in accordance with the Society of Thoracic Surgeons (STS) congenital cardiac surgery database guidelines. The STS database is widely accepted as the most trusted comprehensive database by both insurance companies and consumer groups. We have been participants in this database since 2007.

We hope you will find the information in this brochure valuable as you make informed decisions as to where to refer your pediatric cardiac patients for surgery. Our specialists are available for consultations and second opinions, evaluation and treatment. Thank you for taking the time to review our summary. For more information about our programs, please feel free to contact us by phone at **212-305-2688,** by email **congenitalheart@nyp.org,** or visit the Hospital's website at **nyp.org/kids.**

We consistently rank as the best in pediatric care in the New York Tri-State region, with the lowest mortality for pediatric heart surgery in the state.

Sincerely,

Emile A. Bacha, MD
Chief, Division of Cardiac, Thoracic and Vascular Surgery
NewYork-Presbyterian/Columbia University Medical Center
Director, Congenital and Pediatric Cardiac Surgery
NewYork-Presbyterian
Calvin F. Barber Professor of Surgery
Columbia University College of Physicians and Surgeons
Adjunct Professor of Surgery
Weill Cornell Medical College
Co-Director
NewYork-Presbyterian Congenital Heart Center

Julie A. Vincent, MD, FACC, FSCAI, FAAP
Chief, Pediatric Cardiology
NewYork-Presbyterian
Welton M. Gersony Professor of Pediatric Cardiology
Columbia University College of Physicians and Surgeons
Samberg Scholar in Children's Health
NewYork-Presbyterian/Morgan Stanley Children's Hospital
Co-Director
NewYork-Presbyterian Congenital Heart Center

Center Overview 2011-2014

Our outcomes are
more than 30% better
than established national benchmarks.

It has been demonstrated that improved clinical outcomes are closely linked to centers with high surgical volumes. As a center's activity increases, cardiothoracic surgeons, cardiologists, anesthesiologists, critical care specialists, nurses, perfusionists and other cardiac team members become more experienced at caring for patients with congenital heart disease.

While we treat some of the most complex cases, our outcomes are well above established national benchmarks. For the years 2011-2014, our average hospital mortality was

3.0%

For years 2011-2014, the Society of Thoracic Surgeons (STS) global hospital mortality for all participating pediatric cardiac centers was

3.3%

Each year, our pediatric cardiac surgical teams perform more than 700 cardiac operations, many of which are complex surgeries referred to us from medical centers across the country and around the world.

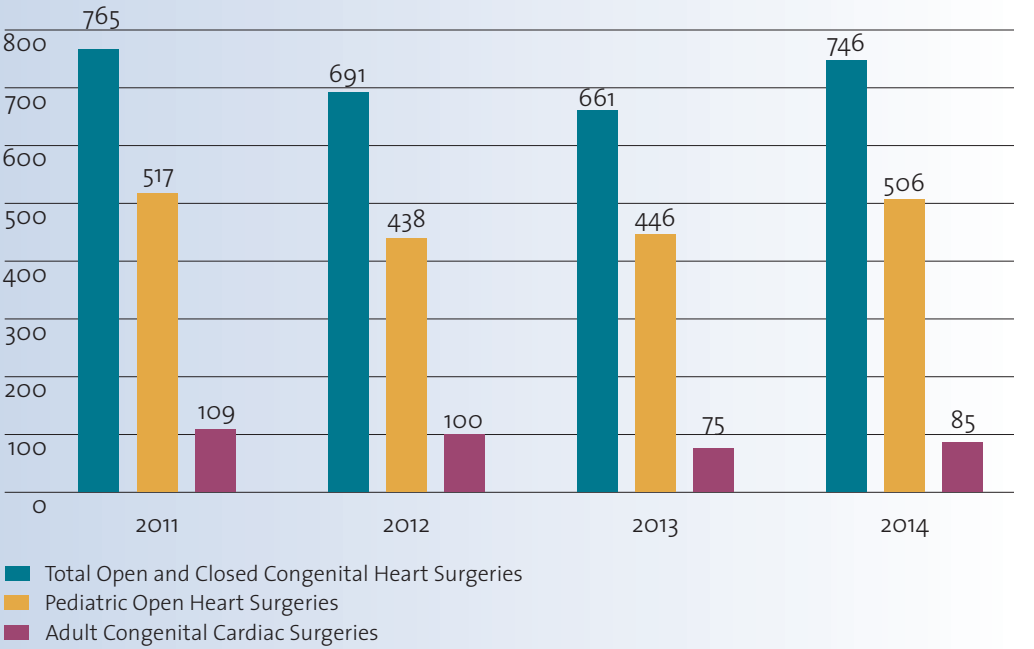
We rank as the best in pediatric care in the New York region, with the lowest mortality for pediatric heart surgery in the Tri-State area.

Pediatric & Adult Congenital Cardiac Surgeries 2011-2014

Each year, our pediatric cardiac surgical teams perform more than

700

pediatric & adult congenital heart surgeries



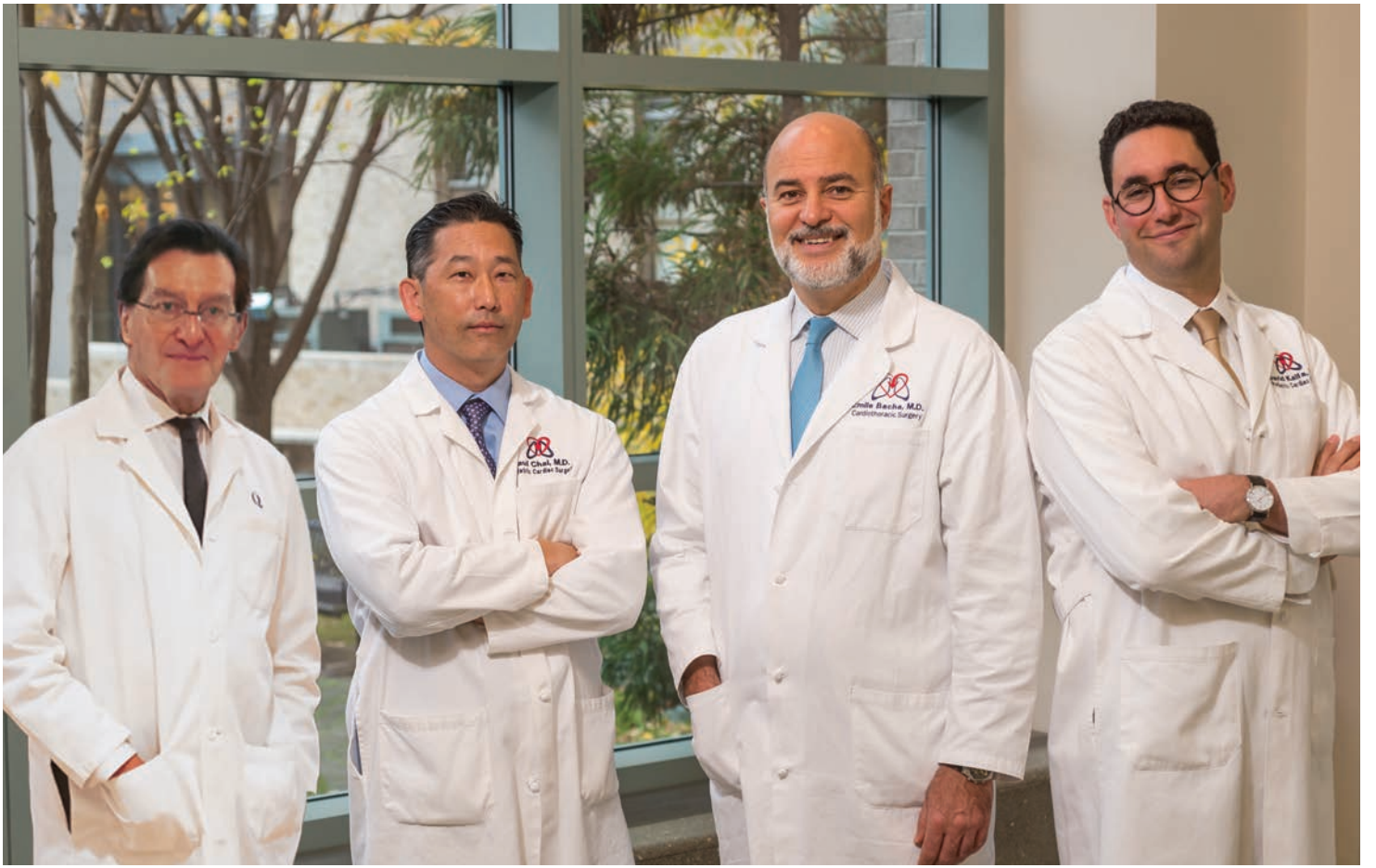
Neonatal Volume (2011-2014)	2011	2012	2013	2014
Surgical Procedures (neonate <30 days)	**145**	**126**	**103**	**146**

Survival Statistics 2011-2014

Procedure	Number of Cases | Survival			
	2011	2012	2013	2014
Aortic Valve/Ross	11 | 91%	5 | 100%	9 | 100%	12 | 100%
Arterial Switch Operation (ASO)	14 | 100%	18 | 100%	13 | 100%	25 | 96%
Atrial Septal Defect Repair (ASD)	49 | 100%	59 | 100%	62 | 100%	38 | 100%
Atrioventricular Canal Defect (AV Canal)	27 | 100%	27 | 100%	29 | 97%	35 | 94%
Fontan	17 | 94%	25 | 96%	21 | 91%	22 | 95%
Glenn	17 | 100%	15 | 93%	16 | 100%	21 | 95%
Norwood	27 | 85%	16 | 88%	16 | 82%	18 | 100%
Tetralogy of Fallot Repair (TOF)	51 | 98%	33 | 97%	33 | 100%	50 | 100%
Total Anomalous Pulmonary Venous Return (TAPVR)	7 | 100%	12 | 92%	4 | 100%	16 | 94%
Transplant	28 | 96%	21 | 100%	30 | 93%	22 | 100%
Ventricular Septal Defect (VSD)	50 | 100%	28 | 100%	37 | 100%	48 | 98%

Overall Hospital Discharge Mortality Rate	NYP Congenital Heart Center	STS National Benchmark 2011-2014
2011	2.7%	3.3%
2012	1.5%	3.2%
2013	3.0%	3.2%
2014	2.5%	2.9%

About the Congenital Heart Center



From left: Dr. Quaegebeur, Dr. Chai, Dr. Bacha, and Dr. Kalfa

NewYork-Presbyterian has built a national reputation for outstanding care devoted to children. Our integrated Congenital Heart Center is one of the largest and most preeminent pediatric cardiology and cardiac surgery centers in the nation. We provide both adult and pediatric patients with congenital heart defects treatment options never thought possible just a short time ago, with outcomes that are among the best in the nation.

Our patients come to us from around the country and around the world to seek the most advanced, safest, and proven treatments for congenital heart conditions and for the revision of previous surgery when that treatment fails.

A Leading Pediatric Heart Center

In 2015, *U.S. News & World Report* ranked NewYork-Presbyterian as one of the top pediatric heart and heart surgery programs nationally, reflecting our reputation and surgical outcomes, the expertise of our surgical teams, our volume of cases and other patient-care related data.

Since *U.S. News & World Report* first began ranking hospitals and their departments, our pediatric heart and heart surgery program has consistently been recognized as one of the top ten in the country.

Academic Excellence

Under the direction of pediatric cardiovascular surgeon Dr. Emile Bacha and pediatric cardiologist Dr. Julie A. Vincent, the Congenital Heart Center combines the outstanding physician faculty of two esteemed medical schools – Columbia University College of Physicians and Surgeons and Weill Cornell Medical College – and the facilities of NewYork-Presbyterian/Morgan Stanley Children's Hospital and NewYork-Presbyterian Hospital/Phyllis and David Komansky Center for Children's Health. Our team of cardiologists and cardiac surgeons at both locations share their perspectives, patient care philosophies, and knowledge to address every form of congenital heart disease.

Dr. Bacha is known for developing novel techniques to perform hybrid surgical-interventional catheter-based procedures for many complex congenital heart defects, including hypoplastic left heart syndrome. He specializes in minimally invasive approaches to pediatric cardiac surgery and cardiac surgery in low birthweight infants and has pioneered methods of improving surgical safety. He has developed a method of pediatric cardiac surgical performance metrics that is now an accepted method of surgical monitoring for pediatric cardiac surgeons.

Dr. Vincent's clinical expertise includes transcatheter therapies for congenital heart disease (CHD) including all types of device closure techniques for atrial and ventricular septal defects, the patent ductus arteriosus, and abnormal vascular connections or collaterals. She is internationally recognized as an expert in transcatheter pulmonary valve replacement techniques.

Therapeutic Excellence

We provide all therapies a newborn, child, adolescent or adult with congenital heart disease may need – from evaluating heart function and anatomy in utero to pediatric heart transplant and extended heart/lung support via Extracorporeal Membrane Oxygenation (ECMO) and other devices. We are also widely recognized for neonatal heart surgery and many of the procedures we perform are in low birthweight premature newborns and in infants under the age of one month.

Each year, the Center performs more than 1,200 diagnostic and interventional cardiac catheterizations.

How Often Is Cardiac Surgery Required in Children?

Approximately 30,000 children – or about one percent of all live births – are born with congenital heart defects each year in the United States. Of these, about **.2 to .3 percent** require surgery.

Collaborative, Multi-Disciplinary Care

Bringing our pediatric surgical, medical, anesthesiology, perfusionist, critical care and cardiovascular support specialists together into an integrated care team helps us to optimize patient outcomes. This integrated care model enables us to provide seamless interaction with all sub-specialties, resulting in the best and safest treatment for our youngest patients.

A family referred to the Center can be assured that they will be in the expert hands of a medical team renowned for excellence in pediatric cardiology and cardiac surgery and committed to a shared goal of providing our patients with the safest, most advanced surgical techniques available.

State-of-the-Art Interventional Catheterization

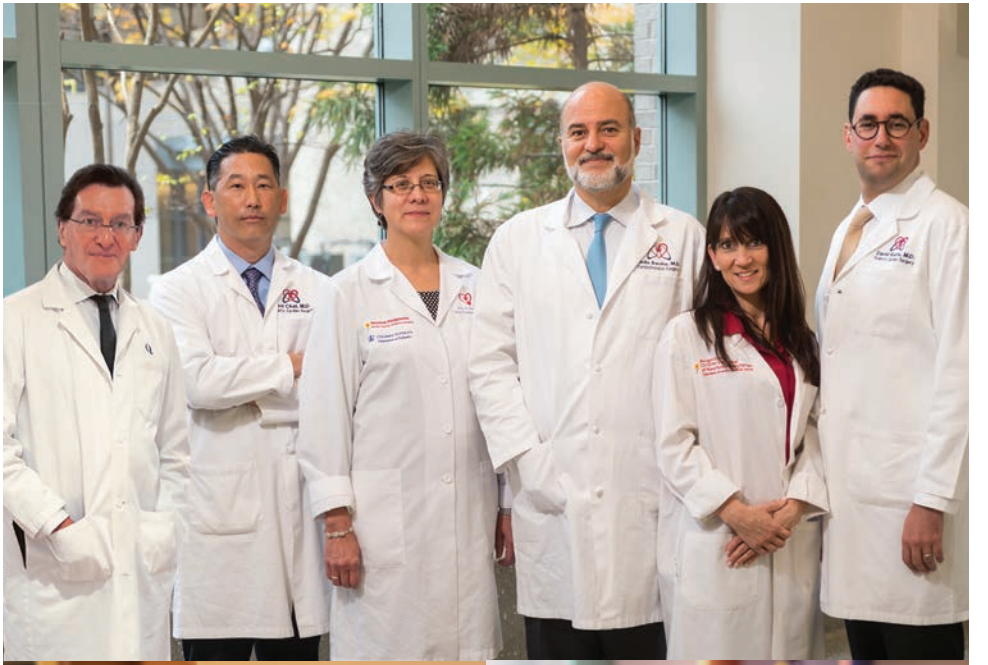
The Congenital Heart Center has the only pediatric catheterization laboratories in metropolitan New York dedicated to pediatric pulmonary hypertension and arrhythmia studies, as well as diagnostic and therapeutic interventions, such as radiofrequency ablation for cardiac arrhythmias and balloon valvuloplasty of the aortic and pulmonary valves. Many of the pediatric interventional procedures that have become standard of care worldwide have been developed by interventional cardiologists at NewYork-Presbyterian.

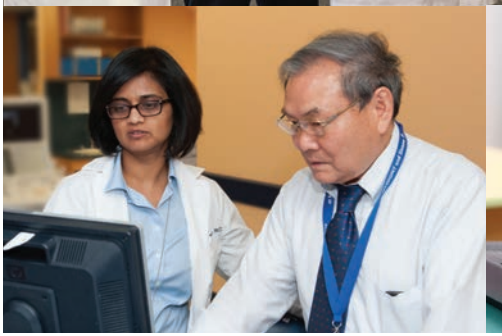
A great number of congenital heart defects can now be treated in the cath lab, requiring only a single day of hospitalization, and eliminating the need for open heart surgical repair.

Catheter-Based Interventions

The NewYork-Presbyterian Congenital Heart Center has particular expertise in pediatric interventional cardiology, a unique specialty that involves the non-surgical treatment of congenital and acquired cardiovascular disorders. Catheter-based interventions we perform regularly include:

- Balloon valvuloplasty of the aortic and pulmonary valves
- Balloon valvuloplasty for distal pulmonary artery narrowing (stenosis)
- Angioplasty, including dilation and stent implantation, to open narrowed arteries and veins
- Balloon atrial septostomy to improve mixing of oxygen-rich and oxygen-poor blood to ensure that the body's oxygen saturation remains in a safe range
- Atrial septoplasty or blade septostomy to treat pulmonary hypertension
- Pulmonary artery dilation and stent implantation
- Coil and Amplatzer device closure of open ductus arteriosus, atrial septal defect, Fontan fenestration, and patent foramen ovale – a defect in the wall between the two upper chambers of the heart
- Closure of ventricular septal defect
- Percutaneous pulmonary valve replacement – a new approach for the management of pulmonary regurgitation and conduit obstructions





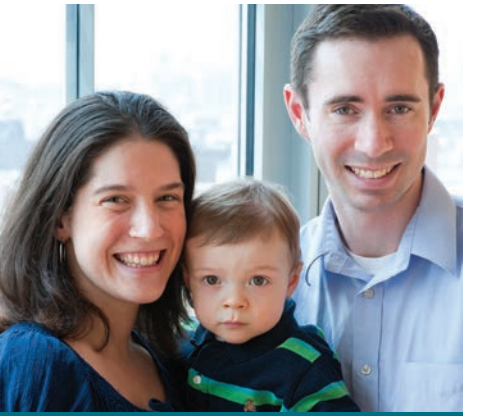
Photos, clockwise from top right: *(from left)* Dr. Quaegebeur, Dr. Chai, Dr. Vincent, Dr. Bacha, Dr. Berman Rosenzweig, and Dr. Kalfa;

Dr. Ganga Krishnamurthy *(left)* and Dr. Jen-Tien Wung, Division of Neonatology

We have a distinguished roster of highly-skilled and experienced pediatric cardiologists, interventional cardiologists and cardiovascular surgeons who share their perspectives and knowledge to address virtually every form of congenital heart disease in children and adults. Seamless integration between the Division of Pediatric Cardiology and the Division of Pediatric Cardiac Surgery ensures that patients who require surgical intervention receive continuity of care throughout treatment and recovery.

UPDATE

Today, Mark is a happy, well-adjusted five-year-old who is growing well and enjoying a normal childhood. Mark will need his mitral valve replaced when he gets a little older, but the surgery is not expected to present any unusual difficulties. Since Mark has now reached normal height and weight, we expect to be able to place a new adult-size prosthetic mitral valve that he will grow into as he ages.



BABY MARK

Diagnosis: Hypoplastic left heart complex & borderline left heart

Treatment: Biventricular Repair

Mark was born with a difficult-to-treat congenital defect known as hypoplastic left heart complex and a borderline left heart size. Mark's parents visited several of the nation's most prestigious pediatric heart centers and concluded they wanted him cared for by pediatric cardiac surgeons at NewYork-Presbyterian/Morgan Stanley Children's Hospital.

Rather than a Fontan single ventricle circulation, we achieved a 2-ventricle circulation for Mark. We first performed a Norwood Stage I procedure when Mark was a neonate. We then performed two more procedures to separate his heart into two distinct pumping chambers:

- EFE (endocardial fibroelastosis) resection, ASD and VSD closure, and
- mitral valve replacement

Minimally Invasive or Hybrid Options

Hybrid heart surgery refers to procedures that use conventional surgical methods in conjunction with minimally invasive, catheter-based interventional approaches. These less invasive alternatives use a much smaller incision through the breast bone or right chest, with the advantage of less pain, avoidance of cardiopulmonary bypass, faster return to normal activities and definite cosmetic advantages.

At the NYP Congenital Heart Center, each patient is evaluated for less invasive treatment options first. In some cases, a hybrid approach may enable the surgeon to treat a condition with a single operation rather than a series of surgeries or to treat conditions that would otherwise be inoperable. The Congenital Heart Center is one of just a few U.S. centers to offer hybrid heart operations to infants and children.

The Congenital Heart Center is one of just a few U.S. centers to have a hybrid program for infants and children and the only one in the Tri-State area.

Hybrid Therapy for Hypoplastic Left Heart Syndrome

Center surgeons are successfully using a less invasive hybrid technique for a difficult-to-treat defect in newborns known as hypoplastic left heart syndrome (HLHS). To survive, babies born with this anomaly must undergo surgery in the first week of life. Until recently, the only treatment available was the Norwood procedure, which requires three difficult standard open operations and carries a 10-20% or greater risk of mortality. (Source: Society of Thoracic Surgeons Congenital Heart Surgery Database 2011-2014 Report "*Discharge mortality for all participating centers: 14.8%*").

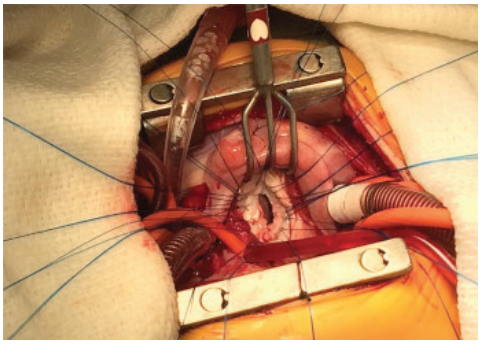
The Stage 1 hybrid procedure removes dependence on the heart-lung machine. At approximately six months, when the baby is better able to handle major open surgery, the second stage operation is performed. The hybrid procedure is thought to be safer in high-risk patients such as low birthweight or premature babies because it avoids use of the heart-lung machine.

Hybrid techniques are not applied universally and they are not appropriate for every child. Some babies still do better with the Norwood procedure and we decide on a case-by-case basis, in a multidisciplinary fashion, whether a child will benefit most from one procedure or the other.

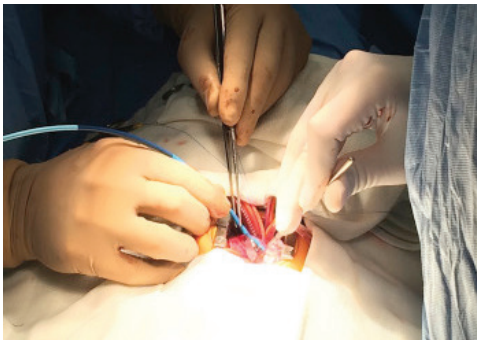
Hybrid Therapy for Ventricular Septal Defect Repairs (VSDs) or Valve Implantation
Center physicians are expanding applications of minimally invasive hybrid techniques to include closing ventricular septal defects or holes in the heart tissue with excellent results.

Typically, holes in the heart are closed by suturing a patch on the hole during open heart surgery. The hybrid technique allows surgeons to go through the chest and deliver a device to close holes and prevent the need for multiple surgeries. We have developed special instruments that allow us to make these repairs using much smaller incisions than previously possible, resulting in markedly improved cosmetic results.

We have also implanted valves using a hybrid approach, resulting in less need for anticoagulation. Typically, valves are sutured inside the heart and often require anticoagulation with Coumadin. By using stented valves, we can implant biological valves that do not require anticoagulation. Biological valves can also be dilated and enlarged to keep up with the child's growth, unlike traditional "surgical" valves that cannot be enlarged and must be exchanged surgically.



Sutures are placed around the mitral valve annulus on the atrial side.



The valve is positioned through the mitral annulus before balloon expansion.

BABY ANJALI

Diagnosis: Tetralogy of Fallot with Pulmonary Atresia (TOF-PA) & small branch pulmonary arteries

Treatment: Complete repair using Right Ventricle-to–Pulmonary Artery (RV-PA) homografts and mechanical support

Anjali was born premature at 1.2kg (2.6 lbs), with challenging and complex congenital heart disease – TOF-PA and small branch pulmonary arteries. We waited to operate on Anjali until 45 days of age when she had reached a weight of 1.8kg (3.9 lbs). We then performed a complete repair which included VSD closure, Pulmonary Artery plasty and a 10mm Right Ventricle-to-Pulmonary Artery homograft. She did well initially, but her Right Pulmonary Artery (RPA) became progressively obstructed, requiring re-operation.

At six weeks post-op, she was re-operated for RPA plasty and required post-op mechanical support in the form of the Pedimag® circulatory assist device. Anjali did very well with this technology and was discharged home in very good condition.

At age 10 months, she underwent an RV-PA conduit change to a 16mm aortic homograft, and has had normal Right Ventricle pressures since.

Anjali is developing normally, and is the smallest child ever to be successfully supported by a Pedimag® device.

UPDATE

Now age five, Anjali is a healthy and completely normal child. She had a planned right ventricle to pulmonary artery conduit replacement this year and did very well, spending only three days in the hospital. When used in neonates, conduit longevity is markedly shortened, primarily because of a progressive body-weight/conduit size mismatch as the child grows. Now that Anjali has grown to a bigger size, we were able to place an adult-size conduit that we expect will not need replacement again for a very long time.

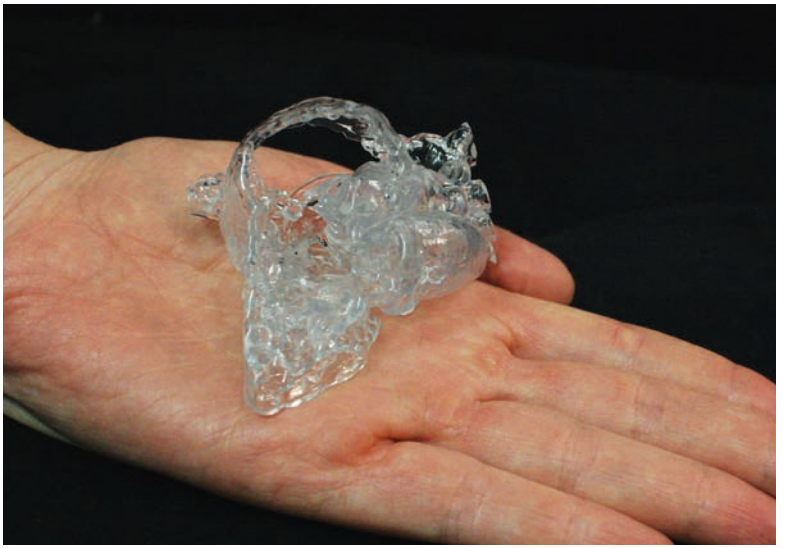
Customized 3D Heart Models Give Surgeons Vital Information About a Heart's Anatomy

When doctors at multiple medical centers told parents that the abnormalities in their baby's heart were very complex and may not be able to be repaired completely and in one surgery, they came to NewYork-Presbyterian/Morgan Stanley Children's Hospital where surgeons were using an advanced new technology – 3D printing – to repair complex lesions.

Fetal imaging revealed double outlet right ventricle (DORV), in which the aorta connects to the right instead of the left ventricle, as well as a posterior ventricular septal defect. The aorta was positioned to the right of the pulmonary artery and appeared to be unusually small and possibly obstructed. Using an advanced 3D printer and software called HeartPrint®, doctors created an intricate 3D model of the baby's heart, providing them in advance with better, more accurate information to plan the surgery and allowing more time in the operating room to repair the child's cardiac defects. Typically, surgeons must wait until they are in the operating room to see the extent of a heart's defect, and then execute the surgical procedure in a limited amount of time.

Intracardiac scan of baby's heart.

The 3D model revealed that the baby had a hole between his two ventricles, and his aorta and pulmonary artery both branched over to the right ventricle. With that information, physicians were able to precisely plan the operation and determined that only one surgery would be required. At just one week old, the baby underwent an arterial switch operation and the ventricular outflow to the aorta was successfully tunneled. The baby went from a limited life span to a normal life expectancy with just one operation.



Thanks to this 3D heart model, cardiac surgeons at NYP/Morgan Stanley Children's could plan an infant's operation before stepping into the OR.

Linda J. Addonizio, MD
Director
Program for Pediatric Cardiomyopathy, Heart Failure and Transplantation
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

One of the Nation's Largest Heart Transplant Programs

We have a rich history of developing innovative surgical treatments that set the standard in pediatric cardiac surgery. In 1984, our surgeons performed the world's first successful pediatric heart transplant in a 4-year-old boy. In the intervening years, more than 500 children have received new hearts at NewYork-Presbyterian/Morgan Stanley Children's Hospital. Today, NewYork-Presbyterian is one of the largest and most successful pediatric heart transplant centers in North America and the world – largely due to the dedication and expertise of our heart transplant team, the use of assist devices in managing heart failure, and the application of novel immunosuppression protocols. The hospital also has a leadership role in the Pediatric Heart Transplant Study Group, which consists of 23 institutions across North America and is responsible for a significant proportion of multi-institutional research related to pediatric heart transplantation today.

Ventricular Assist Devices (VADs)

Our cardiac surgeons are at the forefront of developing and designing ventricular assist devices for infants and small children as a bridge to recovery or transplantation. Leaders in research into alternatives for transplants, we are among the first in the United States to implant a Berlin Heart EXCOR heart pump into a newborn, and currently use a variety of devices to help right, left, or biventricular failure in patients from infant to young adult. Notably, we have the largest pediatric experience in the U.S. with the PediMag (Levitronix) device.

Our cardiac surgeons are at the forefront of developing and designing ventricular assist devices for infants and small children as a bridge to recovery or transplantation.

Extracorporeal Membrane Oxygenation (ECMO)

ECMO is a short-term cardiac assist device for the very young, or for children whose anatomy will not permit a ventricular assist device (VAD). The Center's physicians participated in the earliest development of ECMO, making our facility one of the first in the world to use this life-saving technology successfully in neonates and children. We are an ELSO (Extracorporeal Life Support Organization) Center of Excellence, and have an ECMO transport program to move patients from outside hospitals into ours. In addition, our pulmonary hypertension team has expertise in using ECMO for a bridge to recovery and transplantation when needed.

NYP/Morgan Stanley Children's multidisciplinary transplant team.

Blood Conservation Techniques

For the vast majority of procedures in neonates or small infants, transfusion-free cardiac surgery is unrealistic. However, we have made considerable progress in limiting the need for blood products with simple and safe techniques that involve a decrease in cardiopulmonary bypass prime volume, such as making the heart-lung machine smaller and less injurious.

Every participant in our program, including cardiologists, anesthesiologists, perfusionists, surgeons, intensivists and laboratory technicians, is committed to blood conservation in pediatric cardiac surgery.

Every practitioner in our program, including cardiologists, anesthesiologists, perfusionists, surgeons, intensivists and laboratory technicians, is committed to blood conservation in pediatric cardiac surgery.

Prenatal Diagnosis & Intervention

We have one of the largest and most experienced maternal-fetal medicine teams in the country, with over half of all deliveries designated high-risk or increased risk.

Our Carmen and John Thain Center for Prenatal Pediatrics is the only one of its kind in the metropolitan New York area, offering comprehensive, multidisciplinary prenatal diagnosis and therapy in conjunction with pediatric subspecialty consultation.

When a heart defect is suspected in utero, we bring together a core team of high-risk obstetricians, neonatologists, fetal cardiology specialists, pediatric congenital heart surgeons, and other cardiac specialists. Working jointly with our colleagues in maternal-fetal medicine, we precisely diagnose the anomaly, develop a plan for close surveillance, and prepare for surgical intervention and the proper level of care at delivery, ultimately leading to improved outcomes.

In cases where fetal therapy is possible, such as for cardiac arrhythmia, collaboration with pediatric cardiologists can maximize our ability to improve fetal health while avoiding complications in the mother.

BABY AVA

Ava was diagnosed at birth with Total Anomalous Pulmonary Venous Return (TAPVR) and required emergency surgery at delivery to restore the normal blood flow from the pulmonary veins to the left atrium. If left unoperated this rare condition is uniformly fatal.

Ava's surgery was complicated because of abnormally small, narrowed veins and unusual anatomy. The outcome was very successful, but it was clear that within a few months Ava would need another surgery to relieve some scarring. Scarring is very challenging to treat and frequently occurs with TAPVR patients who are found to have small veins. The second surgery was performed at about six months of age, and required hybrid techniques (intraoperative balloon dilation of vein stenosis) to dilate and open her small veins.

Ava did extremely well after her second surgery and is now considered healthy after treatment for this often fatal condition commonly known as pulmonary vein stenosis. Her long-term prognosis is excellent and the outlook is for no further problems or additional surgeries. Of course, she will have to remain in the care of a pediatric cardiologist with yearly follow-ups.

Diagnosis: Total Anomalous Pulmonary Venous Return (TAPVR)

Treatment: Surgery to repair this rare and complex heart defect is needed as soon as possible. In the normal heart, four pulmonary veins carry oxygenated blood from the lungs to the left side of the heart (left atrium), which pumps the oxygenated blood to the body. In a heart with TAPVR, the pulmonary veins connect to the heart in abnormal positions, which means that oxygenated blood enters or leaks into the wrong chamber and there is not enough oxygen for the entire body. The surgical repair of anomalous pulmonary veins involves the redirection of the abnormal veins to the left atrium of the heart.

Cardiac Critical Care

The Congenital Heart Center offers the enormous resources needed when treating serious heart defects, including all levels of care and one-to-one patient/nurse ratios.

Our Cardiac Neonatal Intensive Care Unit (NICU) is designated the highest level NICU and a regional perinatal center by the New York State Department of Health.

Cardiac Neonatal Intensive Care

Many babies require surgery within hours of birth. A highly specialized team of neonatologists and cardiologists, with subspecialties in neonatal cardiac care, provides care to newborns with such life-threatening conditions as transposition of the great arteries, hypoplastic left heart syndrome, and complex left ventricular obstruction.

By focusing exclusively on neonates with cardiac disease, we feel we have developed unsurpassed expertise in the care of low birthweight and premature babies in particular.

Pediatric Cardiac Critical Care Medicine

The Pediatric Cardiac Intensive Care Unit (PCICU) serves the needs of critically ill infants, children and adolescents. This specialized unit is staffed by a highly skilled team of intensivists working together with multiple subspecialties including anesthesiology, pediatric cardiology, pediatric cardiovascular surgery, critical care, and pulmonology. The care of patients in the PCICU is directed by both pediatric critical care physicians and pediatric cardiologists, with surgical patients managed in close consultation with our cardiothoracic surgical staff and a team of critical care nurses with advanced training. This unit also manages the perioperative care of patients undergoing heart and lung transplants.

The PCICU staff are experts in the management of the most advanced support technology: ECMO, high-frequency oscillatory ventilation, inhaled nitric oxide, continuous renal replacement therapies such as continuous veno-venous hemofiltration (CVVH), and neurologic monitoring including continuous EEG and ventricular assist devices, one of the few institutions in the world offering such technology to the smallest children.

Adult Congenital Heart Program

With the success of cardiac surgery in childhood, the number of young adults with congenital heart defects represents a unique and growing population and more than 30 different forms of congenital heart disease. Because these adults present a unique challenge for the cardiology community, the American Heart Association recently recognized Adult Congenital Heart Disease as a subspecialty of cardiology.

Our adult congenital heart program, the first of its kind in the Tri-State area, includes a team of board-certified pediatric and adult cardiologists, cardiothoracic surgeons, and intensive care experts specifically trained in adult congenital heart disease. They assist in managing young and older adults who present with primary or post-repair congenital heart disease.

Our physicians have expertise in echocardiography, interventional cardiac catheterization, interventional electrophysiology, pulmonary hypertension, complex congenital heart surgery, and cardiac transplantation.

Research: Clinical & Basic Science

Following are a few examples of our ongoing efforts to expand our knowledge and develop new treatment options:

- NewYork-Presbyterian Congenital Heart Center is a participant in a national multicenter trial funded by the National Heart, Lung and Blood Institute (NHLBI) of the National Institutes of Health (NIH) to redefine pulmonary hypertension through Pulmonary Vascular Disease Phenomics. (NHLBI U01)
- We are a participant in a NHLBI U01-funded *Pediatric Pulmonary Hypertension Network Informatics (PPHNet) Registry on Data Fusion,* to explore and compare electronic data capture options using a national pediatric pulmonary hypertension registry.
- The Center is also a participant in a National Institutes of Health-funded *National Biological Sample and Data Repository* for pulmonary arterial hypertension.
- NewYork-Presbyterian physician-scientists are working to overcome restenosis, the primary limitation of conventional angioplasty. Our researchers are investigating intervention with drug-eluting technologies (stents and balloons that hold an artery open and also release a drug that prevents any further blockage or obstruction from occurring) to determine if this intervention will reduce pulmonary vein restenosis rates in children, decreasing morbidity and increasing survival rates.
- The Center is studying the effects of cardiac surgery on ventricular function in infants and children, using state-of-the-art measuring techniques based on hemodynamics and echocardiography; mitochondrial respiratory abnormalities in patients with end-stage cardiomyopathy; and the genetics of ventricular hypertrophy.
- Important clinical research projects also include Computer Modeling of flow dynamics after shunt operations; investigation of biventricular pacing for acute heart failure after cardiac surgery; and the use of TEG (thromboelastography) to evaluate hypercoagulability in single ventricle patients pre- and post-Fontan completion.
- We are active participants in a consortium of major children's hospitals charged with defining quality measures and best practices in pediatric cardiac surgery.
- A new NIH-supported study evaluates the in utero effects of congenital heart disease on neurodevelopmental outcomes in childhood.
- Basic Science research investigates regulation of cardiac Morphogenesis (development of cardiac malformations) by Nkx genes in the zebra fish embryo.

Emphasis on Patient Safety & Quality

Our surgeons are held to a rigorous standard. We hold monthly multi-disciplinary risk-adjusted mortality and morbidity conferences, where we review data on every patient. Additionally, every six months we review surgeon-specific mortality and complications with regard to several specific areas:

- post-operative infection
- unplanned re-operation or re-intervention
- unplanned need for mechanical support
- new post-operative neurological findings
- re-operation for bleeding
- post-operative cardiac arrest
- major technical problems during surgery

We consider referring physicians an important part of our cardiac team.

Twice a year, each surgeon receives a surgeon-specific performance metric. The result: we are able to maintain the highest quality by identifying and correcting potential problems early, which ultimately makes our patients safer.

Open Communication with Referring Physicians

We consider referring physicians an integral part of our cardiac team and are committed to keeping them updated about a patient's medical status, major treatment recommendations and progress during hospitalization. Within hours after patients leave the hospital, we provide a detailed discharge summary to all referring physicians for their reference and continuum of patient care.

Center Outcomes 2011-2014

While we treat some of the most complex cases, our survival rates surpass the national average, with children routinely returning to normal levels of activity and living into adulthood. The observed mortality is lower than expected, given the disease burden of our patients.

Our pediatric surgeons perform more than 700 surgeries for congenital heart disease every year and offer the best possible surgical outcomes. Our participation in the Society of Thoracic Surgeons (STS) congenital heart surgery database allows us to compare our performance with other pediatric and adult congenital heart surgery programs throughout the country.

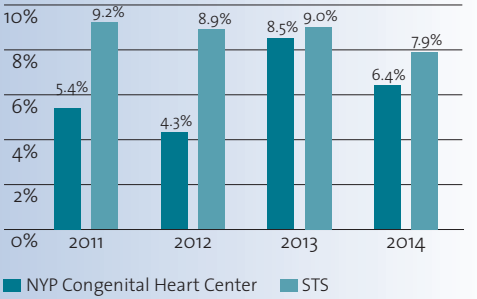
Neonatal Cardiac Surgery at age < 30 days

Early repair of congenital heart defects in neonates can minimize the need for future surgeries. For decades, our comprehensive Neonatal Cardiac Surgery program has been performing neonatal repairs of congenital defects – such as transposition of the great arteries, coarctation of the aorta, truncus arteriosus, and hypoplastic left heart syndrome – with outstanding results. Columbia-Presbyterian surgeons James R. Malm and Frederick O. Bowman Jr. pioneered many of the early cardiac repair techniques used today, including Tetralogy of Fallot repair and the use of the heart-lung machine in children.

Neonatal Cardiac Surgery Mortality 2011-2014
NYP Congenital Heart Center

The mortality rate for neonates at the NYP Congenital Heart Center is among the lowest in the nation:

5.9%



The latest STS report cites an overall neonatal mortality of 5.9% for the NYP Congenital Heart Center based on the complexity of cases. STS predicted mortality was 9.8%.

Performance Excellence

	NYP Congenital Heart Center Mortality	STS Benchmark
Overall	5.9%	9.2%
Difficulty 1	0%	6.1%
Difficulty 2	3.1%	7.3%
Difficulty 3	3.3%	4.2%
Difficulty 4	5.2%	9.7%
Difficulty 5	13.2%	17.1 %

least complex ↓ most complex

Volume: 200 Annual Admissions
The Tri-State area's largest referral center for babies born with congenital heart disease, we admit approximately 200 babies every year. Not all of these infants require surgery.

Complexity-Adjusted Performance Measurement
Mortality is the most common performance metric used in following outcomes of congenital heart surgery. However, many variables can affect patient care outcomes.

To compare performance of congenital heart surgery centers, the Society of Thoracic Surgeons (STS) assigned scores for each surgical procedure based on the potential for mortality, the potential for morbidity, and surgical difficulty – from a risk of 1 to 5, with 5 the most difficult.

Norwood Procedure

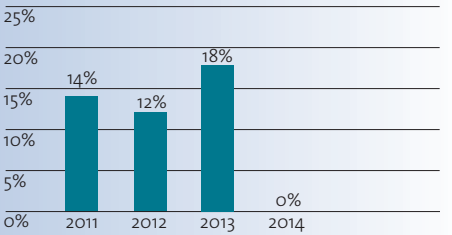
Infants with Hypoplastic Left Heart Syndrome (HLHS) have an incompletely formed left ventricle. Since the early 1980s, a three-step serial procedure designed to create normal blood flow in and out of the heart has extended the life of infants born with HLHS. The Norwood procedure, the first of the three procedures, has the highest risk-adjusted mortality rate among all neonatal and pediatric heart surgeries.

We have extensive experience with the Norwood procedure and stage palliation for HLHS, having performed it since 1985. Our outcomes for this type of repair rank among the best in the country. We are currently involved in a major multi-institutional study evaluating this and other innovative procedures for the treatment of HLHS.

At the NYP Congenital Heart Center the survival rate after the Norwood Procedure is among the best in the country.

88.2% 2011-2014

Norwood Procedure Hospital Discharge Mortality 2011- 2014
NYP Congenital Heart Center



Survival: Over 88%
Survival following the Norwood procedure continues to be a challenge. On average, about 80% survive. Hospital mortality after the Norwood procedure is more than 17% in the Society of Thoracic Surgeons (STS) database for 2011-2014.

The Congenital Heart Center mortality rate following the Norwood Procedure has declined substantially since 2005, with survival now close to 90%. Notably, there was no mortality in 2014 for infants undergoing the first stage operation.

Total Volume 2011-2014 **75**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	11.8%	14.8%

Arterial Switch Operation (ASO)

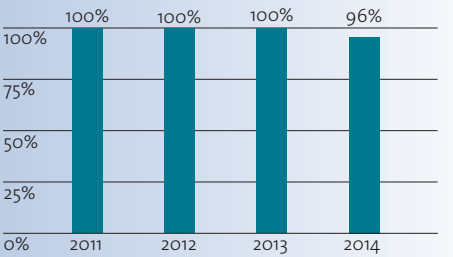
The arterial switch operation corrects transposition of the great arteries, a condition in which anatomical positions of the pulmonary artery and the aorta are switched, so that the aorta rises from the right ventricle and the pulmonary artery arises from the left ventricle. This anomaly causes oxygen-poor blood, a life-threatening medical emergency requiring immediate treatment.

In the 1980s and 1990s, NewYork-Presbyterian's Dr. Jan Quaegebeur, one of the nation's top pediatric heart surgeons, pioneered this innovative procedure which re-establishes normal anatomy and function, while seeking to avoid complications associated with other surgical approaches. We have performed more than 450 arterial switch procedures since 1990 and our surgeons have been at the forefront of a series of evolutionary operations.

Survival Following Arterial Switch Operation
NYP Congenital Heart Center

Survival rates for newborns after the Arterial Switch Operation (2011-2014) at the Congenital Heart Center set world-class standards – most notably, in 2011, 2012 and 2013:

100%



As a quaternary, or subspecialty referral center, a large proportion of the babies transferred to us either pre- or post-natally have complex transposition forms, involving transposition of the great arteries *and* either a Ventricular Septal Defect (VSD) or aortic arch problems such as aortic coarctation or Taussig-Bing anomaly. We also see an unusually large proportion of low birthweight babies with transposition.

Volume 2011-2014 **75**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**1.3%**	**4.1%**

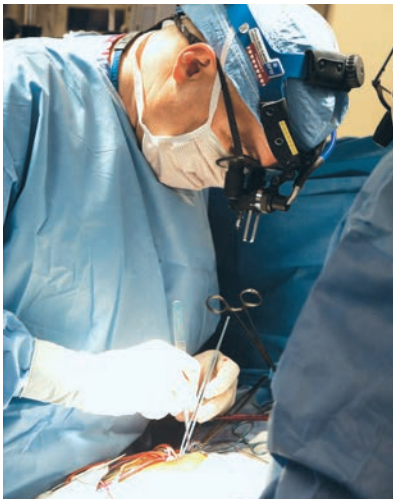
Tetralogy of Fallot

Tetralogy of Fallot is marked by a hole between the right and left ventricles (VSD) in conjunction with an obstruction between the right ventricle and the pulmonary artery (pulmonary stenosis).

As a result of these two abnormalities, unoxygenated blood can bypass the lungs, enter the aorta and produce cyanosis. Most children with this defect have open heart surgery to close the ventricular septal defect and remove the obstructing muscle. The procedure is individualized for each child, depending on age, anatomy and clinical symptoms.*

Volume 2011-2014 **167**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**1.2%**	**1.5%**

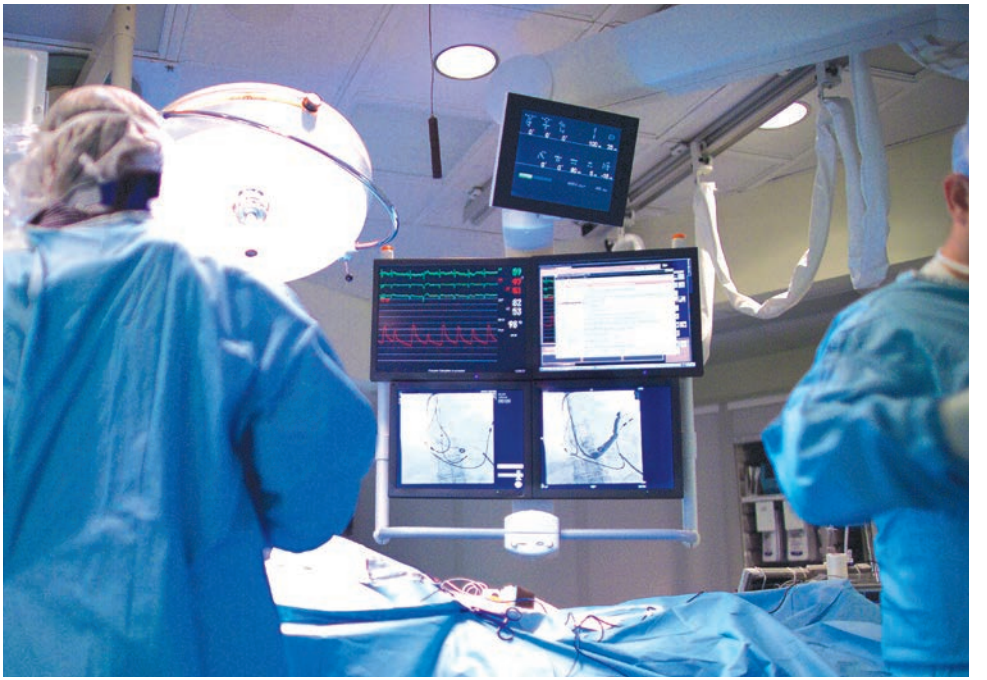


**We also actively attempt preservation of the pulmonary valve in all participants, resulting in a very low ratio of chronic pulmonary regurgitation.*

Atrial Septal Defect Repair (ASD)

ASD is characterized by a hole between the atria (upper chambers of the heart). The majority of straightforward ASDs are closed percutaneously in the cath lab, without the need for surgery. Our interventional cardiologists are particularly adept at this procedure. However, a minority of patients will still require surgery. Typically, these patients have larger holes, or the position of the hole in the heart makes it difficult to close with a device.

When a child requires surgery for an ASD, we always will perform minimally-invasive surgery. Specialized instruments allow us to close these defects through tiny incisions. While cardiopulmonary bypass is still needed, it is more simplified than what we typically use in the repair of more serious defects. In most cases, patients do not require blood transfusions.



Volume 2011-2014 **208**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**0%**	**.24%**

Ventricular Septal Defect Repair (VSD)

Unlike ASDs, most VSDs still require surgical repair. At the NYP Congenital Heart Center, our pediatric cardiac surgeons provide minimally invasive cardiac surgery and hybrid surgery for the treatment of ventricular septal defects, with the goal of small incisions and transfusion-free surgery.

Close to 100% of our patients survive Ventricular Septal Defect Repair, even in premature and very low birthweight babies.

Volume 2011-2014 **163**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**0.6%**	**0.7%**

Atrioventricular Canal Defect (AV Canal)

AV Canal defects are complicated lesions where the center of the septum (the wall that separates the left and right heart) is missing. The mitral and tricuspid valves are fused in this malformation and extremely abnormal. AV Canal defect surgery requires highly specialized and technical expertise. As with other complex cardiac defects, the more often you do them, the better your results are.

Volume 2011-2014 **118**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**2.5%**	**2.4%**

Aortic Valve/Ross Procedure (Pulmonary Autograft)

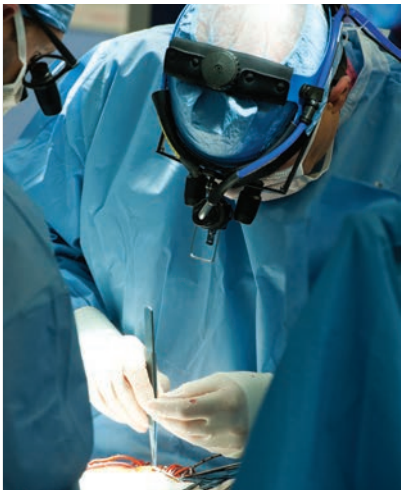
When the aortic valve is so abnormal that it cannot be effectively repaired, a valve replacement operation may be recommended. Our surgeons perform a technically demanding surgery called the Ross procedure, in which the patient's own normal pulmonary valve is used to replace the damaged aortic valve. The pulmonary valve itself is then replaced with a homograft (human tissue) valve. The homograft valve can be large enough to allow for growth and because it is not subjected to high pressure, it can last much longer in the position of the low pressure pulmonary valve. However, it is likely that it will eventually need to be replaced.

Once the homograft valve deteriorates (which takes years), it can often be dilated in the cath lab. And today, our interventional cardiologists can implant a new valve percutaneously into the homograft, avoiding another surgery.

The Ross operation is more complicated than aortic valve replacement with a tissue valve or mechanical valve. However, data have consistently shown excellent durability and long-term function of the pulmonary valve in the aortic position. Studies point to a 10-15% incidence of reoperation for pulmonary homograft degeneration over 10 -15 years and a smaller incidence of reoperation on the new aortic valve.

Volume 2011-2014 **37**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**Ross & Ross-Konno** **2.7%**	**Ross & Ross-Konno** **3.0%**

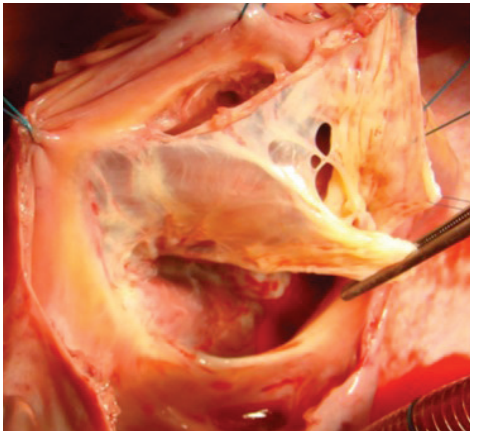


Valve Repair

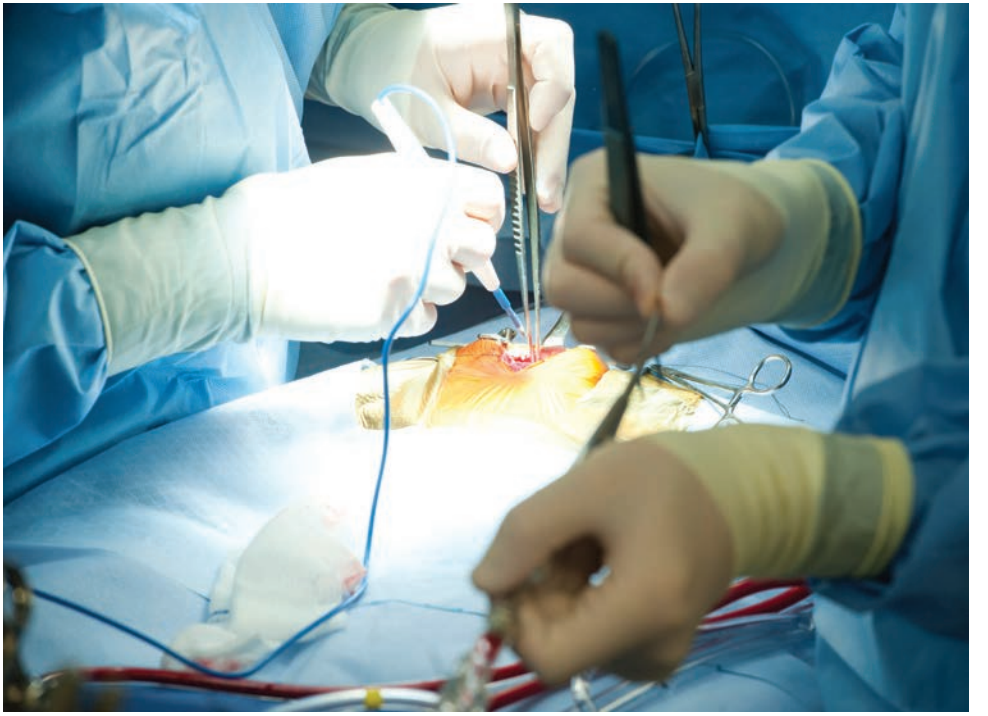
A valve repair is more complicated surgery than a valve replace, but the advantage is that patients retain their own valve. And in young patients, the repaired valve grows with the child as he or she gets older.

Pediatric and congenital heart surgeons at NewYork-Presbyterian/Morgan Stanley Children's Hospital and NewYork-Presbyterian/Phyllis and David Komansky Center for Children's Health have published extensively on pediatric heart valve surgery and have pioneered many of the valvuloplasty techniques used today to repair conditions such as:

- Ebstein's anomaly
- aortic valve disease
- congenital mitral valve disease



Cone repair for Ebstein's malformation



Our pediatric heart surgeons have pioneered many of the innovative surgical techniques used today to treat heart valve disease in children.

Pediatric Transplant & Mechanical Assist Devices

Having performed more than 500 pediatric heart transplants since 1984, we are one of the largest pediatric heart transplant programs in the United States, ranking in the nation's top five centers for pediatric heart transplant for the last decade. We perform more than 25 pediatric and adult congenital heart transplants each year – typically more than any other hospital in the country – many on children who could not be helped at other institutions.

In 1984, surgeons at NYP/Morgan Stanley Children's performed the world's first successful pediatric heart transplant.

Volume 2011-2014 **101**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**2.9%**	**4.0%**

Adult Congenital Heart Surgery

As more patients survive open heart repairs as children, they often require additional procedures such as valve surgeries or Fontan conversions in adulthood. In fact, it is expected that by the year 2020, more adults than children will need open heart procedures to correct congenital heart defects.

The Schneeweiss Adult Congenital Heart Center at NewYork-Presbyterian is one of the oldest centers for treatment adult congenital heart disease. Our surgeons perform sometimes lengthy and complex adult surgeries at the Vivian and Seymour Milstein Family Heart Center, where patients are cared for by a team with specialized expertise in adult congenital heart disease under the leadership of Dr. Marlon S. Rosenbaum.

Volume 2011-2014 **437**

	NYP Congenital Heart Center	STS National Benchmark 2011-2014
Overall Hospital Discharge Mortality Rate	**1.8%**	**1.9%**

Meet Our Cardiovascular Surgeons & Cardiologists

Emile A. Bacha, MD
Chief, Division of Cardiac, Thoracic and Vascular Surgery
NewYork-Presbyterian/
Columbia University Medical Center

Director, Congenital and Pediatric Cardiac Surgery
NewYork-Presbyterian

Calvin F. Barber Professor of Surgery
Columbia University College of
Physicians and Surgeons

Adjunct Professor of Surgery
Weill Cornell Medical College

Co-Director
NewYork-Presbyterian Congenital Heart Center

Surgeons

Dr. Emile A. Bacha is Director, Congenital and Pediatric Cardiac Surgery at NewYork-Presbyterian Congenital Heart Center, located at NewYork-Presbyterian's two primary locations – Morgan Stanley Children's Hospital and the Phyllis and David Komansky Center for Children's Health. He is also the Calvin F. Barber Professor of Surgery at Columbia University College of Physicians and Surgeons, and Adjunct Professor of Surgery, Weill Cornell Medical College. Immediately prior to joining NewYork-Presbyterian, he was Associate Professor of Surgery at Harvard Medical School and Senior Cardiac Surgeon at Children's Hospital Boston. Dr. Bacha is widely recognized as a pioneer in developing minimally invasive techniques for correcting congenital heart defects. Among his notable innovations is the development of a less invasive surgical alternative for treating babies born with ineffective left ventricles – one of the most life-threatening birth defects. These innovations are reinforced by his interest in outcomes research. Dr. Bacha is funded through a grant from the American Heart Association to study operating room procedures with the aim of maximizing safety and ensuring the best possible surgical results.

After receiving his medical degree from Ludwig-Maximilians-University in Munich, Germany, Dr. Bacha completed an internship and the first portion of his general surgery residency at the affiliated Klinikum Grosshadern University Hospital and German Heart Center. He completed his residency at Massachusetts General Hospital/Harvard Medical School in Boston and Emory School of Medicine Affiliated Hospitals in Atlanta. He was a Research Fellow in cardiothoracic surgery at Hospital Marie-Lannelongue in Paris, and completed his cardiothoracic surgery fellowship at Massachusetts General Hospital and Children's Hospital Boston /Harvard Medical School. In 2000, he joined faculty of the University of Chicago where he helped establish their pediatric cardiac surgery program, including a minimally invasive surgery program. In 2005, he returned to Harvard and Children's Hospital Boston, serving as Associate Professor of Surgery and Senior Associate in the Department of Cardiac Surgery where he was named Chief, Adult Congenital Heart Disease Surgery in 2006 and Director, Congenital Heart Valve Disease Center in 2008. He joined NewYork-Presbyterian/ Morgan Stanley Children's Hospital in January of 2010.

Dr. Bacha is Board Certified by the American Board of Surgery, American Board of Thoracic Surgery and the American Board of Congenital Heart Surgery. He has received many professional honors and awards and is widely published.

Paul J. Chai, MD
Director, Pediatric Heart Transplantation and Mechanical Assist Device Services
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

Site Director, Pediatric and Congenital Cardiac Surgery
NewYork-Presbyterian Hospital/
Phyllis and David Komansky Center
for Children's Health

Associate Professor of Surgery
Columbia University College of Physicians and Surgeons

Adjunct Associate Professor of Surgery
Weill Cornell Medical College

Surgeons

An expert in complex neonatal surgery and minimally invasive cardiac surgery, Dr. Chai directs the NewYork-Presbyterian/Morgan Stanley Children's Hospital pediatric heart transplantation and mechanical assist device services, as well as congenital heart surgery at our NewYork-Presbyterian Hospital/Phyllis and David Komansky Center for Children's Health. He has extensive experience in aortic surgery, including valve-sparing root replacements, in both pediatric and adult patients. Dr. Chai continues to care for his patients as they grow into adulthood as part of the hospital's adult congenital heart disease service.

Dr. Chai comes to NewYork-Presbyterian most recently from the Johns Hopkins Children's Heart Surgery Program at All Children's Hospital in St. Petersburg, Florida, where he served as pediatric cardiac surgeon and Associate Medical Director of the Heart Institute from 2004 until his appointment at NewYork-Presbyterian in 2013.

He completed his undergraduate degree, medical school, general surgical residency and cardiothoracic surgical fellowship at Duke University and Duke University School of Medicine. During that time, he spent an additional two years studying methods to minimize the detrimental effects of cardiopulmonary bypass and hypothermic circulatory arrest on neurologic and pulmonary function. He completed a fellowship in pediatric cardiac surgery at the University of Michigan in 2004.

Dr. Chai is board certified in general surgery by the American Board of Surgery and in subspecialties of congenital cardiac surgery and thoracic and cardiac surgery by the American Board of Thoracic Surgeons.

He is a peer reviewer for *Cardiology in the Young, World Journal for Pediatric and Congenital Heart Surgery,* and *Annals of Thoracic Surgery,* and he has authored multiple book chapters, journal articles and abstracts.

David Kalfa, MD, PhD
Assistant Professor of Surgery
Section of Pediatric and
Congenital Cardiac Surgery
Columbia University College of
Physicians and Surgeons

Adjunct Assistant Professor of Surgery
Department of Cardiothoracic Surgery
Weill Cornell Medical College

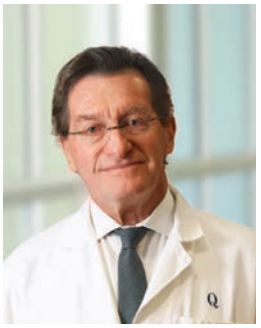
Surgeons

As a board-certified cardiothoracic surgeon with a subspecialization in pediatric cardiac surgery, Dr. Kalfa has extensive experience in neonatal surgery and complex heart reconstructions in children, including minimally invasive congenital cardiac surgery, hybrid procedures and procedures for single ventricle patients. His international training and career also brought him a large experience in aortic surgery and cardiac procedures for adult congenital heart disease. He currently holds a joint position as Assistant Professor of Surgery in pediatric and congenital cardiac surgery, Columbia University College of Physicians and Surgeons, and Adjunct Assistant Professor of Surgery in the Department of Cardiothoracic Surgery, Weill Cornell Medical College.

A native of France, Dr. Kalfa graduated from Marseilles University Graduate School of Medicine with the highest level of distinction. During his certification, he developed a research program in tissue engineering applied to the field of congenital heart diseases. After receiving his PhD degree at Paris University with the highest level of distinction, Dr. Kalfa performed a two-year clinical fellowship in congenital cardiovascular surgery at Marie Lannelongue Hospital, Paris, and a clinical fellowship in adult cardiac surgery at Laval University Hospital in Quebec, Canada. He then served as Assistant Attending Surgeon in congenital cardiac surgery at Columbia University Medical Center.

As a pediatric cardiac surgeon and a biomedical researcher, Dr. Kalfa's research initiatives center on tissue engineering in the field of congenital cardiac diseases. He has received numerous international grants supporting his research, and was appointed as a surgical expert for the National Association for Biomedical Research. He is currently leading numerous North American and European multicentric studies about outcomes after repair of complex congenital cardiac defects and long-term neuropsychological outcomes after neonatal cardiac surgery. Dr. Kalfa is also principal investigator of a 7-partner European consortium aiming at creating a tissue-engineered living valve for repair of complex congenital cardiac disease (European FP7 grant of 4.5 millions €). He recently co-patented a tissue-engineered polymeric bioresorbable valved cardiovascular prosthesis.

Dr. Kalfa acquired a high expertise in complex neonatal and congenital heart surgery, combined with his development of innovative solutions in the field of congenital heart defects, in order to maximize the safety of pediatric cardiac surgery and improve the outcome of children with a congenital heart disease.



Jan M. Quaegebeur, MD
Director, Pediatric Cardiac Surgery
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

Morris & Rose Milstein Professor of Surgery
Columbia University College of Physicians
and Surgeons

Surgeons

Dr. Jan Quaegebeur is of the generation that helped to create modern pediatric cardiac surgery. He was born in Belgium and trained in the Netherlands, Boston, Birmingham (Alabama) and Houston.

Widely recognized as one of the nation's top pediatric cardiac surgeons, Dr. Quaegebeur is currently the Morris & Rose Milstein Professor of Surgery at Columbia University College of Physicians and Surgeons. He is well known in the medical world for having developed the arterial switch, a procedure performed on newborns with Transposition of the Great Arteries.

Before Dr. Quaegebeur entered the field, heart surgeons hesitated to operate on newborns, believing they were too fragile to undergo open heart surgery. For Dr. Quaegebeur, the imperative to operate early crystallized in the mid-seventies with a specific defect where the arteries that should go to a child's lungs connected instead to the aorta, the big vessel that feeds blood to the body. The solution was obvious. You had to switch the arteries – and you had to do it immediately.

The operation was considered extremely difficult, if not impossible. But Dr. Quaegebeur pressed on, studying some 7,500 hearts. By the early eighties, Dr. Quaegebeur had dramatically lowered the mortality rate of the procedure to approximately 5 percent. Today, mortality is about 2 percent.

The arterial switch is Dr. Quaegebeur's signature operation. Close to sixty percent of his operations are performed on children in the first three months of life.

Julie A. Vincent, MD, FACC, FSCAI, FAAP
Chief, Pediatric Cardiology
NewYork-Presbyterian

Welton M. Gersony Professor of Pediatric Cardiology
Columbia University College of Physicians and Surgeons

Samberg Scholar in Children's Health
NewYork-Presbyterian/ Morgan Stanley Children's Hospital

Co-Director
NewYork-Presbyterian Congenital Heart Center

Cardiologists

Julie A. Vincent, MD, joined Columbia University and the Division of Pediatric Cardiology in 2008 as the Director of Pediatric Interventional Cardiology and Cardiac Catheterization laboratories at NewYork-Presbyterian/Morgan Stanley Children's Hospital and NewYork-Presbyterian Hospital/Komansky Center for Children's Health. In 2012 she was named Interim Chief of Pediatric Cardiology and has been the permanent Division Chief since 2013. In October, 2015 she was promoted to Professor of Pediatrics at Columbia University College of Physicians and Surgeons. Dr. Vincent was also named a 2015 Samberg Scholar in Children's Health. She has extensive experience in the care of children with congenital cardiac defects. Her clinical expertise is in transcatheter therapies for congenital heart disease (CHD), including all types of device closure techniques; balloon angioplasty and valvuloplasty procedures; as well as in the use of intravascular stents for treatment of non-coronary vascular lesions. She is also an internationally recognized expert in transcatheter pulmonary valve replacement.

Dr. Vincent continues to participate in many multi-center trials involving new catheter-based technologies, as well as in multiple follow-up studies to assess outcomes of these many new technologies for the treatment of patients with congenital/structural cardiovascular diseases. In her clinical practice she has cared for patients of all ages with congenital heart disease.

Dr. Vincent earned her medical degree from Wayne State University, School of Medicine in Detroit, Michigan in 1988. She completed her pediatric residency and pediatric cardiology fellowship at the Children's Hospital of Michigan, Detroit Medical Center, Wayne State University, School of Medicine. She then went on to complete an interventional cardiology fellowship at Texas Children's Hospital, Baylor College of Medicine, Houston, Texas. She is board certified in pediatrics and in the subboard of pediatric cardiology. Dr. Vincent is a Fellow of the American Academy of Pediatrics (FAAP), the American College of Cardiology (FACC), and the Society of Cardiac Angiography and Interventions (FSCAI), where she was past chair of the CHD Committee. She is the author of many articles published in peer-reviewed, professional journals.

Dr. Vincent is dedicated to providing excellence in the care and education of people with congenital heart disease and their families, as well as to improving the quality of life of all patients with CHD.

Erika S. Berman Rosenzweig, MD
Associate Chief, Division of Pediatric Cardiology
Director, Pediatric Pulmonary Hypertension Center
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

Associate Professor of Pediatrics (in Medicine)
Columbia University College of Physicians
and Surgeons

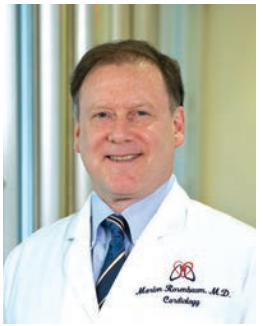
Cardiologists

Dr. Erika Berman Rosenzweig is the Director of the Pediatric Pulmonary Hypertension Center at NewYork-Presbyterian/Morgan Stanley Children's Hospital, one of the largest in the world serving patients with all forms of pulmonary hypertension. Dr. Rosenzweig received her medical degree from the Mount Sinai School of Medicine in New York City. She completed her pediatric residency and pediatric cardiology fellowship training at Columbia University College of Physicians and Surgeons in 1999, where she has been a member of the faculty since that time, in the Division of Pediatric Cardiology.

Dr. Rosenzweig is widely regarded as national and international expert in the field of pulmonary hypertension. She has authored numerous articles and book chapters, and currently lectures extensively on topics related to pulmonary hypertension and congenital heart disease. Her clinical work and research efforts have focused on the use and study of novel advanced drug and mechanical therapies for pediatric and adult patients with pulmonary hypertension, as well as the genetic origins of pulmonary hypertension. She has also been a principal investigator for many national and international clinical research trials evaluating novel medical therapeutics for pulmonary hypertension.

Dr. Rosenzweig is an active member of the national and international pulmonary hypertension scientific community as the Scientific Leadership Council Chair-elect for the Pulmonary Hypertension Association, and as Vice-Director of the Pediatric Pulmonary Hypertension Network of North America, (PPHNet).

Under Dr. Rosenzweig's leadership, the Pediatric Pulmonary Hypertension Center has been designated as a Pulmonary Hypertension Care Center (PHCC) by the Pulmonary Hypertension Association and has continued to expand the services provided at NYP/Morgan Stanley Children's to the most complex patients with pulmonary hypertension, particularly those with associated congenital heart disease and neonatal forms of pulmonary hypertension. She works closely with surgical colleagues to manage patients through high-risk heart surgeries. Dr. Rosenzweig is committed to enabling patients with even the most severe forms of pulmonary hypertension and congenital heart disease to benefit from the advanced and comprehensive medical care available at NYP/Morgan Stanley Children's.



Marlon S. Rosenbaum, MD
Director, Schneeweiss Adult Congenital Heart Center
NewYork-Presbyterian/
Columbia University Medical Center

Associate Clinical Professor of Medicine and Pediatrics
Columbia University College of Physicians and Surgeons

Cardiologists

Dr. Marlon Rosenbaum is Director of the Schneeweiss Adult Congenital Heart Center at NewYork-Presbyterian/Columbia University Medical Center and an Associate Clinical Professor of Medicine and Pediatrics at Columbia University College of Physicians and Surgeons. He received his MD from the New York University School of Medicine and completed his internship and residency in internal medicine at Columbia-Presbyterian. He subsequently did post-graduate training in Cardiology and Cardiac Electrophysiology at New York Medical College, Massachusetts General Hospital and Columbia-Presbyterian.

Dr. Rosenbaum is the co-author of "Congenital Heart Disease in the Adult." He lectures extensively on adult congenital heart disease and is responsible for cardiology Fellowship training in this field. His research interests include outcome studies involving the systemic right ventricle and cardiac MRI, pulmonary valve replacement in patients with pulmonary regurgitation, and mechanism of atrial arrhythmias in Tetralogy of Fallot.

Dr. Rosenbaum is a Fellow of the American College of Cardiology and a member of the American Heart Association, International Society for Adult Congenital Heart Disease, and Adult Congenital Heart Association.

Ganga Krishnamurthy, MBBS, DCH
Director, Neonatal Cardiac Intensive Care
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

Garrett Isaac Neubauer Assistant Professor of Pediatrics
Columbia University College of Physicians and Surgeons

Cardiac Neonatal-Perinatal Medicine

Dr. Krishnamurthy is a specialist in neonatal-perinatal medicine and Director of the Cardiac Neonatal Intensive Care Unit at NewYork-Presbyterian/Morgan Stanley Children's Hospital, where she was named Physician of the Year in 2013.

Dr. Krishnamurthy received a Bachelor of Medicine/Bachelor of Surgery (MBBS) from Mysore Medical College, Mysore, Karnataka, India and completed residency at Bangalore University, Bangalore, Karnataka, earning a Diploma in Child Health (DCH). She also completed residency in pediatrics at Maimonides Medical Center in Brooklyn, New York, where she was Chief Resident and named best graduating resident in pediatrics. Her post-doctoral training included fellowship programs in pediatric cardiac intensive care at Harvard University, Children's Hospital of Boston and in neonatal-perinatal medicine at NewYork-Presbyterian and Columbia University College of Physicians and Surgeons. She joined NYP/Morgan Stanley Children's in her current position in 2005.

Her specialties include catecholamine resistant hypotension in neonates after congenital heart surgery, brain monitoring in the neonate, non-invasive monitoring of tissue perfusion, and neurodevelopment outcomes in infants with congenital heart disease.

Dr. Krishnamurthy is board certified by the American Board of Pediatrics in both pediatrics and neonatal-perinatal medicine. She is the author of many peer reviewed articles and abstracts.

Arthur J. Smerling, MD
Medical Director
Pediatric Cardiac ICU and Respiratory Therapy
NewYork-Presbyterian/
Morgan Stanley Children's Hospital

Associate Professor of Pediatrics and Anesthesiology
Columbia University College of
Physicians and Surgeons

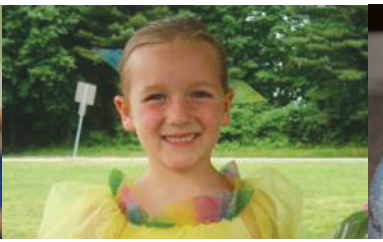
Cardiac Intensive Care

Dr. Arthur Smerling is Medical Director of the Pediatric Cardiac ICU and Respiratory Therapy at New York-Presbyterian/Morgan Stanley Children's Hospital and Associate Professor of Pediatrics and Anesthesiology at Columbia University College of Physicians and Surgeons. He received his MD degree from the University of Pittsburgh School of Medicine and completed pediatric residency at the Albert Einstein College of Medicine where he was Chief Resident. He subsequently completed residency in anesthesiology at NewYork-Presbyterian and a fellowship in anesthesiology and critical care at Children's Hospital Boston, Harvard Medical School, where he was Chief Fellow.

Dr. Smerling has published and lectured extensively on pediatric cardiac critical care, both nationally and internationally. He developed the pediatric cardiac ICU at NYP/Morgan Stanley Children's and has trained fellows who have gone on to develop pediatric cardiac ICUs throughout the country. He has received several awards, including NYP/Morgan Stanley Children's Physician of the Year award. Dr. Smerling is board certified in pediatrics, anesthesiology and critical care.




For more information about our pediatric and adult congenital heart surgery programs,
visit our website: nyp.org/kids
Contact our physicians: call **212-305-2688** email **congenitalheart@nyp.org**


NewYork-Presbyterian/Morgan Stanley Children's Hospital and NewYork-Presbyterian Hospital/Phyllis and David Komansky Center for Children's Health have built a national reputation for outstanding care devoted to children.

NewYork-Presbyterian AMAZING THINGS ARE HAPPENING HERE for kids

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New York, NY 10065

Physician-to-Physician Transfer**: 1-800-NYP-STAT (1-800-697-7828)**

For more information about our pediatric and adult congenital heart surgery programs, visit: **nyp.org/pediatrics**

Contact our physicians: **phone 212-305-2688 e-mail congenitalheart@nyp.org**