Pediatric Insights

BEST CHILDREN'S HOSPITALS U.S.News & WORLD REPORT CARDIOLOGY & HEART SURGERY 2018-19

Fall 2018

An Update From the Heart Institute at UPMC Children's Hospital of Pittsburgh

In This Issue

UPMC CHILDREN'S HOSPITAL OF PITTSBURGH

Heart Institute Welcomes New CICU Chief

On August 1, UPMC Children's Hospital of Pittsburgh and the Heart Institute welcomed **Justin C. Yeh, MD**, as its new Pediatric Cardiac Intensive Care Unit (CICU) chief, and as a co-director of the Heart Institute. Prior to joining UPMC Children's, Dr. Yeh held appointments and clinical responsibilities at the Stanford University School of Medicine and Rady Children's Hospital at the University of California San Diego.

Dr. Yeh is board certified in Pediatric Cardiology and Pediatric Critical Care Medicine. After medical school at Albany Medical College in New York, Dr. Yeh completed his residency at Children's Hospital of Orange County followed by pediatric cardiology fellowships at Tulane University Health Sciences Center in New Orleans, and Children's National Health System in Washington, D.C. Dr. Yeh then completed his critical care fellowship training, also at Children's National Health System.

"We are very excited to bring Dr. Yeh's expertise to the Heart Institute. His experience in cardiac critical care is an important addition to our team," says Vivek Allada, MD, executive director of the Heart Institute at UPMC Children's.

As the new CICU chief at UPMC Children's, Dr. Yeh is responsible for the management and clinical care of the 12-bed Cardiac Intensive Care Unit at UPMC Children's, and the CICU at St. Joseph's Children's Hospital in Tampa, Florida, with which UPMC Children's has a partnership.

With respect to research, Dr. Yeh has published and presented on numerous subjects, including most recently on the diagnosis and treatment of children with myocarditis, ventricular assist devices, risk factors for mechanical ventilation and reintubation after heart surgery, and prolonged cardiac ECMO support. Now that he has joined UPMC Children's, Dr. Yeh's research plans will continue to involve the use of ventricular assist devices to support children with advanced heart failure.

"The cardiac program at UPMC Children's already is one of the highest performing in the country, and I look forward to partnering with my new team members to bring the program to even greater heights. With strengths in both clinical care and research, we are uniquely positioned to lead congenital heart care into the next era," says Dr. Yeh.

Dr. Yeh is a member of the Western Society of Pediatric Cardiology, Pediatric Cardiac Intensive Care Society, International Society for Heart and Lung Transplantation, and Society of Critical Care Medicine.

Heart Institute Expands Cardio-Oncology Services

Joining the Heart Institute at UPMC Children's Hospital of Pittsburgh in August 2018, Kirsten Rose-Felker, MD, is a specialist in the field of Heart Failure and Transplantation with a special career and research interest in Cardio-oncology. Cardiac dysfunction in children and adolescents who have been treated for cancer is a major cause of morbidity and mortality in this growing population. Mitigating the cardiovascular dysfunction that can arise as a late-effect of cancer treatment is a major focus of Dr. Rose-Felker's clinical work and research.

Dr. Rose-Felker completed her medical degree at the George Washington University School of Medicine in 2010 and continued her training with a Pediatric residency at Northwestern University followed by fellowships in both Pediatric Cardiology (2017) and Pediatric Heart Failure and Transplant (2018), both at Children's Healthcare of Atlanta at Emory University.

"Joining UPMC Children's will allow me to pursue my work in heart failure and transplant in one of the best transplant programs in the country. UPMC Children's was also very willing to support my interest in cardio-oncology and to help build and expand this program to treat this growing patient population," says Dr. Rose-Felker.

Cardio-Oncology: A Growing Need in Patient Care

Pediatric oncology patients can face a cruel consequence of their treatments: heart disease and cardiac dysfunction that results from the systemic therapies necessary to treat or cure their cancer. There can be myriad other late-effects of cancer treatment, but cardiovascular disease is the leading cause of morbidity and mortality in these patients outside of a secondary cancer or recurrence. "Cancer care has progressed so much over the last 30 years. Decades ago, many of these children would not have survived long enough for heart disease to manifest as a late effect of treatment. That equation has completely changed now," says Dr. Rose-Felker. "Unfortunately, as cardiologists, we often see these patients too late — when irreversible damage has been done and their now limited treatment options include cardiac transplant. By seeing high risk patients sooner, we hope to provide them with better options and a longer life."

Who's at the Highest Risk for Cardiac Complications?

Dr. Rose-Felker is a proponent for a more integrated approach between oncology and cardiology to better identify the highest risk patients and get them into treatment to change outcomes. "Patients with certain types of aggressive childhood cancers which require the use of high-dose anthracyclines as part of the treatment regimen are amongst those at greatest risk of heart-related issues given the cardiotoxicity of this class of chemotherapy. These patients require close surveillance by their oncology team and proactive management by a cardiologist when changes are identified."

Patients who have experienced radiation therapy involving the chest cavity have unique cardiovascular risk factors. Those with more traditional cardiovascular risk factors including hypertension, obesity, and diabetes, even if these comorbidities also are late effects, are at increased risk for cardiac complications.

Pathways to Cardiac Dysfunction

With respect to the heart muscle itself, the limited regenerative capacity of cardiomyocytes and the unique metabolic demands of the heart muscle, including its high tissue oxygen consumption, place it at disproportionate risk after cancer therapy when compared to other organs. "Anthracyclines cardiotoxic effects include interference with DNA and RNA synthesis and generation of oxygen free radicals which are particularly toxic to the abundance of mitochondria in cardiomyocytes," says Dr. Rose-Felker.

Treating a Difficult to Treat Patient Population

It takes a collaborative approach to manage this patient population, one where cardiologists and oncologists work together to refer the most appropriate patients who are likely at highest risk based on their treatment regimens, type of cancer, and other comorbidities. Dr. Rose-Felker is actively working with colleagues from the Division of Hematology/Oncology to develop relationships and create the appropriate referral patterns. "Dr. Jean Tersak in the Pediatric Cancer Survivorship Clinic, and the leaders of the Heart Institute have been incredibly helpful in getting these conversations started. Our goal is to change the future of our hospital's cancer survivors most at risk for cardiac complications."

Recent Publications

A sample of recent publications from Dr. Rose-Felker includes:

Rose-Felker K, Mukhtar A, Kelleman MS, Deshpande SR, Mahle WT. Neutropenia in Pediatric Heart Transplant Recipients. *Pediatr Transplant.* 2018; 22(3). Epub ahead of print.

Rose-Felker K, Robinson JD, Backer CL, Rigsby CK, Eltayeb OM, Monge MC, Rychlik K, Sammet CL, Gossett JG. Preoperative Use of CT Angiography in Infants With Coarctation of the Aorta. *World J Pediatr Congenit Heart Surg.* 2017; 8(2): 196-202.

Rose-Felker K, Border WL, Hong BJ, Chow EJ. Cardio-oncology Related to Heart Failure: Pediatric Considerations for Cardiac Dysfunction. *Heart Failure Clin.* 2017; 13(2): 311-325.

Rose-Felker K, Kelleman MS, Campbell RM, Sachdeva R. Appropriateness of Outpatient Echocardiograms Ordered by Pediatric Cardiologists or Other Clinicians. *J Pediatr.* 2017; 184: 137-142.

Rose-Felker K, Kelleman MS, Campbell RM, Oster ME, Sachdeva R. Appropriate Use and Clinical Impact of Echocardiographic Evaluation of Murmur in Pediatric Patients. *Congenit Heart Dis.* 2016; 11(6): 721-726.

Portable Innovation:

Creating the First Mobile Xe-133 Lung Ventilation Scan System in the United States

Michael R. Czachowski, MBA, CNMT, NCT, PET, ASCP(N), R.T.(N)(BD) (ARRT), is the supervisor of the Nuclear Medicine and Molecular Imaging Departments. He explains that UPMC Children's Hospital of Pittsburgh was the first facility in the United States to perform portable Xenon-133 lung ventilation exams on patients in the pediatric cardiac intensive care unit (CICU). "This is an extremely innovative process that was devised to allow us to perform the ventilation lung exams using the Digirad Ergo™ portable nuclear camera on the most medically fragile patients without having to move them to the nuclear medicine department," says Mr. Czachowski.

The journey for developing this process began in the CICU while performing a portable perfusion lung exam on a patient. A CICU physician asked Mr. Czachowski and his team if there was a possibility of also performing a portable ventilation lung exam on patients in the intensive care units. The current standard of practice in performing ventilation lung scans in nuclear medicine is through the use of Tc-99m DTPA (diethylenetriamine pentaacetic acid) aerosol. However, as Mr. Czachowski points out, "using an aerosol for these critically ill patients in the CICU is not an option due to the inability to deliver the aerosol and the possibility of radiation contamination."

"The first option that came to mind was to perform the portable ventilation lung exams using a Krypton-81m gas generator. After some research, it was determined that the generators were no longer available in the United States. Because of this, we had to explore other options. This eventually led to the idea of using Xenon-133 gas in conjunction with the patient's ventilator and our Pulmonex system," says Mr. Czachowski. The Pulmonex system is used in the nuclear medicine department to perform Xenon-133 lung ventilations exams. The system is designed to safely capture the exhaled Xenon-133 into a lead-lined trap.

Digirad Ergo™

"The challenge was to find a way to perform the exam on patients in the CICU who are ventilator-dependent without removing them from the device or transporting them to the nuclear medicine department. Because Xenon-133 is a radioactive gas that would be exhaled by the patient during the exam, we had to think of how to capture the gas from the patient into the Pulmonex system, while ensuring a safe environment for the patient, family, and staff," says Mr. Czachowski.

Mr. Czachowski collaborated closely with Alvin Saville, RRT, who is the respiratory education coordinator at UPMC Children's. They developed a way to keep the patient on the ventilator and administer the Xenon-133 gas through a tubing adaption placed between the patient's endotracheal tube and the ventilator circuit. The exhaled radioactive Xenon-133 gas is then safely trapped in the Pulmonex system upon exhalation.

The system was used for the first time on a patient in April 2018 after months of development and testing in the Nuclear Medicine Department by Mr. Czachowski and his

Continued on Page 7

Heart Institute Attains STS Three-Star Rating

The Heart Institute at UPMC Children's Hospital of Pittsburgh attained a Society of Thoracic Surgeons (STS) overall **three-star rating** for its congenital heart surgery program in the latest rankings that analyzed program data from participating health care systems for the four-year period from January 1, 2014 to December 31, 2017.

UPMC Children's was one of 41 high volume centers out of the 129 reporting institutions during the latest reporting period. Only 12 programs in North America received a three-star designation in the latest survey period, and this is the fourth consecutive reporting period in which UPMC Children's has received the three-star designation.

UPMC Children's overall non-risk adjusted mortality rate of **1.9 percent** was lower than all but six of the 41 high volume centers, with the overall mortality rate for the 129 STS institutions being 2.94 percent.

With respect to the observed-to-expected mortality ratio, the UPMC Children's program's overall ratio was 0.56, with an adjusted mortality rate of **1.6 percent**.

In the highest risk congenital heart disease neonatal surgical cases, UPMC Children's mortality rate was **five percent** compared to the national average of 16.1 percent. The UPMC Children's program specializes in treating the highest-risk cases. In the last three years, the program has experienced **no mortalities** in any of its Norwood procedure cases.

In heart transplant outcomes, UPMC Children's ranks **first** in the United States with a **100 percent** three-year pediatric graft and patient survival rate.

"The STS rating our cardiothoracic surgery program has achieved is a real tribute to the leadership of Victor Morell and the entire UPMC Children's team," says Vivek Allada, MD, executive director of the Heart Institute.

For complete ratings details and methodology, visit the STS website at **https://publicreporting.sts.org**.

Heart Institute Leadership Team (L to R): Drs. Victor Morell, Jacqueline Kreutzer, and Vivek Allada

New Leadership Role for Victor Morell, MD

Victor Morell, MD, cardiothoracic surgeon and chief of the Division of Pediatric Cardiothoracic Surgery, who has helped to make UPMC Children's a national leader in cardiothoracic quality and safety measures, was named surgeon-in-chief in July.

"Dr. Morell is an incredibly talented surgeon and leader who, over the last decade, has helped to elevate UPMC Children's to be among the best cardiothoracic surgery programs in the country," says Christopher Gessner, president, UPMC Children's. "As the new surgeon-in-chief, Dr. Morell will enhance all of our surgical divisions by employing best practices that have made UPMC Children's a leading center for complex congenital heart surgery."

Dr. Morell will continue in his existing roles as chief of the Division of Pediatric Cardiothoracic Surgery, and as co-director of both the Heart Institute at UPMC Children's and the UPMC Heart and Vascular Institute.

Under Dr. Morell's leadership, UPMC Children's pediatric cardiovascular surgery program has outcomes that are among the highest in the nation. He also led a highly successful 2014 collaboration between UPMC Children's and St. Joseph's Children's Hospital in Tampa, Florida. Dr. Morell and other UPMC Children's cardiothoracic surgeons, cardiologists, and staff collaborate with St. Joseph's cardiac team on surgical and noninvasive cardiology services, as well as monitoring of St. Joseph's cardiac intensive care unit via telemedicine.

Research Update from the Heart Institute

Faculty and staff from the Heart Institute at UPMC Children's are engaged in a continual effort to advance the basic science understandings of the cardiovascular system, and to develop new and novel clinical and translational investigations to improve patient care. Below is a sample of the manuscripts, book chapters, reviews, and scientific statements authored by Heart Institute faculty in the last year.

Manuscripts

Soriano BD, Fleishman CE, Van Hoever AM, Wright B, Printz B, Tacy TA, Allada V, Lai WW, Buddhe S, Srivastava S. Determinants of Physician, Sonographer, and Laboratory Productivity: Analysis of the Third Survey From the American Society of Echocardiography Committee on Pediatric Echocardiography Laboratory Productivity. *S J Am Soc Echocardiogr.* 2018 May 16. pii: S0894-7317(18)30130-5. doi: 10.1016/j.echo.2018.03.001. [Epub ahead of print]

Fleishman C, Banka P, Sachdeva R, Fogel M, Ferguson ME, Allada V, Drant S: ACC/ACPC Comprehensive Pediatric Echocardiographic Examination. 2017.

Beach C, Follansbee CW, Beerman L, Mazzocco S, Wang L, Arora G. Automated QT Analysis on Holter Monitors in Pediatric Patients Can Differentiate Long QT Syndrome From Controls. *Pacing Clin Electrophysiol.* 2018 Jan; 41(1): 35-41.

Follansbee CW, Beerman L, Arora G. Paroxysmal Complete Atrio-ventricular Block in Pediatric Heart Transplant Recipients Following Cardiac Catheterization: A Case Series. *Pacing Clin Electrophysiol.* 2018 Jan; 41(1): 50-56.

Law YM, Plonka CM, Feingold B. Norepinephrine Levels in Children with Single Ventricle Circulation. *Progress in Pediatric Cardiology.* 2017 Dec; 47: 58-63.

Godown J, Thurm C, Dodd DA, Soslow JH, Feingold B, Smith AH, Mettler BA, Thompson B, Hall M. A Unique Linkage of Administrative and Clinical Registry Databases to Expand Analytic Possibilities in Pediatric Heart Transplantation Research. *Am Heart J.* 2017 Dec; 194: 9-15.

Feingold B, Picarsic J, Lesniak A, Popp BA, Wood-Trageser MA, Demetris AJ. Late Graft Dysfunction After Pediatric Heart Transplantation Is Associated With Fibrosis and Microvasculopathy by Automated, Digital Whole-Slide Analysis. *J Heart Lung Transplant.* 2017 Dec; 36(12): 1336-1343.

Adams PS, Zahid M, Khalifa O, Feingold B, Lo CW. Low Nasal NO in Congenital Heart Disease With Systemic Right Ventricle and Postcardiac Transplantation. *J Am Heart Assoc.* 2017 Dec 6; 6(12). PubMed PMID: 29212650.

Hart SA, Arora G, Feingold B. Resource Utilization at the Time of Prostacyclin Initiation in Children in Pulmonary Arterial Hypertension: A Multicenter Analysis. *Pulm Circ.* 2018 Jan-Mar; 8(1): 2045893217753357. PubMed PMID: 29313743.

West SC, Webber SA, Zeevi A, Miller SA, Morell VO, Feingold B. Charges and Resource Utilization for Pediatric Heart Transplantation Across a Positive Virtual and/or Cytotoxicity Crossmatch. *Pediatr Transplant.* 2018 Feb; 22(1): e13095.

Feingold B. The Challenges Of Donor-Derived Risk, Donor Shortage and Waitlist Mortality in Children: Time for a New Measuring Stick? *J Heart Lung Transplant.* 2018 Mar; 37(3): 317-318.

Green DJ, Duong SQ, Burckart GJ, Sissung T, Price DK, Figg Jr WD, Brooks MM, Chinnock R, Canter C, Addonizio L, Bernstein D, Naftel DC, Zeevi A, Kirklin JK, Webber SA, Feingold B. Association Between Thiopurine S-Methyltransferase (TPMT) Genetic Variants and Infection in Pediatric Heart Transplant Recipients Treated With Azathioprine: A Multi-Institutional Analysis. *J Pediatr Pharmacol Ther.* 2018 Mar-Apr; 23(2): 106-110.

Chew JD, Soslow JH, Thurm C, Hall M, Dodd DA, Feingold B, Simmons J, Godown J. Heart Transplantation in Children with Turner Syndrome: Analysis of a Linked Dataset. *Pediatr Cardiol.* 2018 Mar; 39(3): 610-616.

Godown J, Thurm C, Hall M, Soslow JH, Feingold B, Mettler BA, Smith AH, Bearl DW, Dodd DA. Changes in Pediatric Heart Transplant Hospitalization Costs Over Time. *Transplantation.* 2018 Apr 19. Epub ahead of print.

Godown J, Smith AH, Thurm C, Hall M, Dodd DA, Soslow JH, Mettler BA, Bearl D, Feingold B. Mechanical Circulatory Support Costs in Children Bridged to Heart Transplantation — Analysis of a Linked Database. *Am Heart J.* 2018 Jul; 201: 77-85.

Magnetta DA, Feingold B, Beerman LB, Blasiole B, Arora G. Paroxysmal Complete Atrioventricular Block In Pediatric Heart Transplant Recipients Following Cardiac Catheterization: A Case Series. *Pediatr Transplant.* 2018 Aug; 22(5): e13206.

Follansbee CW, Beerman L, Arora G. Adenosine-Sensitive Wolff-Parkinson-White: Longer Time Across The Atrioventricular Groove. *Pediatr Cardiol.* 2018 Mar; 39(3): 637-639. doi: 10.1007/s00246-018-1829-4. Epub 2018 Feb 12.

Liu R, Lee J, Kim BS, Wang Q, Buxton SK, Balasubramanyam N, Kim JJ, Dong J, Zhang A, Li S, Gupte AA, Hamilton DJ, Martin JF, Rodney GG, Coarfa C, Wehrens XH, Yechoor VK, Moulik M. Tead1 Is Required to Maintain Adult Cardiomyocyte Function, and its Loss Results in Lethal Dilated Cardiomyopathy. *JCI Insight.* 2017 Sep 7; 2917).

Continued on Page 6

Research Update *Continued from Page 5*

Manuscripts (continued)

Nwankwo, U, Morell, E, Trucco, SM, Morell, V, Kreutzer, J. Hybrid Strategy for Neonates with Ductal-dependent Systemic Circulation at High Risk for Norwood. *Ann Thorac Surg.* 2018 Apr 6. Epub ahead of print.

West SC, Webber SA, Zeevi A, Miller SA, Morell VO, Feingold B. Charges and Resource Utilization for Pediatric Heart Transplantation Across a Positive Virtual and/or Cytotoxicity Crossmatch. *Pediatr Transplant.* 2018 Feb; 22(1).

Mistry MS, Trucco SM, Maul T, Sharma MS, Wang L, West S. Predictors of Poor Outcomes in Pediatric Venoarterial Extracorporeal Membrane Oxygenation. *World J Pediatr Congenit Heart Surg.* 2018 May; 9(3): 297-304.

Harris TH, Adler M, Unti SM, McBride ME. Pediatric Heart Disease Simulation Curriculum: Educating the Pediatrician. *Congenital Heart Disease.* 2017; 00: 1–8.

Zinn MD, Wallendorf MJ, Simpson KE, Osborne AD, Kirklin JK, Canter CE. Impact of Routine Surveillance Biopsy Intensity on the Diagnosis of Moderate to Severe Cellular Rejection and Survival After Pediatric Heart Transplantation. *Pediatr Transplant.* 2018; 22:e13131.

Butts RJ, Boyle GJ, Deshpande SR, Gambetta K, Knecht KR, Prada-Ruiz CA, Richmond ME, West SC, Lal AK. Characteristics of Clinically Diagnosed Pediatric Myocarditis in a Contemporary Multi-Center Cohort. *Pediatr Cardiol.* 2017 Aug; 38(6): 1175-1182. Epub 2017 May 23.

Mercer CW, West SC, Sharma MS, Yoshida M, Morell VO. Polytetrafluoroethylene Conduits Versus Homografts for Right Ventricular Outflow Tract Reconstruction in Infants and Young Children: An Institutional Experience. *J Thorac Cardiovasc Surg.* 2018 May; 155(5): 2082-2091.

Cevallos, PC, Armstrong, AK, Glatz, AC, Goldstein, BH, Gudausky, TM. Leahy, RA. Petit, CJ, Shahanavaz, S, Trucco, SM, Bergersen, LJ. Radiation Dose Benchmarks in Pediatric Cardiac Catheterization: A Prospective Multi-Center C3PO-QI study. *Catheter Cardiovasc Interv.* 2017 Aug 1; 90(2): 269-280.

Gray, RG, Menon, SC, Johnson, JT, Armstrong, AK, Bingler, MA, Breinholt, JP, Kenny, D, Lozier, J, Murphy, J, Sathanandam, SK, Taggert, NW, Trucco, SM, Goldstein, BH, Gordon, BM. Acute and Midterm Results Following Perventricular Device Closure of Muscular Ventricular Septal Defects: A Multicenter PICES Investigation. *Catheter Cardiovasc Interv.* 2017 Aug 1; 90(2): 281-289.

Nwankwo, U, Goldstein, J, Trucco, SM, Kreutzer, J. Transcatheter Closure of a Mitral Valve Paravalvular Leak in an Infant. *J of Struct Heart Dis.* 2017; 3 (5).

Tague L, Wiggs J, Li Q, McCarter R, Sherwin E, Weinberg J, Sable C. Comparison of Left Ventricular Hypertrophy by Electrocardiography and Echocardiography in Children Using Analytics Tool. *Pediatr Cardiol.* 2018. Epub ahead of print.

Menon S, Al-Dulaimi R, McCrindle B, Goldberg D, Sachdeva R, Goldstein B, Seery T, Uzark K, Chelliah A, Butts R, Henderson H, Johnson T, Williams W. Delayed Puberty and Abnormal Anthropometry and its Associations With Quality of Life in Young Fontan Survivors: A Multicenter Cross-Sectional Study. *Congenital Heart Disease.* 2018; 00: 1-7.

Cabalka AK, Hellenbrand WE, Eicken A, Kreutzer J, Gray RG, Bergersen L, Berger F, Armstrong AK, Cheatham JP, Zahn EM, McElhinney DB. Relationships Among Conduit Type, Pre-Stenting, and Outcomes in Patients Undergoing Transcatheter Pulmonary Valve Replacement in the Prospective North American and European Melody Valve Trials. *JACC Cardiovasc Interv.* 2017 Sep 11; 10(17): 1746-1759.

Christopher A, Kreutzer J, Ezon D. DVHTi is Associated with Aortic Coarctation Gradient at Catheterization Independent of Echocardiographic and Clinical Blood Pressure Gradients. Accepted for publication *Congenit Heart Dis.* 2018.

Scientific Statements and Editorials

Feingold B, Mahle WT, Auerbach S, Clemens P, Domenighetti AA, Jefferies JL, Judge DP, Lal AK, Markham LW, Parks J, Tsuda T, Wang PK, Yoo S. Management of Cardiac Involvement Associated With Neuromuscular Diseases: A Scientific Statement From the American Heart Association. *Circulation.* 2017; 136: e200-31.

Yester JW, Kühn B. Mechanisms of Cardiomyocyte Proliferation and Differentiation in Development and Regeneration. *Curr Cardiol Rep.* 2017 Feb; 19(2): 13. Review.

Kreutzer J, Kreutzer C. Lymphodynamics in Congenital Heart Disease: The Forgotten Circulation. *J Am Coll Cardiol.* 2017; 69(19): 2423-2427.

Books and Book Chapters

Kreutzer J, Porras D. Cateterismo Intervencionista En Niños. In: Diaz Gongora G, Sandoval N, Velez JFM, editors. *Cardiología Pediátrica.* Distribuna Editorial 2017. 2da Edición; p 287-313.

Kreutzer C, Kreutzer J, Kreutzer G. Evolución Histórica Del Bypasss Total De Ventrículo Venoso (Operación Fontan-Kreutzer). In: Diaz Gongora G, Sandoval N, Velez JFM, editors. *Cardiología Pediátrica.* Distribuna Editorial 2017. 2da Edición; p 653-663.

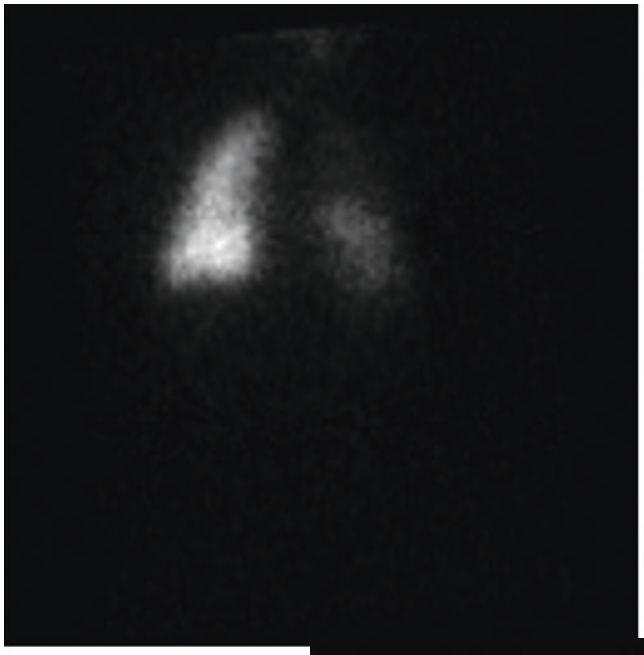
Beerman L, Kreutzer J, Allada V: Chapter: Cardiology in Atlas of Pediatric Physical Diagnosis, Sixth Edition. Ed. Zitelli BJ, McIntyre S, Nowalk A, Philadelphia PA, Elsevier, 2018. In Press.

Portable Innovation *Continued from Page 3*

collaborators. They continue to refine the protocol and look for new ways to use the technology to expand the ability to help clinicians and patients across the hospital. "You have to remember these are critically ill patients. To do the lung ventilation exam with no interruption of the patient's physiological and physical environment in the CICU or elsewhere is quite an accomplishment. We have developed a seamless process that is safe and efficient," says Mr. Czachowski.

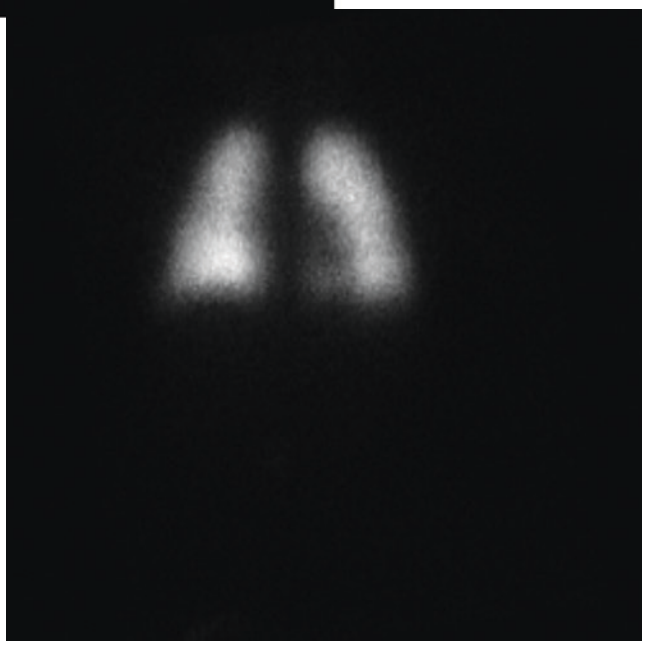
"We could always perform perfusion lung exams portably in the intensive care units with our Digirad Ergo, but now with this new approach, we can add the ventilation lung exam with no disruption in the environment of the patient. This additional piece of information provided by the ventilation exam can be critical in the clinical decisions made for the patient. The importance of such collaboration and innovation can lead to better patient outcomes," says Mr. Czachowski.

There are certain conditions where a perfusion exam may be normal but an accompanying ventilation exam may show abnormalities. The lung ventilation exams can help determine whether the patient needs an additional procedure and, if so, what procedure. Some procedural examples are cardiac catheterization or a bronchoscopy. The additional information provided by the lung ventilation exam can help to narrow down and guide the best course of treatment. "This is where the importance of such an innovative way of doing these tests really shows up. The right treatment for the right patient at the right time."



Left: Lung Ventilation Xe-133 with portable camera in CICU.

Below: Lung Perfusion Tc-99m with portable camera in CICU.



The left upper lobe especially is photopenic, suggesting poor ventilation of the left lung in general and the left upper lobe in particular. Unexplained desaturations raise concern for severe V/Q mismatch.

About the Heart Institute

The Heart Institute at UPMC Children's Hospital of Pittsburgh is a leader in cardiovascular care, with a rich history in clinical research and innovation. It offers comprehensive care to patients with congenital conditions throughout their lives, from prenatal through adulthood. As a comprehensive pediatric heart transplantation center, and a national leader in the use of pediatric heart-assist devices, the Heart Institute at UPMC Children's continues to advance the field of cardiovascular medicine.

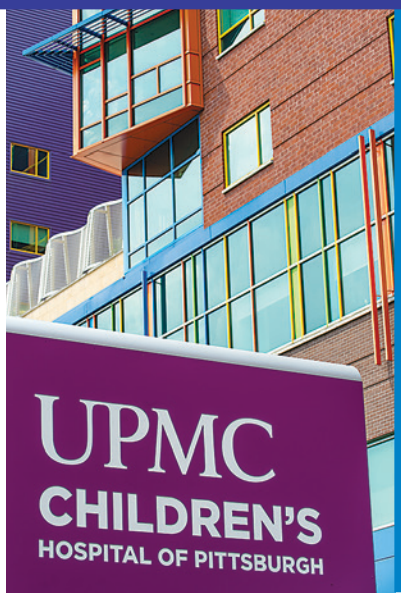
UPMC | CHILDREN'S HOSPITAL OF PITTSBURGH

4401 Penn Ave.
Pittsburgh, PA 15224

Ranked #6 in the Nation and Best in Pennsylvania for Cardiology and Heart Surgery by *U.S News & World Report*

The 2018-19 *U.S. News & World Report* rankings of the country's "Best Children's Hospitals" ranked UPMC Children's sixth nationally, and number one in Pennsylvania for cardiology and heart surgery. UPMC Children's jumped to number six in the rankings from number 12 the previous year.

UPMC Children's Hospital of Pittsburgh is affiliated with the University of Pittsburgh School of Medicine and nationally ranked in nine clinical specialties by *U.S. News & World Report*.



About UPMC Children's Hospital of Pittsburgh

Regionally, nationally, and globally, UPMC Children's Hospital of Pittsburgh is a leader in the treatment of childhood conditions and diseases, a pioneer in the development of new and improved therapies, and a top educator of the next generation of pediatricians and pediatric subspecialists. With generous community support, UPMC Children's Hospital has fulfilled this mission since its founding in 1890. UPMC Children's is recognized consistently for its clinical, research, educational, and advocacy-related accomplishments, including ranking 13th among children's hospitals and schools of medicine in funding for pediatric research provided by the National Institutes of Health (FY2017).

USNW509009 AS/MP 10/18