CONGENITAL CARDIOLOGY TODAY
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How I Do It: Tips, Tricks, and Techniques – Szabo Technique

A PICS Society Education Series

Osamah Aldoss, MD, FSCAI, FPICS & Bassel Mohammad Nijres, MD

Introduction

The Szabo technique was initially described as a novel approach for coronary stent implantation at the aorto–ostial location. The technique utilizes a second coronary wire threaded through the proximal stent cell and acts as a retention mechanism for precise stent placement,[1] specifically for Congenital Heart Disease.[2-7] Girona et al[2] described some Congenital Heart Disease specific modifications to the technique and classified it into different subtypes based on where the anchor wire thread is in relationship to the stent. In the Congenital Heart Disease field the Szabo technique can be applied to avoid jailing certain vessels such as branch pulmonary artery during RVOT stenting or left subclavian artery while stenting aortic arch. Other applications include PDA stenting and in atrial septum fenestration.

The goals of the technique:

- Avoiding jailing important branches and maintaining access after stent implantation. An anchoring wire is passed inside the stent parallel to the balloon (between the stent and the balloon). This method was also used for coronary artery stenting to protect bifurcating branches. In congenital heart disease, it is frequently utilized during RVOT stenting to protect one of the branch pulmonary arteries.[2] Less commonly, it is used during arch stenting to protect brachiocephalic arteries, most commonly the left subclavian artery.
- Achieving stable and precise stent placement. This is applied for aorto-coronary ostial position and during PDA stenting. To attain the aim, the wire is typically threaded in the proximal stent cell. Similarly, it can be threaded through the middle cell to maintain position during atrial septum stenting to maintain half of the stent on each side of the septum.[2]

Anticipated Challenges of the Procedure

- Cannulating the vessel of interest using the anchoring wire can be challenging if done after the stent is crimped onto the anchoring wire.
- Advancing the stent assembly through the sheath can damage the tip of the anchoring wire.

TIP 1 – Planning and Preparation

1. ***Access***
   - Access is dictated by the case, with no special or extra access needed.
2. ***Imaging***
   - Imaging is dictated by the case, with no special or extra imaging needed.

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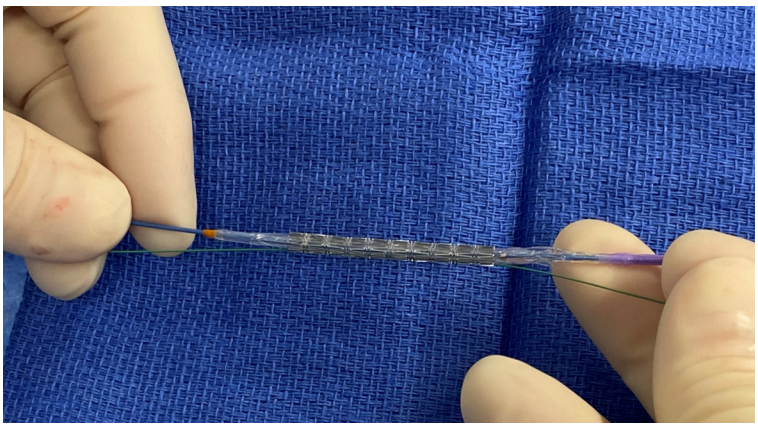

FIGURE 1 The desired stent mounted on the balloon catheter and the anchoring wire.

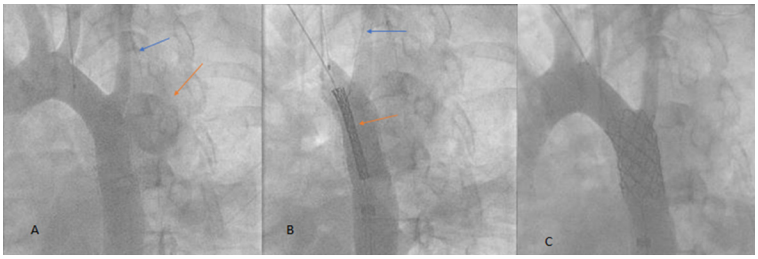

FIGURE 2
A. *Initial aortic angiogram shows the pseudoaneurysm (orange arrow), and its relationship to the left subclavian artery (blue arrow) (Video 8)*
B. *Szabo technique: anchoring wire in the left subclavian artery (blue arrow), and covered stent (orange arrow) (Video 9)*
C. *Post stent placement angiogram shows the complete covering of the pseudoaneurysm and patency of the left subclavian artery (Video 10)*

TIP 2 – Tools Needed

1. ***Sheaths*** – The sheath used must accommodate the crimped stent in addition to the anchoring wire.
2. ***Wires*** – In addition to the guidewire that will be used to advance the balloon, an "anchoring wire" (typically an 0.018" wire, but other wires can be used depending on the case) will be used to cannulate a vessel of interest to allow precise deployment of the stent (typically 0.014" or 0.018" wire).

TIP 3 – How I Do It

Technique – For the sake of simplicity, we will describe this method in protecting a branch PA while stenting RVOT. Two methods of delivery were used.

1. The first method is to advance the whole system (including the mounted stent on the balloon catheter and the anchoring wire) through the sheath and then once in position, the anchoring wire is manipulated to cannulate the branch that needs to be protected.
2. The second method is to pre-cannulate the branch needed to be protected and then mount the stent on the balloon and anchoring wire on the table before advancing the system over both wires.

The typical scenario is a short right ventricular outflow track where the area of stenosis is very close to the pulmonary artery bifurcation. More commonly the right pulmonary artery is the branch that needs to be protected due to the lower takeoff in comparison to the left pulmonary artery. The main guidewire will be placed in the left lower pulmonary artery. Next, the desired stent will be mounted on the balloon catheter and the anchoring wire (**Figure 1**). Typically, the anchoring wire is a 0.014" or 0.018" guidewire used to facilitate its manipulation under the stent. Once the stent is secured, the entire stent assembly will be introduced into the long sheath that was originally placed in the right ventricular outflow tract. Caution should be practiced to avoid damaging the tip of the anchoring wire while advancing the system through the valve of the sheath. Once the stent assembly is at the tip of the long sheath in the RVOT, the anchoring wire is manipulated to cannulate the desired branch pulmonary artery to protect it in case access is needed after stent implantation (**Video 1**). Then, the stent assembly is further advanced as distal as possible to span the entire area of interest, including the most distal segment of the conduit. Next, the stent is deployed in the standard fashion and the balloon catheter will be removed. A repeat angiogram is obtained to determine the need for opening the right pulmonary artery. If the right pulmonary artery is completely jailed, a small balloon is advanced over the anchoring wire to dilate the right pulmonary artery (RPA). The anchoring wire is exchanged for a 0.035" wire and further balloon angioplasty is performed as needed with larger balloons. In some cases, a double balloon technique of both branch pulmonary arteries might be needed.

Occasionally it is difficult to cannulate the branch that needs to be protected by external manipulation of the anchoring wire, therefore method #2 can be used where the branch PA is canulated with the anchoring wire and then the stent is mounted over the balloon catheter and the anchoring wire. The assembly is advanced inside the sheath over both wires (**Video 2**).

Case Presentation 1 – The next series of videos showed a case of a 14-year-old male with Tetralogy of Fallot who underwent a trans-annular patch with subsequent development of severe pulmonary regurgitation and very dilated RV. He was referred for transcatheter pulmonic valve placement. His anatomy was complex, including a short main pulmonary artery (MPA) segment that was amenable for balloon expanding pulmonic valve. Nonetheless, the RPA has an early take-off and is near the landing zone for the valve.

Video 3 (a and b) – A main pulmonary artery angiogram (a frontal and b lateral projections) through the long sheath showing the stent assembly over both wires with the anchoring wire positioned into the right pulmonary artery. The presence of the anchoring wire allowed advancing the stent as distal as possible while maintaining access to the RPA.

Video 4 (a and b) – Post stent placement angiogram (a frontal and b lateral projections) showed a well-positioned stent capturing the area of interest.

Video 5 – This showed balloon angioplasty of the jailed right pulmonary artery over 0.035" wire after an initial angioplasty using a small balloon over the 0.018" wire.

Video 6 (a and b) – RPA angiogram (a frontal and b lateral projections) post balloon angioplasty showed a deformity in the stent at the right pulmonary artery take-off with good flow.

Video 7 (a and b) – Final right ventricular angiogram (a frontal and b lateral projections) post pulmonic valve replacement showing good flow into both branch pulmonary arteries.

Case Presentation 2 – Another example using the Szabo technique to protect the left subclavian artery while treating an aortic arch pseudoaneurysm.

**All videos can be viewed here: https://www.picsymposium.com/tips_and_tricks_szabo_technique.html*

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

1. A potential problem using method #1 would be the inability to cannulate the vessel that needs to be protected by manipulation of the anchoring wire. In that case, method #2 can be used by pre-cannulating the vessel followed by advancing the stent over the two wires.
2. Advancing the stent assembly in method # 1 through the sheath can be challenging. Being able to advance the anchoring wire adjacent to the stent through the sheath valve can potentially damage the anchoring wire tip. In that case, using a hemostat to open the valve while advancing the system tackles this problem.
3. In case of a significant covering of the branch pulmonary artery by the stent, serial balloon angioplasty might be necessary starting with a small balloon and working our way up to the desired size. The kissing balloon technique might be needed.

Summary

Using the Szabo technique in congenital heart disease interventions can be very useful. The main objective using the technique is to achieve a precise and stable position of the stent, such as in atrial septal and PDA stenting. The other objective, which is more commonly used, is to maintain access to a potentially jailed vessel by stenting. Although this method is time-consuming and technically demanding, it mitigates the risks of potential major complications that would require a much longer time trying to recanalize a jailed vessel or malposed stent.

The main objective using the technique is to achieve a precise and stable position of the stent.

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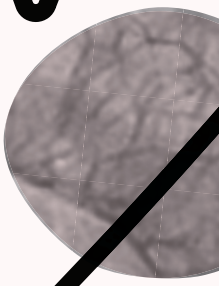

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New CPET Model Reflects Altitude-Related Impacts and Improves Accuracy at Children's Hospital Colorado

Christopher Rausch, MD; Roni Jacobsen, MD; Julie Fernie; Lori Silveira, PhD

Key Takeaways

- The research establishes new pediatric cardiopulmonary exercise testing (CPET) norms tailored to physiological responses at moderate altitudes.
- The study demonstrates that altitude-specific norms outperform sea-level models for predicting exercise capacity.
- Study authors used the largest reported dataset of its kind to develop a model that more accurately interprets results from CPETs performed at moderate altitude.
- These new norms could significantly impact how pediatric patients with congenital heart disease living at moderate-to-high elevation are evaluated and treated.

Research Study Background

Researchers in the Heart Institute at Children's Hospital Colorado have developed and reported the first normative values for pediatric cardiopulmonary exercise testing (CPET) performed at moderate altitude. Moderate altitude typically refers to an elevation range of approximately 4,900 to 8,200 feet (1,500 to 2,500 meters) above sea level. This work addresses a critical gap in existing interpretive data, derived from sea-level populations that overlook the physiological differences associated with changes in elevation.

Accurate interpretation of CPET results, which assess exercise capacity and cardiovascular response to exercise, is particularly important for clinical decision-making in patients with Congenital Heart Disease (CHD).

In this retrospective study, the new norms were compared against the widely used traditional models created by Cooper and Bruce and the updated model by Burstein. The study authors evaluated 1,154 maximal CPETs from a diverse cohort of 6- to 18-year-olds tested on a treadmill or cycle ergometer between 2014 and 2023. Tests were conducted at four Children's Colorado exercise labs located between approximately 5,184 to 6,926 feet (1,580 to 2,111 meters) above sea level. All participants had normal cardiac structure and function and completed CPETs for symptoms during exercise and/or family history of cardiac disease.

Key testing parameters included peak oxygen consumption (VO2 peak), peak heart rate (HR), peak ventilation (VE) and respiratory exchange ratio (RER). The team conducted separate analyses for the treadmill and cycle ergometer, developing polynomial regression models with independent variables, including: age, gender, body mass index and ethnicity, to predict CPET testing parameters. These models were applied to a validation cohort for both exercise modalities, using root mean square error to evaluate predictive accuracy.

Overall, results demonstrated that existing models overestimated exercise parameters and were poor predictors of actual exercise values. The new model outperformed the existing models in all exercise variables except resting systolic blood pressure, where the Burstein model was more accurate. In addition, predicted VO2 values in all existing models were higher than the study authors' equation, suggesting altitude significantly affects the differences between the models.

Clinical Implications

These new altitude-specific normative values, derived from the largest known reported pediatric exercise dataset, provide a critical framework for improving diagnostic accuracy and patient management. For patients with CHD who live at moderate elevation, the new model could reduce the risk of misdiagnosing normal exercise performance as pathological and enhance clinical decision-making for improved outcomes. This work underscores the importance of considering altitude when developing normative exercise data.

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The Congenital Heart Initiative (CHI) has Relaunched its New and Improved Registry

What is the Congenital Heart Initiative (CHI)?

The Congenital Heart Initiative (CHI) is the first global patient-powered registry for adults with Congenital Heart Disease (CHD). The registry unites patients, providers and researchers, yielding data that spurs new research, informs the future of care, and improves quality of life for people with CHD.

Adults with CHD face unique health challenges. Patient-centered research is essential to improving care. The CHI serves as a platform for patients to share their information, helping experts answer key questions to evaluate and address unmet needs. Your data will help to enhance the lives of others with CHD to improve care access, patient advocacy and health outcomes!

How Can You Participate?

Anyone living with CHD can sign up for the registry. Participation is voluntary and confidential.

CHI enrollment is on pause and will be back soon. Please reach out to ACHDresearch@childrensnational.org with your full name to submit interest in future participation!

Why Join the CHI?

You will be contributing to crucial medical research that directly informs future research to improve medical care for you and future generations. You will also join a community of other adults with CHD in a space that brings patients together to learn, engage, and build connections!

The CHI is currently exploring new research areas, including neurocognitive disabilities, care coordination models in pregnancy, physical activity interventions, gaps in care, home-based delivery of mental health support, and more.

Enroll in the Registry

https://www.connection.solutions.iqvia.com/icportal/login?redirect=/CHI

Program Directory
2025-2026

Currently Updating
Published Mid-August

Directory of Congenital & Pediatric Cardiac Care Providers in North America

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Contact Kate Baldwin
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American Pediatric Society Honors Dr. Bruce D. Gelb with 2026 APS John Howland Award

The American Pediatric Society (APS) proudly announces Bruce D. Gelb, MD, as the recipient of the 2026 APS John Howland Award, the highest honor bestowed by the Society. Widely regarded as the most prestigious recognition in academic pediatrics, the award celebrates Dr. Gelb's outstanding contributions to advancing child health and the field of pediatrics.

Established in 1952 to honor clinician-scientist John Howland, MD, the APS John Howland Award annually recognizes individuals for their distinguished service to pediatrics. Dr. Gelb will be formally honored during the APS Presidential Plenary at the Pediatric Academic Societies (PAS) 2026 Meeting, taking place in Boston, MA, from April 24 to April 27.

Dr. Bruce D. Gelb, a pioneering pediatric cardiologist and geneticist from the Icahn School of Medicine at Mount Sinai, is known for his transformative research uncovering the genetic causes of congenital heart disease (CHD) and related disorders. His early work, supported by the National Institutes of Health, helped establish the molecular foundations of CHD and led to landmark discoveries explaining why some children are born with heart defects. Among his most influential contributions was identifying the first genetic cause of Noonan syndrome, work that paved the way for understanding a broader group of developmental conditions now known as the RASopathies. These insights have shaped how physicians worldwide diagnose, predict, and treat these disorders.

"Dr. Gelb exemplifies the spirit of the John Howland Award through his groundbreaking research, visionary leadership, and unwavering dedication to mentoring future leaders in pediatrics," said Stephen R. Daniels, MD, PhD, President of the American Pediatric Society. "His work has profoundly shaped our understanding of congenital heart disease and developmental disorders, and his influence continues to elevate the field of pediatric medicine.

In addition, during his presidency of APS, he led a strategic plan process that transformed our organization into one of action, leveraging the expertise of our members to improve the health and well-being of children and adolescents."

Beyond his scientific achievements, Dr. Gelb has been an exceptional leader and mentor. As the founding Director of the Mindich Child Health and Development Institute and Dean for Child Health Research at the Icahn School of Medicine at Mount Sinai, he has built a thriving research community dedicated to improving child health through innovation and collaboration. Under his leadership, the institute has expanded major initiatives in clinical research, health services, and artificial intelligence. Dr. Gelb has combined visionary science with a steadfast commitment to mentoring the next generation of physician-scientists, leaving an enduring legacy in pediatric medicine and molecular genetics.

Throughout his career, Dr. Gelb has been a dedicated leader in national academic medical organizations, with a particular focus on advancing pediatric research and advocacy. He served on the APS Council from 2012 to 2020, including a term as President. Dr. Gelb also played a pivotal role in the Pediatric Academic Societies (PAS) meetings, serving as Program Chair in 2010 and 2011. He later became the inaugural President of the newly formed PAS Board, where he was instrumental in establishing the organization's bylaws and governance structure. Most recently, Dr. Gelb completed his term as President of the American Society of Human Genetics.

APS looks forward to celebrating Dr. Gelb's achievements at the PAS 2026 Meeting, where his legacy will inspire the next generation of pediatric leaders.

The Push to Get 3D Echo into the Congenital Operating Room

Dave Fornell, Cardiovascular Business

A quiet revolution is taking place in pediatric heart surgery. Across children's hospitals, teams are increasingly turning to 3D transesophageal echocardiography (TEE) to plan, guide and assess complex congenital heart procedures in real time.

One of the leaders in that transformation is Nee Khoo, MBChB, director of the echocardiography laboratory at Stollery Children's Hospital in Edmonton, Canada. Khoo has become one of the strongest advocates for integrating 3D echocardiography directly into the congenital operating room, a change he says is already improving surgical precision and communication between cardiologists and surgeons.

Due to the complex nature of congenital heart disease and the wide variation in unusual anatomy, real-time 3D echo imaging can help answer questions quickly and allow surgeons to see issues from a surgeon's view, enabling better decision-making. The movement is similar to the integration of TEE echocardiographers in the cath lab to enable guidance and imaging assessments of structural heart procedures for interventional cardiologists and cardiac surgeons.

"I think this introduction of 3D TEE probes for pediatrics has really made a difference. We certainly think that the 3D echo technology, has been a long time coming, but it's very, very rapid now and people are learning the skills required to use this technology effectively," Khoo explained.

3D TEE Imaging Comes of Age in Pediatric Surgery

For years, preoperative planning was based on 2D or transthoracic imaging, Khoo explained. But pediatric 3D TEE probes now allow use of real-time 3D information in the operating room.

"There is nothing like seeing the structures of the heart in real three dimensions that really brings a whole different level of understanding. It definitely improves our communication with the surgeons, because they are very used to seeing anatomy. So it's much easier for them to adopt the technology, and what I find is that the champions of this technology usually are the surgical team. Surgeons don't put up with things that are going to waste their time. It's very rare now that we will take someone to the OR without a 3D echo as a preparation. That's where we're at," Khoo explained.

In the past, pediatric cardiologists relied on transthoracic echo for pre-surgical planning, only bringing echo into the OR when complications arose. But with the advent of miniaturized 3D TEE probes, teams like Khoo's can now evaluate surgical repairs immediately, and adjust them before the chest is closed.

Over the last year, Khoo's team has made 3D TEE a near-routine part of valve and defect repair surgeries. He said when something is not quite right, they can identify it instantly and provide the surgeon with precise information. That feedback loop lets them go back and correct the issue with much greater confidence, which is changing the way they work together.

The difference between 2D and 3D, Khoo said, is nothing short of "night and day." Traditional 2D echocardiography requires expert interpretation to mentally reconstruct heart anatomy from slices and angles. But 3D imaging delivers an intuitive, anatomically accurate view, the same kind of visualization surgeons are accustomed to seeing directly.

"In the past, we might say, 'It's probably this,'" Khoo said. "Now we can say with certainty, 'This is the problem.' That level of precision completely changes the conversation in the OR."

The technology has been particularly valuable for complex valve repairs and ventricular septal defect (VSD) surgeries, where anatomy can vary widely. "Congenital hearts are tiny, and the surgical field is incredibly small," Khoo said. "3D pre-planning and intraoperative guidance make those repairs faster, more accurate, and ultimately safer."

Surgeons trained at Stollery who move on to other hospitals are now requesting 3D TEE systems at their new institutions. "They know what they're missing," Khoo said. "That's how change spreads."

The Challenged of Proving the Value of 3D TEE

As with many emerging technologies, one of the biggest hurdles is convincing administrators to invest in the new and more expensive technology. Khoo compared the transition to when color Doppler was introduced in echocardiography decades ago. "There was no paper proving its value — we just knew it made a difference," he said. "It's the same with 3D."

Still, Khoo acknowledged that broader adoption will require new training standards. "We're working with societies to define what level of 3D experience is needed and how to build that into fellowship programs," he said.

Beyond surgery, pediatric 3D TEE is also finding a role in the cardiac catheterization lab, where it can guide interventions while reducing radiation exposure, a critical advantage in children. "That's one area where the benefit is clear and measurable," Khoo said. "It's an easy case to make."

He believes that in the next few years, 3D TEE will become a standard expectation in congenital heart surgery, much like it already is in adult cardiac imaging.

Khoo spoke with Cardiovascular Business at the 3D Echo Academy 2025: Beyond Pretty Pictures - Acquisition and Application of 3D Imaging in Congenital Heart Disease, hosted by the Ann & Robert H. Lurie Children's Hospital of Chicago.

Mount Sinai Launches Cardiac Catheterization Artificial Intelligence Research Lab

New AI research lab at The Mount Sinai Hospital aims to transform patient care for complex heart procedures

Mount Sinai Fuster Heart Hospital has announced the launch of The Samuel Fineman Cardiac Catheterization Artificial Intelligence (AI) Research Lab. This new lab will leverage the hospital's world-renowned Cardiac Catheterization Lab and its unrivaled expertise to advance the field of interventional cardiology and enhance patient care, patient outcomes, as well as to optimize complex treatment decisions.

Annapoorna Kini, MD, will serve as Director of The Samuel Fineman Cardiac Catheterization Artificial Intelligence Research Lab. As Director of The Mount Sinai Hospital's Cardiac Catheterization Lab, she leads an internationally acclaimed team renowned for its exceptional safety, outstanding patient outcomes, and expertise in treating complex cases.

"While AI is not a magic solution to every problem, there are many places it can make a notable improvement over traditional techniques or bring some approaches that were never possible within reach. In five or so years, we think that many workflows can be augmented by AI to better focus our resources where they are most needed," says Dr. Kini.

"In our cath lab at Mount Sinai, we have always been at the forefront of using rapidly evolving AI technologies to advance patient care. We have already implemented AI applications to augment patient engagement and care coordination, and we are now moving to the next level by integrating AI technologies in our research and clinical work," says Dr. Kini, who also serves as Director of The Mount Sinai Hospital's Cardiac Catheterization Laboratory. "As an early adopter in adapting to a future with AI, we plan to continue to be a leader in embedding AI in our processes and work flows to achieve even better outcomes for our patients."

Dr. Kini and her team hosted the lab's inaugural AI Symposium with The Fineman Cardiac Catheterization Artificial Intelligence Research Lab on Monday, September 15th. The event was held at The Mount Sinai Hospital.

Dr. Kini will lead all AI research efforts within The Samuel Fineman Cardiac Catheterization Artificial Intelligence Research Lab. The new lab will focus on many aspects of interventional cardiology, from procedural to educational. Through internal as well as external collaborations, new explorations into existing data expose insights that can make a significant impact on how health care is delivered. From risk stratification to case planning, optimizing outcomes, and more, artificial intelligence has the capability to spur whole new levels of innovation.

The Fineman Cardiac Catheterization Artificial Intelligence Research Lab honors the memory of Samuel Fineman, who passed away in 2021 and left a generous gift to Mount Sinai. This gift was made in appreciation of the exceptional cardiac care he received from Samin K. Sharma, MD, Director of the Mount Sinai Fuster Heart Hospital Cardiovascular Clinical Institute and former Director of The Mount Sinai Hospital's Cardiac Catheterization Laboratory. The lab was dedicated this summer in his memory and in honor of Dr. Kini. Mr. Fineman's generosity will be permanently recognized on a plaque outside of the Catheterization Lab, ensuring his gift to Mount Sinai is memorialized for years to come.

Dr. Annapoorna Kini (left) and her team outside of The Samuel Fineman Cardiac Catheterization Artificial Intelligence Research Lab

"I am particularly proud of the foresight and enthusiasm demonstrated by our team at the Mount Sinai Cardiac Catheterization Lab in adopting artificial intelligence technologies in our work," says Dr. Sharma. "While we are proud to be recognized as a global leader in the quality and safety of the care we provide to our patients, I am confident that we will continue to leverage and apply the latest revolutions in AI technologies to drive the standards of our care and patient outcomes to even higher levels."

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