Welcome to Surgery at Riley Children’s Health

As pediatric surgeons and dedicated perioperative surgical teams, one of our most important jobs is to offer hope to children and families—to restore health, normalcy and the promise of a bright future. Our latest Riley Children’s Health Surgery Annual Report provides an overview of our surgical specialties*, highlighting the expertise, innovation and commitment that enable us to reach these goals.

Working in collaboration with nurses, anesthesiologists, child life specialists and other multidisciplinary team members, surgeons at Riley performed more than 19,000 operating room procedures in 2019. Everyone involved with Riley Surgery—from team members in environmental services and sterile processing to our colleagues in the operating room—contributes to providing children and families with exceptional patient experiences and the best possible outcomes.

Our partnership with Indiana University School of Medicine and our long-standing commitment to research and scholarly activity continue to set Riley at IU Health apart from others locally, regionally and nationally. As our surgical program and capabilities continue to grow, we’re excited about the future of Riley Surgery, marked by progress in the areas of fetal intervention, precision surgery, artificial intelligence and machine learning, and further refinement and use of minimally invasive surgical techniques.

On behalf of our entire surgical team, I hope you enjoy learning more about our dedicated team members and the 13 specialties that comprise Riley Surgery. With a commitment and passion for children’s health that’s unmatched, our team strives every day to make a difference in the lives of children and families by restoring health and working to ensure improved quality of life.

On the cover
Adriana Carrera, age 5, flashes a smile while coloring in one of the play rooms at Riley. A sudden onset of pain led to her visit. The pain began during the day and continued into the night so her parents took her to the Riley Emergency department. Riley physicians discovered an issue with Adriana’s appendix, and within a few hours, she was in the operating room. After four days recovering from surgery, Adriana returned home.

Inspiring patients, world-class care: stories of Riley kids
Surgeons and surgical teams at Riley Children’s Health treat thousands of children each year. Read some of their stories on pages 3, 4 and 40.

Riley Surgery expands virtual care
Many of our surgical specialties are using virtual visits to increase statewide access to Riley’s skilled surgical teams. During the COVID-19 pandemic, virtual care outreach—via a secure, user-friendly app—has expanded to include not only critical follow-up visits, but also initial assessments. Using close observation and patient family consultation, Riley neurosurgeons are now performing thorough pediatric neurological exams virtually. Riley Pediatric Surgery can facilitate nearly any type of preoperative or postoperative appointment with a virtual visit.

* The medical specialties of Riley Children’s Health are highlighted in a separate annual report. To view this report, visit rileychildrens.org/medicalannualreport; print copies may also be requested from rileychildrens@iuhealth.org.
Connor Guthrie doesn’t remember much about the accident. What he does remember is the excruciating pain. The injuries to Connor’s abdomen, stomach and esophagus from a car crash in Bloomington were so severe they required the combined skills of surgeons at Riley Hospital for Children and IU Health University Hospital to repair. The boy’s esophagus had ruptured where it connects to the stomach, tearing a hole and spilling the contents of the stomach into his abdomen.

“I admit when the Bloomington trauma team told me the injury they thought Connor had, I didn’t believe it because it’s something you never hear about,” said Matthew P. Landman, MD, director, Riley Trauma Services.

“When Connor got to Riley, he was awake but was in a lot of pain, and it was very clear immediately that he would need an operation,” Dr. Landman said. “We took him to the OR urgently and found a very unusual perforation of his stomach as the esophagus comes from the chest into the abdomen. It’s exceedingly rare.”

So rare, in fact, that Dr. Landman had never seen it in an actual patient.

“It’s one of those things you read about, you learn how to take care of it, then you never see it. And here it was on our doorstep.”

Dr. Landman chose to correct the problem by stapling off the esophagus to prevent more contamination in the abdomen. Connor underwent subsequent surgeries, including a reconstruction surgery performed by Dr. Landman and IU Health University Hospital thoracic surgeon Kenneth A. Kesler, MD. The complex reconstruction rarely used on a child involved turning the stomach into a tube and bringing it up to connect to the repaired esophagus.

Though the tube will grow with Connor, he will always have to be careful how much he eats at one time.

At 5 feet, 6 inches and barely 90 pounds, Connor is thin but healthy. He tried out for the basketball team at school but was cut after the second round, mostly, he believes, because his stamina is not yet what it needs to be. His mom, Amber Hattabaugh, is proud nonetheless.

“For him to even be able to try out was a big deal,” she said.

Today, Dr. Landman said seeing Connor offers no hint of what he’s been through.

“It was one of the more complex injuries I’ve ever seen. Complex in how it first presented, how we had to think about it immediately after the injury; and then how we had to proceed with reconstruction.”
Ellie Griffith, age 9

Story of a Riley kid: Ellie Griffith, age 9

Skillful urologic surgeries make full life possible.

Helen “Ellie” Griffith is used to making her way around Riley Hospital for Children. She’s been doing it for years. When Ellie was born, she was diagnosed with bladder exstrophy, a rare condition in which the bladder develops outside of the body. She also had PELVIS syndrome, characterized by a perineal hemangioma that formed inside her body, affecting her urinary system. At just nine months old, Ellie underwent her first surgery, performed by urologic surgeon Richard C. Rink, MD, to address the problems.

“We got a phone call from Dr. Rink to come into the office, and it turned out that the routine pathology from Ellie’s surgery showed that she had embryonal rhabdomyosarcoma of the bladder (cancerous bladder),” said Ellie’s mom, Jamie Griffith. “It was really hard news to take—it had already been a very long nine months and then to have a cancer diagnosis on top of it, it was horrible just trying to figure out how to deal with it.”

With expert treatment by Riley oncologists and support from the care team, Ellie completed 48 weeks of chemotherapy before undergoing a second surgery.

“Dr. Rink was able to take out the entire bladder, which made the difference in her survival,” Jamie said. “I feel like he saved her life because he was able to do that.”

After the surgery, which included an ostomy, Ellie finished her course of chemotherapy. Following the successful cancer treatment, Ellie’s parents knew they wanted to help their daughter be more independent, so when Ellie was 4, they turned once again to Dr. Rink.

“He went back in and completely reconstructed her urinary system and made it all internal so now she has a catheterizable channel into a bladder made of bowel,” Jamie explained. “She’s just like any other kid on the outside.”

Ellie, who’s now 9 years old, is grateful for all the things she’s able to do.

“When I had my last surgery, I was able to swim and stuff and after a while I was able to do taekwondo, and it was easier to do the things I like to do,” she said.

Jamie credits the skilled surgical team and specialists at Riley for her daughter’s recovery and for the full life Ellie’s now able to live.

“Riley saved her life and gave her the opportunity to live it as fully as she can—and knowing her, I have no doubt it will be very full.”

Riley Surgery at a glance

DEDICATED TEAMS IN 13 PEDIATRIC SURGICAL SPECIALTIES COMPRISE RILEY SURGERY:

- Cardiothoracic Surgery
- Dentistry
- Interventional Cardiology and Electrophysiology
- Interventional Radiology
- Maternal Fetal Medicine
- Neurosurgery
- Ophthalmology
- Orthopedic Surgery
- Otolaryngology – Head & Neck Surgery
- Pediatric Surgery
- Plastic Surgery
- Transplant Surgery
- Urology

More than 90 SURGEONS AND ANESTHESIOLOGISTS

More than 250 SURGICAL TEAM MEMBERS

More than 19,000 SURGICAL PROCEDURES PERFORMED IN 2019

Riley Children’s Health Operating Room Volume

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Operating Room Volume</th>
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<tr>
<td>2016</td>
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<tr>
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<td>10,150</td>
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Riley Surgical Research Day: Celebrating academic achievement, innovation

Attended by nearly 300 perioperative team members, the third annual Surgical Research Day at Riley Hospital for Children at IU Health took place on May 15, 2019. The conference included 50 abstracts highlighting clinical and basic science research within Riley at IU Health perioperative services. All surgical specialties, anesthesiology and nursing were represented.

Jeremy L. Hermann, MD, and Riley Cardiothoracic Surgery received the Best Oral Presentation award for their work, “Long-term Outcomes of Neonatal Patients Undergoing Aortic Switch Operations for TGA.” Riley Plastic Surgery earned Best Poster Presentation for “Safety and Trends in Ketorolac Use During Cleft Palate Repair: An Examination of the Pediatric Health Information System (PHIS) Database.”

Stacy M. Nance, RN, received the Best Nursing Research award for her work, “Feeding and Activity Restrictions After Infant Cleft Palate Repair: A Survey of North American Cleft Programs and Infant Cleft Palate Repair: A Survey of North American Cleft Programs and Evaluation of Online Content Availability.”

As the nursing research award winner, Nance received funding from Riley Children’s Foundation to further her research. For the third consecutive year, Riley Anesthesia was recognized for submitting the most abstracts.

Keynote speaker Lynn Martin, MD, MBA, (left) presented “Operative Services Outcome Improvement Using Toyota (LEAN) Methods,” challenging attendees to think differently about operational effectiveness in the perioperative arena. Dr. Martin, an attending anesthesiologist, is the medical director of continuous improvement and innovation at Seattle Children’s Hospital.
New maternity tower to feature unique, fully integrated care model

The Maternity Tower at Riley Hospital for Children at IU Health is scheduled to open in 2021. The facility centralizes all of Riley’s obstetric and neonatal care across the Riley Hospital for Children and IU Health Methodist Hospital campuses. The maternity tower features a new coordinated care model anchored by the long-standing reputation of Riley at IU Health for delivering expert care for complicated pregnancies and at-risk newborns. Riley, alongside our partners at IU Health, offers comprehensive, multidisciplinary services and exceptional medical support to patients experiencing low- to high-risk pregnancies.

In March 2020, Riley Maternal Fetal Medicine relocated to the Riley Outpatient Center, expanding its footprint with additional private exam rooms and ultrasound suites. The Riley Fetal Center is housed in the same area and includes a “nesting room” for patients to relax between appointments and testing.

Riley Fetal Center
The Riley Fetal Center provides preeminent management of a broad range of complex and high-risk conditions, while supporting families with coordinated care specific to the needs of the patient.

- Advanced fetal imaging, including echocardiography, extensive ultrasound and the state’s only fetal MRI
- Personalized, multidisciplinary and family-centered care consultations with families and support team members
- Multidisciplinary fetal care conferences, bringing together more than 40 Riley specialists, to discuss best practices and management plans for complex fetal diagnoses

Maternity Tower at Riley Hospital for Children
Expertise and services

- Most comprehensive obstetrics and maternal fetal medicine program in the state
- High-risk pregnancy consultation and services for women with medical and obstetrical issues
- On-site Level III and Level IV NICUs
  - Riley’s combined Level III and Level IV NICU is the largest NICU in Indiana and among the largest in the country
- Specialty maternal fetal medicine programs:
  - Mood Disorders Program (collaboration with IU Health Psychiatry)
  - Maternal Recovery Program (women recovering from substance abuse disorders)
  - Centering Pregnancy Program (group prenatal care)
  - Programs for pregnant women with medical conditions such as diabetes and cardiac disease
- General pregnancy care, including experienced obstetricians and midwifery program

Method Tuuli, MD, co-medical director, Riley Maternity and Newborn Health, answers common questions from referring providers and patients about the program.

Q: How is Riley’s care model different?
Dr. Tuuli: One of the overarching benefits of our program is the true integration of obstetrics, maternal fetal medicine and neonatology care. While collaboration between OB and neonatology exists in most health centers in Indiana and across the country, Riley’s care model is integrated both operationally and physically in our children’s hospital. This allows us to deliver services in a seamless manner from initial consultation and maternal and fetal assessment to delivery planning—and finally, to management of labor and delivery. For babies needing immediate, high-level care, our pediatric subspecialists are available on site, with no need for transport, resulting in consistently better patient outcomes.

Q: How will Riley ensure quality care for mothers?
Dr. Tuuli: We are committed to providing high-quality, safe care for all mothers delivering at Riley. While our maternity services are located in a children’s hospital, our program is closely aligned with IU Health adult services. Our obstetrics intensive care unit will be covered 24/7 by an adult intensive care physician, and both adult and pediatric experts from throughout the IU Health Adult Academic Health Center will be on call day and night for consultations at Riley, if needed.

Q: Why should women with normal or low-risk pregnancies also consider delivering at Riley?
Dr. Tuuli: Being equipped to manage the highest risk cases means we’re more than prepared to take care of mothers experiencing normal pregnancies. Complications during labor and delivery are unpredictable and occur even in pregnancies that are considered low risk. Which mother, for example, is going to bleed heavily after delivery? Despite extensive knowledge of risk factors, OB physicians still predict very few of these. Our expertise in managing complex pregnancies makes Riley the safest place even for low-risk patients because of our ability to skillfully respond at the highest level to unexpected complications that can happen.

We’re also excited about our new midwifery program, an alternative for women who want a more natural labor and delivery experience but also desire the security of a hospital setting. Our certified nurse midwives provide patient-centered care for women through pregnancy, birth, postpartum and beyond.
Cardiothoracic Surgery

Home to one of the nation’s leading pediatric heart centers, Riley Hospital for Children at IU Health provides the expertise, experience and resources to care for infants, children and adults with congenital or acquired heart disease. Achieving exceptional outcomes year after year, the board certified surgeons in our cardiovascular and cardiothoracic surgery program treat and manage the entire spectrum of heart defects—from the most common to the most rare and complex.

Specialized, integrated pediatric heart care

Offering a fully integrated program to care for children and adults with congenital heart disease, we attract patients from Indiana, the United States and many parts of the world. With a variety of resources, our high-volume program is organized and ready to provide a rare level of coordinated care at one of the nation’s top destinations for acute care.

The Riley pediatric heart team is comprised of world-renowned specialists trained in cardiovascular and cardiothoracic surgery, cardiac anesthesiologists, imaging technicians, congenital cardiologists, cardiovascular intensive care specialists, dedicated cardiovascular nurses and many others who specialize in working with heart defects and thoracic conditions. As part of a comprehensive pediatric healthcare system for advanced care, our team collaborates with other highly skilled specialists to deliver the right care at the right time.

The Riley at IU Health Adults with Congenital Heart Disease Program manages a child’s condition into adulthood to promote optimal health through every stage of life. In addition, families affected by congenital heart disease linked to their genetic traits can also seek guidance from our Cardiovascular Genetics Program to determine whether future children or other family members may be at risk for the same disorder.

Highest rating from the Society of Thoracic Surgeons

The Society of Thoracic Surgeons (STS) hosts the largest pediatric congenital heart database in the world, which includes participants from more than 95% of U.S. hospitals performing congenital heart surgery. The STS star rating system is one of the most sophisticated and highly regarded measures of overall quality in healthcare. The highest possible rating is three stars, which denotes lower than expected mortality with the highest category of quality. Riley at IU Health is one of only seven programs to earn the prestigious three-star designation.

Operative and Adjusted Operative Mortality

<table>
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<th>NEO NATES/ INFANTS/ CHILDREN/ ADULTS</th>
<th># DEATHS/ ELIGIBLE RILEY</th>
<th>OBSERVED MORTALITY RILEY</th>
<th>EXPECTED MORTALITY RILEY</th>
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<tr>
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<td>3.7%</td>
<td>2.7%</td>
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<td>6.1%</td>
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<tr>
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<td>1.7%</td>
<td>15.8%</td>
<td>13.3%</td>
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Postoperative Length of Stay

Riley patients return home an average of four days sooner than the STS national median across 10 procedures, with accordingly better overall mortality.

Nationally recognized treatment

Our specialists are recognized nationally and internationally as respected resources for complex procedures that repair undersized pulmonary arteries, remove cardiac tumors and rebuild complex heart anatomies. We also have a full complement of ventricular assist devices to support the function of a failing heart, including the total artificial heart. In fact, Riley at IU Health was one of the first pediatric programs in the U.S. to give a child a Berlin heart.

Committed to innovation and excellence

Practicing at the highest level of board certification, Riley heart surgeons have an extra tier of training and practice in congenital heart defects and thoracic disease. These credentials set them apart as a rare breed of surgeons offering a degree of expertise found only in the most advanced pediatric hospitals.

The team’s pursuit of excellence also keeps them invested in research to find new ways of resolving complex congenital heart defects and diseases of the lung, blood vessels and heart. Our surgeons share their knowledge globally through lectures and humanitarian work that promotes children’s heart health.
**Dentistry**

Riley pediatric dentists, faculty members of Indiana University School of Dentistry, have years of experience providing comprehensive dental care to children of all ages, including those with special healthcare needs. We offer a full range of pediatric dental services, including sealants, restorations, fluoride and limited orthodontics for children and adolescents. In our advanced, 12-chair dental facility, the skilled dental team and expert pediatric anesthesiologists from Riley at IU Health administer sedation and general anesthesia for children, including those with special needs such as developmental, emotional, behavioral or cognitive impairments.

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**Dentistry Outpatient Visits: 2016 – 2019**

<table>
<thead>
<tr>
<th>Year</th>
<th>Visits</th>
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<tbody>
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<tr>
<td>2017</td>
<td>14,922</td>
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<td>14,339</td>
</tr>
<tr>
<td>2019</td>
<td>15,000</td>
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**Program distinctions**

- Comprehensive dental care for children of all ages, including those with special medical needs
- Treatment for patients with complex medical conditions
- 24/7 coverage for dental emergencies

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**Our pediatric dentists collaborate with other Riley at IU Health specialists such as oral surgeons, otolaryngologists, ophthalmologists and plastic surgeons to manage conditions and improve children’s health.**

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**Pediatric trauma care**

Riley at IU Health dentists provide 24/7 emergency coverage for children suffering from dental trauma or other emergencies.

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**Early intervention and preventive dental care**

Children should see a dentist when their first tooth erupts into the mouth or by the age of 1 year. Though this may seem early, we see the best outcomes for dental health when children receive dental care at this age. With early intervention, pediatric dentists are able to identify and diagnose any dental development issues before they become serious problems. Our pediatric dentists also teach parents how to care for their child’s teeth and offer guidance about brushing, foods to avoid and general dental care. Early childhood visits can prevent dental issues or complicated surgeries later in a child’s life.

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**Care coordination for complex needs**

Riley dentists treat children with complex medical conditions, including physical disabilities, craniofacial anomalies, genetic disorders, liver and kidney disease, and patients with congenital and acquired heart problems. We work closely with Riley specialists to optimize outcomes for these medically compromised patients.

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**Research and training**

In addition to providing compassionate care, Riley dentists are dedicated to improving pediatric dentistry through education and research. Our dentists conduct research to advance children’s dental health and train dental students and pediatric residents how to manage children’s dental care and use the latest treatments. Working with patients under the supervision of IU School of Dentistry faculty, residents at Riley receive hands-on training.
Interventional Cardiology and Electrophysiology

Board certified and fellowship trained, Riley at IU Health interventional cardiologists diagnose and treat congenital heart defects from the simple to the most complex. Specially trained to perform the latest invasive, catheter-based procedures, our experienced and skilled pediatric cardiologists are available to consult with referring physicians regarding indications for and timing of these procedures.

Interventional Cardiology
As part of a comprehensive interventional cardiology program, our cardiologists provide essential anatomic evidence during diagnostic procedures to direct cardiovascular surgical interventions. In addition, they repair heart defects, such as patent ductus arteriosus (PDA), atrial septal defect (ASD) and ventricular septal defect (VSD), that allow both children and adults to avoid open heart surgery altogether.

Our team performs a variety of interventional cardiology procedures, including:
- Balloon pulmonary and aortic valvuloplasty
- Balloon angioplasty of aortic arch, branch pulmonary arteries, conduits and venous obstructions
- Balloon atrial septostomy (often for transposition of the great arteries)
- Recanalization of occluded venous pathways
- Device closure of:
  - PDA, ASD, VSD, patent foramen ovale (PFO) and Fontan fenestration
  - PDA in premature infants weighing even less than 1,000 grams
- Device/coil occlusion of:
  - Venous or arterial collateral vessels
  - Coronary fistulas and pseudoaneurysms
- Stent implantation in aorta, pulmonary arteries and obstructed veins
- Creation or enlargement of ASD or Fontan fenestration
- Transcatheter implantation of pulmonary and tricuspid valves
- Hybrid procedures in collaboration with cardiac surgeons
- Percutaneous closure
- Vascular access from femoral, jugular, subclavian and transhepatic routes

Interventions by Type: 2019

Electrophysiology
Riley at IU Health pediatric electrophysiologists treat patients with various arrhythmias, often during ablation procedures that abolish the focus of an arrhythmia or by implantation of a pacemaker or implantable defibrillator. These sophisticated methods provide treatment for conditions such as supraventricular tachycardia (SVT), ventricular tachycardia (VT), ventricular fibrillation for history of sudden cardiac arrest and Wolff-Parkinson-White (WPW) syndrome.

Electrophysiology procedures performed at Riley at IU Health:
- Mapping of arrhythmia-causing electrical pathways
- Radiofrequency and cryoablation of abnormal bypass tracts causing arrhythmia (for SVT, VT and WPW)
- Implantation and revision of implantable permanent pacemakers and defibrillators
- Implantation and removal of loop recorders used to detect possible arrhythmias

Program distinctions
Ranked among the top five pediatric heart programs by U.S. News & World Report
Active in clinical trials to provide the latest treatment options
Partner in performing “hybrid” procedures to address complex heart conditions

Direct Contact
Refer a patient: 317.944.8906

Program leader since 2000
Mark H. Hoyer, MD
Professor of Clinical Pediatrics
IU School of Medicine
For full team member list, see page 38.
Interventional Radiology

Riley Interventional Radiology offers a wide range of minimally invasive procedures to diagnose and treat many pediatric conditions. Through the expertise of our skilled interventional radiologists, our program minimizes the physical trauma associated with open surgery and contributes to decreased infection rates, shorter hospital stays and faster overall recoveries. Children benefit greatly from this approach to treatment, which often results in less pain than standard procedures.

With preparation, procedure and recovery rooms together in one location, our environment is specifically suited to treating pediatric conditions and caring for emotional needs. Our team uses procedural sedation and surgical anesthesia to control pain. We also use tools that are smaller in size and made especially for children. A trained child life specialist is available, when needed, to support and calm children before and during procedures.

Advanced techniques and imaging used to diagnose and treat

Specially trained Riley interventional radiologists use X-ray, computed tomography or ultrasound to see inside the body and guide tools such as catheters, needles and stents to:

- Obtain biopsies
- Diagnose conditions
- Stop internal bleeding caused by organ trauma or pelvis fractures
- Stop intestinal bleeding
- Treat
  - Blocked or damaged arteries or veins
  - Tumors
  - Urinary tract blockages
  - Bile ducts that are blocked and damaged
  - Joint pain

RILEY INTERVENTIONAL RADIOLOGY SERVICES*

- Angiography and angioplasty
- Biliary drainage
- Biliary stent insertion
- Chest tube insertion
- Cholecystostomy
- Cryoablation and microwave ablation of vascular malformations and tumors
- Dialysis angioplasty
- Dialysis catheter
- Dialysis fistulagram
- Dialysis stent
- Double J ureteral stent
- Embolization gastrointestinal bleeding
- Embolization of varicocele
- Embolization organ trauma and tumors
- Gastrostomy tube, gastrojejunostomy tube and cecostomy tube placement
- Joint injection and aspiration
- Lymphangiography and embolization
- Nephrostomy tube
- Nephroureterostomy tube
- Paracentesis
- Percutaneous biopsy of solid organs, bone and masses
- Percutaneous drainage of abscesses and fluid collections
- Percutaneous stone retrieval
- Peripherally inserted central catheter (PICC)
- Port-a-cath
- Radiofrequency ablation of osteoid osteomas
- Sclerotherapy and embolization of vascular malformations
- Suprapubic catheter
- Thoracentesis
- Triple lumen catheter
- Transhepatic and translumbar central venous catheter
- Tunneled central venous catheter

*RILEY INTERVENTIONAL RADIOLOGY SERVICES*: Not an all-inclusive list of interventional radiology services.

Program distinctions

- Minimally invasive guided therapy delivers treatment with high standard of quality and safety
- Advanced interventional radiology suites offer low-dose technology, minimizing risk and maximizing benefit to pediatric patients
- Interventional radiologists collaborate with Riley Vascular Anomalies Program to treat vascular malformations with sclerotherapy and embolization

Riley interventional radiologists treat several specific conditions, including vascular malformations, varicoceles, juvenile idiopathic arthritis, osteoid osteomas and liver tumors. Our specialists also place catheters for children requiring long-term intravenous medicines or fluids.

Note: Due to procedure code changes, volume numbers differ from those cited in previous reports.
Maternal Fetal Medicine

Riley at IU Health Maternal Fetal Medicine offers comprehensive high-risk pregnancy consultation and services for women with medical and obstetrical issues, including preexisting diabetes, chronic high blood pressure, preeclampsia, preterm labor and other complex medical conditions that affect pregnancy. Our maternal fetal medicine specialists also care for women who experience unexpected problems during pregnancy, such as early labor, bleeding or high blood pressure, and provide care for newborns who may have birth defects or growth problems.

Our program provides a wide range of multidisciplinary healthcare, and our team is available 24 hours a day, seven days a week. Nurses, social workers and specialists meticulously coordinate evaluation, diagnosis and treatment to help ensure a seamless experience for the patient and family.

Using targeted, advanced diagnostic tools, the Riley at IU Health Prenatal Diagnosis Program evaluates mothers and babies, and includes the following services:

- Abnormal placentation evaluation
- Amniocentesis
- Extensive ultrasounds
- Follow-up ultrasounds
- Multifetal pregnancy management
- Preconception consultation
- Preconception genetic counseling
- Prenatal blood tests
- Prenatal genetic counseling
- Prenatal ultrasound

Riley Fetal Center

Working closely with the Riley Fetal Center, our maternal fetal medicine specialists coordinate care for pregnant women whose fetuses are diagnosed with congenital anomalies. The multidisciplinary center managed treatment for 256 referral patients in 2019—56 more than in 2018. For more on the Riley Fetal Center, refer to pages 6 and 27.

Riley Maternal Fetal Medicine provides leading-edge treatment and patient-centered care for the following conditions:

**Maternal conditions**
- Antiphospholipid syndrome
- Asthma in pregnancy
- Cervical insufficiency
- Gestational diabetes
- Maternal acquired cardiac disease
- Maternal congenital heart disease
- Preexisting diabetes
- Prior stillbirth
- Prior venous thromboembolism or deep venous thrombosis
- Recurrent pregnancy loss
- Rheumatologic diseases
- Substance abuse in pregnancy
- Systemic lupus erythematosus
- Thyroid disease in pregnancy

**Fetal conditions**
- Anomalous band syndrome
- Anencephaly
- Bladder outlet obstruction
- Brain malformations
- Branchial pulmonary sequestration
- Congenital heart block
- Congenital pulmonary airway malformation
- Duodenal atresia
- Encephalocele
- Hydrops
- Platelet alloimmunization
- Pleural effusions
- Pyelectasis/hydronephrosis
- Red blood cell alloimmunization
- Skeletal dysplasia
- Twin-to-twin transfusion syndrome

**Outpatient-Based Opioid Treatment Program**

Riley at IU Health maternal fetal medicine physicians provide outpatient treatment for opioid-exposed pregnant women. In 2019, our team treated 70 patients through this medical recovery program.

**Program distinctions**

- Comprehensive care of pregnancies complicated by maternal medical conditions, including diabetes and cardiovascular disease
- Riley Fetal Center supports preeminent management of a wide range of complex or high-risk fetal conditions
- Maternal recovery program provides comprehensive treatment, including opioid replacement therapy, counseling and group prenatal care

A leader in training and research

Riley at IU Health offers Indiana’s only maternal fetal medicine fellowship to train physicians in evaluating and treating complex pregnancies. In addition, our specialists in maternal fetal medicine conduct research aimed at improving care in pregnancies complicated by preterm labor, diabetes and maternal opiate dependence.
Neurosurgery

The skilled team of neurosurgeons at Riley at IU Health manages complex brain, spine and nervous system conditions in children of all ages, from infants to young adults. As one of the most highly skilled pediatric neurosurgery teams in the United States, Riley neurosurgeons see patients from all over the world. Performing approximately 900 procedures annually, we routinely treat the most complicated issues, including intractable epilepsy, skull and spine deformities, traumatic injuries, congenital conditions such as spina bifida, benign and malignant tumors, and blood vessel abnormalities in the brain.

We are committed to addressing any neurological need and partner closely with the neurology team and other colleagues at Riley at IU Health, including specialists in oncology and hematology, neonatology, urology, neuro-oncology, cleft and craniofacial anomalies, otolaryngology, developmental pediatrics, adolescent medicine, interventional neuroradiology, genetics, orthopedic surgery, pediatric intensive care medicine, and physical therapy and rehabilitation. To focus on providing specialized treatment for neurologic disorders, our teams have developed a number of programs and centers of excellence, such as the comprehensive Epilepsy Program.

Riley Neurosurgery is at the center of many of the hospital’s perioperative surgical homes and multidisciplinary programs:

- Adult spina bifida
- Brachial plexus injuries/nerve disorders
- Complex spine/scoliosis
- Craniosynostosis/craniofacial deformities
- Epilepsy
- Movement disorders/spasticity
- Neuro-oncology
- Pain management
- Traumatic brain injury/concussion
- Vascular/stroke/moya-moya disorders

Using highly specialized equipment, Riley neurosurgeons offer minimally invasive epilepsy surgery (featuring laser ablation of seizure foci) and robot-assisted seizure surgery. In addition, our team has access to the latest clinical trials, providing leading-edge patient care to children and young adults with neurological conditions.

Riley Neurosurgery uses the Donabedian model to evaluate quality of care. With the exception of same-day appointments, we strive for the lowest number possible.

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</thead>
<tbody>
<tr>
<td>Process: Use of nonstandardized shunt valves</td>
<td>27</td>
<td>17</td>
<td>13</td>
<td>19</td>
<td>8</td>
<td>11</td>
<td>20</td>
<td>21</td>
<td>13</td>
<td>15</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

Outcome:

- Cerebrospinal fluid (CSF) leak: 1111131302242
- Shunt infection: 011100110000
- Baclofen pump infection: 000000000000
- Other surgical site infection: 11400000000020
- Readmission < 90 days: 4131646254434
- Structure: Overuse of OR block time: 19385384646463

Number equals occurrences in each category.

By adopting this framework for quality improvement in pediatric neurosurgery, we meet or exceed national benchmarks for postoperative complications, such as CSF leaks, shunt infections, baclofen pump infections, other surgical site infections and readmissions within 90 days of surgery.

Leaders in research and innovation

Riley neurosurgeons and scientists are actively involved in research to advance understanding of why spine and brain disorders occur and to develop better operative and nonoperative treatments that are effective and safe for children. In 2019, our neurosurgery team participated in 38 Institutional Review Board-approved studies to investigate:

- Hydrocephalus
- Traumatic brain injury in pediatric patients
- Craniofacial anomalies
- Brain tumors
- Spinal column shortening for tethered cord syndrome
- Patient-reported outcomes
- Quality improvement

For full team member list, see page 38.
Ophthalmology

Offering comprehensive care and early detection for children with all varieties of eye conditions and visual impairments, Riley Ophthalmology is the only program of its kind in Indiana. Our expert physicians treat a wide range of concerns from vision problems remedied with only eyeglasses to complex conditions that require sophisticated surgical procedures. Our team is led by board certified, fellowship-trained pediatric ophthalmologists who collaborate with pediatric optometrists and certified ophthalmic technicians to offer the most advanced eye care available to children, as well as adults with strabismus.

Our ophthalmologists have detailed knowledge of children’s developing visual systems and can objectively evaluate children of all ages and developmental stages, regardless of their ability to communicate what they see.

Comprehensive treatment for eye disorders
Riley ophthalmologists evaluate, diagnose and treat all types of eye conditions, including:
- Amblyopia (“lazy eye”)
- Strabismus (eye muscle disorders)
- Pediatric cataract
- Eyelid lesions, including ptosis, tumors, etc.
- Pediatric glaucoma
- Ocular trauma
- Optic nerve diseases
- Refractive errors
- Retinoblastoma and other ocular tumors
- Retinopathy of prematurity

As part of a multidisciplinary team at Riley at IU Health, our eye specialists are trained to distinguish vision problems from learning problems, so we can direct children to proper care and treatment. In addition, Riley ophthalmologists partner with other departments, including neurosurgery, neurology, rheumatology, hematology/oncology and developmental pediatrics to evaluate and address the variety of ocular manifestations of many systemic conditions. These include Down syndrome, juvenile idiopathic arthritis, idiopathic intracranial hypertension, retinoblastoma and neurofibromatosis.

Pediatric eye evaluation, diagnosis and treatment require a different approach than adult care, and our team brings specialized skills and expertise to every child’s treatment plan.

Experts in pediatric ophthalmology
Riley ophthalmologists train the next generation of pediatric eye specialists and hold national and international leadership positions in professional associations such as the American Academy of Ophthalmology, the American Association for Pediatric Ophthalmology and Strabismus, and the International Pediatric Ophthalmology and Strabismus Council. We are active in clinical trials that study new methods of diagnosis and treatment, and our ophthalmologists are widely published in peer-reviewed medical journals and texts used to train medical students, residents and fellows.
Orthopedic Surgery

Treat infants and children of all ages, the pediatric orthopedic specialists at Riley at IU Health are committed to ensuring children receive leading-edge, patient- and family-centered musculoskeletal care with superior outcomes. Our orthopedics program is a major regional referral center with a team of fellowship-trained surgeons who are internationally recognized as clinical experts. Our specialists provide consultation, diagnosis and treatment for a variety of orthopedic concerns.

Fractures, injuries and trauma
Riley at IU Health is the only children's hospital in Indiana—and one of just a few across the country—to be verified as a Level I Pediatric Trauma Center by the American College of Surgeons. In 2019:
- 394 patients transferred to Riley for inpatient care of fractures or musculoskeletal injuries
- 231 patients received fracture care in our OR within 18 hours of admission for isolated femoral shaft fracture and supracondylar fracture of the humerus
- 539 patients under the age of 14 received radiographically assisted reductions of both bone forearm fractures in the Emergency department
- 2,236 patients received care for fractures or musculoskeletal injuries

Scoliosis and other pediatric spine conditions
Riley orthopedic surgeons provide treatment for a variety of spinal deformities in patients from infancy to adolescence. Our innovative surgical techniques include the use of growing spine constructs such as the MAgeXtensional Expansion Control (MAGEC) rod, which minimizes spinal fusion, preserves spine motion and results in better patient outcomes. Riley at IU Health is the only location in Indiana to provide casting for infantile or early-onset scoliosis. In 2019:
- 127 patients were treated for surgical correction of idiopathic scoliosis
- 89 patients were treated for surgical correction of neuromuscular scoliosis
- 22 patients under the age of 5, diagnosed with infantile scoliosis, were treated through Risser casting techniques
- Using a team-oriented, multimodal pain control protocol, the average length of stay after spinal fusion for idiopathic scoliosis has decreased to an average of 2.1 days.

Pediatric musculoskeletal oncology program
We provide the most comprehensive care in the state for pediatric orthopedic oncology, including tumors and non-tumor conditions. Our orthopedic oncologists work closely with the pediatric hematologic/oncology team at Riley to provide world-class care. In 2019:
- 102 patients diagnosed with a malignant neoplasm received treatment
- 199 patients diagnosed with a benign neoplasm received treatment

Skeletal malformations and congenital/developmental conditions
Riley orthopedic specialists care for children of all ages with a wide range of skeletal malformations and congenital/developmental conditions. We use a variety of treatment methods, including guided-growth procedures, external fixation devices and multiple-level osteotomies. Long bone lengthening is also possible for patients with leg length discrepancies. In 2019:
- 104 patients under the age of 2 were treated using the Ponseti technique for correction of clubfoot
- 25 patients were treated with Bernese pelvic osteotomies
- 18 patients diagnosed with developmental dysplasia of the hip received open reduction treatment

Neuromuscular conditions
Our physicians diagnose and treat a variety of orthopedic complications related to neuromuscular conditions such as spinal deformities and gait abnormalities. These conditions include any syndrome or disorder that impairs the functions of the nervous system or muscles, such as cerebral palsy or muscle disorders.

Riley Orthopedic Surgery uses the latest diagnostic and surgical technology
EOS imaging – We use Indiana’s only EOS imaging machine for most patients who have conditions such as scoliosis, leg deformities or leg length discrepancies. EOS provides patients with up to four times less radiation than other imaging services, an especially important value to patients requiring many radiographic studies as part of their care plan. Primary care doctors can request use of the EOS imaging machine whether or not the child is a patient of Riley at IU Health.

Intraoperative O-arm - This surgical imaging system provides high-quality 2D and 3D intraoperative images of the anatomy and is designed for use in orthopedic, spine and related surgeries.

Committed to research and innovation
Our team is actively involved in a variety of surgical performance and study groups, including IMpAckett, Pediatric Spine Study Group, Setting Scoliosis Straight, Collaborative Orthopaedic Educational Research Group and Spinal Anesthesia for Clubfoot Patients.

New locations and same-day access for urgent needs
With plans for continued growth, the Riley orthopedic surgery team has added locations to provide greater patient access. We currently see patients at offices in Indianapolis, Avon, Bloomington, Carmel and Fishers. We also offer same-day appointments at select locations for patients with urgent needs.

Program distinctions
Ranked among the nation’s top pediatric orthopedics programs by U.S. News & World Report
Comprehensive musculoskeletal care—using the latest technological advances—for children of all ages, infancy through adolescence
A partner in providing superior trauma care in the state’s only Level I Trauma Center
Holistic spinal deformity program, supported by a dedicated team of pediatric anesthesiologists, features the latest advancements in technology and postoperative care


<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
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<tr>
<td>1000</td>
<td>1,190</td>
<td>1,112</td>
<td>1,237</td>
<td>1,168</td>
<td>1,485</td>
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</table>

Orthopedic Outpatient Visits: 2015 – 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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<td>10,000</td>
<td>12,083</td>
<td>12,728</td>
<td>14,321</td>
<td>13,526</td>
<td>15,757</td>
</tr>
</tbody>
</table>
Otolaryngology – Head & Neck Surgery

The expert team of fellowship-trained otolaryngologists at Riley provides the full range of pediatric ear, nose and throat care from common issues to more complex disorders. Our board certified otolaryngology – head and neck specialists, as well as audiologists and speech-language pathologists, use leading-edge technology to perform extensive diagnostic evaluation of conditions and provide customized treatment.

Our team is committed to ensuring patients receive highly advanced head and neck care for the best outcomes. Riley otolaryngology specialists evaluate and treat a variety of conditions, including:

- Acute and chronic airway obstruction
- Chronic ear disease
- Balance and dizziness disorders
- Communication disorders
- Cleft lip and palate
- Head and neck masses
- Congenital ear anomalies
- Hearing loss
- Salivary gland conditions
- Nasal breathing problems
- Sinusitis
- Snoring, voice and sinus disorders
- Sleep apnea
- Vascular anomalies
- Voice and speech conditions

Skilled Riley otolaryngology surgeons routinely perform thyroid surgeries and surgical interventions for disorders involving the tonsils and adenoids.

A partner in patient-centered, interdisciplinary care

Working closely with other Riley specialists to coordinate excellent care, our otolaryngologists are integral members of a number of multidisciplinary programs:

Vascular Anomalies Program

The Riley at IU Health Vascular Anomalies Program provides high-quality, advanced care for children with vascular anomalies to help restore function and a more normal appearance. Children with vascular anomalies receive care from our multidisciplinary team that includes board certified specialists in:

- Blood disorders
- Dentistry
- Dermatology
- Interventional radiology
- Oral and maxillofacial surgery
- Otolaryngology – head & neck surgery
- Plastic surgery
- Physical therapy

Cochlear Implant Program

The Riley at IU Health Cochlear Implant Program—an internationally recognized leader in cochlear implants and related research for children with severe to profound hearing loss—includes surgeons and audiologists specially trained to treat all patients with cochlear implants.

Deaf and Hard of Hearing Clinic

This specialized program is designed to support children through medical, social and educational care related to hearing loss.

Cleft and Craniofacial Anomalies Program

One of the largest and most experienced programs of its kind in the nation, the Cleft and Craniofacial Anomalies Program cares for more children with cleft lip and/or cleft palate than any other hospital in Indiana. For more on this program, refer to page 28.

Aerodigestive Program

By providing multidisciplinary care to children with structural airway and functional gastroenterology disorders, this program strives to improve clinical outcomes. We coordinate outpatient evaluations and diagnostic and operative procedures, while conveying timely feedback to referring physicians and families for ongoing care.

Otolaryngology – Head & Neck Surgery Volume: 2019

- 3,922 Surgical cases
- 5,892 Outpatient visits

Program distinctions

First program in Indiana with fellowship-trained pediatric otolaryngologists

Cochlear implant program internationally recognized for clinical care and research

Clinical partner in providing multidisciplinary care and support to children who are deaf or hard of hearing

DIVISION CHIEF
Bruce H. Matt, MD, MSc
Program leader since 1989
Associate Professor of Otolaryngology – Head & Neck Surgery, IU School of Medicine
For full team member list, see page 39.

Aerodigestive Program
Pediatric Surgery

Nine board certified pediatric surgeons at Riley at IU Health are experienced in performing the full spectrum of pediatric surgery. Our surgery team provides 24/7, onsite surgical coverage, allowing for timely evaluation of children with emergent and urgent surgical conditions. We also lead Indiana’s only pediatric Level I Trauma Center, which annually serves more than 1,600 patients.

For more on trauma services at Riley, refer to pages 36 – 37.

Our pediatric surgeons treat a variety of conditions:
- Appendicitis
- Chest wall conditions
- Pectus excavatum
- Pectus carinatum
- Poland syndrome
- Slipping rib syndrome
- Colon and rectal surgery
- Imperforate anus
- Hirschsprung’s disease
- Anorectal abscess/fistula
- Ulcerative colitis
- Crohn’s disease
- Familial adenomatous polyposis
- Short bowel syndrome
- Gastroesophageal reflux
- Gastrostomy tube placement
- Hypertrophic pyloric stenosis
- Inguinal hernias, hydroceles and undescended testes
- Neonatal surgical conditions
- Intestinal obstructions
- Congenital diaphragmatic hernia
- Esophageal atresia and tracheoesophageal fistula
- Omphalocele, gastrochisis
- Necrotizing enterocolitis
- Solid tumors
- Trauma
- Vascular access devices

Improving quality outcomes through research

The Riley pediatric surgery team has drastically reduced narcotic use through multimodal pain management strategies. Our one-month quality improvement study of 38 patients with appendicitis (12 perforated) determined that despite these reductions, we were still prescribing more medication than needed. Based on these findings, Riley Pediatric Surgery determined that despite these reductions, we were still prescribing more medication than needed. Based on these findings, Riley Pediatric Surgery continues to expand the use of minimally invasive surgical techniques, including thoracoscopy, laparoscopy and robotic surgery, and therapeutic interventions, such as extracorporeal membrane oxygenation (ECMO).

Laparoscopic appendectomy postoperative narcotic use

<table>
<thead>
<tr>
<th>Patients (N = 38)</th>
<th>Average number of doses prescribed at discharge</th>
<th>9.0</th>
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<tbody>
<tr>
<td></td>
<td>Average number used after 48 hours at home</td>
<td>1.8</td>
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<tr>
<td></td>
<td>Excess total number of doses in one month</td>
<td>297</td>
</tr>
<tr>
<td></td>
<td>Projected excess total number of doses in one year</td>
<td>3,564</td>
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Partners in global health

Riley pediatric surgeon Britney Grayson, MD, PhD, will join the pediatric surgery training program at Kijabe Hospital in Kijabe, Kenya. The hospital is one of the few sites in sub-Saharan Africa that provides training in pediatric surgery. Dr. Grayson will serve in the program for two years.

Leaving the way in basic science research

The Riley at IU Health Pediatric Surgery Basic Science Research Laboratory, under the direction of Troy A. Markel, MD, focuses on defining novel diagnostic tools and therapies for neonatal intestinal disorders such as necrotizing enterocolitis and intestinal ischemia. The lab is funded for the next four years through the National Institutes of Health and the American College of Surgeons. Current studies focus on developing formula supplements that would reduce the risk for necrotizing enterocolitis in infants for whom breastmilk is not available. Other studies aim to bring novel machine learning technologies from the agrochemical and petroleum industries to the healthcare market that would allow for the detection and treatment of necrotizing enterocolitis before it is clinically appreciated. The lab’s scientists hope to initiate clinical trials for these drugs and devices within the next year.
Plastic Surgery

The Riley at IU Health plastic surgery team, led by board certified plastic surgeons with subspecialty fellowship training, provides a wide range of reconstructive surgical care to children. Treating children across Indiana, our surgeons are committed to providing leading-edge, compassionate care to restore patients to their best selves.

Cleft and Craniofacial Anomalies Program

Approved by the American Cleft Palate-Craniofacial Association, the Riley at IU Health Cleft and Craniofacial Anomalies Program is responsible for the ongoing care and treatment of nearly 2,000 children. Patients see specialists in a variety of fields, including plastic surgery, neurosurgery, dentistry, speech pathology, craniofacial orthodontics, oral and maxillofacial surgery, developmental pediatrics, otolaryngology, audiology, nutrition, social work, and care coordination. Specialized treatment is available for many craniofacial conditions:

- Cleft lip
- Cleft palate
- Palatal fistulas
- Acrocephalosyndactyly
- Hemifacial microsomia
- Velopharyngeal dysfunction
- Craniosynostosis

The program is managed by fellowship-trained specialists certified by the American Board of Plastic Surgery.

**Cleft and Craniofacial Anomalies Program Outpatient Visits: 2017 – 2019**

<table>
<thead>
<tr>
<th>Year</th>
<th>Outpatient Visits</th>
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<tbody>
<tr>
<td>2017</td>
<td>1,669</td>
</tr>
<tr>
<td>2018</td>
<td>1,741</td>
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<tr>
<td>2019</td>
<td>1,885</td>
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Riley at IU Health plastic surgeons are authors of peer-reviewed scientific literature on craniofacial surgery and contribute to research in the areas of Pierre Robin sequence, mandibular distraction, cleft lip and palate, and other conditions.

Specializing in microvascular reconstruction

Riley plastic and reconstructive surgeons are experts in the microvascular transfer of skin, muscle and bone flaps to reconstruct the scalp, oral cavity, limbs and other areas.

**Expertise in hand surgery**

Our surgical specialists provide operative solutions and treatment for:

- Aptert syndrome finger and thumb anomalies
- Polydactyly
- Syndactyly (hands and feet)
- Thumb hypoplasia/aplasia
- Thumb duplication
- Cleft hand
- Amniotic band
- Arthrogryposis
- Radial club hand

**Riley at IU Health Burn Center**

The comprehensive pediatric burn center at Riley provides care for children with burns to all parts of the body. The inpatient unit provides critical care, wound management and rehabilitation for children who have been burned. With the help of nursing, occupational therapy, physical therapy, wound care and reconstructive plastic surgery, outpatient care assists patients in transitioning back to normal life.

**Pediatric burn center: 2019**

- 207 patient consultations
- 289 outpatient visits
- 127 burn surgeries
- 98 admissions

**Hand and upper extremity abnormalities: 2019**

- 248 surgeries
- 1,061 outpatient visits

- Cerebral palsy (part of a multidisciplinary team)
- Brachial plexus palsies (part of a multidisciplinary team)
- Traumatic bony and soft tissue injuries
- Nerve and tendon reconstruction

**Pediatric plastic surgery**

Our highly trained team uses the latest surgical techniques to treat a wide range of conditions:

- Ear anomalies (prominent ears, cryptotia, microtia, constricted ears)
- Breast abnormalities (macromastia, Poland syndrome, constricted breasts, tuberous breasts, breast asymmetry, gynecomastia)
- Vascular anomalies (hemangiomomas, port wine stains, venous and lymphatic malformations)
- Skin conditions (nevus, giant congenital nevi, melanoma, tissue expansion, serial excision)
- Keloids and hypertrophic scars
- Laser therapy for scars

**Program distinctions**

- Home to Indiana’s only comprehensive, multidisciplinary cleft and craniofacial program
- Pediatric burn center offers comprehensive inpatient and outpatient care
- Skilled in treating children born with hand and upper extremity abnormalities
Our transplant surgical team performs transplants for many conditions:

**Kidney transplant**
- Congenital diseases of the kidney and urinary tract
  - Dysplasia
  - Obstructive uropathy
  - Reflux nephropathy
- Focal segmental glomerulosclerosis (FSGS)
- Glomerulonephritis
- Kidney tubular acidosis
- Nephrotic syndrome
- Polycystic kidney disease

**Liver transplant**
- Biliary atresia
- Autoimmune liver diseases
- Liver cancer
- Metabolic disorders
- Acute/fulminant liver failure
- Cystic fibrosis

**Intestine/multivisceral transplant**
- Intestinal atresia
- Midgut volvulus
- Gastroschisis
- Necrotizing enterocolitis (NEC)
- Short bowel syndrome (SBS)
- Hirschsprung’s disease
- IU Health Transplant at Riley Children’s Health is one of the few programs in the nation with Medicare approval to perform pediatric intestine and multivisceral transplants.

Our pediatric transplant surgeons have transplanted more than 775 abdominal organs since 1969. These surgeries are more than a number. They represent lifesaving organ transplants made possible through organ donation and the children who have received a second chance at a longer, healthier life.

**Liver transplant volume**
- 25th in the nation

**Kidney transplant volume**
- 25th in the nation

**Intestine transplant volume**
- Eighth in the nation

**Kidney transplant**
- Indiana’s first pediatric kidney transplant in 1969
- Largest kidney transplant program in Indiana

**Liver transplant**
- Indiana’s first pediatric liver transplant in 1988

**Pancreas**
- Indiana’s first pediatric liver-pancreas transplant in 2004

**Intestine/multivisceral**
- Indiana’s first pediatric intestine transplant in 2003
- Indiana’s first pediatric multivisceral transplant in 2003

A pediatric transplant surgery leader

**Kidney**
- Indiana’s first pediatric kidney transplant in 1969

**Liver**
- Indiana’s first pediatric liver transplant in 1988

**Pancreas**
- Indiana’s first pediatric liver-pancreas transplant in 2004

**Intestine/multivisceral**
- Indiana’s first pediatric intestine transplant in 2003
- Indiana’s first pediatric multivisceral transplant in 2003

**Liver transplant**
- 18th in the nation

**Kidney transplant**
- 25th in the nation

**Intestine transplant**
- Eighth in the nation

**Transplant Surgery**
Specialized care, experience and exceptional outcomes are hallmarks of IU Health Transplant at Riley Children’s Health. Our pediatric transplant program is part of IU Health Transplant, a nationally recognized organ transplant center that ranks among the top transplant centers in the U.S. by volume and is the largest, most comprehensive center in Indiana.

Offering comprehensive transplant services for pediatric patients, our eight abdominal transplant surgeons perform kidney, pancreas, liver, intestine and multivisceral (intestine along with two or more abdominal organs) transplants. While abdominal transplant surgery is not ranked by U.S. News & World Report, each organ program contributes to the rankings of Riley Children’s Health in the pediatric specialties of nephrology and gastroenterology and gastrointestinal surgery.

In collaboration with referring physicians and other Riley at IU Health pediatric specialists, our transplant surgeons determine the best course of treatment for each child. When a transplant is necessary, our abdominal transplant team has the expertise to facilitate both routine and extremely complex cases with excellent outcomes. The multidisciplinary team of transplant surgeons, pediatric subspecialists, transplant coordinators, OR teams, inpatient nurses, pharmacists, social workers, dietitians and other professionals works together to support our pediatric patients and their families before, during and after transplant. This level of experience, dedication and excellent clinical care translates to better outcomes for our patients.

Of 104 transplant centers in the U.S. in 2019 to perform pediatric abdominal transplants, our program’s top 25 rankings include:

- Intestine transplant volume: eighth in the nation
- Liver transplant volume: 18th in the nation
- Kidney transplant volume: 25th in the nation

Riley Children’s Health Surgery Annual Report 2019
Urology

Skilled in complex open, endoscopic and robotic urologic surgery, Riley urology surgeons specialize in treating conditions of the pediatric urinary tract (kidneys, ureter, bladder) and genitalia. These conditions come in many forms—from common pediatric and adolescent urologic problems to the most complex abnormalities affecting urogenital development. All of our surgeons are fellowship trained and board certified in pediatric urology and are recognized leaders in the field.

Known for expertise in complex genital reconstruction, Riley at IU Health is one of only four centers in the nation designated as a Center of Surgical Excellence for surgical reconstruction for children born with congenital adrenal hyperplasia. Additionally, we are designated by the Association for the Bladder Exstrophy Community as one of 10 International Centers of Excellence for the care of children with bladder exstrophy.

As many of the conditions in pediatric urology have serious implications for children’s health and emotional well-being, Riley at IU Health has organized multidisciplinary clinics with specialists to assist in managing complex patients. These include comprehensive programs to care for patients with spina bifida, stones, prenatal urologic anomalies and differences in sexual development. We are internationally recognized for our transitional program, ensuring that children’s urologic needs are cared for appropriately as they become adults.

For every child’s care, our goal is to develop a treatment plan that addresses every aspect of health, personal development and quality of life, supported by life professionals are also ready to help children understand and cope with difficult routine tests they may find frightening. The Riley Transitional Urology Clinic provides specialized services for patients requiring lifelong care and follow-up after surgery, and is one of only two such clinical programs in the nation based in a children’s hospital.

Riley urologists treat a wide variety of conditions, including:
- Bladder exstrophy and epispadias
- Congenital adrenal hyperplasia
- Cloacal anomalies
- Hernias and hydroceles
- Hydronephrosis
- Hypospadias
- Kidney stones
- Labial adhesions/vaginitis
- Neurogenic bladder
- Phimosis and paraphimosis
- Posterior urethral valves
- Prenatal hydrourephrosis and urologic anomalies
- Undescended testes
- Ureterovascular junction obstruction
- Urethrovesical junction obstruction
- Urinary tract infections
- Vesicoureteral reflux
- Voiding dysfunction

Our urologists are supported by a team of more than 40 nurses dedicated exclusively to pediatric urological care.

Coordinated care for complex medical needs

Our pediatric urologists and nurse practitioners are actively involved in numerous multidisciplinary programs to provide a wide range of services in collaboration with other Riley at IU Health physicians.

Each of these programs is unique, representing the only opportunity for patients in Indiana to receive coordinated care for these complex medical problems.

- Complex Voiding Dysfunction Center
- Refractory Bowel and Bladder Dysfunction Clinic (Sacro Neuromodulation Clinic)
- Congenital Adrenal Hyperplasia Clinic
- Disorder of Sexual Differentiation Clinic
- Spina Bifida Clinic
- Transitional Spina Bifida Clinic
- Maternal Fetal Medicine Program
- Urology-Nephrology Stone Clinic
- Center for Urogenital and Colorectal Health

In addition to these multidisciplinary programs, Riley Urology provides care at 16 outreach offices across the state.

Urology Surgical Procedures: 2019

Distal hypospadias (N = 248) 98.2%*  
Pyeloplasty (N = 60) 100%*  
Unplanned reoperation 0%  
* Successful surgeries without need for revision

Committed to clinical research

Riley Urology maintains the largest database in the world for complex urinary tract reconstruction, including bladder augmentation with intestine, Mitrofanoff/Monti bladder channels and MACE procedures. This allows us to continually monitor success and refine our techniques.

Our world-class team of urologists is academically productive in all areas of urology, including four NIH-funded grants investigating patient-centered and long-term outcomes of robotic kidney surgery, hypospadias and spina bifida. Our focus on clinical translational research is also supported by the Riley Children’s Foundation.

Urology Volume: 2017 – 2019

Surgical cases 9,501  
Hospital visits 37,703
Anesthesia

The Riley Children’s Health anesthesia team delivers evidence-based, safe, compassionate and value-based care to pediatric patients in all aspects of anesthesia, perioperative medicine, and acute and chronic pain management. Our team offers outstanding care and is also committed to leading innovative and personalized perioperative care research, providing high-quality clinical education and improving health outcomes.

Dedicated to achieving the best outcomes, maximizing safety and minimizing discomfort, our multidisciplinary team of board certified pediatric anesthesiologists, anesthetists and nurse practitioners tailors equipment and protocols to meet children’s unique surgical care needs and physiology. We continually improve the standard methods of clinical care based on the latest evidence and develop more effective, safe and reliable practices for protecting a child’s heart, lung and brain function, and blood circulation during anesthesia and medical care.

Riley at IU Health anesthesiologists use dedicated pediatric experience, reliable practices for protecting a child’s heart, lung and brain function, and care based on the latest evidence and develop more effective, safe and chronic pain management in the state. We provide excellent and cost-efficient outcomes with an interactive team approach to acute and chronic pain management in the state.

Riley at IU Health anesthesiologists use dedicated pediatric experience, clinical skills and expertise to safely deliver surgical anesthesia for pediatric patients of all ages, from babies still in the womb to young adults.

Our anesthesiologists offer a wide range of services, including:

- Surgical anesthesia for all types of common pediatric surgical procedures, including outpatient surgery at Riley Hospital for Children at IU Health and IU Health North Hospital
- Anesthesia for complex surgeries in children, such as complex urogenital reconstruction, major neurosurgery, orthopedic surgery including spine fusions, congenital heart surgery, organ transplantation and craniofacial reconstruction
- Anesthesia management for diagnostic and therapeutic procedures, including MRI, CT scanning, interventional radiology, gastrointestinal endoscopies, radiotherapy, vesico-urethropogram and cardiac catheterization
- Acute postoperative pain management, including standardized, protocol-driven epidural, spinal, caudal and advanced regional analgesia, as well as patient-controlled analgesia
- Chronic pain management in children
- Multidisciplinary consultation with surgeons and pediatricians
- Preadmission anesthetic evaluation and testing, including preoperative consultations and instructions

Anesthesiologists at Riley at IU Health provide comprehensive anesthesia services to approximately 21,000 children each year.

Leadership in pediatric anesthesia

- More than 55 anesthesia physicians, anesthetists, nurse practitioners and research nurses from top programs
- Largest (and still expanding) anesthesia programs for pediatric acute and chronic pain management in the state
- Safe, leading-edge, evidence-based clinical care before, during and after surgery and procedures

Center for Anesthesia Research Excellence (CARE)

The Riley Anesthesia research program, CARE, has three goals specific to the services we provide:

- To lead the research field in translating personalized anesthesia and pain management research to clinical practice, as well as pediatric anesthesia safety and outcomes research
- To discover the mechanisms, physiologic and clinical elements of pediatric anesthesia and pain management, and to translate into clinical practice
- To develop the next generation of clinical researchers in the field of pediatric anesthesia and pain medicine and developmental neurobiology

Riley at IU Health clinical anesthesia sections

The Section of General Anesthesia provides anesthesia before, during and shortly after inpatient surgical procedures. The division provides multidisciplinary, coordinated care with a goal of better health and reduced cost of care. We accomplish this through patient-centered decision-making and seamless continuity of care from preoperative preparation and surgery through recovery, discharge and follow-up.

The Section of Cardiac Anesthesia provides anesthesia and pain management for patients undergoing complex cardiac, thoracic or vascular surgeries and procedures.

The Section of Pain Medicine makes surgical procedures in children safe, comfortable and less painful. We provide excellent and cost-effective outcomes with an interactive team approach to acute pain treatment and chronic pain management with consultative and outpatient programs that tailor treatment options to individual patient needs.

To refer a patient to the pediatric pain management program, call 317.944.2353.
Trauma Services

Riley Hospital for Children at IU Health provides 24/7 trauma care to evaluate and treat the most severely injured pediatric patients. In our Level I Pediatric Trauma Center, experienced pediatric surgeons, emergency medicine physicians, anesthesiologists, critical care physicians and other healthcare professionals work collaboratively as a team, taking decisive and rapid action to provide effective treatment in critical situations when seconds matter.

More than 80% of all injured children arrive at Riley during the evening or at night, making our 24/7 in-house coverage by pediatric specialists essential. Our trauma services team is ready for any scenario with four trauma bays in the Emergency department and an operating room always available for incoming critical cases.

Level I Pediatric Trauma Center since 1992

Verified by the American College of Surgeons (ACS) as a Level I Pediatric Trauma Center, Riley at IU Health is one of a select number of children’s hospitals in the nation to earn this designation. The hospital requested the verification, with an on-site review conducted by an ACS team of reviewers experienced in trauma care.

This verification program for hospitals, established by the ACS in 1987, promotes the development of trauma centers in which verified centers provide not only the hospital resources necessary for trauma care, but also the entire spectrum of care to address the needs of all injured patients from the prehospital phase through rehabilitation, as well as injury prevention.

Pediatric traumatic brain injury and concussion program

The Riley Traumatic Brain Injury and Concussion Program, the first and only program of its kind in Indiana, facilitates a multidisciplinary, team-based approach to the care of infants, children and adolescents with concussions and other traumatic brain injuries. Care is provided by specialists in:
- Neurosurgery
- Physical medicine and rehabilitation
- Neuropsychology

Riley physicians and other medical professionals continue to discover more about the complexities of concussions, including which patients are susceptible, why concussions occur, how problems develop and the role of healthcare providers in helping to ensure good outcomes.

In 2019, 51% of all trauma cases came directly to Riley at IU Health from the scene of the injury, while 49% of children in need of trauma care were transferred from other hospitals in the state and region.

Quality improvement benchmarks for pediatric trauma

The American College of Surgeons trauma quality improvement benchmarking is risk based and allows comparison of patient outcomes with other trauma centers across the nation that care for pediatric patients. The ACS cited the robust quality improvement process for injured children at Riley as one of many strengths of our hospital trauma program.

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>RILEY</th>
<th>NATIONAL DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median injury severity score</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Blunt splenic injury with splenic preservation</td>
<td>97.6%</td>
<td>95.1%</td>
</tr>
<tr>
<td>Time to operative fixation of mid-shaft femur greater than 24 hours</td>
<td>4.2%</td>
<td>7.1%</td>
</tr>
<tr>
<td>Time to intracranial pressure (ICP) monitoring</td>
<td>1.9 hours</td>
<td>2.9 hours</td>
</tr>
<tr>
<td>Time to craniotomy</td>
<td>1.9 hours</td>
<td>1.9 hours</td>
</tr>
</tbody>
</table>

Riley at IU Health outperforms national benchmark for these indicators.

Increasing recognition by referring physicians, parents and others that children should be treated by pediatric specialists contributes to continued growth in the number of injured children treated at Riley at IU Health.

Program distinctions

- Only Level I Pediatric Trauma Center in Indiana
- Recognized by the American College of Surgeons review committee for robust quality improvement review
- Experienced pediatric trauma surgeons, pediatric critical care physicians and anesthesiologists available in-house, 24/7

Program Manager

Dawn M. Daniels, PhD, RN, PHCNS-BC
Program manager since 2012
For full team member list, see page 39.

Director

Matthew P. Landman, MD
Program leader since 2020
Assistant Professor of Surgery, IU School of Medicine
Story of a Riley kid:
Noah Howard, age 10
Complex surgery relieves life-threatening seizures.

Noah Howard was just 17 months old when Riley surgeons removed a grapefruit-sized tumor from his brain, saving his life. Nine years later, he was back at Riley for another surgery—a functional hemispherotomy, a rare neurological procedure—to give him relief from worsening epileptic seizures he suffered for years.

It wasn’t an easy journey for Noah or his mom, Susan Pahls, who lived in a state of near-constant anxiety for years, first with the cancer, then with the seizures. After the malignant tumor was removed, Noah went through 33 radiation treatments with resulting damage to his brain that contributed to severe seizures—as many as 300 to 400 a day—that threatened his life.

Based on an operation performed last year by pediatric neurosurgeon Jeffrey S. Raskin, MD, those days are hopefully in the past for Noah. A functional hemispherotomy is a disconnection of one cerebral hemisphere from the body and the brain. Used to isolate abnormal brain activity in one half of the brain to limit serious seizures, it offers fewer complications than a hemispherectomy, which involves physically removing the brain tissue.

“In the early days of neurosurgery, they removed the whole cerebral hemisphere, which caused hydrocephalus at a very high rate,” Dr. Raskin said. “We found over time that if you leave brain tissue behind that’s disconnected, it seizes by itself but it just takes up space and can’t signal any distress to the body.”

For weeks after the surgery, Noah rehabbed at Riley before being released amid cheers and well wishes from hospital team members.

“This is a really good illustration of how seizures have more of an impact on quality of life than tumors sometimes,” Dr. Raskin said. “Noah’s original problem was a brain tumor, and it was an aggressive tumor. It’s because of the tumor and treatment that he had the seizures and that was really what was impacting his life. To remove or reduce the seizures is the most meaningful thing we could do for him.”

“One of the steps of the procedure is to disconnect a very large cerebral artery; it’s as aggressive as any epilepsy surgery gets, and we’re doing it here.”

Jeffrey S. Raskin, MD
Pediatric neurosurgeon

Refer a patient
Riley Children’s Health cares for children in Indiana, across the nation and around the world. Same-day appointments are available for some providers. To schedule an appointment or to speak with a surgical specialty administrator, please call:

<table>
<thead>
<tr>
<th>SPECIALTY</th>
<th>PHONE NUMBER</th>
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<tbody>
<tr>
<td>Cardiotoracic Surgery</td>
<td>317.944.7150 (heart)</td>
</tr>
<tr>
<td></td>
<td>317.944.2394 (lung or throat)</td>
</tr>
<tr>
<td>Dentistry</td>
<td>317.944.3865</td>
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<tr>
<td>Interventional Cardiology and Electrophysiology</td>
<td>317.944.8906</td>
</tr>
<tr>
<td>Interventional Radiology</td>
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<tr>
<td>Maternal Fetal Medicine</td>
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<tr>
<td>Neurosurgery</td>
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<td>Ophthalmology</td>
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<td>Orthopedic Surgery</td>
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<tr>
<td>Otolaryngology – Head &amp; Neck Surgery</td>
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<td>Pediatric Surgery</td>
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<td>Plastic Surgery</td>
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<td>Transplant Surgery</td>
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<tr>
<td>Urology</td>
<td>317.944.8896</td>
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</tbody>
</table>
Riley Children’s Health is Indiana’s only full-service statewide pediatric health system. Riley Children’s Health offers complete, comprehensive pediatric care ranging from routine primary care checkups to the most complex acute care needs from highly skilled pediatric specialists. The system connects patients with 200 primary care and 400 specialty care physicians in communities across the state of Indiana. Riley Physicians treat patients in their home communities, bringing top-notch care close to home. This statewide network is an extension of Riley Hospital for Children at Indiana University Health, one of the nation’s leading children’s hospitals.