Table of Contents

Welcome ........................................... 2
Texas Children’s Hospital and
Baylor College of Medicine .................. 3
Texas Children’s Pavilion for Women ........ 4
Texas Children’s Fetal Center ............... 5
Fetal Center Services ........................... 6
2015 Volumes .................................... 8
Cumulative Volumes and Outcomes ........ 10
Fetal Cardiology Program .................... 14
Hypoplastic Left Heart
Syndrome (HLHS) .............................. 19
Fetal Cardiac Interventions .................. 20
Fetal Endoscopic Tracheal
Occlusion (FETO) ............................. 23
Fetoscopic Neural Tube
Defect (NTD) Repair ......................... 27
Lower Urinary Tract
Obstruction (LUTO) ........................... 31
Meet Our Leaders .............................. 34
Physicians ...................................... 38
Providers and Staff ............................ 41
Publications .................................... 43
Referrals ....................................... 46

For access to Texas Children’s Fetal Center outcomes information online, please visit women.texaschildrens.org/fetaloutcomes.

For information about Texas Children’s Fetal Center, informative videos, physician profiles and more, visit women.texaschildrens.org/fetalcenter.
Dear colleagues, parents and friends:

Welcome to the 2015 Texas Children’s Fetal Center® Outcomes book. We are pleased to share important information about our services, including volumes and outcomes data, which we know can be crucial in helping patients, families and physicians decide which program is right for them.

At Texas Children’s Fetal Center, we are proud to offer what we believe is the broadest scope of fetal procedures of any center in the world, and to be one of only a few programs in the United States to offer the full spectrum of fetal therapies. We receive referrals from around the world seeking the newest therapies and best outcomes for mothers and unborn babies facing difficult odds. We are one of the oldest and most experienced programs in the nation, with a history of leading the development and implementation of innovative therapies and procedures as well as cutting-edge, evidence-based programs that give new options to the patients and families who need them the most.

Our core staff of fetal and pediatric surgeons, maternal-fetal medicine specialists, medical and surgical subspecialty consultants, geneticists, radiologists, imaging specialists and coordinators work tirelessly to deliver seamless, multidisciplinary, family-centered care. Our patients are treated in state-of-the-art facilities at Texas Children’s Pavilion for Women and Texas Children’s Hospital, featuring the largest and highest-ranked NICU in the South.

In 2015, we performed more than 100 procedures and 764 evaluations, including 12 fetoscopic repairs of neural tube defects, a minimally invasive in-utero repair of spina bifida. The year was also notable for our continued expansion and growth. We now have six community maternal-fetal medicine clinics across the area and partner with 11 community hospitals where we help provide expert care for high-risk mothers and babies. Additionally, the construction of a new tower at our main campus for high-acuity areas such as surgery, intensive care and cardiology will help us treat more patients and enhance our surgical capabilities.

The best part of our job is seeing our patients survive and thrive in ways that wouldn’t have been possible without the sophisticated therapies we provide. As they grow up, we continue to provide care and follow their progress. In this publication, you’ll meet four patients whose stories are an inspiration, and who are lifelong members of our extended family.

We hope you enjoy reading about our stellar multidisciplinary team and their recent activities. Thank you for your interest in our center.

Sincerely,

Texas Children’s OB/GYN-in-Chief
Michael A. Belfort, MD, PhD

and

Texas Children’s Fetal Center Co-Directors
Darrell L. Cass, MD
Wesley Lee, MD
Oluyinka O. Olutoye, MD, PhD
Jimmy Espinoza, MD, PhD
Texas Children's Hospital and Baylor College of Medicine

The mission of Texas Children’s Hospital is to create a healthier future for children and women throughout our global community by leading in patient care, education and research. Renowned worldwide for our expertise and breakthrough developments in clinical care and research, Texas Children’s Hospital is ranked #4 among top children’s hospitals in the nation and was also ranked in all 10 pediatric subspecialties in U.S. News & World Report’s list of America’s Best Children’s Hospitals.

Texas Children’s Hospital is affiliated with Baylor College of Medicine in the areas of pediatrics, pediatric surgery and obstetrics and gynecology. Baylor is ranked by U.S. News & World Report as one of the nation’s top 25 medical schools for research. Currently and throughout our 61-year partnership, Texas Children’s Hospital has served as Baylor’s primary pediatric training site. The collaboration between Texas Children’s Hospital and Baylor is one of the top 10 such partnerships for pediatric research funding from the National Institutes of Health.

Texas Children’s Hospital is one of the nation’s largest and most comprehensive specialty pediatric hospitals, with more than 3.5 million patient encounters in 2015. Texas Children’s also operates Texas Children’s Health Plan, the nation’s first health maintenance organization (HMO) created just for children, and Texas Children’s Pediatrics, the nation’s largest primary pediatric care network with more than 50 practices throughout the greater Houston area.

The main campus of Texas Children’s Hospital is located near downtown Houston in the Texas Medical Center, the largest medical center in the world. The main campus includes over 500 licensed inpatient beds, the Clinical Care Tower for outpatient visits, the Feigin Tower for pediatric research and Texas Children’s Pavilion for Women, a comprehensive OB/GYN facility with a focus on high-risk births. Located nearby is the Jan and Dan Duncan Neurological Research Institute at Texas Children’s Hospital, a basic research institute dedicated to solving childhood neurological diseases. To serve the rapidly growing population of Houston, Texas Children’s opened its first community hospital in 2011, Texas Children’s Hospital West Campus, and will open its second community hospital in 2017, Texas Children’s Hospital The Woodlands. Both locations offer a 24/7 pediatric emergency center, ICU beds, inpatient beds, surgical suites and more than 20 subspecialty clinics.

With a staff of more than 11,000 employees and more than 2,000 board-certified physicians, pediatric subspecialists, pediatric surgical subspecialists and dentists, Texas Children’s offers more than 40 subspecialties, programs and services.
Texas Children’s Pavilion for Women

Texas Children’s Pavilion for Women brings together obstetricians, gynecologists, adult medical and surgical specialists, neonatologists, maternal-fetal medicine specialists, geneticists, fertility specialists and support staff under one roof to provide women and babies the highest quality health care available. OB/GYNs in top academic practices, including Baylor OB/GYN, Partners in OB/GYN Care and the Women’s Specialists of Houston, provide comprehensive OB/GYN services at the Pavilion for Women.

With more than 6,000 births annually at the Pavilion, we are pleased to provide a model of care called family-centered maternity care. This evidence-based approach is designed to help a woman achieve her wishes for her birth experience and to provide postpartum care for mother and baby together, rather than apart. To promote enhanced bonding and attachment, mothers and babies remain together unless separation is medically necessary. For babies who need extra care and monitoring, the Pavilion’s blended-care NICU provides state-of-the-art medical care in a family-centered environment. In circumstances which require more complex care and access to subspecialists, babies are transferred to Texas Children’s level IV NICU – the highest level of care available for newborns – through a private, patient-only bridge.

The Pavilion for Women specializes in high-risk pregnancies and births. Because we are part of one of the nation’s top pediatric hospitals, we are able to offer seamless, comprehensive, multidisciplinary care before, during and after birth. A cornerstone of this unique model of care is the Texas Children’s Fetal Center, one of only a few centers worldwide to offer a wide range of fetal diagnostic and intervention therapies.

Texas Children’s Fetal Center is located in the Pavilion for Women. The close proximity of the Fetal Center’s treatment and administrative areas enables team members to respond quickly to patient and family needs or emergencies and promotes collaboration among our multidisciplinary team.
Texas Children's Fetal Center

Advances in fetal medicine and fetal surgery mean that early detection of fetal problems and anomalies is often matched by equally sophisticated treatments. Such innovation has helped change emotion surrounding a complex pregnancy from fear to hope.

Texas Children's Fetal Center, established in 2001 and located within Texas Children's Pavilion for Women, is one of only a few centers in the United States to offer the full spectrum of fetal therapies. We provide comprehensive care to meet the needs of pregnant women, including advanced diagnostic procedures and consultation to help families understand complex diagnoses and plan treatment.

Our Approach
Fetal Center physicians are among the world's leaders in fetal medicine and in perinatal surgery. Our core staff includes fetal and pediatric surgeons, maternal-fetal medicine specialists, and specialized clinical coordinators. Depending on the case, the Fetal Center team may call on pediatric specialists, cardiologists, neonatologists, urologists, neurologists, neurosurgeons, anesthesiologists, radiologists or genetics specialists with expertise in fetal conditions. The patient's entire multidisciplinary care team meets on a regular basis to discuss every aspect of care for the fetal patient and mother.

Fetal surgery and other interventions are performed in the state-of-the-art operating facilities at Texas Children’s Pavilion for Women, with immediate access to Texas Children's level IV NICU. Texas Children's Fetal Center is open around the clock with physicians on call to discuss diagnoses and care plans with referring doctors.

Dedicated Support
Every family that comes to Texas Children's Fetal Center for treatment is paired with a clinical coordinator highly trained in the needs of patients with fetal anomalies. The coordinator is available to the family from the moment of arrival until treatment is complete. This team provides patients and families with a direct link to medical information, insight and explanation, and – equally important – a familiar face and source of support during treatment.
Texas Children’s Fetal Center Services

Advanced Diagnostic Imaging
Texas Children’s Fetal Center offers state-of-the-art fetal imaging services and consultation from a multidisciplinary collaboration of specialties that include maternal-fetal medicine, radiology, pediatric surgery and cardiology. We perform routine screening for first and second trimester pregnancies, nuchal translucency assessment, detailed anatomic surveys, fetal growth evaluation, and antenatal assessment for obstetrical complications. The Fetal Center offers advanced expertise in fetal magnetic resonance imaging (MRI) as a complementary diagnostic imaging technology for the prenatal diagnosis of severe congenital anomalies.

The process starts with the use of cutting-edge imaging that includes 2D, 3D and 4D ultrasound scans in addition to the possible use of fetal MRIs to detect any anomalies before delivery. These advanced tests allow our multidisciplinary team to make a diagnosis and create a course of care that best suits each individual family.

After a diagnosis has been made, we provide multispecialty consultations, antenatal testing for optimizing fetal health, delivery planning, and plan ahead for neonatal care coordination at Texas Children’s Pavilion for Women.

Some pregnancies with specific severe anomalies, such as hypoplastic left heart syndrome, spina bifida or congenital diaphragmatic hernia, may be good candidates for the Fetal Surgical Intervention program. The earlier we can determine the diagnosis, the sooner a comprehensive care plan can be created.

Prenatal Diagnosis
The Fetal Center also performs standard and advanced diagnostic procedures for genetic and other testing, including:

• Chorionic villus sampling
• Amniocentesis
• Fetal cord blood sampling (cordocentesis)
• Fetal skin and muscle biopsy

Genetic Counseling
Experienced genetic counselors at Texas Children’s Fetal Center provide education and support to families regarding the risks, causes and tests related to genetic and fetal conditions. We work with families to:

• Discuss the potential cause(s) of fetal conditions
• Make recommendations for further genetic testing
• Offer modern and comprehensive methods for genetic diagnosis, such as chromosomal microarray analysis (CMA)
• Explain the purpose of and meaning of results from complex genetic testing
• Provide emerging new genetic tests, such as whole exome sequencing (WES), for the most complex fetal conditions
Fetal Therapies
Texas Children’s Fetal Center is one of the few programs in the country to offer the full spectrum of fetal therapies, including:

- Catheter-based fetal cardiac intervention (balloon atrial septostomy for HLHS and balloon dilation for critical aortic stenosis with evolving HLHS)
- Maternal hyperoxygenation therapy for borderline left heart (research study)
- Treatment of fetal arrhythmias
- Open fetal surgery for lung masses/CCAM
- Open fetal surgery for sacrococcygeal and vascular tumors
- Open and experimental fetoscopic surgery for myelomeningocele (spina bifida)
- Ex-utero intrapartum treatment (EXIT)
- Fetoscopic laser photocoagulation for twin-twin transfusion syndrome
- Experimental fetal tracheal occlusion for both moderate and severe cases of congenital diaphragmatic hernia (FETO)
- Fetoscopic amniotic band resection
- Fetal shunt placement for pleural effusion and lower urinary tract obstruction (LUTO)
- Intrauterine transfusion
- Management of complicated monochorionic pregnancies using radio frequency ablation, bipolar cord coagulation and/or microwave methods

Common Fetal Anomalies Treated
Texas Children’s Fetal Center evaluates and treats many conditions, including the following:

- Abdominal wall defects (gastroschisis and omphalocele)
- Amniotic band syndrome
- CNS lesions (anecephaly, encephalocele, holoprosencephaly, hydrancephaly and hydrocephalus)
- Congenital airway obstruction (CHAOS)
- Congenital diaphragmatic hernia
- Craniofacial anomalies (cleft lip and palate)
- Duodenal and intestinal atresia
- Esophageal atresia with tracheoesophageal fistula
- Congenital heart disease (including hypoplastic left heart syndrome, tetralogy of Fallot, atroventricular septal defects, other simple and complex anomalies)
- Fetal arrhythmia (including congenital heart block, supraventricular tachycardia, atrial flutter)
- Cardiac masses
- Pericardial effusions
- Fetal chylothorax or hydrothorax
- Giant head and neck masses (teratomas)
- Lung lesions (congenital cystic adenomatoid malformation (CCAM), hybrid lesions, pleural effusion, pleuro pulmonary blastoma, and pulmonary sequestration)
- Maternal immune disorders affecting the fetus (congenital heart block, platelet alloimmunization, red cell alloimmunization)
- Myelomeningocele (spina bifida)
- Non-immune hydrops
- Small bowel obstruction
- Sacrococcygeal teratoma
- Skeletal dysplasia
- Twin abnormalities including discordant intrauterine growth restriction (IUGR), discordant structural anomalies, TRAP sequence (acardiac twin), and twin-twin transfusion syndrome (TTTS)
- Urinary tract obstructions (bladder outlet obstruction and hydronephrosis)
Texas Children’s Fetal Center 2015 Volumes

### Overall Evaluations and Procedures

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluations at Texas Children’s Fetal Center</td>
<td>764</td>
</tr>
<tr>
<td>Total procedures</td>
<td>107</td>
</tr>
<tr>
<td>Fetoscopic procedures (fetal interventions + fetoscopic NTD + FETO)</td>
<td>95</td>
</tr>
<tr>
<td>Open fetal surgeries (excluding EXITs)</td>
<td>7</td>
</tr>
<tr>
<td>EXIT* procedures</td>
<td>5</td>
</tr>
</tbody>
</table>

*EXIT – ex-utero intrapartum treatment

### Abdominal Wall Defects

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for gastroschisis</td>
<td>21</td>
</tr>
<tr>
<td>Patients evaluated for omphalocele</td>
<td>7</td>
</tr>
</tbody>
</table>
### Amniotic Band Syndrome
Patients evaluated for amniotic band: 2

### Congenital Diaphragmatic Hernia (CDH)
- Prenatal evaluations for CDH: 18
- Average number of newborns with CDH cared for each year: 20
- Number of FETO procedures: 1

### EXIT Procedures
- EXIT-to-airway: 2
- EXIT-to-resection of high-risk tumor: 3

### Fetal Cardiac Conditions
- Unique patients undergoing fetal echocardiograms: 1,188
- Fetal echocardiograms: 1,832
- Fetal cardiac intervention (Fetoscopic): 1
- Fetal cardiac intervention (Open resection of pericardial teratoma): 1

### Fetal Lung Malformations
Patients evaluated for congenital pulmonary airway malformation (CPAM) / congenital cystic adenomatoid malformation (CCAM): 31
- EXIT-to-resection procedures: 2

### Fetal Tumors
Patients evaluated for fetal tumors, including cervical, mediastinal and sacrococcygeal teratomas: 4
- EXIT-to-airway procedures performed to treat patients with cervical tumors or epignathus neck masses: 2

### Lower Urinary Tract Obstruction (LUTO)
- Evaluations at Texas Children’s Fetal Center: 22
- Total fetal bladder shunts: 15

### Neural Tube Defects (NTD)
- Patients evaluated for NTD: 59
- Open fetal procedures: 6
- Fetoscopic procedures: 12

### Twin-Twin Transfusion Syndrome (TTTS)
- Evaluations for TTTS, including triplet gestations: 56
- Fetal surgical interventions to treat TTTS (SFLP): 31

*SFLP – selective fetoscopic laser photocoagulation*
Cumulative Volumes and Outcomes

Since 2001, Texas Children’s Fetal Center has been at the forefront of innovations in fetal diagnostics and intervention therapies. The following data represent evaluations, procedures and available outcomes through 2015.

### Overall Totals

<table>
<thead>
<tr>
<th>Category</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluations</td>
<td>764</td>
<td>3,970</td>
</tr>
<tr>
<td>Fetoscopic procedures</td>
<td>95</td>
<td>542</td>
</tr>
<tr>
<td>EXIT (ex-utero intrapartum treatment) procedures</td>
<td>5</td>
<td>44</td>
</tr>
<tr>
<td>Open fetal surgeries excluding EXITs</td>
<td>7</td>
<td>39</td>
</tr>
<tr>
<td>Fetal Echocardiograms</td>
<td>1,832</td>
<td>11,733</td>
</tr>
<tr>
<td>Unique patients undergoing fetal echocardiograms</td>
<td>1,188</td>
<td>7,770</td>
</tr>
</tbody>
</table>

### Amniotic Band Syndrome

<table>
<thead>
<tr>
<th>Category</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for amniotic band syndrome</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Fetoscopic interventions for amniotic band release/shunt complications</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Survival rate after fetoscopic procedure</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Percent of patients who did not need amputation after fetoscopic procedure</td>
<td></td>
<td>83%</td>
</tr>
</tbody>
</table>

### Congenital Diaphragmatic Hernia (CDH)

<table>
<thead>
<tr>
<th>Category</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for CDH</td>
<td>18</td>
<td>230</td>
</tr>
<tr>
<td>Number of FETO (fetal endoscopic tracheal occlusion procedures)</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Survival to discharge for isolated CDH*</td>
<td></td>
<td>83%</td>
</tr>
<tr>
<td>Survival to discharge for CDH with associated anomalies</td>
<td></td>
<td>64%</td>
</tr>
</tbody>
</table>

*O/E – TFLV ≥ 35%

### Survival to Discharge for CDH Patients

(February 2004 to December 2015)

- **All patients treated** (n=224)
  - **Isolated CDH** (n=125, 83% survival)
    - ECMO n=40 (survival=55%)
    - O/E-TFLV>35% n=36 (survival=95%)
    - Liver up n=78 (survival=74%)
  - **Associated anomalies** (n=99, 64% survival)
    - ECMO n=31 (survival=61%)
    - O/E-TFLV>35% n=22 (survival=94%)
    - Liver up n=67 (survival=63%)
### EXIT Procedures 2015

<table>
<thead>
<tr>
<th>Procedure</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXIT-to-airway</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>EXIT-to-ECMO (extracorporeal membrane oxygenation)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>EXIT-to-resection of high-risk lung mass</td>
<td>3</td>
<td>17</td>
</tr>
</tbody>
</table>

### Fetal Cardiac Interventions 2015

<table>
<thead>
<tr>
<th>Description</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of catheter-based fetal cardiac interventions</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Number of fetuses undergoing chronic maternal hyperoxygenation for borderline left heart</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

### Fetal Lung Malformations 2015

<table>
<thead>
<tr>
<th>Description</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for congenital pulmonary airway malformation/congenital cystic adenomatoid malformation (CCAM)</td>
<td>31</td>
<td>193</td>
</tr>
<tr>
<td>Open fetal surgeries for CCAM</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>EXIT-to-resection procedures</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>Patients evaluated for high-risk lung malformations*</td>
<td>8</td>
<td>55</td>
</tr>
<tr>
<td>Survival rate for open fetal surgeries for CCAM</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>Survival rate for EXIT-to-resection procedures</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Survival rate for patients with high-risk lung masses*</td>
<td></td>
<td>85%</td>
</tr>
<tr>
<td>Survival rate for patients with low-risk lung masses**</td>
<td></td>
<td>99%</td>
</tr>
</tbody>
</table>

*Defined as those with hydrops or CCAM volume ratios ≥ 1.6%
**Two deaths due to non-pulmonary-related problems

### Fetal Tumors and Neck Masses 2015

<table>
<thead>
<tr>
<th>Description</th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for fetal tumors, including cervical, mediastinal and sacrococcygeal teratomas</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>EXIT-to-airway procedures performed to treat patients with cervical tumors or epignathus</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Patients evaluated for fetal neck masses</td>
<td>1</td>
<td>41</td>
</tr>
</tbody>
</table>
## Cumulative Volumes and Outcomes

### Lower Urinary Tract Obstruction (LUTO)

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for LUTO</td>
<td>22</td>
<td>65</td>
</tr>
<tr>
<td>Fetal bladder shunts</td>
<td>15</td>
<td>37</td>
</tr>
<tr>
<td>Survival for patients with fetal bladder shunts</td>
<td></td>
<td>79%</td>
</tr>
</tbody>
</table>

### Neural Tube Defects (NTD)

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for NTD</td>
<td>59</td>
<td>165</td>
</tr>
<tr>
<td>Open fetal procedures</td>
<td>6</td>
<td>31</td>
</tr>
<tr>
<td>Fetoscopic procedures</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Median gestational age at delivery for all cases</td>
<td><strong>35.7 wks</strong></td>
<td></td>
</tr>
<tr>
<td>Shunt rate at 1 year of age* (n=22)</td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td>Perinatal mortality fetoscopic (n=13)</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Perinatal mortality open (n=31)</td>
<td></td>
<td>6%</td>
</tr>
</tbody>
</table>

*Includes endoscopic third ventriculostomy (ETV) or shunt

### Omphalocele

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients evaluated for omphalocele</td>
<td>7</td>
<td>84</td>
</tr>
<tr>
<td>Survival for isolated omphalocele in live-born infants</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Survival for minor omphalocele with associated anomalies</td>
<td></td>
<td>90%</td>
</tr>
<tr>
<td>Survival for major omphalocele with associated anomalies</td>
<td></td>
<td>50%</td>
</tr>
</tbody>
</table>

### Open Fetal Surgeries

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac teratoma</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lung lesions and teratomas</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Neural tube defects</td>
<td>6</td>
<td>31</td>
</tr>
</tbody>
</table>

### Twin-Twin Transfusion Syndrome (TTTS)

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total evaluations for TTTS</td>
<td>56</td>
<td>682</td>
</tr>
<tr>
<td>Fetal surgical interventions to treat TTTS</td>
<td>31</td>
<td>443</td>
</tr>
<tr>
<td>Procedures for TTTS with triplet gestation</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Survival of at least one twin after SFLP*</td>
<td></td>
<td>84%</td>
</tr>
<tr>
<td>Survival of both twins after SFLP*</td>
<td></td>
<td>62%</td>
</tr>
</tbody>
</table>

*SFLP – selective fetoscopic laser photocoagulation
Fetal Cardiology Program

Prenatal diagnosis can improve outcomes for babies with cardiac conditions. Patients who seek treatment at Texas Children’s Fetal Center are cared for by a multidisciplinary team of experts, in collaboration with Texas Children’s Heart Center, one of the top two pediatric heart centers in the country. This collaboration between the Fetal and Heart Centers is called the Fetal Cardiology Program and has provided new hope for children with congenital heart issues. To learn more about Heart Center outcomes, please visit texaschildrens.org/heartoutcomes.

Below are charts that show the total number of visits and patients for specific conditions treated by the Fetal Cardiology program from 2005 through the end of 2015.

Fetal Echocardiograms by Year

[Chart showing the total number of visits and patients for specific conditions treated by the Fetal Cardiology program from 2005 through the end of 2015.]

Atrioventricular Septal Defects

[Chart showing the total number of visits and patients for specific conditions treated by the Fetal Cardiology program from 2005 through the end of 2015.]
### Arrhythmias

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of patients</th>
<th>Total number of visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td>2006</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>2007</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>2008</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>2009</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>2010</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td>2011</td>
<td>6</td>
<td>32</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>2013</td>
<td>11</td>
<td>59</td>
</tr>
<tr>
<td>2014</td>
<td>11</td>
<td>68</td>
</tr>
<tr>
<td>2015</td>
<td>32</td>
<td>72</td>
</tr>
</tbody>
</table>

### Hypoplastic Left Heart Syndrome and Related Disorders

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of patients</th>
<th>Total number of visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>2006</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>2007</td>
<td>22</td>
<td>16</td>
</tr>
<tr>
<td>2008</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>2009</td>
<td>31</td>
<td>44</td>
</tr>
<tr>
<td>2010</td>
<td>27</td>
<td>56</td>
</tr>
<tr>
<td>2011</td>
<td>25</td>
<td>53</td>
</tr>
<tr>
<td>2012</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>2013</td>
<td>37</td>
<td>45</td>
</tr>
<tr>
<td>2014</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>2015</td>
<td>87</td>
<td>42</td>
</tr>
</tbody>
</table>

### Other Single Ventricle

<table>
<thead>
<tr>
<th>Year</th>
<th>Total number of patients</th>
<th>Total number of visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>2006</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2008</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>2009</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>2010</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>2011</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>2012</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>2013</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>2014</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>2015</td>
<td>34</td>
<td>60</td>
</tr>
</tbody>
</table>
Heterotaxy

Transposition of Great Arteries

Pericardial Effusion

[Charts showing data for each condition from 2005 to 2015, with bars representing total number of patients and visits]
Lifesaving Surgical Care for Patient with HLHS

Aiden Rodgers is a fun-loving and mischievous 2-year-old who has no idea how serious his early days were. But his parents know that if it weren’t for the close teamwork between Texas Children’s Fetal Center and Heart Center, he might not be here today.

When his mother, Jenny, was 20 weeks pregnant, she learned the fetus she was carrying had hypoplastic left heart syndrome (HLHS), a hole in the wall separating the upper chambers of the heart. She was told he would need at least three open-heart surgeries, the first just days after his birth, and even then his chances of survival weren’t certain.

“It was probably the worst day of our lives,” she said. “The weeks that followed were a blur of tears, prayers, desperation and grieving the loss of the life we had envisioned as a family.”

After the diagnosis, she and her husband got to work researching fetal surgical centers. They found one of the best in Houston, just three hours away from their home in Louisiana.

At their first visit to the Fetal Center, a coordinator set up appointments with their personal team of experts and guided them through the process. They met with Nancy Ayres, MD, director of non-invasive imaging and fetal cardiology, who spent hours checking Aiden’s heart with fetal echocardiograms. They also met with obstetrician, Richard Ivey, MD, toured the CVICU and met Jeffrey Heinle, MD, associate chief of congenital heart surgery, who would operate on their newborn’s heart.

“To be able to do all of this prior to having Aiden was just invaluable,” Jenny said. “Having everyone involved in Aiden’s care under one very large roof was a great comfort and a huge convenience.”

When Aiden was four days old, he had his first surgery, a Norwood procedure. After six weeks, he was discharged until his next surgery, a Glenn procedure at 4 months old. After that major operation, Aiden and Jenny had to remain in Houston for two weeks before going home.

“To say it was a joyful homecoming is an understatement,” Jenny said. “To have Aiden and his older brother home together was the most amazing thing.”

Now, when Aiden has periodic checkups, his appointments are scheduled with the entire team all in one day to make it easier on the family.

“Aiden still has at least one more surgery to face, and his heart will never be completely fixed,” Jenny said. “He will always have half of a functioning heart, but with the advancements in medicine, we pray he will have a long and wonderful life.”

The family is grateful for Texas Children’s expertise and the incredible life Aiden has been able to lead thus far.

“It helps to have so much love and care surrounding you when you’re dealing with a child with a very complex heart,” Jenny said. “This whole journey is not easy – not one second of it. But we have hope because of Texas Children’s Hospital.”
Hypoplastic left heart syndrome (HLHS) is a complex congenital heart defect that occurs when the left side of the heart does not form properly. The mitral valve, the left ventricle and the aortic valve are too small, and there is not enough blood pumping through the left side of the heart to support the rest of the body. Related conditions include evolving HLHS, where the valve is beginning to narrow and there is concern that the baby will have HLHS by the time of birth, and borderline left heart, where multiple left-sided structures are smaller than they should be. Texas Children’s Hospital has successfully performed in-utero fetal cardiac interventions for all three conditions. With a coordinated effort among a large, multidisciplinary team of fetal cardiologists, obstetricians and gynecologists, interventional cardiologists, congenital heart surgeons, fetal imaging experts, maternal and fetal anesthesiologists and other clinical specialists, Texas Children’s Hospital is the first in the southwestern U.S. to create a program to treat these defects in utero.

Catheter-Based Fetal Aortic Valvuloplasty for Fetal Aortic Stenosis (Evolving HLHS)

Texas Children’s Hospital has successfully performed this catheter-based procedure for babies with severe aortic stenosis in utero (evolving HLHS). A tiny balloon is inflated inside the aortic valve to open up the leaflets, after which the balloon is then removed. This allows blood to flow more easily through the left side of the fetal heart and potentially improve growth of left-sided structures.
Catheter-Based Atrial Septal Interventions for HLHS with Intact or Restrictive Atrial Septum (RAS)

Babies who already have HLHS in utero with no potential for growth of the left-sided structure depend on a hole in the atrial septum to keep blood circulating throughout their body. In some babies, this hole either does not exist or it is too small, and they have a high risk of complications and death. In a catheter-based procedure, we use a balloon or stent to create an atrial septal defect (a hole between the top chambers of the heart) to keep blood flowing through the fetal heart.

HLHS with RAS
baseline

HLHS with RAS
intervention

HLHS with RAS
after stent placement

Chronic Hyperoxegenation for Borderline Left Heart

For fetuses with borderline left heart structures, Texas Children's Fetal Center was the first in the country to offer a research protocol in which mothers receive daily oxygen therapy throughout their third trimester. By delivering extra oxygen to the mother through face mask or cannula, we hope to increase the amount of oxygen in her blood, the amount of oxygen going to the placenta and fetus, and ultimately the amount of oxygen flowing into the fetal lungs and into the left side of the baby’s heart. By improving flow to the left side of the heart, growth should improve as well. We are also studying the effects of extra oxygen for the fetal brain. We are currently enrolling mothers in the first randomized controlled trial of this therapy.

Borderline left heart
Groundbreaking Procedure for Severe CDH

When Jenny and Tawa Torry lost their first child to birth defects caused by congenital diaphragmatic hernia (CDH), they never dreamed they’d have to face the same heartbreaking possibility again.

But when Jenny was 17 weeks pregnant with the couple’s second child, an ultrasound showed the fetus had a life-threatening CDH.

“After my experiences with ultrasounds, I know how things should look,” Jenny said. “When I looked at the monitor, I started to cry. I couldn’t believe we were going through this nightmare again.”

The couple lost no time in going to Texas Children’s Fetal Center, where their daughter, Milan, was the first to benefit from fetal endoscopic tracheal occlusion (FETO), an experimental procedure to treat severe CDH.

“Milan’s CDH was quite severe, which we were able to ascertain by the fetal lung to head ratio (LHR), presence of liver herniation into the chest, percentage of liver herniation and total fetal lung volume,” said Oluyinka Olutoye, MD, PhD, co-director of Texas Children’s Fetal Center.

“Although this was the first time we had performed the procedure, the operation went smoothly with no complications. An endoscope was inserted through the fetal mouth and into the fetal trachea. The scope was advanced to just above the carina, and the balloon was deployed and left in the trachea above the carina.”

Michael Belfort, MD, PhD, OB/GYN-in-chief, and the team of surgeons then placed the balloon. About six weeks later, the process was repeated and the balloon was removed.

The procedure was a success, and Milan was born at a little over 35 weeks gestation. The postnatal diaphragm repair-surgery went smoothly as well. She spent five months in neonatal intensive care but was able to go home healthy.

Now 4, Milan is doing remarkably well, and she’s on target with physical and developmental milestones. She does not have pulmonary hypertension, and her heart functions are normal. She no longer takes any medication, and although she has a g-button, she rarely uses it.

“Milan is so smart and funny,” Jenny said. “She really is a joy. Some of her favorite things are singing, dancing and playing with her toys. She’s very artistic and learns quickly.”

The family will return to Houston to see Dr. Olutoye about once a year until Milan enters college. In the meantime, they keep him posted on Milan’s progress with emails and cards. Dr. Olutoye is pleased with what he sees as Milan grows.

“The surgery was a success because we were able to minimize pulmonary hypoplasia and pulmonary arterial hypertension,” he said. “She’s had a remarkable response and has done very well. I’d say she has an excellent prognosis.”

Jenny said they are reminded every time they look at Milan how much of a blessing she is.

“I can’t express how happy and proud we are that Milan is healthy and growing so strong and beautiful,” she said. “Everyone at Texas Children’s worked so hard to help our little girl, and we are forever grateful for their skill, expertise and care.”
**Fetal Endoscopic Tracheal Occlusion for Congenital Diaphragmatic Hernia**

About one in 2,500 fetuses has a congenital diaphragmatic hernia (CDH), which if not treated successfully can result in death of the newborn. Those who survive may have serious acute and chronic conditions.

For select patients with moderate to severe CDH, Texas Children’s Fetal Center offers fetal endoscopic tracheal occlusion (FETO), a breakthrough research protocol with potential to dramatically improve lung growth before birth.

FETO is a minimally invasive procedure in which a tiny balloon is inserted into the fetus’ trachea. The balloon is then inflated to block the trachea, left in place for several weeks to allow the fetus’ lungs to grow, and then removed a few weeks before delivery.

“If the lungs can be made to grow before the baby is born, it gives the child a head start by providing sufficient lung capacity at birth,” said Dr. Oluyinka Olutoye, MD, PhD, fetal surgeon and co-director of Texas Children’s Fetal Center. “This may be the difference between life and death.”

Texas Children’s comprehensive approach to CDH begins with the first prenatal visit, continues through delivery and the postnatal period, and into adolescence and early adulthood. Care is provided by a multidisciplinary team that includes some of the nation’s top maternal-fetal medicine specialists, surgeons, neonatologists, cardiologists and pulmonologists, among others.

Dr. Olutoye believes FETO holds great promise for serious and life-threatening cases of CDH in the future.

“We continue to study this procedure to effectively determine those who would benefit the most,” Dr. Olutoye said. “In collaboration with other fetal centers around the world, we seek to thoughtfully expand the provision of this management option to other fetuses to improve their long-term outcomes and not merely survival.”

As of October 2016, Texas Children’s Fetal Center has performed 17 successful FETO procedures.

To read the most recent study showing outcomes of FETO for fetuses with severe cases of CDH, please reference the medical publication below:


Additionally, Texas Children’s is now accepting patients with moderate cases of CDH for the Moderate TOTAL Trial, an international randomized controlled trial. For more details on the trial, please visit totaltrial.eu/?id=2.
Step 1 – Each pregnancy is carefully evaluated to determine whether the FETO procedure is appropriate. FETO is offered for moderate to severe congenital diaphragmatic hernia with pulmonary hypoplasia, shown above.

Step 2 – Through a small trocar placed into the uterus, a FETO bronchoscope is passed into the mouth of the fetus, into the airway.

Step 3 – The bronchoscope guides the inflation of the balloon in the fetal trachea.

Step 4 – The balloon is left in place, blocking the trachea, causing fluid to build in the lungs of the fetus.

Step 5 – The accumulation of lung fluid in the occluded airway causes the lungs to grow.

Illustrations by Beth Sumner
Less Invasive Approach to Fetal Spina Bifida Repair

Julia Wallace vividly remembers the moment a routine ultrasound revealed her unborn daughter had myelomeningocele, a type of spina bifida.

“The whole room was devoid of noise, and the world stopped, just like people always say,” she said.

But timing, it turned out, was on her side. Her baby was one of the first ever to benefit from a pioneering experimental fetal surgery procedure to treat this serious birth defect – one that is performed only at Texas Children’s Fetal Center. Now, Nell Eloise, or Ouisie for short, is a healthy toddler.

“I remember thinking, ‘It’s not fair. Why my baby?” Julia said. “But I’m the type of person who has a pity party for one night then wakes up and makes a plan.”

The plan was to travel from Baton Rouge, Louisiana, to Texas Children’s Hospital to meet the only team in the nation doing this type of surgery. Julia felt better as soon as she made the appointment.

At 22 weeks gestation, Michael Belfort, MD, PhD, OB/GYN-in-chief, and William Whitehead, MD, pediatric neurosurgeon, worked in tandem to perform a groundbreaking minimally invasive fetal surgery to repair Ouisie’s birth defect.

First they made an abdominal incision to expose the uterus. Then they lifted the uterus so it was outside the abdomen, removed the amniotic fluid and replaced it with carbon dioxide gas. They put ports into the uterus; inserted scopes and instruments through them; and performed endoscopic, or keyhole, surgery to repair the defect in the fetus’ lower spine. They dissected the membrane attached to the exposed spinal cord and then sutured the remaining skin together to cover the spina bifida defect to protect it from further exposure to the amniotic fluid. The amniotic fluid was returned; then the uterus was returned to the abdomen; the abdominal incision was closed; and gestation resumed normally.

Ouisie was born at almost 37 weeks with a normal vaginal delivery. She did develop hydrocephalus and coronal synostosis, which were treated surgically at 9 months, and her bladder function will be closely monitored, since many children with spina bifida require catheterization. But overall, she is healthy, and she is expected to walk normally.

“Eloise is doing extremely well,” Dr. Whitehead said.

“The experimental nature of the procedure means that it’s currently only performed on the most serious cases, those most likely to have severe debilitation,” added Dr. Belfort. “So for this baby, who had very limited options, to have this kind of outcome and be expected to walk normally and develop typically, it’s monumental. It’s a major turning point, and we’re extremely excited about it.”

Julia says she sometimes stares at Ouisie and realizes she truly is a miracle. She can crawl, pull herself up and bear weight on her feet, and she is verbal and incredibly social.

“Ouisie has stolen everyone’s heart,” Julia said. “She’s defied all odds and our expectations – and she’s changed a lot of people’s lives.”
**Fetoscopic Repair of Spina Bifida**

Myelomeningocele, or open neural tube defect (NTD), is the most severe form of spina bifida. It occurs when the spinal cord/neural elements are exposed through the opening in the spine, resulting in partial or complete paralysis of the parts of the body below the spinal opening.

Occurring in more than three of every 10,000 live births in the U.S., it is the most common permanently disabling birth defect for which there is no known cure.

The defect can be repaired in the first few days of life, but many babies develop hydrocephalus and require cerebrospinal shunts for life.

A landmark clinical trial demonstrated that open fetal surgical repair can lead to better outcomes, lower rates of hydrocephalus, decreased need for shunts and improved leg function compared to after-birth repair.

Texas Children’s Fetal Center was one of the first centers to perform open fetal surgery to treat spina bifida in 2011. The procedure has had good outcomes, but it also carries risks, including increased incidence of preterm birth, caesarean section and uterine rupture.

In 2014, a multidisciplinary team at Texas Children’s performed an experimental fetoscopic closure of NTD – the first in the nation. The surgery has the potential to achieve similar outcomes without the dangers of open fetal repair.

The approach was developed over a three-year period by Michael Belfort, MD, PhD, OB/GYN-in-chief, and William Whitehead, MD, pediatric neurosurgeon. It features an in-utero, single layer, sutured repair through two 4-millimeter incisions in the uterus.

“We believe this is an excellent alternative to open repair, and we are eager to offer it to as many patients as want it,” Dr. Belfort said. “Obviously we have small numbers, and data on outcomes are not long term, but fetoscopic results suggest an equivalent repair to that of open uterus repair, and the obstetric benefits of the fetoscopic approach are immense.”

“Our hope is this innovation and others will lead us to a new era of fetal medicine and surgery,” he said. “With ever-advancing technology and imaging capabilities and dedicated surgeons, I am excited to see the future of repairing anomalies fetoscopically.”

As of October 2016, Texas Children’s Fetal Center has performed 25 successful fetoscopic repairs of NTD.
An Illustrated Guide to Fetoscopic Repair of Spina Bifida

**Step 1** - The uterus is accessed via a transverse incision made in the maternal abdomen.

**Step 2** - The uterus is then exteriorized, and the fetus is positioned for surgery.

**Step 3** - Fetoscopic ports are carefully inserted into the uterus under ultrasound guidance. After the ports are in place, some amniotic fluid is removed and exchanged with carbon dioxide gas to allow for better visualization and execution of the procedure. Prior to beginning the repair on the fetus, an injection of pain medication will be given.

**Step 4** - The neurosurgeon will reduce the MMC sac.

**Step 5** - The defect will be closed.
Extraordinary Outcome for Devastating LUTO Case

Before Luke Vela was even born, his big brother nicknamed him Tuff because of the challenges he’d already overcome.

At 18 weeks gestation, Luke was diagnosed with a fetal congenital lower urinary tract obstruction (LUTO) that was so severe his bladder took up the entire uterine cavity. It pressed against his heart, causing cardiac distress and decreasing amniotic fluid to a dangerously low level. The condition required Luke to undergo three fetal surgeries and one shortly after birth.

In the first procedure, a multidisciplinary team of surgeons performed an ultrasound-guided vesicocentesis (fetal bladder tap) and drained 700 ccs of fetal urine, alleviating the pressure inside Luke’s bladder.

“We then performed a fetal cystoscopy and diagnosed a possible urethral atresia (complete obstruction of the urethra),” said Jimmy Espinoza, MD, PhD, Luke’s fetal surgeon. “We placed a fetal vesicoamniotic shunt, which improved the amount of amniotic fluid and decreased the pressure inside Luke’s renal system.”

As Luke grew inside the womb, his shunt had to be surgically replaced twice.

At 34 weeks, Luke was born by cesarean section and immediately taken to the NICU. Postnatal examination confirmed a completely obstructed urethra that was impossible to catheterize, necessitating a vesicostomy at 4 days old to protect the kidneys from further damage. However, he was found to have normal renal function.

After Luke spent about one month in the NICU, his family was finally able to take him home.

In utero, Luke developed prune belly features, or a flaccid abdominal wall.

“Many physicians confuse this with prune belly syndrome, a genetic disease in which a primary muscular weakness causes a flaccid abdominal wall without bladder outlet obstruction,” Dr. Espinoza said.

“Luke’s case is one for the history books,” said Dr. Espinoza. “Survival with normal renal function in such a severe case of urethral atresia is extremely rare.”

Despite Luke’s challenges, including chronic kidney disease, his mother Kate remains positive.

“Luke is our miracle baby,” she says. “He is thriving and continues to meet every physical and cognitive milestone. We still have a long road ahead of us because he will need many reconstructive surgeries and there are many unknown variables. But every time I see him smile, I know that we made the best possible choices, and I would do it all over again.”

Three years after his brother first called him Tuff, he continues to live up to the name.

“Luke has enormous strength and will to live,” Kate said. “He wanted to be here in this world and was as determined as we were not to give up.”
Fetal Surgery for LUTO

Bladder outlet obstruction, a type of lower urinary tract obstruction, is an uncommon birth defect that occurs most often in males.

The flow of urine from the urethra is blocked, causing urine to back up and enlarge the bladder. This lessens the amount of amniotic fluid and sets up the fetus for a host of possible problems, including lung and heart problems, kidney damage and deformities of the face and extremities. It usually is diagnosed by routine ultrasound in the second trimester of pregnancy.

If the defect is severe, a vesicoamniotic shunt may be necessary. Texas Children’s Fetal Center is one of the nation’s leaders in performing this delicate and complex procedure.

Guided by ultrasound, surgeons place a small shunt (catheter) from the fetal bladder to the amniotic cavity. The objective is to bypass the bladder outlet obstruction, releasing the pressure inside the bladder and the renal system as well as increasing the amount of amniotic fluid.

This procedure is indicated for fetuses with complete bladder outlet obstruction whose odds of survival are less than 10 percent (a 90 percent chance of end stage renal disease) without fetal intervention.

At Texas Children’s, the one-year survival rate after fetal vesicoamniotic shunt placement is 79 percent.

“Our success is based on a prenatal multidisciplinary evaluation that helps us plan the best prenatal treatment and management, the best moment to deliver, and the best postnatal therapy and follow-up,” said Jimmy Espinoza, MD, PhD, co-director of Texas Children’s Fetal Center. We have the most up-to-date equipment and technology, and we have developed:

• Protocols to treat only fetuses that need and will benefit from this therapy
• Algorithms based on our experiences and literature studies
• A staging system to classify cases according to severity of the disease

As of October 2016, Texas Children’s Fetal Center has performed 37 successful fetal bladder shunts.
Meet Our Leaders

Michael A. Belfort, MBBCH, MD, PhD, is OB/GYN-in-chief of Texas Children’s Pavilion for Women and the Ernst W. Bertner chairman and professor in the Department of Obstetrics and Gynecology at Baylor College of Medicine. A nationally and internationally renowned specialist in maternal-fetal medicine and fetal intervention, Dr. Belfort is board certified in Obstetrics and Gynecology and in Maternal-Fetal Medicine by the American Board of Obstetrics and Gynecology.

A native of South Africa, Dr. Belfort received his medical degree (MBBCH) from the University of the Witwatersrand in Johannesburg, South Africa. He has been awarded two postgraduate research degrees, a Doctorate in Medicine (MD) from the University of Cape Town, South Africa, and a PhD from the Karolinska Institute in Stockholm, Sweden. Dr. Belfort is the author/editor of several textbooks notably, Hypertension in Pregnancy, Obstetric Clinical Algorithms: Management and Evidence, Preeclampsia: Etiology and Clinical Practice and Critical Care Obstetrics, and he has over 219 peer-reviewed papers.

His interest in global women’s health was one of the main reasons for his move back to Houston in 2011. Under his guidance, Baylor and Texas Children’s Hospital are expanding their global reach and influence on women’s health care, a subject about which he is passionate.

Darrell Cass, MD, is co-director of Texas Children’s Fetal Center and associate professor of surgery, pediatrics and OB/GYN at Baylor College of Medicine. He is co-founder of the fetal surgery team and a general pediatric and thoracic surgeon. After receiving his MD in 1991 from the University of California Los Angeles School of Medicine (with AOA honors), Dr. Cass pursued residency in general surgery at the University of California San Francisco. Dr. Cass studied as a postdoctoral research fellow at the Fetal Treatment Center at the University of California San Francisco and at the Center for Fetal Diagnosis and Treatment at The Children’s Hospital of Philadelphia. He completed training in pediatric surgery at Texas Children’s Hospital and Baylor College of Medicine in 2001.

Dr. Cass has expertise and clinical interest in fetal and neonatal surgery for a range of problems, including fetal lung malformations, congenital diaphragmatic hernia, omphalocele and esophageal atresia. He is also experienced in laparoscopic and minimally invasive surgery, chest and lung surgery, the Nuss repair of chest wall deformities, and endocrine surgery. His basic research interests center on the mechanisms of fetal tissue healing. His research goal is to understand the mechanisms involved in these unique reparative processes in order to develop new strategies to surgically treat problems that affect the developing fetus. Dr. Cass’s clinical research focuses on treatment advances of fetal and neonatal surgical conditions.
Wesley Lee, MD, is co-director of Texas Children’s Fetal Center and professor of Obstetrics and Gynecology at Baylor College of Medicine. He also serves as Division Director for Women’s and Fetal Imaging. His medical degree was from Oregon Health Sciences University in Portland, and his OB/GYN residency was completed at Parkland Memorial Hospital in Dallas. Additional training included a maternal-fetal medicine fellowship at Baylor College of Medicine in Houston.

Dr. Lee has authored more than 160 peer-reviewed articles and over 20 book chapters pertaining to perinatal medicine, prenatal detection of congenital anomalies, fetal growth, 3D/4D fetal ultrasonography, and fetal magnetic resonance imaging. He is an associate investigator with the Perinatology Research Branch of the Eunice Kennedy Shriver National Institute of Child Health and Human Development and served as a scientific advisor to the World Health Organization for fetal growth studies. He has chaired several task force committees regarding the development of practice guidelines for prenatal ultrasonography; chaired the Clinical Standards Committee at the International Society of Ultrasound in Obstetrics and Gynecology; serves as a deputy editor of the Journal of Ultrasound in Medicine, and has co-edited the textbook Sonography in Obstetrics & Gynecology, Principles and Practice, McGraw-Hill, 2011. In 2015, Dr. Lee received the William J. Fry Memorial Lecture Award for his significant contributions to the scientific progress of fetal imaging for the American Institute of Ultrasound in Medicine.

Oluyinka Olutoye, MD, PhD, is co-director of Texas Children’s Fetal Center and professor of Surgery, Pediatrics, and OB/GYN at Baylor College of Medicine. He is co-founder of the fetal surgery team and a general pediatric and thoracic surgeon. Dr. Olutoye received his M.D. from Obafemi Awolowo University in Ile-Ife, Nigeria, and his Ph.D. in anatomy from Virginia Commonwealth University. He completed his residency in general surgery at the Medical College of Virginia Hospitals, Virginia Commonwealth University, and his fellowship in pediatric surgery at The Children’s Hospital of Philadelphia and the University of Pennsylvania School of Medicine. Dr. Olutoye is the 2016 co-president of the International Fetal Medicine and Surgery Society (IFMSS), a Fellow of the Surgical Section of the American Academy of Pediatrics, the American College of Surgeons, the West African College of Surgeons and the American Surgical Association. He is certified by the American Board of Surgery both in general surgery and pediatric surgery.

Dr. Olutoye has specialized clinical expertise in fetal and neonatal surgery, with specific interest in congenital diaphragmatic hernia, necrotizing enterocolitis and complex wounds. Dr. Olutoye’s research interests include understanding the role of the fetal inflammatory response in scarless fetal wound healing, development of animal models of congenital anomalies, in-utero correction of severe congenital malformations, determination of early indicators of necrotizing enterocolitis and effects of anesthesia on fetal brain development.
Jimmy Espinoza, MD, PhD, co-director of Texas Children’s Fetal Center and associate professor in the Department of Obstetrics and Gynecology at Baylor College of Medicine, is board certified in Obstetrics and Gynecology. Dr. Espinoza earned his medical degree at San Fernando Faculty of Medicine, University of San Marcos in Lima, Peru. He completed his residency in Obstetrics and Gynecology at William Beaumont Hospital, Royal Oak, MI. Dr. Espinoza earned the degree of Master in Science in Reproductive Health at the University of Cardiff, Wales, where he graduated with distinction, followed by a Diploma in Fetal Medicine under the auspices of the Fetal Medicine Foundation in London, UK. Dr. Espinoza’s clinical interests include fetal interventions in the management of twin-twin transfusion syndrome, lower fetal urinary tract obstructions, fetal pleural effusions, fetal congenital diaphragmatic hernia, fetal neural tube defects and placental chorioangiomas. Additional clinical and research interest include the use of imaging modalities in the prenatal diagnosis of congenital heart defect, in particular the use of 3D/4D ultrasonography in the diagnosis of fetal heart defects and fetal neurosonography. Dr. Espinoza is leading the efforts at Baylor College of Medicine in the use of dual-perfused placental explants to provide insight into the mechanisms of disease in pregnancy complications including preeclampsia, fetal growth restriction, gestational diabetes and preterm parturition as well as in the evaluation of placental transfer of medications commonly used in obstetrics. A particular focus on Dr. Espinoza’s research is the role of fetal signaling in the pathogenesis of preeclampsia, gestational diabetes and preterm parturition.
Fetal Center Fellowships

**Perinatal Surgery Fellowship**

Baylor College of Medicine, through its Department of Obstetrics and Gynecology and the Michael E. DeBakey Department of Surgery, has developed a unique two-year fellowship program designed to enhance the training and expertise of both maternal-fetal medicine specialists and pediatric surgery-trained physicians in the diagnosis and management of fetuses and neonates with specific conditions and congenital malformations. This program is approved by the Texas Medical Board and is only available at Texas Children’s Hospital and Baylor College of Medicine.

**Fetal Intervention Fellowship**

The Fetal Intervention Fellowship is a one-year program only open to maternal-fetal medicine specialists with the objective of training them in ultrasound-guided fetal interventions such as shunt for urinary tract obstruction and laser ablation of placenta anastomoses for twin-twin transfusion syndrome. Only one person is accepted per year. This fellowship is approved by the Texas Medical Board and co-directed by Drs. Michael Belfort and Jimmy Espinoza.

---

*Alireza Abdollah Shamshirsaz, MD,* is director of the Perinatal Fellowship. He is a fetal surgeon and a dual board-certified obstetrician/gynecologist and maternal-fetal medicine specialist. He attended medical school in Tehran University of Medical Sciences in Iran and spent four years on research as a post-doctoral fellow in two of the best research institutes of the country. In 2003, he came to the United States as a graduate post-doctoral research fellow working at University of Colorado Health Science Center. He did his internship and residency at University of Buffalo and University of Iowa Health Care. He then attended the University of Connecticut where he received his maternal-fetal medicine fellowship. In 2012, he came to Baylor College of Medicine for two more years of training in fetal intervention and perinatal surgery, where he now works as an assistant professor of obstetrics and gynecology, maternal-fetal medicine specialist and fetal surgeon. Dr. Shamshirsaz’s clinical interests include fetal interventions in the management of twin-to-twin transfusion syndrome, lower fetal urinary tract obstructions, fetal pleural effusions, fetal congenital diaphragmatic hernia and fetal neural tube defects. He is also one of the core members of the multidisciplinary team for management of morbidly adherent placenta in the division of Maternal-Fetal Medicine.
Texas Children’s Fetal Center Physicians

To view online profiles for each of our physicians, visit women.texaschildrens.org/our-team.

Anesthesiology
Titi Aina, MD, MPH
Priscilla Garcia, MD
David Mann, MD
Kim Nguyen, MD
Toyin Olutoye, MD, MSc
Catherine Seipel, MD
Thomas Shaw, MD
Luigi Viola, MD
Erin Williams, MD

Cardiovascular Surgery
Iki Adachi, MD
Charles D. Fraser Jr., MD
Jeffrey S. Heinle, MD
Lauren Kane, MD
Carlos M. Mery, MD

Craniofacial Team – Plastic and Reconstructive Surgeons
Edward P. Buchanan, MD
Larry H. Hollier, MD
Laura A. Monson, MD

Down Syndrome Clinic
Kathryn K. Ostermaier, MD
Jonathan Porter-Castillo, MD

Fetal Cardiology / Echocardiography
Carolyn A. Altman, MD
Nancy A. Ayres, MD
Judith A. Becker, MD
Regina Lantin-Hermoso, MD
Emily J. Lawrence, DO, MS
Keila N. Lopez, MD, MPH
Shiraz A. Maskatia, MD
Shaine A. Morris, MD, MPH
Alexia Beatriz Santos MD, MPH
S. Kristen Sexson Tejtel, MD, PhD
Betul Yilmaz, MD

Fetal Imaging / Radiology
Christopher Cassady, MD
Nilesh Desai, MD
Carolina Guimaraes, MD
Amy Mehollin-Ray, MD

Fetal Interventional Cardiology
Henri Justino, MD
Amiee Liou, MD
Athar Quershi, MD

Fetal Intervention / Fetal Surgery
Michael A. Belfort, MD, PhD
Jimmy Espinoza, MD
Magda Sanz-Cortes, MD, PhD
Alireza Shamshirsaz, MD

Genetics
Carlos Bacino, MD
Karla M. Bermudez-Wagner, MD
Seema Lalani, MD
Melissa Russo, MD
Vernon R. Sutton, MD
Ignatia B. Van den Veyver, MD

Infectious Disease
Gail J. Demmler-Harrison, MD

Maternal-Fetal Medicine Specialists
Kjersti M. Aagaard-Tillery, MD
Jerasimos Ballas, MD
Michael A. Belfort, MD, PhD
Karla Bermudez-Wagner, MD
Robert Carpenter Jr., MD
Steven Clark, MD
 Christina Davidson, MD
Gary A. Dildy, MD
Catherine Eppes, MD
Nancy Eriksen, MD
Jimmy Espinoza, MD
Karin Fox, MD
Manisha Gandhi, MD
Lisa Hollier, MD
Wesley Lee, MD
Michael Lucas, MD
Joan Mastrobattista, MD
Manju Monga, MD
Martha Rac, MD
Mildred Ramirez, MD
Melissa Russo, MD
Magda Sanz-Cortes, MD, PhD
Alireza Shamshiraz, MD
Stacy L. Strehlow, MD
Anju Suhag, MD
Kiran Tam Tam, MD
Ignatia B. Van den Veyver, MD
Alex Vidaeff, MD

Neonatology
Gerardo Cabrera-Meza, MD
Melissa Carbajal, MD
Xanthi Couroucli, MD
Jonathan Davies, MD
Daniela Dinu, MD
Caraciolo Fernandes, MD
Paraskev Georgiadis, MD
Ganga Gokulakrishnan, MD
Charleta Guillory, MD, MPH
Amy Hair, MD
Karen Johnson, MD
Pablo Lohmann, MD
Torey Mack, MD
George Mandy, MD
Mohan Pammi, MD
Frank Placencia, MD
Muralidhar Premkumar, MD
Chris Rhee, MD
Danielle Rios, MD
Alina Saldarriaga, MD
Nathan Sundgren, MD, PhD
Guatham Suressh, MD

Neurology
Gary Clark, MD
Lisa Emrick, MD

Neurosurgery
Daniel Curry, MD
Robert Dauser, MD
Thomas Luerssen, MD
William Whitehead, MD

Obstetrics
Jennifer Bump, MD
R. Todd Ivey, MD
Susan Raine, MD

Orthopedics
Howard R. Epps, MD
Frank Travis Gerow, MD
Jaclyn F. Hill, MD
Scott McKay, MD
William A. Phillips, MD
Scott B. Rosenfeld, MD
Vinitha Shenava, MD

Pathology
Edwina Popek, MD

Perinatal Pediatric Advanced Care Team
Karen Johnson, MD
Tiffany McKee-Garrett, MD
Frank Placencia, MD

Pediatric Surgeons / Fetal Surgeons
Darrell Cass, MD
Sundee G. Keswani, MD
Timothy Lee, MD
Oluyinka Olotuyi, MD, PhD

Spina Bifida Clinic
Jonathan P. Castillo, MD, PhD
Kathryn K. Ostermaier, MD

Urology
Chester Koh, MD
David Roth, MD

Nephrology
Joseph R. Angelo, MD
Michael Braun, MD
Texas Children’s Fetal Center Providers and Staff

To view online profiles for each of our clinical staff, visit women.texaschildrens.org/our-team.

<table>
<thead>
<tr>
<th>Clinical and Business Operations</th>
<th>Fetal Echosonographers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aimee Jackson, DNP, RNC-OB, RDMS, WHNP-BC</td>
<td>James Dozier, RDCS (AE,PE)</td>
</tr>
<tr>
<td>Sean McGowen</td>
<td>Maggie Nguyen, RDCS (FE, PE)</td>
</tr>
<tr>
<td>Jodi Harris</td>
<td>Lacey Schopppe, RDCS (FE, PE)</td>
</tr>
<tr>
<td>Jodi Harris</td>
<td>Jianhong Zhang, ARDMS (FE, PE, AE)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fetal Center Nurse Coordinators</th>
<th>Fetal Medicine Sonographers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florence Anyanwu, DNP-BC, RNC-OB, FNP-BC</td>
<td>Nasrin Benion, RDMS, NTQR</td>
</tr>
<tr>
<td>Annie Boggs, RN</td>
<td>Maria Gonzalez, RDMS, NTQR</td>
</tr>
<tr>
<td>Laura Mollett, RN</td>
<td>Chris Hoang, RDMS, NTQR</td>
</tr>
<tr>
<td>Jayme Molohon, BSN, RN</td>
<td>Mary Jones, RDMS, NTQR</td>
</tr>
<tr>
<td>Christine Moran, BSN, RN</td>
<td>Deborah Reid, RDMS, NTQR</td>
</tr>
<tr>
<td>Carol Roth, RN, RNC-MNN</td>
<td>Jeannie Silva, RDMS, NTQR</td>
</tr>
<tr>
<td></td>
<td>Tamara Wilson-Nelson, RDMS, NTQR</td>
</tr>
<tr>
<td></td>
<td>Michelle Goepfert, RDMS, NTQR</td>
</tr>
<tr>
<td></td>
<td>Mary Jones, RDMS, NTQR</td>
</tr>
<tr>
<td></td>
<td>Teresa Diaz, RDMS, NTQR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fetal Center Intake Coordinators</th>
<th>Physician Liaison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ivonne Gutierrez</td>
<td>Elizabeth More</td>
</tr>
<tr>
<td>Veronica Montoya</td>
<td></td>
</tr>
<tr>
<td>Blanca Perrett</td>
<td></td>
</tr>
<tr>
<td>Tisha Lawrence</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fetal Center Outcomes Coordinator</th>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angel Krueger, BS, RN</td>
<td>Cris Daskevich, MBA/MHA, FACHE</td>
</tr>
<tr>
<td></td>
<td>Ivett Shah, MSHA, MBA</td>
</tr>
<tr>
<td></td>
<td>Haley Jackson, MPH</td>
</tr>
</tbody>
</table>
Texas Children’s Fetal Center Publications 2015

**Congenital Diaphragmatic Hernia**


**Fetal Cardiology**


**Fetal Diagnosis**


**Fetal Growth**


**Fetoscopy**


**Genetics**


**Giant Neck Mass**

Neural Tube Defects

Omphalocele

Twin-Twin Transfusion Syndrome

Urinary Tract Obstruction

Established in 2001, Texas Children’s Fetal Center is one of the only centers in the United States to offer the full spectrum of fetal therapies. Our core staff includes fetal and pediatric surgeons, maternal-fetal medicine physicians, specialized coordinators and support staff. Working with a multidisciplinary team of experts including cardiologists, neonatologists, urologists, neurologists, neurosurgeons, anesthesiologists, radiologists and genetics specialists, we provide seamless, collaborative and comprehensive care before, during and after birth.

Send us your toughest cases. We’re known for delivering.

Meet the Texas Children’s Fetal Center team.
Referrals

The Texas Children’s Fetal Center is staffed and supported for surgical or medical intervention around the clock, all year long.

You can have confidence knowing that when you refer your patients to Texas Children’s Fetal Center, they will not only receive the best possible fetal evaluation and treatment, but they will also be treated with care and compassion.

To refer a patient to Texas Children’s Fetal Center for consultation for fetal intervention or fetal surgery, contact us at:

832-822-BABY (2229)
1-877-FetalRx (338-2579) - toll-free
fetalcenter@texaschildrens.org

To find the referral form online, please visit women.texaschildrens.org/fetalreferrals.