Cancer risks increase with complex heart tests
Study measures radiation exposure in children with heart disease

Complex heart imaging can increase cancer risks for children throughout their lifetime, according to a new study co-authored by Le Bonheur Cardiologist Jason Johnson, MD, MHS. The study, which appears in the June 9 issue of the American Heart Association’s journal *Circulation*, is the first to measure cumulative radiation doses in pediatric heart patients and predict lifetime cancer risks based on the frequency and types of exposures.

In the study, Johnson and fellow researchers found that radiation from standard X-rays doesn’t significantly raise cancer risks for young children, in general, but children undergoing more complex procedures with higher radiation – like cardiac catheterizations and computed tomography (CT) scans – have higher risks. In fact, cardiac catheterization can expose children to radiation doses that increase their lifetime risk of cancer by up to 6 percent above baseline.

The study followed 337 patients younger than age 6 who underwent surgery for heart disease at Duke University Medical Center and measured the amount of radiation absorbed by their organs during the most common imaging procedures, including X-rays, CT scans and fluoroscopies. Researchers used a National Academy of Sciences report to analyze lifetime cancer risks based on the amounts of each procedure’s exposure.

Researchers noted that radiation exposure in pediatric heart patients is of particular concern because these patients are exposed to multiple imaging procedures throughout their lifetime and are most sensitive to radiation because of their small body size.

“Cancer risk overall is relatively low, but we hope that this awareness will encourage providers to limit radiation exposure in children, when alternative procedures can offer the same benefit with less radiation,” Johnson said.

Johnson is an assistant professor at the University of Tennessee Health Science Center and specializes in congenital heart disease and advanced cardiovascular imaging. He helped complete the research at Duke University Medical Center, where he completed his pediatric cardiology and advanced imaging fellowships.

### Number of exams, radiation exposure, and cancer cases per surgical type

<table>
<thead>
<tr>
<th>Surgery</th>
<th>No. of exams per patient</th>
<th>Average annual effective dose (mSv/yr)</th>
<th>Cumulative effective dose (mSv)</th>
<th>LAR (Cancer cases per 100,000 children exposed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Septal Defect (n=21)</td>
<td></td>
<td>0.09</td>
<td>0.19</td>
<td>6</td>
</tr>
<tr>
<td>Ventricular Septal Defect (n=83)</td>
<td></td>
<td>0.20</td>
<td>0.36</td>
<td>12</td>
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<tr>
<td>Atrioventricular Canal Defect (n=52)</td>
<td></td>
<td>0.26</td>
<td>0.49</td>
<td>20</td>
</tr>
<tr>
<td>Tetralogy of Fallot (n=63)</td>
<td></td>
<td>0.27</td>
<td>0.55</td>
<td>14</td>
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<tr>
<td>Arterial Switch Operation (n=24)</td>
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<td>0.29</td>
<td>0.60</td>
<td>13</td>
</tr>
<tr>
<td>Cardiac transplant (n=10)</td>
<td>117</td>
<td>42.54</td>
<td>63.79</td>
<td>1677</td>
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<tr>
<td>Norwood operation (n=84)</td>
<td>63</td>
<td>20.08</td>
<td>28.93</td>
<td>799</td>
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<tr>
<td>Total (n=337)</td>
<td>17</td>
<td>1.34</td>
<td>2.67</td>
<td>65</td>
</tr>
</tbody>
</table>

### Ebstein’s repair survival by age group, 4 years

- **Le Bonheur**
- **Society of Thoracic Surgeons (STS) national averages**

### Survival Rate by Procedure, 4 years

- **Le Bonheur**
- **Society of Thoracic Surgeons (STS) national averages**

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**HEART INSTITUTE OUTCOMES**

Le Bonheur’s Heart Institute measures quality using data compiled by the Society of Thoracic Surgeons, or STS. STS compiles data from other top pediatric heart programs in the country, and publishes that information twice a year. Shown are Le Bonheur Children’s latest outcomes.
Meet the Team

The Heart Institute at Le Bonheur Children's Hospital uses the combined expertise of an advanced pediatric cardiac team to provide specialized care for children with congenital heart disease. Pediatric cardiologists, pediatric cardiothoracic surgeons, cardiac intensivists, pediatric intensivists and anesthesiologists make up the Heart Institute. Advanced practice nurses, perfusionists, cardiac nurses, respiratory therapists and lab and imaging technicians are specially trained in pediatric cardiology care.

Leaders of the Heart Institute include:

**Chris Knott-Craig, medical director of Cardiovascular Surgery and co-director of Heart Institute**
Christopher Knott-Craig, MD, graduated from the University of Cape Town in South Africa and completed training in cardiac surgery at the Grooto Schuur Hospital in South Africa. He is board certified by the South African Medical & Dental Council in cardiothoracic surgery. Knott-Craig is also a professor for The University of Tennessee Health Science Center (UTHSC) School of Medicine. His areas of special focus include neonatal/infant cardiac surgery, Ebstein’s anomaly, Ross Procedure, minimally invasive valve surgery, cardiopulmonary bypass, ambulatory thoracic surgery, hyperhidrosis and pediatric congenital heart disease.

**B. Rush Waller, medical director of Cardiovascular Catherization Lab; interim co-director of Heart Institute**
B. Rush Waller, MD, studied at UTHSC and completed fellowships in pediatric cardiology and pediatric interventional cardiology at the Medical University of South Carolina. Waller is an associate professor at UTHSC and is board certified by the American Board of Pediatrics with a cardiology subspecialty. His areas of focus include interventional pediatric cardiology, including therapeutic catheterizations for critically ill neonates, critically ill preoperative patients and complex cases of adults with congenital heart disease and transcatheter closure of intracardiac shunts.

**Vijay Joshi, medical director of Non-Invasive Cardiology; interim chief of Division of Pediatric Cardiology, UTHSC Department of Pediatrics**
Vijay Joshi, MD, attended medical school at the University of Vermont and completed a fellowship in pediatric cardiology at Children’s Hospital of Philadelphia. Board certified by the American Board of Pediatrics with a cardiology subspecialty, Joshi is also an associate professor at UTHSC. His patient care emphasis is on general cardiology with focus on fetal cardiology, advanced echocardiography, cardiac MRI and exercise testing.

**Mayte Figueroa, medical director of Cardiovascular Intensive Care Unit**
Mayte Figueroa, MD, is a graduate of Mount Sinai School of Medicine. She completed a fellowship in pediatric cardiology at the Medical University of South Carolina and an advanced fellowship in pediatric critical care cardiology at Baylor College of Medicine. Figueroa is board certified in pediatrics and has a cardiology subspecialty. She is also an associate professor at UTHSC. Her areas of focus include pediatric cardiomyopathy, cardiovascular disease, non-invasive pediatric cardiology, pediatric cardiac critical care, pulmonary hypertension, quality improvement and simulation-based education.

**Glenn Wetzel, medical director of Pediatric Electrophysiology, director of Fellowship Program**
Glenn Wetzel, MD, PhD, completed fellowship training in pediatric cardiology at University of California at Los Angeles. He is board certified by the American Board of Pediatrics and has a cardiology subspecialty. Wetzel is also a professor at UTHSC. His special interests include pediatric electrophysiology (arrhythmias), radiofrequency ablation and cryoablation, cardiomyopathy, pediatric pacemakers and internal defibrillator devices (ICDs).

**Le Bonheur joins REDUCE trial**
Le Bonheur has joined a multi-site study examining the best way to treat patent foramen ovale (PFO). PFO is a common opening in the septum between the right and left atria. In most cases, this opening closes around the time of birth. If the opening remains after birth, it can allow the blood to mix in the two upper chambers of the heart. Untreated it may increase the risk for stroke by allowing clots to cross from the right side of the heart to the left. It is not known for sure if closing the PFO reduces the risk for another stroke.

The Gore REDUCE clinical study aims to determine if closing a patient’s PFO with the GORE Septal Occluder plus taking some medication or taking medications alone without closing the PFO, reduces the risk of having another stroke.

**Heart Institute expands clinic offerings**
Le Bonheur’s Heart Institute has expanded services for patients with a handful of new, specialized clinics.

The institute’s newest clinics include:

- **Sports Cardiology**: Led by Pediatric Cardiologist Alex Arevalo, MD, the clinic offers cardiopulmonary stress testing and advanced imaging techniques to diagnose and treat young athletes with heart issues. The clinic involves a multidisciplinary team of specialists including cardiologists, pulmonologists, orthopedists, physical therapists, sports nutritionists and sports medicine specialists.

- **Dysautonomia/Syncope**: Le Bonheur’s Heart Institute opened a weekly Dysautonomia/Syncope Clinic to treat children and adolescents with dysautonomia, a condition that causes the body’s autonomic nervous system to function inappropriately. The clinic offers cardiology and neurology consults and is led by pediatric cardiologists Glenn Wetzel, MD, PhD, and Ryan Jones, MD. Testing available through the clinic includes ECG and echocardiograms, as well as holter monitor, stress, tilt-table and finapres testing.

- **Tuberous Sclerosis Complex**: Le Bonheur Pediatric Cardiologist Thomas Yohannan, MD, is part of a multidisciplinary team of specialists who treat patients with Tuberous Sclerosis Complex (TSC), a genetic disease that causes benign tumors to grow on vital organs. Designated by the national Tuberous Sclerosis Alliance, the clinic follows patients from childhood into adulthood. The clinic is led by Pediatric Nephrologist John Bissler, MD, and Pediatric Neurologist James Wheless, MD, Pharm.D.

**Le Bonheur Pediatric Neurologist James Wheless, MD, PharmD.**

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Danielle Moss was diagnosed, at birth, with Marfan syndrome, a genetic condition that affects the body’s connective tissue. Because Marfan syndrome can cause damage to the heart’s aorta, Moss was followed regularly by a pediatric cardiologist in her hometown of Kansas City, Mo.

Moss lived her childhood with no heart-related issues. She dropped off her parents’ insurance plan when she turned 18 and stopped seeing a cardiologist regularly. She moved to Memphis and later learned she and her husband were expecting their first child.

Moss was referred to Pediatric Cardiologist Ryan Jones, MD, at Le Bonheur Children’s for an appointment to make sure her heart was still healthy.

At her first appointment at Le Bonheur, Jones learned her aorta was dangerously dilated and that she needed heart surgery as soon as possible. Even worse, with her condition, Moss likely wouldn’t survive labor.

“I was surprised by the news and didn’t think something like this would happen to me,” said Moss.

She terminated the pregnancy and underwent surgery a month later at Le Bonheur to repair her aorta.

Now, more than two years after open heart surgery, Moss is doing well. She and her husband, James, have a 1-year-old son, Gavin.

Moss is one of a growing number of patients that Jones and Pediatric Cardiologist B. Rush Waller, MD, see in Le Bonheur’s Adult Congenital Heart Disease (ACHD) program. Together, they see more than 400 patients each year through the program. “We’re seeing more and more patients with congenital heart disease live into adulthood thanks to advancements in the field,” Jones said. “Before, these patients might not have lived to see their 20s.”

Adult patients continue to be followed by a pediatric team of cardiologists and surgeons because they understand the pathology of their congenital disease, says Jones.

“We know what past procedures they’ve had and understand the long-term issues related to their defect,” he said.

“As our patients grow older, we are learning more about the unique health problems that they face. This is why seeing a cardiologist who specializes in adult congenital heart disease is important,” said Jones.

Sathanandam wins PICS-AICS Young Leadership Award

Pediatric Cardiologist Shyam Sathanandam, MD, recently received the 2014 Pediatric and Adult Interventional Cardiac Symposium (PICS-AICS) Young Leadership Award. The award recognizes early career interventional cardiologists.

Shyam’s clinical and research interests include radiation reduction in children, advanced cardiac 3-D imaging, fetal intervention and neonatal and infant stenting. In the past three years, he has worked to develop a neonatal stent that can be “unzipped” in the catheterization lab to redilate the stenotic segment – allowing children to avoid multiple surgeries to relieve fixed stenosis caused by endovascular stents. He has proven feasibility and now established an animal lab for his research.

Shyam was also one of three selected as a finalist for the organization’s Charles S. Kleinman Scientific Scholarship Award.

Shyam is an assistant professor at the University of Tennessee Health Science Center. He completed his residency in pediatrics at SUNY Downstate Medical Center, NY and pediatric cardiology fellowship at Advocate Christ Medical Center, Chicago, Ill. He trained with Dr. Jonathan Rome during his senior fellowship in interventional cardiology at Children’s Hospital of Philadelphia.