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Aurora Health Care’s Heart & Vascular program comprises more than 100 cardiovascular specialists offering services at hospitals and clinics throughout eastern Wisconsin and northern Illinois.

Cardiovascular subspecialists provide cutting-edge care to prevent, diagnose, and treat patients with heart and vascular disease in a high-volume and high-quality clinical practice that is supported by robust education and research programs.

Aurora’s cardiovascular division includes collaborative subspecialty clinics that focus on structural heart disease, peripheral vascular disease, electrophysiology, channelopathies, hybrid AF (AF) treatment, congestive heart failure, and pulmonary hypertension.

Aurora St Luke’s Medical Center was ranked in the top 50 nationally in Cardiology and Heart Surgery by U.S News & World Report, and was recognized for using evidenced-based guidelines to improve the quality of care for patients with heart disease and stroke by the American Heart Association/American Stroke Association.

Collaborative efforts between interventional cardiologists and cardiovascular surgeons have resulted in the largest transcatheter valve program in the state, where over 1,000 transcather aortic valve replacement (TAVR) procedures were performed. Aurora St. Luke’s also offers mitral clip technology and is participating in transcatheter mitral valve research for degenerative mitral regurgitation. In addition, Aurora St. Luke’s is a training center for TAVR technology.

Our electrophysiology program is one of the oldest and largest programs in the nation. We have trained physicians from all over the world and provide cutting-edge technology and treatment for all types of arrhythmias. Our program is one of few centers in the US offering hybrid AF catheter ablation, improving the success rate for this procedure. We are a training center for this and many other electrophysiology technologies.

The center’s transplant program is among the top in the country. The center has reached over 890 transplants and over 785 ventricular assist device implants. We continue to have clinical outcomes in the upper quartile for quality outcomes.

Through the use of the da Vinci Surgical System, we have one of the largest thoracic robotic surgery programs in the country. In 2016, we have performed over 1,000 thoracic robotic surgeries, and we continue to be an international training center for this technology.

In 2016, 24 fellows-in-training participated in Aurora Health Care’s graduate medical education program in the areas of Cardiovascular Disease, Interventional Cardiology, Electrophysiology, and Heart Failure. The program consists of basic, translational, and clinical research components.

Aurora cardiovascular specialists have a long history of publishing cutting-edge abstracts, articles in peer-reviewed medical journals, and chapters in medical textbooks. In 2016, Aurora authors had 71 abstracts and 58 articles and book chapters published.
Aurora Health Care’s Heart & Vascular Service Line is honored to provide this publication highlighting our commitment to the quality of the cardiovascular services we provide for preventing, diagnosing, and treating heart and vascular disease.

We are dedicated to using state-of-the-art technology and the latest advancements in clinical research to provide the best treatment options in the management of cardiovascular disease for the patients we serve.

Our world-renowned specialists use the most advanced tools and technologies currently available in the industry.

Our patients benefit from having a team of experts who collaborate in providing the best treatment options, which may not be available in all health care settings. We continually monitor our quality performance by participation in national registries to benchmark our performance and the services that we provide. Our multidisciplinary core improvement teams are dedicated to providing the highest quality of care possible.

Aurora Health Care is committed to transparency in reporting the quality of our services. If you have any questions or feedback, please contact heartandvascular@aurora.org.

Sincerely,
Daniel O’Hair, MD
Jasbir Sra, MD
At Aurora Health Care, we are fortunate to be in the quality-of-life business. We help people live well. That’s our purpose, and it drives everything we do as an integrated not-for-profit health care provider serving more than 90 communities and 30 counties throughout eastern Wisconsin and northern Illinois.

Our patients enjoy care that is coordinated across a comprehensive network of facilities, services, and providers. Our 15 hospitals and 159 clinics are bringing the latest technologies to communities throughout eastern Wisconsin. From primary and specialty care to hospitals, pharmacies, labs, and the largest home care organization in Wisconsin, we’ve developed a model of care that improves quality, makes care more efficient and affordable, and enhances every patient’s health care experience. Today, we are Wisconsin’s largest private employer with more than 31,000 amazing caregivers, including 1,800 employed physicians. We are governed by a community board of directors, business and community leaders who offer their expertise and resources to help guide our work today and prepare us for the future. As caregivers, we feel privileged to serve more than 1.2 million patients every year and to experience 7.8 million patient encounters.
Aurora’s Heart & Vascular Program prides itself on treating the most heart patients in Wisconsin. Our studies confirm that high-risk patients have better outcomes at hospitals that perform high volumes of complex procedures.

Aurora Health Care is dedicated to excellence in every aspect of heart, vascular, and thoracic care, including research, wellness, prevention, diagnosis, treatment, and follow-up care. Our world-renowned specialists and subspecialists provide cutting-edge care to prevent, diagnose, and treat patients with heart and vascular disease. We are proud of our national reputation for offering solutions for patients with the most complex conditions who have been told they have no other option.

Aurora’s Thoracic Surgery program prides itself on providing a multidisciplinary approach to treating patients. Our minimally invasive techniques reduce length of stay, decrease pain, and allow for a shorter recovery time. Additionally, Aurora’s robot-assisted thoracic surgery program is the busiest in Wisconsin and the Midwest. Aurora Grafton Medical Center is one of 10 approved robotic surgery mentor sites in North America.
Accreditations & Recognitions

- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification – Cardiovascular & Pulmonary
- American College of Cardiology (ACC) Foundation’s National Cardiac Data Registry® (NCDR) ACTION Registry® Get With The Guidelines™ – Platinum Performance Achievement Award
- American College of Cardiology – Nurse Navigator Award
- American Heart Association (AHA) Mission: Lifeline® Accreditation for Heart Attack Receiving Center - Silver Award
- AHA Get With The Guidelines® Gold Plus Award for Stroke and Target Stroke Elite Plus Honor Roll
- AHA Get With The Guidelines® for Heart Failure – Gold Plus Achievement Award
- AHA Get With The Guidelines® for AFIB - Silver Achievement Award
- Blue Cross Blue Shield Designated Blue Distinction® Center of Cardiac Care
- Truven Health 100 Top Cardiovascular Hospitals
- UnitedHealth Premium® Cardiac Specialty Center – Cardiac Care
- UnitedHealth Premium® Cardiac Specialty Center – Cardiac Surgery
- UnitedHealth Premium Cardiac Specialty Center – Heart Rhythm Disorders
AHA Get With The Guidelines® Gold Plus Award for Stroke

AHA Get With The Guidelines® Gold Plus Award for Heart Failure Care and Target: Heart Failure Honor Roll

Top Performing Hospital by The Joint Commission for Heart Attack

Aurora Memorial Hospital of Burlington

AHA Get With The Guidelines® Gold Plus Award for Heart Failure and Target: Heart Failure Honor Roll

AHA Get With The Guidelines® Gold Plus Award for Stroke and Target: Stroke Honor Roll - Elite

American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification - Cardiovascular

Blue Cross Blue Shield Designated Blue Distinction® Center of Cardiac Care

Aurora Medical Center in Grafton

AHA Get With The Guidelines® Gold Plus Award for Heart Failure

American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification - Cardiovascular

Aurora Medical Center in Kenosha
Accreditations & Recognitions

- AHA Get With The Guidelines® Gold Plus Award for Stroke
- AHA Get With The Guidelines® Gold Plus Award for Heart Failure Care and Target: Heart Failure Honor Roll
- Society of Cardiovascular Patient Care - Chest Pain Accreditation

Aurora Lakeland Medical Center

- AHA Get With The Guidelines® Gold Plus Award for Stroke and Target: Stroke Honor Roll - Elite
- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification - Cardiovascular & Pulmonary

Aurora Sheboygan Memorial Medical Center

- AHA Get With The Guidelines® Gold Plus Award for Heart Failure

Aurora Sinai Medical Center

- AHA Get With The Guidelines® Gold Plus Award for Stroke and Target: Stroke Honor Roll
• American College of Cardiology Foundation’s NCDR® ACTION Registry® Get With The Guidelines™ – GOLD Performance Achievement Award
• AHA Get With The Guidelines® Gold Plus Award for Heart Failure and Target Gold Heart Failure – Honor Roll
• AHA Get With The Guidelines® Gold Plus Award for Stroke and Target Gold Stroke – Honor Roll Elite – Plus
• AHA Mission: Lifeline® Gold Plus Award for Heart Attack Receiving Center
• American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification - Cardiovascular & Pulmonary
• Blue Cross Blue Shield Designated Blue Distinction® Center of Cardiac Care
• Society of Cardiovascular Patient Care – Chest Pain Accreditation
• Accreditation for Cardiac Excellence (ACE) – PCI and PVI
• The Joint Commission Advanced Certification in Ventricular Assist Device
• The Joint Commission Advanced Certification in Comprehensive Stroke
• Magnet Recognition for Nursing Excellence – Fourth Time Recognition
• US News and World Report Nationally Ranked #31 for Cardiology and Heart Surgery
• US News and World Report Regionally Ranked #3 in Wisconsin
## Accreditations & Recognitions

### Aurora St. Luke's South Shore
- AHA Get With The Guidelines® Silver Plus Award for Stroke and Target Gold Stroke – Elite Plus Honor Roll
- AHA Target Silver Plus Award for Heart Failure
- AHA Mission: Lifeline® NSTEMI Early Adopter

### Aurora Medical Center in Summit
- AHA Get With The Guidelines® Gold Plus Award for Stroke
- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification – Cardiovascular
- Blue Cross Blue Shield Designated Blue Distinction® Center of Cardiac Care

### Aurora Medical Center in Manitowoc County
- AHA Get With The Guidelines® Gold Plus Award for Stroke and Target Gold Stroke – Honor Roll
- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification – Cardiovascular & Pulmonary
Aurora Medical Center in Oshkosh

- AHA Get With The Guidelines® Silver Plus Award for Heart Failure and Target Gold Heart Failure – Honor Roll
- AHA Get With The Guidelines® Gold Plus Award for Stroke

Aurora West Allis Medical Center

- American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) Certification – Cardiovascular
## System Cardiovascular Overview

### Cardiovascular Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary Artery Bypass Graft</td>
<td>941</td>
</tr>
<tr>
<td>Aortic Valve (AV) Replacement</td>
<td>718</td>
</tr>
<tr>
<td>Mitral Valve (MV) Replacement</td>
<td>114</td>
</tr>
<tr>
<td>Valve Replacement/Other</td>
<td>22</td>
</tr>
<tr>
<td>Aortic Valve Repair</td>
<td>15</td>
</tr>
<tr>
<td>Mitral Valve Repair</td>
<td>39</td>
</tr>
<tr>
<td>Valve Replacement/Other</td>
<td>23</td>
</tr>
<tr>
<td>Cardiac Ablation (Open)</td>
<td>212</td>
</tr>
</tbody>
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### Interventional Cardiology

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Catheterization</td>
<td>9,051</td>
</tr>
<tr>
<td>Myocardial Biopsy</td>
<td>426</td>
</tr>
<tr>
<td>Percutaneous Coronary Artery Intervention (PCI)</td>
<td>2,354</td>
</tr>
<tr>
<td>PCI with Stent</td>
<td>2,206</td>
</tr>
<tr>
<td>PCI with Atherectomy</td>
<td>112</td>
</tr>
<tr>
<td>Transcatheter Aortic Valve Intervention</td>
<td>334</td>
</tr>
<tr>
<td>Transcatheter Mitral Valve Intervention</td>
<td>26</td>
</tr>
<tr>
<td>Percutaneous Balloon Valvuloplasty</td>
<td>43</td>
</tr>
<tr>
<td>PFO/ASD Closure</td>
<td>111</td>
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<tr>
<td>Open</td>
<td>66</td>
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<tr>
<td>Closed</td>
<td>45</td>
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### VAD & Transplant

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Implantable Ventricular Assist Device (VAD)</td>
<td>39</td>
</tr>
<tr>
<td>Heart Transplants</td>
<td>25</td>
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</table>

### Cardiac Electrophysiology

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
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<tbody>
<tr>
<td>Electrophysiology Study</td>
<td>1,151</td>
</tr>
<tr>
<td>Cardiac Mapping</td>
<td>880</td>
</tr>
<tr>
<td>Cardioversion (Atrial)</td>
<td>1,530</td>
</tr>
<tr>
<td>Percutaneous Cardiac Ablation</td>
<td>999</td>
</tr>
<tr>
<td>Pacemaker Implant</td>
<td>1,138</td>
</tr>
<tr>
<td>Lead Extraction</td>
<td>117</td>
</tr>
<tr>
<td>Implantable Cardioverter Defibrillator (ICD)</td>
<td>904</td>
</tr>
</tbody>
</table>
### Vascular

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral Vascular Intervention (PVI)</td>
<td>2,360</td>
</tr>
<tr>
<td>PVI with Stent</td>
<td>1,032</td>
</tr>
<tr>
<td>PVI with Atherectomy</td>
<td>1,328</td>
</tr>
<tr>
<td>Intracranial Intervention</td>
<td>69</td>
</tr>
<tr>
<td>Precerebral Intervention</td>
<td>-</td>
</tr>
<tr>
<td>Carotid Artery Stenting</td>
<td>34</td>
</tr>
<tr>
<td>Stenting of Other Precerebral Artery</td>
<td>3</td>
</tr>
<tr>
<td>Abdominal Aortic Aneurysm (AAA) Repair</td>
<td>168</td>
</tr>
<tr>
<td>Endovascular</td>
<td>147</td>
</tr>
<tr>
<td>Open</td>
<td>21</td>
</tr>
<tr>
<td>Thoracic Aortic Aneurysm (TAA) Repair</td>
<td>292</td>
</tr>
<tr>
<td>Endovascular</td>
<td>37</td>
</tr>
<tr>
<td>Open</td>
<td>255</td>
</tr>
<tr>
<td>Carotid Endarterectomy</td>
<td>327</td>
</tr>
<tr>
<td>Other Endarterectomy</td>
<td>168</td>
</tr>
<tr>
<td>Lower Extremity Bypass</td>
<td>203</td>
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</tbody>
</table>

### Cardiac Imaging

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac MRI</td>
<td>528</td>
</tr>
<tr>
<td>Coronary CTA</td>
<td>494</td>
</tr>
<tr>
<td>Echocardiogram, Transthoracic</td>
<td>68,952</td>
</tr>
<tr>
<td>Echocardiogram, Transesophageal</td>
<td>2,708</td>
</tr>
<tr>
<td>Echocardiogram, Stress</td>
<td>7,518</td>
</tr>
<tr>
<td>Myocardial Perfusion</td>
<td>16,863</td>
</tr>
<tr>
<td>Cardiac PET</td>
<td>768</td>
</tr>
</tbody>
</table>

Source: Aurora Health Care EMR ICD - 10/CPT billing
Aurora’s heart & vascular program is a premier place for high-risk surgical candidates. Our second opinion program gives high-risk patients who have been declined by other organizations another chance for treatment with our expert surgical team. The Aurora Cardiovascular surgery team collaborates with a multidisciplinary team to provide the highest quality of care and superior results to every patient every day. We combine evidence-based practice with the most highly trained and experienced physicians, advanced practice practitioners, nationally ranked pulmonary services, critical care specialists, and allied health professionals to provide innovative care for our patients.

Cardiovascular surgery provides referring physicians and patients with options for receiving highly specialized services and access to the latest technological advancements. Our team has integrated a preoperative anemia clinic to minimize blood utilization. Additionally, we have a preoperative pharmacy consult team to maximize medications in order to prevent arrhythmias. Our services include a high-risk team that includes cardiologists, anesthesiologists, and cardiovascular surgeons who in turn offer opinions regarding surgery versus high-risk angioplasty.

We offer surgical and collaborative services including:

- Ascending aortic surgery
- Arch surgery
- Aortic root replacement
- Atrial myxoma surgery
- Carotid endarterectomy
- Chronic total occlusion procedures
- Coronary artery bypass surgery
- Endovascular harvest techniques
- Extracorporeal membrane oxygenation (ECMO)
- Heart transplantation
- Hybrid aortic operations
• Hybrid surgery - AF
• ICD/pacemaker implantation
• Preoperative consultation
• Redo Surgery
• Robot-assisted procedures
• Robotic Heller myotomy
• Robotic mitral valve surgery
• Second opinion
• Thoracoabdominal aneurysm repair
• Thoracic graft stenting
• Thoracic surgery (see Thoracic Surgery section)
• Total artificial heart
• Transcatheater heart valves
• Valve repair (Allows the patient to maintain their current valve but corrects the defect. This is a highly trained procedure that has better outcomes than replacing the valve.)
• Valve replacement surgery (with options of mechanical versus tissue valve)
• Complicated ICD lead placements (extractions)
• MAZE procedures for atrial fibrillation
• Off pump coronary artery bypass (bypass on a beating heart. This decreases length of stay and postoperative complications.)
• Ventricular assist devices (VADs)

Our comprehensive team offers the newest surgical techniques, including robot-assisted surgery, beating heart surgery (off-pump), and minimally invasive surgeries. We offer a preoperative evaluation with our anemia clinic to minimize the use of blood products intraoperatively. Our pharmacists assess patients prior to surgery for medications to prevent irregular rhythms after surgery. The physician assistants are trained in the newest technology for endovascular vein harvest, which allows for small incisions and quicker healing.
Aurora Health Care’s heart surgeons perform more heart surgeries than any other health care organization in Wisconsin. The team’s experience offers our patients a high skill level and a multidisciplinary approach to care combined with the latest technological advances.

Aurora has a dedicated multidisciplinary improvement team that meets regularly to discuss quality outcomes, best practices, and improvement opportunities. Our team-based approach to care has improved our care delivery and patient satisfaction.

### Isolated CABG In-Hospital Outcomes

<table>
<thead>
<tr>
<th>Condition</th>
<th>Aurora</th>
<th>STS Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Hospital Reoperation</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Postoperative Stroke</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Perioperative Renal Failure</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Deep Sternal Wound Infection</td>
<td>2%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: STS Cardiac Surgery Registry

### Isolated CABG Discharge Medications

<table>
<thead>
<tr>
<th>Medication</th>
<th>Aurora</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>100%</td>
<td>75%</td>
</tr>
<tr>
<td>ACE Inhibitors</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>Beta Blockers</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>Statin</td>
<td>100%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Source: STS Cardiac Surgery Registry

Isolated procedures are those procedures performed without any other surgery. The Society of Thoracic Surgeons (STS) has developed a comprehensive rating system for the quality of coronary artery bypass grafting (CABG) surgery. Approximately 12-15% of hospitals received the “3 star” rating for CABG and valve surgeries, which denotes the highest category of quality. Our Aurora hospitals have achieved and continue to work diligently to achieve this ranking.

Our nurse practitioners are instrumental in assuring patients are on the correct medications after surgery and upon discharge. Aurora Health Care has been 99-100% compliant on the STS process measures that include perioperative beta blocker, use of the internal mammary artery, and the use of beta blocker, statin, and aspirin at discharge.
ISCHEMIC HEART DISEASE
Coronary artery disease (CAD), also called ischemic heart disease, is one of the most prevalent types of heart disease, affecting nearly 17 million Americans.

Our program offers state-of-the-art technology, opportunities to participate in clinical trials, and adherence to clinical best practices, such as same-day discharge after a coronary angioplasty and radial artery approach. Post-discharge care includes an extensive cardiac rehabilitation program.

Aurora Health Care is committed to adhering to the ACC/AHA performance measures in order to provide defect-free care for our acute myocardial infarction (AMI) patient population. We continue to be above the national average.

Time-to-treatment is a critical factor in outcomes for patients with ST-segment elevated myocardial infarction. Our STEMI teams have achieved response times well under national targets and significantly outperform regional and national averages.

Aurora St. Luke’s Medical Center was one of the first centers to establish a 24/7/365 in-house cardiology program for heart attack care to restore blood flow in less than 60 minutes to reduce permanent heart damage. Through this program, we continue to achieve some of the shortest times to reperfusion in the country.

**BY THE NUMBERS**

<table>
<thead>
<tr>
<th>Door-to-Balloon, Minutes (Median)</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Myocardial Infarction - Defect-Free Care</td>
<td>73.9%</td>
</tr>
</tbody>
</table>

Source: ACC-NCDR CathPCI Registry

Source: ACC-NCDR ACTION Registry
Patients with complex medical backgrounds present greater challenges for PCI procedures. In 2016, patients who had PCI at Aurora Health Care had more co-morbidities than patients at comparable hospitals.

In 2016, Aurora Health Care treated a variety of patients with complex procedure findings in comparison to other hospital systems across the nation.

Our cardiovascular specialists at Aurora Health Care offer the latest techniques for treating chronic total occlusion (CTO) of the arteries supplying the heart. By precisely guiding a catheter to the site of the blockage and employing a combination of balloon angioplasty and stent placement, specialists re-establish the blood supply to the heart muscle. The CTO procedure restores quality of life for patients who might not be candidates for coronary bypass surgery.

With the growing body of evidence that transradial catheter insertion is associated with lower complication rates compared to the traditional transfemoral technique, there is an upward trend in radial use for Aurora Health Care. Radial approach allows patients to be safely discharged the same day of the procedure and has increased patient satisfaction, while lowering the cost associated with length of stay.
Chronic Total Occlusion
Procedure Volumes
2014 - 2016

Radial Access for Patients
Undergoing PCI Procedures
2013 - 2016

Source: ACC-NCDR CathPCI Registry
Source: CathPCI
CARDIAC RHYTHM DISORDERS
The Cardiac Electrophysiology division of Aurora Health Care is internationally renowned for its pioneering work in electrophysiology since its inception in the early 1980s. The group has grown to one of the largest in the country and continues to perform cutting-edge electrophysiology procedures, participate in basic, translational, and clinical trials, present new science at major national and international symposia and meetings, and publish in peer-reviewed scientific journals.

One area of particular importance is sudden cardiac death, which claims more than 300,000 lives annually in the United States, with the majority caused by life-threatening heart rhythms—the cause of “cardiac arrest.” Today such patients can be managed through a variety of treatment options offered at Aurora Health Care, including medications, ablative therapy (controlled heart tissue destruction to eliminate abnormal and dangerous heart beats), and multiple implantable cardiac defibrillator (ICD) options.

Also of note, the number of people in the United States with atrial fibrillation (AF) is increasing at epidemic proportions. AF is the most common arrhythmia in clinical practice and it affects millions of lives each year with serious and often life-threatening complications including heart failure, stroke, and death. Aurora Health Care offers patients with AF a variety of treatment options tailored to their specific needs, ranging from simple medication options to complex coordinated procedural solutions. In fact the first “hybrid” AF ablation in Wisconsin—a combined surgical and catheter-based technique—was performed in Aurora Health Care.

At Aurora Health Care we strive to always remain on the cutting edge of technology and innovation in cardiac rhythm management so that we can provide the most comprehensive management options to our patients, helping them live better and providing them the best care.

Along with various types of outpatient monitoring and testing, our diagnostic and interventional tools include:

- Electrophysiology studies
- Cardioversions
- Tilt table testing
- Catheter ablation, including ablation for atrial fibrillation and other complex arrhythmias
- Device therapy
- Drug therapy
- Hybrid surgery
- Intraoperative 3-dimensional mapping
- Channelopathy clinic
- Device optimization clinic

**EP PROCEDURES**

The electrophysiologists at Aurora Health Care provide patients with individualized treatment approaches using cutting-edge technology to eliminate or manage their heart rhythm disorders. Aurora Health Care has performed more ablation and device-related procedures than other Wisconsin health care systems. Aurora electrophysiologists implant pacemakers and defibrillators to treat cardiac rhythm disorders. A special type of pacemaker or defibrillator called a cardiac resynchronization therapy (CRT) device may also be implanted to treat heart failure in a select group of patients.

Patients with irregular or rapid cardiac rhythms may benefit from a procedure that ablates or blocks the electrical impulse or heart beats when they are out of control and causing heart fluttering. Aurora Health Care also performs tilt table testing to diagnose autonomic dysfunction that may lead to syncope (fainting).
AF ABLATION

Our electrophysiologists use multiple approaches to control or eliminate AF. In addition to drug therapy, the electrophysiologists use ablation with radiofrequency (heat) or cryoablation (cold) in conjunction with specialty three-dimensional mapping to achieve the best outcomes for ablating AF. Aurora Health Care is one of few providers in Wisconsin to offer a hybrid (surgical and minimally invasive) ablation procedure for patients with AF that has not been eliminated by drug therapy or conventional ablation.

Aurora electrophysiologists also can implant a very small device (loop recorder) under the skin that can monitor the patient continuously to record AF episodes the patient may not be aware of. This can be easily checked in the office and helps the physicians evaluate the effectiveness of therapy for the patient.

Other Innovations
Aurora Health Care’s electrophysiologists are implanting leadless pacemakers. A percutaneous (non-surgical) approach is used to place the device, which does not require a standard pacemaker lead in the heart. This is particularly beneficial for nephrology patients and young athletes.

AUTONOMIC CENTER

In collaboration with neurologists and other specialists, the electrophysiology service evaluates patients with dysautonomia. Dysautonomia is an umbrella term used to describe various conditions that cause a malfunction of the autonomic nervous system (ANS). The ANS is made up of two branches: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The SNS controls the more active “fight or flight” responses, such as increasing heart rate and blood pressure. The PNS can be thought of as the “rest and digest” part of the autonomic nervous system, as it slows down the heart rate and aids in digestion.
People living with various forms of dysautonomia have trouble regulating these systems, which can result in symptoms such as lightheadedness, fainting, unstable blood pressure, tachycardia or bradycardia, gastroparesis, and more. Dysautonomia can occur as a primary disorder or in association with other conditions, such as diabetes, rheumatoid arthritis, and Parkinson’s disease. Some of the more common forms of dysautonomia include neurocardiogenic syncope (NCS, sometimes called vasovagal syncope), postural orthostatic tachycardia syndrome (POTS), and orthostatic intolerance (OI). Some of the less common forms of dysautonomia include pure autonomic failure (PAF), multiple system atrophy (MSA), familial dysautonomia, baroreflex failure, autoimmune autonomic ganglionopathy, and dopamine beta hydroxylase deficiency.

There currently is no cure for dysautonomia, but secondary forms such as Sjogren’s syndrome-induced autonomic neuropathy or diabetic autonomic neuropathy may improve with treatment of the underlying disease. There are many treatments available to improve quality of life, including medications and lifestyle changes/adaptations geared toward the type of dysautonomia and unique health situation of the patient. Physical therapy and cardiac rehabilitation are available. Tests offered may include tilt table testing and autonomic lab testing, as well as various lab analyses.

Research protocols for POTS and neurogenic orthostatic hypotension are currently enrolling subjects.

**CARDIAC CHANNELOPATHY CENTER**

Channelopathies pose a unique diagnostic and management challenge because the abnormalities are molecular, consequences are severe, and treatment may have significant physical and psychological impacts. Channelopathies may affect family members and generations of family members. In particular, genetic testing results require careful interpretation and have implications for family screening, planning, and counseling. Such patients are best served through a dedicated clinic focused and sensitive to their unique needs.

In 2016, the Aurora Cardiac Channeopathy Center saw 76 new patients for inherited sudden death arrhythmia syndromes, such as long QT syndrome, Brugada syndrome, and idiopathic ventricular fibrillation, as examples. 72 patients received genetic testing and interpretation along with family and genetic counseling. In addition, these families have now had other family members with similar genetic predisposition to sudden death identified through cascade screening. The center has actively engaged these family members to address their associated risks as well and to educate them on their clinically and genetically unique needs.

**Electrophysiology Lab**

**Atrial Fibrillation Ablation Volumes**

 **2011-2016**

Source: STS Cardiac Surgery Registry
Sites: Aurora BayCare, Grafton, St. Luke’s & Summit
Aurora Health Care performs more than 650 heart valve surgeries per year, including repair and replacement of the mitral valve, aortic valve, pulmonic valve, and tricuspid valve.

Aurora Health Care uses a comprehensive, multidisciplinary approach to performing complex, technologically advanced heart valve surgery. The depth of surgeon experience allows us to perform high-risk, second- and third-time reoperations, as well as surgeries to patients who were deemed inoperable at other facilities.

The Aurora Transcatheter Heart Valve program specializes in the evaluation and treatment of high-risk patients who require careful planning and assessment prior to treatment options. The team of specially trained cardiologists and cardiothoracic surgeons, nurses, researchers, and other experts works together to determine the best course of treatment for each patient and offers them access to clinical trials and cutting-edge therapies for aortic and mitral valve disorders. Since the inception of the program in June 2011, thousands of patients have been evaluated with more than 1,000 patients undergoing transcatheter aortic valve replacement (TAVR).

Valve Program Evaluations

Source: Valve Program Database
**Intervention/Treatment**

Outcomes of Valve Program Referrals

2016

Source: Valve Program Database
Owing to the minimally invasive nature of many of the treatment options available, patients who are not candidates for open-chest surgery may be eligible for treatment with a catheter-based system. Through a multidisciplinary approach focused on treating patients with the best technologies available, the transcatheter heart valve team has been able to achieve excellent outcomes for patients, restoring their health, and improving their quality of life.

Among the options available for the treatment of severe aortic stenosis is transcatheter aortic valve replacement (TAVR). This treatment is utilized for patients who are at high risk for surgical aortic valve replacement. For treatment of mitral regurgitation, we have the minimally invasive mitral clip therapy, which also is placed without opening the chest and is utilized for patients who are not a candidate for open-heart surgery and mitral valve repair or replacement.

We have multiple clinical trials going on at Aurora St. Luke’s Medical Center giving our patients multiple options for treating their valve disease. Aurora Health Care recognizes the importance of technological advancement in the treatment of vascular disease and is proud to offer these cutting-edge treatments to our patients.

The Valve Program has grown considerably with the expansion of our structural heart program, inclusive of TAVR and transcatheter mitral valve replacement (TMVR), mitral clip, and other valve treatment options.
Aurora Cancer Care’s multidisciplinary team brings together a group of dedicated thoracic cancer specialists, including thoracic surgeons, pulmonologists, medical oncologists, radiation oncologists, cancer care coordinators, cancer rehabilitation specialists, and specialized nurses to provide personalized care using the latest treatments and technologies. The thoracic surgeons at Aurora Health Care treat patients with a wide variety of conditions pertaining to the lung, diaphragm, esophagus, and chest.

The team specializes in malignant diseases including lung and esophageal cancer, mesothelioma, mediastinal masses, and tumors of the chest wall, as well as benign processes including pneumothorax, pleural effusions, empyema, achalasia, and diaphragmatic hernias. In addition, technological advancements have led Aurora Health Care’s thoracic surgeons to perform rib plating, bronchial and tracheal stenting, and robot-assisted surgery. Our comprehensive program offers cutting-edge techniques and screenings for patients from all 50 states. Ninety-two percent of our thoracic surgery patients receive minimally invasive surgery for their cancer. According to US News and World Report, Aurora received the ‘best’ ranking for survival 30 days after thoracic surgery as well as the ‘best’ ranking for preventing prolonged hospitalizations. Additionally, Aurora Health Care treats more lung cancer than any other health care system in Wisconsin. Aurora Thoracic Surgery is proud to provide a highly qualified and effective treatment team for thoracic surgery patients.

Our robot-assisted thoracic surgery program is nationally recognized. Dr. William Tisol leads the busiest robot-assisted thoracic surgery practice in Wisconsin and the Midwest. Aurora Medical Center in Grafton serves as an observation center for the state-of-the-art Intuitive Surgical da Vinci XI® surgical system. Surgeons and their teams come from all over the country to observe robot-assisted thoracic surgery. Aurora Medical Center at Grafton is one of 10 approved thoracic robotic surgery mentor sites in North America and one of two in the Midwest hosting over 50 guests per year.

### General Thoracic Surgery Volumes

<table>
<thead>
<tr>
<th>Year</th>
<th>Volumes</th>
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<tbody>
<tr>
<td>2011</td>
<td>693</td>
</tr>
<tr>
<td>2012</td>
<td>758</td>
</tr>
<tr>
<td>2013</td>
<td>647</td>
</tr>
<tr>
<td>2014</td>
<td>885</td>
</tr>
<tr>
<td>2015</td>
<td>993</td>
</tr>
<tr>
<td>2016</td>
<td>1,029</td>
</tr>
</tbody>
</table>

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)
Although the thoracic team specializes in a variety of disease processes, the majority of procedures performed are pulmonary.

The majority of thoracic surgeries performed are done with a minimally invasive approach which decreases length of stay and significantly reduces the pain associated with thoracic surgery.
LOBECTOMIES

The majority of pulmonary resections (97.5%) performed at Aurora Grafton, Aurora Summit and Aurora St. Luke’s in 2015 were video-assisted procedures VATS, a minimally invasive technique that is used when appropriate to yield the best possible outcome for each patient.

VATS also may be used with a robotic technique. Minimally invasive surgery has been shown to decrease length of stay as well as postoperative complication rates. Aurora Health Care is able to accommodate the many patients who desire a minimally invasive approach.

Lobectomy Postoperative Length of Stay (Days)

2014 - 2016

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>3.7</td>
<td>4.0</td>
<td>4.9</td>
</tr>
<tr>
<td>2015</td>
<td>3.7</td>
<td>4.0</td>
<td>4.9</td>
</tr>
<tr>
<td>2016</td>
<td>3.7</td>
<td>4.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)

Minimally Invasive Lobectomy for Clinical Stage 1 Lung Cancer (Percent)

2014 - 2016

<table>
<thead>
<tr>
<th></th>
<th>Aurora (Jan 2014 - Dec 2016), N=303</th>
<th>STS (Jan 2014 - Dec 2016), N=18,378</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.5%</td>
<td>3.7</td>
<td>72.9</td>
</tr>
</tbody>
</table>

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)
Most esophagectomies for esophageal cancer in 2015 and 2016 were done using a minimally invasive technique, which decreases the length of stay, minimizes pain, and decreases recovery time.

Thoracic surgeons from Aurora Medical Center in Grafton, Aurora St. Luke’s Medical Center, and Aurora Medical Center in Summit performed 108 esophageal procedures in 2016.

Aurora Health Care performed exceptionally well for discharge mortality rate following esophagectomy at 0.0% among the patients who had surgery, which is better than the STS reported value of 2.2%.

![Esophageal Procedure Volumes](chart)

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)
Esophageal Procedures by Indication

Source: STS Thoracic Registry (St. Luke's, Grafton, & Summit)
**BY THE NUMBERS**

**Lobectomy** In-Hospital Mortality (Percent) 2014 - 2016

- **Aurora Health Care** (Jan 2014-Dec 2016) N=420: 0.1%
- **STS** (Jan 2014-Dec 2016) N=25,696: 0.8%
- **NIS** (Jan 2014-Dec 2016) N=25,675: 1.4%

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)

**Minimally Invasive Esophagectomy** In-Hospital Mortality (Percent) 2016

- **Aurora Health Care**: 0.0%
- **STS Thoracic Registry**: 2.6%

Source: STS Thoracic Registry (St. Luke’s, Grafton, & Summit)
ADVANCED HEART FAILURE THERAPIES
The Center for Advanced Heart Failure Therapies (AHFT) offers lifesaving options for end-stage left and right heart diseases. We compassionately provide the highest quality cutting-edge care individualized for patients and their families. Our integrated right and left heart program combines the national expertise of specialists in pulmonary hypertension treatment and board-certified advanced heart failure and transplant cardiologists to cover all aspects of heart care. Treatment options range from medical optimization and enrollment with our AHFT program to advanced surgical treatments for advanced heart disease. We are proud to continue the pioneering legacy of heart replacement therapy in the Midwest, including the artificial heart program and heart transplantation.

Having performed more than 890 heart transplantations and having more than 775 artificial heart devices, we are among the largest and longest-standing programs in the country.

Our outcomes are equally impressive, and we are the preferred program for all major insurance providers and the only program certified by Medicare and Medicaid services to provide all forms of heart replacement options in southeastern Wisconsin.

An interdisciplinary team is involved with every patient from the point of referral through each phase of care. Your team will consist of Advanced Heart Failure and Transplant cardiologists, cardiothoracic surgeons, physician assistants, advanced practice nurse practitioners, nurse coordinators, pharmacists, social workers, psychologists, financial counselors, chaplains, dietitians, engineers, and organ procurement coordinators. Our holistic approach to patient care is designed to improve quality and quantity of life.

The Tendick Clinic for Advanced Heart Failure Therapies encompasses the entire 4th floor of the Galleria Building within Aurora St. Luke’s Medical Center. Within this clinic, there is a blood draw lab, 12 patient exam rooms, two echocardiogram rooms, two consultation rooms, and staff offices for the left and right heart interdisciplinary teams and the clinical engineers.

The Pulmonary Artery (PA) Pressure Sensor program has continued to grow since its addition to the AHFT program in 2015. This technology is implanted in the patient’s pulmonary artery and provides daily remote pulmonary arterial pressure measurements. This allows our team to tailor the patient’s medications and interventions based on readings that were previously only obtained through invasive catheterization procedures. We have implanted 44 PA pressure sensor devices since the inception of the program. These patients have had a 61% reduction in heart failure admissions compared with their pre-implant admissions.

In 2016, the Karen Yontz Center for Cardio-Oncology was created within the Advanced Heart Failure Therapies clinic. The center was formed as a partnership between oncology and cardiology. Patients who have received cardiotoxic chemotherapy are seen in the clinic to assess the need for preventive care and ongoing testing. Patient care includes using state-of-the-art technology such as 4-D echocardiography and robust protocols to help the patient live well.
Left Heart Clinic Visit Types

2016

<table>
<thead>
<tr>
<th>Volume</th>
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<th>2016</th>
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<tbody>
<tr>
<td>Chronic Heart Failure</td>
<td>0</td>
<td>2,994</td>
</tr>
<tr>
<td>Heart Transplant</td>
<td>1,463</td>
<td></td>
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<tr>
<td>LVAD</td>
<td>845</td>
<td></td>
</tr>
<tr>
<td>Cardio-Oncology</td>
<td>39</td>
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</tr>
</tbody>
</table>

Source: Internal Database

This graph shows the total number of patients seen in the Left Heart Program in 2016.

ECMO, Heart Transplants, and VADs by Indication

2015 - 2016

- **ECMO**
  - V-V
  - V-A

- **Heart Transplants**

- **VADs by Indication**
  - Bridge to Recovery
  - Destination Therapy
  - Bridge to Transplant

Source: Internal Database

This graph displays the volume of ECMOs inserted, heart transplants performed, and VADs implanted by indication at Aurora St. Luke’s from 2013-2016.
OUTCOMES

The outcomes for our transplanted graft procedures and patient mortality rates from 1/1/14 to 6/30/16 are listed below and are better than the expected rates for both. These are the most recent results available through the Scientific Registry of Transplant Recipients (SRTR) website.

Our Kaplan-Meier Survival curve for ventricular assist devices is listed below. When compared to the InterMACs benchmark of 0.85 at 180 days, our survival is better than the benchmark.

VAD Survival (Kaplan-Meier)
7/1/2015 - 6/30/2016

Source: www.srtr.org

One-Year Cardiac Transplant Outcome
(Solitary Transplants)
1/1/2014 - 6/30/2016
*Retransplants excluded from patient survival

Source: Internal Database
Benchmark Source: InterMACs Report
The Center for Advanced Heart Failure Therapies is a sought-after site for the most innovative bench-to-bedside research programs. Internally funded and collaborative efforts have yielded information that meaningfully impacts patients’ lives. In 2016 alone our program published one book chapter, 17 abstracts and posters at national and international meetings, and eight manuscripts for peer-reviewed journals. We are actively enrolling patients in the most cutting-edge clinical projects. In total, we are enrolling patients into 14 heart failure projects and 10 pulmonary hypertension clinical trials and registries.

Training the next generation of clinicians is an equally important program initiative; we have a highly sought-after one-year American Board of Internal Medicine accredited Advanced Heart Failure and Transplant Cardiology fellowship program. In addition to knowledge-based expertise, cardiologists accepted to this program will be taught to work in a highly integrated team, which we believe is the future of patient care and medical training.
The Accredited Pulmonary Hypertension Clinic at Aurora St. Luke’s Medical Center is a multidisciplinary specialty clinic for the diagnosis and management of all forms of pulmonary hypertension. We have over 30 years of experience and use all treatment modalities with a holistic approach.
Research and Education

Funds

<table>
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<th>Type of Funds</th>
<th>Amount</th>
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<tr>
<td>Advisory Boards</td>
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<td>Educational Grants</td>
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<td>Clinical Trials</td>
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Research and Education

Projects

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<td>Clinical Trials</td>
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<td>Publications</td>
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<td>Presentations</td>
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Pulmonary Hypertension Clinic

Volumes

<table>
<thead>
<tr>
<th>Type</th>
<th>Volume</th>
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<tbody>
<tr>
<td>New Consultation</td>
<td>304</td>
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<tr>
<td>Clinic Follow-up</td>
<td>2,309</td>
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<tr>
<td>Echocardiogram</td>
<td>1,348</td>
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</table>
AT A GLANCE

Etiology of PH in Pregnant Patients
This graph explains the etiology of pulmonary hypertension in our pregnant patients.

- Idiopathic/Familial: N=58
- Sickle Cell Disease: N=11
- Congenital Heart Disease: N=24
- Connective Tissue Disease: N=23
- Anorexic Drug Exposure: N=4
- Mitral Valve Disease: N=6
- Pulmonary Emboli: N=8
### Pulmonary Hypertension Etiologies

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Who Group I</th>
<th>Who Group II</th>
<th>Who Group III</th>
<th>Who Group IV</th>
<th>Who Group V</th>
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<tr>
<td>Primary</td>
<td>P 199</td>
<td>U 3</td>
<td>Sleep Disorder</td>
<td>SD 10</td>
<td></td>
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<tr>
<td>Collagen Vascular Disease</td>
<td>CV 115</td>
<td>CH 82</td>
<td>Cor pulmonale</td>
<td>CP 14</td>
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<tr>
<td>Lupus</td>
<td>L 6</td>
<td>PH 6</td>
<td>CTEPH</td>
<td>CT 65</td>
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<tr>
<td>Scleroderma</td>
<td>S 26</td>
<td>H 5</td>
<td>Acute PE</td>
<td>PE 8</td>
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<tr>
<td>MCTD</td>
<td>M 34</td>
<td>PV 2</td>
<td>Blood Disorder</td>
<td>BD 12</td>
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<tr>
<td>Sjögren’s</td>
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<td>HF 212</td>
<td>Sickle Cell</td>
<td>SC 2</td>
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<tr>
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<td>R 17</td>
<td>V 6</td>
<td>Sarcoid</td>
<td>SA 2</td>
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<tr>
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<td>CV 24</td>
<td>I 45</td>
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<tr>
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<tr>
<td>CREST</td>
<td>CV 24</td>
<td></td>
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VASCULAR SERVICES
Aurora Health Care provides a multidisciplinary approach to diagnosing and treating all types of vascular disorders. Our specialized Vascular Team is a multidisciplinary team experienced in performing multiple vascular interventions, some of which are not available elsewhere in Wisconsin. Our experts include vascular medicine specialists, vascular interventionalists, and vascular and cardiovascular surgeons who work closely with one another to provide the best possible care and outcomes.

Our entire team is located throughout the system to better serve each of our patient service markets. Our wound care services are the largest in the state. We have eight locations with hyperbaric treatment and 12 sites with wound care services. This collaboration has improved our patients’ outcomes.

At Aurora Health Care, we consistently perform more endovascular repair procedures than open repair procedures.
AORTIC DISSECTIONS

The vascular team can quickly assess, treat, and follow up with patients presenting with both acute and nonacute abdominal aortic aneurysms. Surgeons and interventionalists are able to use minimally invasive endovascular techniques to repair both stable and rupturing aneurysms. The use of infrarenal stent grafts has increased over the years as an alternative to conventional surgery with a shorter inpatient stay and shorter recovery time. More complex abdominal aneurysms involving the renal arteries can be repaired using a fenestrated stent, which is a custom-made stent graft to accommodate the patient’s specific anatomy. More complex abdominal aneurysms that are not suitable for endovascular repair are repaired by our vascular surgeons using a conventional open abdominal repair. Acute aortic dissection or impending ruptures are taken immediately to surgery and can be repaired by either conventional or endovascular procedure.

Abdominal Aortic Aneurysm (AAA)
Repair Volumes by Year
2012 - 2016

Source: VQI Registry

Abdominal Aortic Aneurysm (AAA) Repair Volumes by Year
2012 - 2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Endovascular Repair</th>
<th>Open Repair</th>
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<tbody>
<tr>
<td>2012</td>
<td>110</td>
<td>90</td>
</tr>
<tr>
<td>2013</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>2014</td>
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</tr>
<tr>
<td>2015</td>
<td>140</td>
<td>60</td>
</tr>
<tr>
<td>2016</td>
<td>150</td>
<td>50</td>
</tr>
</tbody>
</table>

Source: VQI Registry
PERIPHERAL ARTERY DISEASE

Aurora Health Care’s multidisciplinary team of vascular interventionalists, vascular surgeons, wound care physicians, cardiologists, and interventional radiologists are highly skilled at performing a number of procedures to treat peripheral artery disease. These include procedures to the lower extremity, carotid arteries, and visceral arteries.

LOWER EXTREMITY PROCEDURES

Lower extremity atherosclerotic disease interventions are treated by endovascular means or by traditional surgical repair.

ENDOVASCULAR PROCEDURES:

• Angiography
• Angioplasty
• Drug-coated balloon angioplasty
• Atherectomy
• Stent placement
• Thrombolysis

SURGICAL PROCEDURES:

• Thrombectomy
• Endarterectomy
• Aortobifemoral bypass
• Femoral to femoral bypass
• Femoral to tibial bypass

BY THE NUMBERS

Peripheral Vascular Intervention (PVI) Volumes by Year
2012 - 2016

Lower Extremity Bypass Volumes by Year
2012 - 2016

Source: VQI Registry
CAROTID PROCEDURES

Carotid artery disease is one of the primary causes of transient ischemic attack (TIA) or stroke. Aurora Health Care’s interventional and surgical specialists are highly proficient at endovascular and surgical carotid artery repair with excellent post-procedure results. Endovascular stent placement is less invasive and may be indicated in select cases.

VASCULAR QUALITY INITIATIVE

The Vascular Quality Initiative (VQI) is a collaborative of regional quality groups collecting and analyzing data in an effort to improve vascular care. The VQI collects perioperative and one-year follow-up data to generate real-time benchmarked reports to assess quality of care and determine best practices in vascular interventions. The VQI is governed by the Society for Vascular Surgery Patient Safety Organization (SVS PSO), which provides oversight of data-sharing arrangements, key outcome and quality measure analyses, and dissemination of information to participating providers. The VQI encourages vascular surgeons, cardiologists, radiologists, and other specialists who perform the vascular procedures collected in the VQI to join this important quality initiative.

Aurora Health Care is dedicated to quality of vascular care. It is through our leadership and participation in this initiative that we can measure and ensure the highest quality services and outcomes. There are eight vascular procedures that we measure our quality performance on:

- Carotid endarterectomy
- Carotid stent
- Peripheral vascular interventions (PVI)
- Peripheral bypass grafts
- Endovascular AAA graft
- Open AAA graft
- Thoracic endovascular graft
- Amputation

HYBRID PROCEDURES

Aurora Health Care vascular surgeons and interventionalists perform hybrid procedures that include surgical procedure, such as an endarterectomy, followed by an endovascular procedure such as balloon angioplasty and stent placement. Two new state-of-the-art hybrid suites accommodate both the vascular surgeon and interventionalist in jointly performing these specialized procedures seamlessly.
Carotid Artery Stenting
Volumes by Year
2012 - 2016

Source: VQI Registry
THORACIC AORTIC PROGRAM
OUR MISSION

The Aurora Heart & Vascular Program developed a dedicated program for treating diseases of the thoracic aorta. Aurora Health Care’s focus on integrated care, heart and vascular expertise, adoption of state-of-the-art technology, and the current lack of dominant aortic centers in the region allow Aurora to be positioned as a regional, national, and global leader in this field.

The program offers the most cutting-edge treatments available, with use of hybrid technology, minimally invasive approaches, and endovascular work. Recognizing that aortic diseases have a strong genetic and familial component, the program focuses on care across generations.
WHAT TYPES OF PATIENTS CAN THE AORTIC PROGRAM SERVE?

Diseases of the aorta represent a combination of some of the most life-threatening, yet insidious conditions we face. The aorta is the main conduit that channels blood away from the heart and to the rest of the body. Conditions fall into one of two main types:

1. **Acute**, which represents immediately life-threatening aortic emergencies such as dissection, rupture or transections.

   Aortic dissection is one type of acute catastrophic event with certain types having a mortality rate of 2%/hour after diagnosis and occurs with an incidence of 15/100,000 person-years, which puts it on par with diseases such as non-Hodgkin’s lymphoma or cervical cancer.

2. **Chronic**, which consists of mostly aneurysmal disease and predisposes patients to rupture, dissection, and aortic valvular insufficiency.

   1-2% of the population has a bicuspid aortic valve, predisposing these patients to aneurysmal degeneration (occurs roughly 70% of the time), a significant health problem that has little awareness, effective screening, known knowledge of disease progression, and inconsistent treatments used among health providers.
WHAT SERVICES DOES THE AORTIC PROGRAM OFFER PROVIDERS?

Acute aortic emergencies: Rapid evaluation and treatment of acute aortic emergencies including:

- Dissections
- Intramural hematomas
- Penetrating aortic ulcers
- Transections
- Ruptures
- Rapidly expanding aneurysms

Chronic conditions of the aorta:

- Comprehensive surveillance clinic
- Genetic aortopathy clinic

Surgical treatment of aortic aneurysms from root to abdominal aorta:

- Valve sparing root replacement
- Aortic valve repair/replacement
- Ascending aortic replacement
- Aortic arch work
- Hybrid aortic operations
- Endovascular repair of thoracic and abdominal aortic aneurysms
- Minimally invasive aortic surgery
- Thoracoabdominal aortic repair

Thoracic aortic disease has become more prevalent. We have performed over 450 TAA procedures since 2013.
Aurora’s thoracic aortic aneurysm procedures (both elective and emergent, including dissection and/or rupture) have a mortality rate of 3.4%, which is well below the national average. The elective cases at Aurora have a mortality rate of 0.7% for 2016.

Operative mortality* rates for all TAA patients, both elective and emergent (including dissection &/or rupture) in 2016 = 3.4%.

Operative mortality rates for all elective TAA patients in 2016 = 0.7%.

*Operative mortality is defined as death <30 days post procedure.

TAA Procedures by Volume
2013 vs. 2016

Since 2013, Aurora has seen a 76% increase in thoracic aortic aneurysm (TAA) procedures.
TAA Operative Mortality Rate 2016

<table>
<thead>
<tr>
<th></th>
<th>Elective TAA Cases</th>
<th>Emergent TAA Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>5.0%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Aurora</td>
<td>1.0%</td>
<td>3.0%</td>
</tr>
</tbody>
</table>
CARDIOVASCULAR IMAGING
CARDIOVASCULAR SERVICE LINE DIAGNOSTIC IMAGING CAPABILITY

Aurora’s heart & vascular program has a dedicated cardiovascular imaging capability. Diagnostic testing is decentralized in the intimacy of the physician-based practice location for the convenience and comfort of the patients. Their experience is enhanced by being in the same location in which their cardiovascular specialists practice. The diagnostic modalities available include:

- **Cardiovascular CT.** The state-of-the-art GE Revolution™ is positioned to capture CT calcium scoring, CT angiography of the coronary arteries, CT angiography of the vascular system, and general radiology imaging. The 16 cm detector coverage is the largest available on the market, which allows for less heart rate management. Dramatically decreased radiation exposure is another feature. There are 256 detectors that define the images. This technology is applied for evaluation of TAVR procedures, abdominal vascular interventions, and noninvasive examination of the coronary arteries, among other uses.

- **Dedicated Cardiac PET.** Rubidium PET myocardial perfusion imaging is employed. Aurora is the only one in the region to report PET myocardial perfusion, regional wall motion, ejection fraction, and coronary blood flow. Improved imaging as compared to traditional SPECT myocardial perfusion imaging is a significant benefit. This is especially useful for larger patients as well as other clinical presentations. Again, dramatically reduced radiation exposure is possible with PET as well as a four-fold reduction in overall procedure time for the patients.

- **SPECT Myocardial Perfusion.** SPECT myocardial perfusion studies comprise 50% of all nuclear medicine procedures performed nationwide. Using conscientious patient selection, decreasing patient radiation exposure is accomplished. The American Society of Nuclear Medicine set a national goal of decreasing radiation exposure in 50% of the patients. Exposure has been reduced in 90% of patients in this setting.

- **Echocardiography.** A greater than 50% increase in patient studies has occurred since 2011. There have been many advances that have occurred over this period of time. 3D, myocardial strain and contrast imaging are enhancements that have contributed greatly to the management of patients with conditions from congenital to oncologic while utilizing state-of-the-art technology. Aurora has one archive for all echocardiogram images and reports allowing for universal access across the system from any location. Numerous quality measures have been implemented to maintain a high quality service such as weekly educational conferences, a monthly system practice meeting, report turnaround time deadlines, physician peer review, and critical results reporting. In 2016, over 30 manuscripts, reviews, and book chapters were published. The laboratory is recognized by MedAxiom as a high performing laboratory.
• **Stress Testing.** Stress performance is an integral part of both nuclear and echocardiographic imaging. These tests can be exercise, pharmacologic, or a combination. Stress testing also stands alone as the most basic cardiac diagnostic tool. Functional performance or rhythm analyses are adjuncts to the evaluation of standard stress electrocardiograms for ischemia.

• **Vascular Ultrasound.** The physician-based practice is the site for the comprehensive imaging of the cardiovascular system. It is the sole focus of diagnostics in the department. The most routine and challenging imaging of the arterial and venous systems is performed. The images are uniquely stored in a dynamic versus static format to allow for the interpretation of cine studies. Vascular medicine physicians, interventional radiologists, and vascular surgeons are located there for expert, dedicated patient care.

• **Other Imaging.** Additional nuclear procedures include the evaluation of amyloidosis, myocardial viability and radionuclide ventriculography. Enhancements to echocardiography are pioneered routinely. CT coronary artery studies are amenable to fractional flow rate determination.
Aurora Health Care is a leader in the treatment of complex heart conditions. Our cardiovascular specialty heart center serves patients with hypertrophic cardiomyopathy, adult congenital heart disease, Marfan syndrome, and valvular heart disease. Dr. A. Jamil Tajik, an internationally recognized expert, heads the centers and leads a multidisciplinary team of specialists who coordinate patient care. Our experts include cardiologists, nurse practitioners, electrophysiologists, surgeons, interventional cardiologists, and geneticists working together to provide patients with best practices and state-of-the-art care. In 2016, the center evaluated 1,800 patients.

**Hypertrophic cardiomyopathy** is a genetic condition that affects one in 500 individuals in the general population. In these individuals, the heart muscle becomes abnormally thick and can interfere with the blood flowing out of the heart. This can affect individuals at any age. We also care for patients who have inherited cardiomyopathies, familial cardiomyopathies, and arrhythmogenic cardiomyopathies. Symptoms of cardiomyopathy can include chest pain, shortness of breath, palpitations, and fainting. The hypertrophic cardiomyopathy center offers the best imaging technology available. Further diagnostic testing may include cardiac MRI, exercise stress testing, Holter monitor testing, and genetic testing. With the proper diagnosis, evaluation, and treatment, a patient’s outlook for living with hypertrophic cardiomyopathy is excellent and they should be able to lead a normal life with no significant problems. If septal reduction therapy is indicated, we do both alcohol septal ablations and septal myectomies at Aurora St. Luke’s Medical Center. We perform approximately 10 cases of each per year. We had 420 patient visits in our hypertrophic cardiomyopathy program in 2016.
Alcohol Septal Ablation
Volumes by Year
2011 - 2016

ICD Implants in Patients with Hypertrophic Cardiomyopathy
2011 - 2016
Adult congenital heart disease encompasses at least 30 conditions that can be diagnosed in infancy or later in life. This defect occurs before birth. We have expertise in this area and can provide care for complex congenital conditions. Our multidisciplinary team can offer treatment options or interventions to help patients lead a longer life. We have expertise in imaging including cardiac MRI and CT imaging to further help with diagnosis and development of treatment plans. We had 422 patient visits in our adult congenital heart disease clinic in 2016.

**Adult Congenital Heart Disease Diagnosis**

**Volumes**

2016

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**Adult Congenital Disease Clinic Visits**

**Volumes**

2012 - 2016
Adult Congenital Heart Disease Intervention
Volumes

Source: STS Cardiac Surgery Registry
**Marfan syndrome** is an inherited connective tissue disorder that can affect heart valves or enlarge the aorta. Usually people with Marfan syndrome are tall, thin, and have joint flexibility. We also care for individuals who have associated or inherited aortopathies. Aortopathies are a major cause of morbidity and mortality. Advanced imaging, including cardiac MRI/MRA and CT scans, is used to monitor and evaluate these individuals. Aurora Health Care had the opportunity to provide care for 94 patients in 2016.

Valvular heart disease is the second most prevalent cardiac disease after coronary artery disease. At the specialty center, we do advanced imaging to better help patients determine the need for and timeliness of an intervention, either surgical or medical.

The cardiovascular specialty center is unique in the area of genomic medicine. We offer genetic testing for our cardiomyopathy and aortopathy patients, which can help us better care for them and also their family members who may have inherited the condition. We have advanced imaging using 2-and 3-D Doppler. We also use cardiac MRI and CT imaging in selected cases.

In addition, we also perform device (ICD or pacemaker) optimization in our clinic with the assistance of the electrophysiology team. Small changes can be made to improve the hemodynamics of the patients and improve their outcomes and symptoms.

Channelopathies are diseases that involve the dysfunction of an ion channel or the proteins that regulate them. These can either be congenital (from birth) or acquired. We have a team of specialists including physicians, nurse practitioners, genetic counselors, and pharmacists.
CARDIAC REHABILITATION
PREVENTIVE CARDIOLOGY AND REHABILITATION

Cardiac rehabilitation is a medically supervised program designed to help cardiac patients restore their health—physically, physiologically, and socially. Rehab focuses on heart-healthy eating, long-term strategies for weight loss, exercise, managing stress, improving moods, and quitting smoking.

Cardiac rehabilitation is handled by a team of health professionals led by a medical director and including nurses, exercise physiologists, dietitians, and health psychologists. Cardiac rehabilitation usually happens in three phases:

**Phase 1 – Inpatient cardiac rehabilitation** – Immediately after cardiac surgery or another treatment, while still in the hospital, a patient will begin mild exercise to improve his or her strength before going home. The patient will also receive education and counseling about risk factors.

**Phase 2 – Outpatient cardiac rehabilitation** – This usually starts one to four weeks after the patient returns home. A referral from their doctor is required for participation. The program includes supervised exercise at a hospital or clinic. As the patient exercises, we monitor heart rate, heart rhythm, and blood pressure. Various pieces of exercise equipment, such as a treadmill, stationary bike, and elliptical machine, will be used. The participant also will receive group and individual counseling aimed at modifying risk factors, and will learn more about physical activity and nutrition; how to quit smoking; how to manage weight, blood pressure, and cholesterol; and more. Depending on the diagnosis, insurance (including Medicare) usually covers this portion of rehabilitation.

**Phase 3 – Maintenance** – Upon completion of Phase 2, the patient might want to stay in a supervised program in a hospital or clinic because it can help to cement the good habits learned and continue improvement.
**LDL at Target Levels**

2008 - 2016 • Patients who completed at least 28 sessions

- **LDL < 70 mg/dL**
- **LDL < 100 mg/dL**

Source: Milwaukee Metro Cardiac Rehab Programs

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**Phase 2 Cardiac Rehabilitation**

Participation by Indication

- **Surgical Patients**
- **Medical Patients**
- **Other Patients**

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**Phase 2 Cardiac Rehabilitation**

Compliance with Visits

- **Visits 1-27**
- **Visits 28-36**
- **All 36 Visits**

---

(N=3,649)  
(N=564)  
(N=444)  
(N=502)
Phase 2 Cardiac Rehabilitation
Changes in Physical Performance* (METs)

- Initial METs
- Final METs

Surgical Patients

<table>
<thead>
<tr>
<th>Year</th>
<th>Initial METs</th>
<th>Final METs</th>
<th>(N)</th>
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<tbody>
<tr>
<td>(N=730)</td>
<td>(N=130)</td>
<td>(N=101)</td>
<td>(N=112)</td>
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</table>

Phase 2 Cardiac Rehabilitation
Changes in Quality of Life (SF36)*

- Initial PCS
- Final PCS
- Initial MCS
- Final MCS

Medical Patients

<table>
<thead>
<tr>
<th>Year</th>
<th>Initial PCS</th>
<th>Final PCS</th>
<th>Initial MCS</th>
<th>Final MCS</th>
</tr>
</thead>
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<tr>
<td>(N=637)</td>
<td>(N=126)</td>
<td>(N=75)</td>
<td>(N=80)</td>
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</table>

Phase 2 Cardiac Rehabilitation
Changes in Physical Performance*

- Initial METs
- Final METs

Medical Patients

<table>
<thead>
<tr>
<th>Year</th>
<th>Initial METs</th>
<th>Final METs</th>
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<tbody>
<tr>
<td>2007-2013</td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>(N=859)</td>
<td>(N=158)</td>
<td>(N=94)</td>
</tr>
</tbody>
</table>

2016 (N=124)
Cardiac Rehab Locations

AURORA ST. LUKE’S MEDICAL CENTER
AURORA WEST ALLIS MEDICAL CENTER
AURORA MEDICAL CENTER IN KENOSHA
AURORA HOSPITAL OF BURLINGTON
AURORA MEDICAL CENTER IN SUMMIT
AURORA MEDICAL CENTER IN GRAFTON
AURORA MEDICAL CENTER IN MANITOWOC COUNTY
AURORA MEDICAL CENTER IN WASHINGTON COUNTY

AURORA BAY CARE MEDICAL CENTER
AURORA BAY AREA HEALTH CENTER
AURORA SHEBOYGAN MEMORIAL CENTER
AURORA MEDICAL CENTER IN SUMMIT

CLINIC BASED
WEST BEND
OSHKOSH
FOND DU LAC
Aurora Health Care hosts one of the few research centers in the world devoted entirely to studying the effect of aging on the cardiovascular system. The Center for Integrative Research on Cardiovascular Aging (CIRCA) is led by renowned cardiologist Arshad Jahangir, MD.

With the support of a generous $2 million donation from the late Sheikh Khalifa bin Hamad Al Thani in 2014, CIRCA's mission is to conduct basic, translational, and clinical research on the biology of cardiac aging, and to develop new ways to predict, diagnose, and treat age-related cardiovascular dysfunction to preserve wellness and improve the quality of life of older people.

In Discovery Laboratory at Aurora Sinai Medical Center and the cardiovascular research laboratory at Aurora St. Luke’s Medical Center, Dr. Jahangir and the CIRCA team are studying the molecular basis for the aging heart’s decreased ability to tolerate stress and increased susceptibility to injury and heart rhythm disorders.

The CIRCA team has presented original research at national and international conferences.
This translational research study compared atrial tissue from middle-aged and elderly patients with a history of AF to a matched group of patients without AF. The researchers found an association between AF and a reduction in specific mitochondrial activity. This study may help identify targets for therapies that prevent AF.

**Discovery chamber-specific difference in humans**

Research scientist Farhan Rizvi, PhD, and colleagues published a paper in *American Journal of Physiology-Cell Physiology* identifying differences in responsiveness between cardiac fibroblasts from the upper and lower heart chambers. Cardiac fibroblasts, which help repair injured heart tissue by forming scar tissue, have become an intense research focus in aging-associated disease. Excessive or patchy scar tissue buildup increases risk for heart failure and AF. No therapies effectively prevent such scar formation or progression.

The study results highlight the complexity of atrial and ventricular tissue function and their responsiveness to injury. The study provides support for development of therapies targeting atrial fibroblasts to reduce excessive scar formation after injury without significantly altering ventricular fibroblast function.

**Finding a potential new cause for scar buildup**

Research scientist Gracious Ross, PhD, and colleagues published a study in *Biology Open* comparing cardiac fibroblasts from ventricular tissue of patients with advanced heart failure to those of healthy patients. The team discovered a new cause for excessive scar buildup.

This study is an important contribution to medicine as it provides a potential new target for development of therapies to reduce fibrosis and progression of heart failure and arrhythmia in diseased hearts.
GROWING BEATING HEART CELLS IN A DISH

Research scientist Rosy Joshi-Mukherjee, PhD, and research technologist Stacie Edwards are building a cell-based program at CIRCA using induced pluripotent stem (iPS) cell technology. This revolutionary technology takes Aurora researchers closer to growing miniature beating heart tissue on which new therapies for treating cardiovascular disease can be tested in a dish. Use of this technology may reduce or eliminate the need for experimental animal models and the controversial use of embryonic stem cells in the search for new therapies to prevent and treat heart failure.

After launching the cell-based program in late 2015, the team has made progress implementing the iPS cell technology and establishing techniques to successfully grow heart cells derived from reprogrammed iPS cells. The research was presented by Dr. Joshi-Mukherjee at Gordon Research Conference on Cardiac Arrhythmia Mechanisms in Ventura, Calif., in February 2017.

After testing iPS cells for specific markers to ensure the reprogramming had been successful, Dr. Joshi-Mukherjee and her team initiated a cardiac differentiation protocol to transform the iPS cells into beating heart cells that expressed specific cardiac markers and with electrophysiological characteristics of beating cells from various chambers of the heart.

To continue this work, Dr. Joshi-Mukherjee received a $50,000 Cardiovascular Surgery Research Award. In the future, researchers plan to generate iPS cells directly from blood or skin tissues from Aurora patients, potentially leading to a precision medicine approach.
THE TAVR SUCCESS STORY

The journey to bring a new major medical treatment to patients requires cooperation from a dedicated team of researchers, coordinators, doctors, nurses and clinical trial participants. The transcatheter aortic valve replacement (TAVR) procedure represents one success story that continues as Aurora Health Care physician researchers have become national experts on this latest advancement.

What’s TAVR?

TAVR provides a less invasive alternative to open-heart surgery for patients with severe narrowing of the aortic valve who are unable to safely undergo surgery because of age or other medical condition. Left untreated, these patients have a 50 percent risk of dying at one year.

During the procedure, the physician inserts a new valve into the heart through an artery using a catheter. Patients spend less time in the hospital because the chest cavity does not need to be opened.

Aurora’s Role

Aurora Research Institute played a key role in Medtronic Inc.’s CoreValve™ device being used for the TAVR procedure, participating in clinical trials that led to US Food and Drug Administration (FDA) approvals in 2014 through 2016.

Aurora has been the only site in the state to participate in the clinical trials contributing to CoreValve’s approvals and the first site in the state to commercially offer the CoreValve™ device to patients after each approval.

In October 2016, the FDA approved the Evolut™ R 34-mm aortic valve in the CoreValve family, and it is currently the largest-sized TAVR system available in the US. Aurora enrolled more patients in this clinical trial than any other site in the country.

This large valve expands the population that can undergo the procedure. Previously, patients with larger aortic anatomy would have had to undergo open-heart surgery.

1,000th TAVR

Since it became available through participation in a clinical trial in 2011, Aurora St. Luke’s Medical Center celebrated its 1,000th TAVR procedure Dec. 8, 2016.

A brief ceremony began when cardiologist Tanvir Bajwa, MD, and cardiovascular and thoracic surgeon Daniel O’Hair, MD, arrived just moments after completing their latest TAVR case. Drs. Bajwa and O’Hair have served as local principal investigators for the different clinical trials studying the CoreValve platform. Paul Werner, MD, and Suhail Allaqaband, MD, have assisted as subinvestigators for these trials.

No other health system in the country has a team that has performed as many TAVR procedures together. The team at Aurora St. Luke’s performs typically eight to 10 TAVR procedures a week with a 100 percent success rate. Physicians and government officials from around the world have visited Milwaukee to watch the Aurora St. Luke’s TAVR team in action.

TAVR into the Future

Aurora’s expertise with TAVR will continue as the institute is currently involved in seven TAVR trials with more to come in 2017. Six of the trials are studying Medtronic’s CoreValve™ and one is studying Boston Scientific’s Lotus™ Valve System (REPRISE III trial).

No other health system in the country has a team that has performed as many TAVR procedures together.
PATIENT STORY:
Charles Zern
One Man’s TAVR Experience

Nonagenarian Charles Zern volunteered to enroll in a CoreValve clinical trial in 2013. After having hip surgery in 2010, the Wauwatosa resident developed atrial fibrillation, an irregular heartbeat, while in the hospital. Less than a year later, he was rushed to the hospital with heart failure.

Tests determined that Zern had severe aortic stenosis. He had no other major health concerns, and the surgeon determined that open-heart surgery presented an intermediate risk, despite his age of 88 years. His cardiologist sent him to Aurora St. Luke’s to see Dr. Daniel P. O’Hair and learn more about the TAVR clinical trial.

Wendy Dunaj, RN, manager of cardiovascular clinical trials, and Deb Waller, BSN, research coordinator, explained the clinical trial process and answered Zern’s questions regarding participation. Zern qualified for the SURTAVI clinical trial, but his treatment assignment would be comparable to flipping a coin to either open-heart surgery or TAVR. After being randomly selected, Zern underwent TAVR on July 8, 2013. Dr. Tanvir Bajwa and Dr. O’Hair performed the procedure together.

Zern said that he would do it all again in a heartbeat. He is happy that his participation in this clinical trial could help others. He is about halfway through his clinical trial participation. Researchers will follow him for another two years.

“I feel fine now, but I get a little short of breath because of the heart failure,” Zern said.
“The best part of the whole experience is that I am still here.”

Zern will celebrate his 92nd birthday in June 2017 and is planning a train trip across the Canadian countryside.

“I wouldn’t be here if it weren’t for Dr. Bajwa and Dr. O’Hair,” Zern said. “They are absolutely the top. They not only have an interest, they care.”

Zern’s experience should not be used to predict outcomes of the clinical trial or the procedure. Data collection continues.
For a medical device to become available for widespread use in the United States, generally it must first be cleared by the Food and Drug Administration (FDA). Clinical trial results help the FDA determine whether a device should be cleared. In addition to TAVR (see pages 15-16), Aurora Health Care participated in clinical trials that led to FDA approval of five other heart health innovations in 2016.

### Bioresorbable Stent

Aurora St. Luke’s Medical Center became one of the first sites in the nation to implant the Abbott Absorb bioresorbable stent, approved by the FDA in July 2016 for patients with coronary artery disease. Affecting 15 million people in the US alone, coronary artery disease is the leading cause of death worldwide.

Aurora researchers first studied the stent through a Phase III clinical trial sponsored by Abbott (clinicaltrials.gov identifier: NCT01751906). Aurora St. Luke’s was the only site in the state to participate in the trial. Now the stent is available for widespread use.

“It [the bioresorbable stent] supports the artery for a period of time and then, in about three years, it dissolves and disappears,” said Suhail Allaqaband, MD, local principal investigator. “A game changer in the treatment of clogged arteries.”

Before the advent of the bioresorbable stent, interventional cardiologists used only metal stents for clogged arteries. Metal stents remain in place for the rest of the patient’s life, oftentimes restricting vessel motion. Dr. Allaqaband said the lack of metal will simplify future heart surgeries while promoting healing and enlarging the artery.

Data collection for the clinical trial continues. Don Lobacz, RN, is site coordinator.

### Preventing Stroke Recurrence

Blood clots can travel to the brain through a hole in the heart called a patent foramen ovale (PFO) and cause stroke. This hole often isn’t found until a stroke has occurred. For more than 10 years, Aurora researchers have participated in clinical trials to study PFO closure devices, including the St. Jude Medical Amplatzer PFO Occluder, hoping to reduce stroke recurrence.

In October 2016, the FDA approved the use of the occluder, a device implanted nonsurgically, and in mid-November, interventional cardiologist Tanvir Bajwa, MD, became the first in Wisconsin to implant the approved device.

“The recent FDA approval of the PFO Occluder brings new hope for patients ages 18 to 60 with cryptogenic stroke who may be seeking alternative treatment options for prevention,” Dr. Bajwa said. “Being the first hospital in the state to provide this new device to patients builds on our commitment to innovation and providing the best in patient care.”

Dr. Bajwa is the local principal investigator at Aurora St. Luke’s for the Amplatzer trial (clinicaltrials.gov identifier: NCT00465270). He and Dr. Allaqaband have served as local principal investigators at Aurora St. Luke’s for two additional PFO clinical trials. Aurora enrolled the most subjects of any site for two of the three studies. In the third trial, Aurora enrolled the second most subjects.

Data collection for the clinical trials continues. Deb Waller, BSN, is site coordinator.
Gore Excluder® Iliac Branch Endoprosthesis

With participation by Aurora St. Luke’s, W.L. Gore and Associates proved the safety and effectiveness of the Gore Excluder® Iliac Branch Endoprosthesis to the FDA, receiving approval in February 2016 to make the device commercially available. Interventional radiologist Mark Mewissen, MD, led the clinical trial at Aurora St. Luke’s to evaluate this first-of-its-kind device for endovascular treatment of aneurysms in the common iliac or aortoiliac arteries, which are located in the abdominal area (clinicaltrials.gov identifier: NCT01883999). Aneurysms are ballooning and weakening of the arteries. This device allows for preservation of flow in the internal iliac arteries, and important circulation to vital structures in the pelvis.

Nicole Baecker, BSN, is site coordinator.

Navik 3D™

With support and backing from Aurora, APN Health, LLC in February 2016 received FDA clearance to market its advanced three-dimensional cardiac mapping system, Navik 3D™. Development of the Navik 3D™ system was a collaborative effort led by renowned Aurora cardiac electrophysiologist Dr. Jasbir Sra, MD. The system reduces cost and complexity of electrophysiology procedures by providing real-time 3D maps that provide catheter location in the heart. Navik 3D™ is the first cardiac mapping system that doesn’t require specialized equipment. Instead it uses the patient monitoring and fluoroscopic imaging systems already present in electrophysiology laboratories.

Micra Transcatheter Pacing System

In April 2016, the FDA approved the Micra Transcatheter Pacing System (Medtronic Inc.), the first pacemaker that doesn’t require surgery, and reduces device pocket infections. The device, about the size of a nickel, is implanted directly in the right ventricle via a minimally invasive procedure through a vein in the leg. Serving as principal investigators at Aurora St. Luke’s, cardiac electrophysiologists Dr. Sra and Vikram Nangia, MD, were the first in Wisconsin to implant the miniature leadless pacemaker as part of a clinical trial (clinicaltrials.gov identifier: NCT02004873). Anthony Chambers, BSN, is site coordinator.
Researhing Regeneration of Diseased Heart Muscle

Aurora St. Luke’s Medical Center is the only site in Wisconsin conducting the Phase II ALLSTAR trial sponsored by biotechnology company Capricor Inc. (clinicaltrials.gov identifier: NCT01458405). Local principal investigator Tanvir Bajwa, MD, is testing the safety and effectiveness of cardiac stem cells derived from donors unrelated to the recipients, CAP-1002, in regenerating heart muscle and reducing scar size in subjects who have had a heart attack. A heart attack damages, or scars, heart muscle, which increases the risk of heart failure. Clinical trial subjects are randomly assigned to receive the investigational cardiac stem cell therapy or a placebo. Because the process is blinded to avoid scientific bias, the physician, caregiver and patient do not know whether the study therapy or placebo was used. Investigators will follow the study subjects for up to five years to determine the safety of the treatment and whether the scar, or infarct, size has decreased in those who received the stem cells compared to those who did not. Dena Burke, BSN, is coordinating the trial for Aurora.

Studying Pulmonary Arterial Hypertension

Pulmonary arterial hypertension (PAH), a rare but serious condition, causes pressure in a patient’s pulmonary arteries to become critically high. Aurora St. Luke’s is the only site in Wisconsin to participate in the Multinational, Multicenter Study to Assess the Effects of Oral Sildenafil on Mortality in Adults With Pulmonary Arterial Hypertension (AFFILIATE) and was the first site in the United States to enroll a subject (clinicaltrials.gov identifier: NCT02060487). Led locally by Dianne Zwicke, MD, this study will assess the effect of different dosages of oral sildenafil on mortality in adults with PAH. Pfizer Inc. is sponsoring this Phase IV international study. The trial coordinators are Linda Boehm, RN, and Kelsey Krueger.

Hundreds of patients enroll in cardiovascular trials at Aurora Health Care each year.

Available clinical trials study treatments and devices for the spectrum of heart diseases.

Aurora St. Luke’s is one of 30 sites across the US participating in a national registry trial conducted by the University of California-San Diego for patients with chronic thromboembolic pulmonary hypertension (CTEPH), which is high blood pressure in the pulmonary arteries that lasts six months or more (clinicaltrials.gov identifier: NCT02429284). Led locally by Dr. Zwicke, the registry will track at least 750 subjects with a new CTEPH diagnosis over the next six years. The registry will foster understanding of the disease, treatment responses and improvement of care for patients with CTEPH. Linda Boehm, RN, is the local coordinator.
Tailoring Antiplatelet Drug Decisions to Individual Genetics

After receiving a stent, patients will take antiplatelet medication to prevent blood clots from forming. Studies have suggested that patients with a certain genetic liver enzyme abnormality may not respond as well to the currently approved antiplatelet medication, clopidogrel. A newer antiplatelet drug, ticagrelor, works regardless of the abnormality, but is more expensive and requires more frequent doses. As part of the TAILOR PCI trial, local principal investigator Louie Kostopoulos, MD, is studying whether or not genetic testing can identify the best antiplatelet therapy for patients who receive a coronary stent (TAILOR-PCI, clinicaltrials.gov identifier: NCT01742117). This Phase IV trial is sponsored by Mayo Clinic and National Institutes of Health. Dena Burke, BSN, is coordinating the trial at Aurora St. Luke’s.

”Wrapping-up” Devices to Reduce Infection

Devices such as pacemakers and implantable cardioverter-defibrillators can become infected. Local principal investigator Vinay Mehta, MD, joined Medtronic Inc.’s global study evaluating the TYRX™ Absorbable Antibacterial Envelope’s effectiveness in reducing major infections following cardiovascular implantable electronic device procedures (clinicaltrials.gov identifier: NCT02277990). This postmarketing study tracks subjects’ occurrence of a major infection over one year. Alex Albers is coordinating the trial at Aurora BayCare Medical Center.

Providing Expert Input for Latest Imaging Devices

Aurora St. Luke’s is the only site in the nation providing clinical evaluation of GE Healthcare’s Vivid IQ, Vivid E95 and LOGIQ E9 ultrasound systems. Vivid E95 is looking at the highest resolution four-dimensional ultrasound imaging. Principal investigator Bijoy Khandheria, MD, is providing feedback on workflow, performance, user preference, image quality and device features. Research coordinator Kathy Schmidlkofer is providing site coordination. Vivid and LOGIQ are trademarks of General Electric company.

BY THE NUMBERS

88 cardiovascular clinical trials open to accrual and follow-up as of Dec. 31, 2016

585 new subjects enrolled in cardiovascular clinical trials in 2016
with more than $750,000 in external and internal grant awards, Aurora Health Care researchers launched new and continued existing cardiovascular research projects.

**External Funding**

### 2016 EXTERNAL AWARDS

**Smarter management and resource use for today's complex cardiac care (SMARTCare)**
Investigator: Kenneth Phillips, MD
$225,735 (continuing support)
Centers for Medicare and Medicaid Services subaward from American College of Cardiology Foundation

**Predictive optimal anticlotting treatment for segmented patient populations**
Investigator: Kourosh Ravvaz, MD, PhD
$120,221 (continuing support)
National Institutes of Health subaward from Harvard University

**Predicting risk of cardiotoxicity in cancer patients undergoing chemotherapy incorporating genetic signatures**
Investigator: Vinay Thohan, MD
$80,000
Greater Milwaukee Foundation

**Using systems science methods to study cardiac risk in the Somali community**
Investigator: Ahmed Dalmar, MD
$20,691 (continuing support)
National Heart, Lung, and Blood Institute subaward from HealthPartners Institute for Education and Research

**Biomarkers to identify patients at high risk for heart failure after cardiac surgery**
Investigator: Farhan Rizvi, PhD
$10,000
David V. Uihlein Foundation

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**Award Highlights**

Chemotherapy drugs, such as anthracycline, though effective in combating cancer, can cause damage to the heart that may lead to death. Advanced heart failure and transplant cardiologist Vinay Thohan, MD, hypothesized that the reason for the damage may partially lie in the patient’s genetic structure.

Dr. Thohan and his team are assessing 14 years of data to identify which patients treated with anthracyclines developed heart damage. DNA from these patients stored in Aurora’s Biorepository and Specimen Resource Center will allow the researchers to assess whether any of more than 100 gene variants associated with heart damage correlate with cardiac outcomes.

This project aims to better identify which patients are more susceptible to cardiotoxicities from chemotherapy, allowing oncologists to design patient-centered treatment plans.

This study is supported by an $80,000 grant award from Greater Milwaukee Foundation.

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**Transformational Gift**

A $1 million gift by anonymous donors will help influence the next generation of cardiologists. The gift will create the Colton Scholar in Cardiology Research in honor of Dr. A. Jamil Tajik, which will support the hiring of research scholars to spur cardiovascular advances.
Internal Funding

2016 INTERNAL AWARDS

Sullivan Cardiac Research Award for Residents and Fellows
*Up to $30,000 each*

Echocardiographic mechanisms of left ventricular thrombus formation among patients with heart failure with reduced ejection fraction: the role of strain analysis assessed by two-dimensional speckled tracking
Investigator: Dhruv Chawla, MD

Therapeutic approach to implantable hemodynamic monitoring: A timing-based strategy
Investigator: Shankho Ganguli, MD

Cardiac Research Award
*Up to $40,000 each*

HeartQoL validation in patients with ischemic heart failure
Investigator: Nasir Sulemanjee, MD

Protein phosphatases PP2A and PPMIA in ventricular fibroblasts as potential targets for ventricular fibrosis prevention in heart failure
Investigator: Farhan Rizvi, PhD

A novel strategy to protect against dronedarone-induced myocardial dysfunction in the failing heart (second-year continuation)
Researcher: Larisa Emelyanova, PhD

Cardiovascular Surgery Research Awards
*Up to $50,000 each*

Effect of age-associated epigenetic memory on human-induced pluripotent stem cell-derived cardiomyocytes differentiation and maturation
Investigator: Rosy Joshi-Mukherjee, PhD

Dedifferentiation of cardiac myofibroblasts to fibroblasts as a strategy to mitigate cardiac fibrosis and progression of heart failure
Investigator: Gracious Ross, PhD, DVM

Aurora Cardiovascular Services Research Support Fund
*Up to $2,000 each*

Autoantibodies to angiotensin type 1 receptor in cardiac transplant candidates: Do pre-existing antibodies have a role in long-term outcomes?
Investigator: Martin Oaks, PhD

Award Highlight

Although many patients with congestive heart failure are treated with blood thinners, no definitive recommendation exists to minimize the risk of clotting in patients who do not have pre-existing indications.

Mentored by interventional cardiologist Tanvir Bajwa, MD, and advanced heart failure and transplant cardiologist Vinay Thohan, MD, fellow Dhruv Chawla, MD, will use echocardiography to analyze variation in the heart’s contraction to determine factors leading to the formation of clots inside the heart.

Identifying these subtle differences may help clinicians determine which patients would benefit from blood thinners.

This study is supported by a $30,000 Sullivan Cardiac Research Award for Residents and Fellows. The Sullivan research award is possible thanks to a generous $1 million gift from Vivian and Tim Sullivan to support the research of Dr. Bajwa via the fellowship program.
Funds are available because of the generosity of donors to Aurora Health Care Foundation. 

$304,485 awarded by Aurora Research Institute in 2016 to Aurora Health Care investigators.
PATIENT STORY:
Alan Sanford
My Best Day is Today

In the second half of 2012, after having a ruptured mitral valve repaired more than five years earlier and enduring one heart attack and chronic heart failure, Greendale resident Alan Sanford, then 70, was at the maximum age for heart transplant. Not considered high enough risk to be placed on the waiting list, he seemed to be out of options. Or was he?

In February 2007, while his wife, Adelle Sanford, was out of town, Alan found himself panting and out of breath while taking a short walk down his driveway to take out the trash. When Adelle, a registered nurse at Aurora St. Luke’s Medical Center, returned, she encouraged him to see a cardiologist who told Alan that he had a ruptured mitral valve, the dual-flap valve that helps facilitate the flow of blood into the left ventricle of the heart.

A few weeks later, Alan had the valve repaired, but during one of the subsequent follow-up visits, it was discovered that he had also had a silent heart attack. He then received a Holter monitor, a portable device that continuously measures and records the heart’s activity.

In July 2007 while playing volleyball, a sport Alan and Adelle had enjoyed for almost 35 years, Alan passed out on the sand in cardiac arrest. Adelle lifted his chin to open his airway and was ready to begin cardiopulmonary resuscitation, when he spontaneously returned to consciousness.

“When I came to, I said, ‘I think I can finish the game,’” Alan said. But the paramedics had arrived, and took him to the emergency department. The doctors there received information from the Holter monitor that helped them swiftly make treatment decisions.

Later in the month, Alan received a pacemaker and stent. He began cardiac rehabilitation. His health remained relatively steady for almost three years. However, in May 2010, he suffered a ventricular tachycardia, which means his heart rate became dangerously high. He then needed a stent repair in mid-June. At this point, Alan had grown tired of and from his heart problems.

Interventional cardiologist, Suhail Allaqaband, MD, suggested that Alan consider a heart transplant. “That was second only to hearing the big C-word,” Alan said. He then visited Nasir Sulemanjee, MD, a member of the Aurora St. Luke’s Heart Failure and Transplant team, to learn more about transplantation, but Alan was at the maximum age of 70 for a heart transplant, and his heart was not considered a high enough risk to put him on the waiting list for a transplant.
Taking a Chance

Then Dr. Sulemanjee suggested a clinical trial using stem cells for heart failure that was being conducted at Aurora. DREAM HF-1 is a double-blind, placebo-controlled, Phase III study designed to test the safety and effectiveness of a new stem cell therapy known as rexlemestrocel-L in people with chronic heart failure compared with subjects who do not receive the stem cells (clinicaltrials.gov identifier: NCT02032004). Dr. Sulemanjee is the local principal investigator.

Stem cells may be capable of repairing damaged tissues due to their regenerative abilities. The stem cells in the DREAM HF-1 study are manufactured from the bone marrow of healthy donors and injected into damaged heart tissue.

Alan decided to pursue the study, but did not initially qualify for enrollment because his heart failure was not severe enough. However, seven months later in August 2015, Alan developed a case of pulmonary edema and went to the emergency department. Pulmonary edema is caused by extra fluid in the lungs and can make it difficult to breathe.

Alan called the Aurora research coordinator for the study, Don Lobacz, RN, who determined that Alan qualified for the DREAM HF-1 study. On October 14, 2015, Sanford received his injection.

“This is a double-blind study, so you don’t know if you are going to get the stem cells or not,” Alan said. “I was told that when I went through the procedure, I would go to the operating room, they would insert the catheter, and the doctor will go through the whole routine that he would go through whether or not I received the stem cells.”

Celebrating Today

Alan will not know whether he received a placebo or the stem cells until the study has completed, but he has had no cardiac-related incidents since the infusion.

“Fairly quickly, I started feeling much, much better,” Alan said. “I was also aware that there could be a placebo effect.”

Before receiving the infusion, Alan’s heart ejection fraction, a test that measures the amount of blood leaving the heart as it contracts, was 20 percent. Three months afterward, his ejection fraction had improved to 30 percent. Normal ranges from 55 to 70 percent.

Alan turned 75 in May 2017. He and Adelle celebrated 50 years of marriage in January 2016. They enjoy traveling around the United States to visit their three children and seven grandchildren.

“I am very lucky,” Alan said. “Before the procedure, tomorrow was always my best day. I will do that tomorrow, I would say. Now my best day is today.”

Sponsored by Mesoblast Inc., the clinical trial is ongoing. Alan’s experience should not be used to predict outcomes of the clinical trial. Rexlemestrocel-L is an investigational agent and is being evaluated in clinical trials.

Stem cells may be capable of repairing damaged tissues due to their regenerative abilities.
Research that Never Skips a Beat

When David Kress, MD, came to Aurora St. Luke’s Medical Center in the early 1990s he fell into a rhythm of day in and day out heart surgery. But a heart condition he’d studied in his residency kept needling him … atrial fibrillation.

His persistence in pursuing ways to address the disease has led to a career dedicated to cardiovascular research and innovation.

From the Start

Atrial fibrillation (AF) is an irregular heartbeat that can lead to stroke and heart failure. More than 5 million people in the US have the condition.

Early in his career, Dr. Kress served as principal investigator for several major clinical trials to study AF. As a result, he experienced a series of clinical milestones that include being one of the first in the state and, in some cases, the nation to perform increasingly complex ablation techniques to eliminate AF.

“I was in at the very beginning of the surgical ablation era, and that has matured into something that almost every surgeon does. At the time, only a handful of surgeons in the world were doing it. To me, that has been the most fulfilling part of being involved with research,” said Dr. Kress, who is director of the Surgical Arrhythmia Program at Aurora St. Luke’s.

Today, Aurora St. Luke’s is the only hospital in Wisconsin and one of only a few in the nation to offer the hybrid ablation technique pioneered by electrophysiologist Jasbir Sra, MD, and Dr. Kress. To perform the hybrid technique, an electrophysiologist and cardiothoracic surgeon work together to ablate the heart to restore its normal rhythm. The surgeon’s ablations occur outside of the heart, while the electrophysiologist uses a catheter inside of the heart to create scar tissue. The two ablations block the electrical pathways that are causing the irregular heartbeat.

Not Just AF

To date, Dr. Kress has participated in over 50 clinical trials and has lectured on surgical innovations in cardiac electrophysiology at major scientific meetings throughout the US, Canada, Europe and Asia.

He has authored and reviewed numerous papers and continues to conduct research, perform surgeries, and serve on scientific committees and advisory boards.

Over the years, Dr. Kress has encountered patients with acute kidney injury, an uncommon but serious complication after heart surgery. At Aurora St. Luke’s, he is participating in a Phase II clinical trial to study whether a gene-inhibiting drug prevents this complication.

The sponsor, Quark Pharmaceuticals, has developed an experimental compound, QPI-1002, to temporarily stop a natural genetic response to the trauma of cardiac surgery, allowing time for repair of cellular damage and prevention of kidney injury. The trial’s purpose is to determine the drug’s safety and effectiveness (clinicaltrials.gov identifier: NCT02610283).

Dr. Kress’ research interests also include surgically implanted devices. In the PERIGON Pivotal Trial, researchers are studying the Medtronic Model 400 aortic valve bioprosthesis in patients with aortic valve disease (clinicaltrials.gov identifier: NCT02088554).

The elimination of AFib will always be a primary area of research for Dr. Kress. As he explores new surgical innovations in cardiac electrophysiology, he continues to ensure that hearts don’t skip a beat and neither has he in his over 25 years at Aurora.
To date, Dr. Kress has participated in over 50 clinical trials.
Living Big Data

Precision medicine puts the patient at the center of care. It encompasses individual genetic and molecular profiles and comprehensive longitudinal information stored within massive databases and electronic health records to advance tailored disease prevention and treatment. It means thinking big data.

In the past two years at Aurora Research Institute, physician-researcher Kourosh Ravvaz, MD, PhD, has been living big data, devising ways to improve survival rates, accelerate innovation and lower costs.

“As a physician with several years of experience in clinical practice, I have always had a vision to develop translational research approaches that would improve health outcomes and delivery of high-quality care,” Dr. Ravvaz said.

His team has been investigating use of patients’ genotypes to optimize anticoagulation therapy. Anticoagulants are used to thin the blood, which helps prevent clot formation, a cause of stroke. Warfarin, a common anticoagulant, has been challenging for providers because the effective amount varies greatly between individuals and because many foods and drugs adversely interact with the medicine.

Newer drugs, called novel oral anticoagulants (NOACs), are costly in comparison to warfarin and have not been shown to be universally more effective, but are likely better than warfarin for some people.

“It has been shown that because of a difference in a few genes, one person’s dose could be 20 times that of someone with otherwise similar clinical characteristics,” Dr. Ravvaz said. With the help of Aurora Health Care’s electronic health records and the institute’s Biorepository and Specimen Resource Center and Research Analytics team, the researchers are investigating whether a scoring schema incorporating a patient’s clinical and genotypic information can help clinicians decide between NOACS or warfarin at the start of treatment.

To develop the schema, a database with medical records of 350,000 patients with more than 20 million patient encounters from a 15-year period was created. That’s a lot of data. Big data.

“This effort will help keep patients out of the emergency room while preventing the consequences of stroke,” Dr. Ravvaz said.

This research is being conducted in collaboration with Harvard Medical School and University of Minnesota. After committing to first-year funding in 2015, National Institutes of Health renewed its support for the project with Aurora receiving an additional $120,000 from Harvard. The work also is supported by Aurora Research Institute’s intramural award program.

Big Data Exploration Requires Big Collaboration

Dr. Ravvaz’s team and senior research programmer analyst Jon Cook worked closely to identify patient records and ensure the quality of the cohort-associated data within a de-identified anticoagulation research database. Cook worked continuously with the study team to implement an algorithm based on previously published work regarding a complex exposure period and time in therapeutic range. He cross-referenced biorepository databases to collect available blood specimens.
Cardiovascular Research Committees

Cardiovascular Research Advisory Committee

Suhail Allaqaband, MD  
Khawaja Afzal Ammar, MD  
Tanvir Bajwa, MD  
Indrajit Choudhuri, MD  
Anthony DeFranco, MD  
Wendy Dunaj, RN  
Nina Garlie, PhD  
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Renuka Jain, MD  
M. Fuad Jan, MD  
Bijoy Khandheria, MD  
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Tracy Hammonds, PhD  
Arshad Jahangir, MD  
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Ryan Cooley, MD  
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Arshad Jahangir, MD  
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Linda Stahovic, MSW, MBA  
Nasir Sulemanjee, MD  
Vinay Thohan, MD  
Sara Walczak  

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Arshad Jahangir, MD  
M. Fuad Jan, MD  
Jayant Khitha, MD  
David Kress, MD  
Andy Marek  
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Tonga Nfor, MD  
Sara Planton, BSN  
Katie Richter  
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Eric Weiss, MD  

Cardiovascular Research Fellowship Subcommittee

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Indrajit Choudhuri, MD  
Tracy Hammonds, PhD  
Arshad Jahangir, MD  
Renuka Jain, MD  
M. Fuad Jan, MD (co-chair)  
Jayant Khitha, MD  
Andy Marek  
Tonga Nfor, MD  
Susan Olet, PhD  
Sara Walczak
## Cardiovascular Volumes (systemwide)

**Source:** Aurora Smart Chart

### Cardiovascular Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery bypass graft (CABG), total</td>
<td>926</td>
<td>922</td>
<td>941</td>
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<tr>
<td>CABG on pump</td>
<td>768</td>
<td>793</td>
<td>816</td>
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<tr>
<td>Valve procedures</td>
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<tr>
<td>Aortic valve replacement</td>
<td>446</td>
<td>358</td>
<td>385</td>
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<tr>
<td>Mitral valve replacement</td>
<td>107</td>
<td>105</td>
<td>110</td>
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<tr>
<td>Other valve replacement</td>
<td>19</td>
<td>19</td>
<td>19</td>
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<tr>
<td>Aortic valve repair</td>
<td>7</td>
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<tr>
<td>Mitral valve repair</td>
<td>61</td>
<td>70</td>
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<tr>
<td>Other valve repair</td>
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### Vascular Medicine

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<th>Procedure</th>
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<td>Peripheral vascular intervention</td>
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<tr>
<td>With stent</td>
<td>1,840</td>
<td>2,140</td>
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<tr>
<td>Without stent</td>
<td>1,000</td>
<td>1,052</td>
<td>1,000</td>
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<tr>
<td>Non-coronary atherectomy</td>
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<td>37</td>
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<tr>
<td>Endarterectomy</td>
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<td>487</td>
<td>459</td>
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<tr>
<td>Carotid endarterectomy</td>
<td>303</td>
<td>327</td>
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<td>Other endarterectomy</td>
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<td>160</td>
<td>132</td>
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<tr>
<td>Abdominal aortic aneurysm repair</td>
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<td></td>
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<tr>
<td>Endovascular</td>
<td>172</td>
<td>194</td>
<td>169</td>
</tr>
<tr>
<td>Open</td>
<td>132</td>
<td>166</td>
<td>147</td>
</tr>
<tr>
<td>Thoracic aortic aneurysm repair</td>
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<tr>
<td>Endovascular</td>
<td>99</td>
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<tr>
<td>Open</td>
<td>48</td>
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<td>38</td>
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<tr>
<td>Lower extremity bypass</td>
<td>175</td>
<td>149</td>
<td>203</td>
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<tr>
<td>Extracranial intervention</td>
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<td></td>
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<tr>
<td>With stent</td>
<td>34</td>
<td>37</td>
<td>51</td>
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<tr>
<td>Carotid stent</td>
<td>33</td>
<td>28</td>
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<tr>
<td>Other extracranial stent</td>
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<td>23</td>
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<tr>
<td>Without stent</td>
<td>6</td>
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### Interventional Cardiology

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<th>Procedure</th>
<th>2014</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>Heart catheterization, total</td>
<td>9,446</td>
<td>8,919</td>
<td>9,049</td>
</tr>
<tr>
<td>Catheterization w/ pressures</td>
<td>7,087</td>
<td>6,583</td>
<td>6,529</td>
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<tr>
<td>Angiogram w/o pressures</td>
<td>2,359</td>
<td>2,336</td>
<td>2,520</td>
</tr>
<tr>
<td>Coronary intervention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With stent</td>
<td>2,571</td>
<td>2,402</td>
<td>2,361</td>
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<tr>
<td>Drug-eluting stent only</td>
<td>2,443</td>
<td>2,254</td>
<td>2,206</td>
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<tr>
<td>Non-drug-eluting stent only</td>
<td>2,130</td>
<td>2,031</td>
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<tr>
<td>Both</td>
<td>301</td>
<td>209</td>
<td>132</td>
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<tr>
<td>Percutaneous coronary intervention</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Without stent</td>
<td>12</td>
<td>14</td>
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<tr>
<td>Percutaneous coronary intervention</td>
<td>127</td>
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<tr>
<td>Percutaneous coronary intervention</td>
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<tr>
<td>Myocardial biopsy</td>
<td>345</td>
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<td>Patent foramen ovale/atrial septal defect closure, total</td>
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<td>112</td>
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<tr>
<td>Open</td>
<td>75</td>
<td>58</td>
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</tr>
<tr>
<td>Closed</td>
<td>60</td>
<td>40</td>
<td>46</td>
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<tr>
<td>Transcathester aortic valve replacement (TAVR)</td>
<td>201</td>
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<tr>
<td>Transcathester mitral valve replacement (TMVR)</td>
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### Electrophysiology

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<tbody>
<tr>
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<tr>
<td>Cardiac mapping</td>
<td>837</td>
<td>790</td>
<td>880</td>
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<tr>
<td>Cardioversion</td>
<td>1,185</td>
<td>1,319</td>
<td>1,530</td>
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<tr>
<td>Ablation – percutaneous</td>
<td>1,050</td>
<td>913</td>
<td>863</td>
</tr>
<tr>
<td>Pacemaker/Resynchronization</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pacermaker</td>
<td>1,098</td>
<td>1,087</td>
<td>1,159</td>
</tr>
<tr>
<td>Cardiac resynchronization therapy-pacemaker</td>
<td>1,005</td>
<td>1,000</td>
<td>1,049</td>
</tr>
<tr>
<td>Defibrillator/Resynchronization</td>
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<tr>
<td>Defibrillator</td>
<td>820</td>
<td>807</td>
<td>903</td>
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<tr>
<td>Cardiac resynchronization therapy-defibrillator</td>
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<td>594</td>
<td>706</td>
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### Heart Failure and Transplant

<table>
<thead>
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<th>2015</th>
<th>2016</th>
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</thead>
<tbody>
<tr>
<td>Ventricular assist device</td>
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<td>51</td>
<td>37</td>
</tr>
</tbody>
</table>
Cardiovascular Publications

2016 Aurora-Authored, Peer-Reviewed


Abstract


Singh M, Dalmar A, Heis Z, Katzoff MN, Chua TY, Tajik, AJ. Jahangir A. Middle or older age at the time of bariatric surgery for morbid obesity is associated with a higher risk for cardiovascular events. J Am Coll Cardiol 2016;67(13_S):1453.


Breaking Records

American College of Cardiology in 2016 accepted 19 Aurora Health Care-authored abstracts for presentation at its annual meeting – the most Aurora has ever had accepted.

Of those 19 studies, 10 were conducted under the mentorship of Arshad Jahangir, MD, medical research director of the Sheikh Khalifa bin Hamad Al Thani Center for Integrative Research on Cardiovascular Aging.

The number of Aurora-authored abstracts accepted by American College of Cardiology have been gradually increasing and jumped to 19 from a previous best of 14 presented each in 2014 and 2015.

19 abstracts presented at Heart Rhythm Society’s annual meeting

10 abstracts accepted for presentation

American College of Cardiology abstracts

Breaking another publishing record, Aurora researchers presented 10 abstracts at Heart Rhythm Society’s 2016 annual meeting.

This is the most Aurora has ever had accepted by Heart Rhythm Society.

formerly known as North American Society of Pacing and Electrophysiology. The previous acceptance record was eight for this meeting.
At Aurora, our caregivers continue to strive for excellence as they touch the lives of those they serve. With their dedication and insight, Aurora is able to lead in clinical excellence, innovation, research and education.

Suhail Allaqaband, MD  
Tanvir Bajwa, MD  
Dawn Brester, RN  
Michelle Bush, NP  
Richard Carballo, MD  
John Carpenter  
Indrajit Choudhuri, MD  
Vivian DeHahn, NP  
Jodi Doering, NP  
Francis Downey, MD  
Nina Garlie, PhD  
Jennifer Gross  
Jeff Hall  
Erin Heissel  
Arshad Jahangir, MD  
Bijoy Khandheria, MD  
Amanda Kirby, NP  
Katie Klein  
Santosh Krishnan, MD  
Randall Lambrecht, PhD  
Mark Mewissen, MD  
Daniel Meyer  
Vishnubhakta S. Murthy, MD  
Brenda Napiereka, NP  
Aaron Novotney  
Daniel O’Hair, MD  
Robert Panther, MD  
Diane Penzkowski, MSN  
Jennifer Pfaff  
Mike Peterson  
Doreen Plautz, RN  
Steven Port, MD  
Kathy Princer  
Alexander Roitstein, MD  
Jasbir Sra, MD  
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Sandy Zemke, RN