VOTED NO. 1 IN MICHIGAN AND NO. 13 IN THE COUNTRY

Michigan Medicine’s Frankel Cardiovascular Center was recognized among the best in the nation by U.S. News & World Report for 2019-2020, ranking No. 1 in Michigan and No. 13 in the nation.

The magazine ranks hospitals on a number of factors including patient safety, clinical resources, quality of care, family centeredness and staff professionalism. Some specialty rankings are also based on hospital reputation, which is determined by surveying over 125,000 physicians across the country.

Overall, the academic medical center of the University of Michigan ranks 11 in the U.S. Read more here: michmed.org/VqkRK.

MAGNET AWARD OF EXCELLENCE

Michigan Medicine was honored with the Magnet Award, presented by the American Nurses Credentialing Center. Only 6 percent of U.S. hospitals earn this honor, given to organizations that meet rigorous standards for quality patient care, nursing excellence and innovations in professional nursing practice.

This recognition supports Michigan Medicine’s commitment to carrying out our mission of constantly improving each patient’s experience, safety and satisfaction. And it firmly establishes Michigan Medicine as a worldwide leader in advancing nursing standards, practice and empowerment – attributes that help attract and retain top talent from around the world.

2018 BY THE NUMBERS

INPATIENT DISCHARGES 6,387
CLINIC VISITS 71,614
CARDIAC CATHETERIZATION CASES 4,983
ARRHYTHMIA CASES 2,097
ADULT SURGICAL VOLUME 2,994

A digital version of the U-M Frankel CVC 2019 Activity and Outcomes Report is available at umhealth.me/CVC-Outcomes.
Dear Colleagues,

We are pleased to present the 2019 Samuel and Jean Frankel Cardiovascular Center Activity and Outcomes Report. This report highlights our clinical performance and advanced research initiatives and showcases our commitment to providing exceptional patient care through the work of our experienced faculty and staff, advanced cardiovascular programs and expanding statewide footprint.

Experienced faculty and staff. The outcomes presented in this report are a testament to the hard work of more than 200 clinical faculty, over 100 basic science faculty and our dedicated staff members from all disciplines. Together, we deliver collaborative patient care across every facet of heart and vascular disease for the benefit of patients throughout the state and beyond.

Advanced patient care. Our advanced programs provide patients with the latest treatment options for the spectrum of cardiovascular conditions. On these pages are several patient outcomes, including how a young woman was spared a heart transplant when a U-M surgical team was able to create a new left ventricle outflow tract, aortic root and aortic valve, preserve her mechanical mitral valve and perform a bypass graft on her right coronary artery; how a new mother was treated for peripartum cardiomyopathy, a rare and often misdiagnosed form of heart failure; and how a high school athlete’s extensive surgery for venous thoracic outlet syndrome resulted in complete recovery.

Leading-edge research. The U-M Frankel CVC continues to be at the forefront of basic, translational and clinical cardiovascular research. We build our research initiatives and enhance collective knowledge through our M-BoCA program that focuses on aging and cardiovascular disease and through the Women’s Heart Initiative that focuses on sex differences in cardiovascular disease. We cultivate partnerships with other institutions to support global scientific collaboration and offer our faculty and staff internal funding opportunities to ignite their research ideas and efforts. We educate and train junior faculty and future leaders in research through our Cardiovascular Research and Entrepreneurship Training program. Through all of these initiatives, we aim to heighten our culture of collaboration and innovation to better understand cardiovascular disease and discover potential cures.

Collaboration with our partners. As many of you know, we recently established the Michigan Medicine Provider Portal, a secure, web-based application to help facilitate communication and enable referring physicians and their staff to access patient medical information. This is just one example of the value we place on collaborating with you, our community-based colleagues.

The Frankel CVC team is proud to be a leader in shaping the future of cardiovascular care. We look forward to continuing our partnership with you, our referring physicians, and to providing expanded care opportunities throughout the state.

Thank you for being part of our team.

From the Frankel CVC Leadership
Coronary Heart Disease

A COLLABORATIVE APPROACH FOR HEART DISEASE PATIENTS

Coronary heart disease is the leading cause of death for both men and women in the United States. The Frankel CVC’s collaborative approach includes the patient in determining the most appropriate therapy for his or her coronary artery disease.

Surgical Options
Our faculty is renowned for their expertise in a wide variety of innovative services. Even with the declining number of cardiac surgical cases nationwide, our procedure volume continues to grow. Our surgeons perform standard on-pump coronary bypass as well as beating heart, off-pump bypass, with arterial conduits routinely used.

Angioplasty and Stenting
The Advanced Interventional Cardiology Program offers patients comprehensive and individualized care. Our skilled team of interventional cardiologists uses the latest technologies available for angioplasty and stenting. For acute myocardial infarction patients, our time from door to intervention is well below the national goal of 90 minutes, thanks to a team approach that utilizes in-house staff.

Multiple assist devices may be implanted to maintain blood supply to the heart tissue during high-risk angioplasty and as a bridge to ventricular assist device (VAD) or cardiac transplantation, including the TandemHeart™ Percutaneous Ventricular Assist Device, Impella® 2.5 and 5.0 catheters and extracorporeal membrane oxygenation (ECMO). In fact, ECMO was invented at U-M and we continue to be leaders in this advanced, lifesaving technology.

CTO Expertise
Our expertise extends to innovative methods for treating chronic total occlusion (CTO). While traditional treatment for CTO has been coronary artery bypass grafting (CABG) performed during open-heart surgery, new, advanced technologies have enabled the Frankel CVC to offer minimally invasive methods of treatment.

One such method is CTO PCI (percutaneous coronary intervention), a procedure performed by experienced interventional cardiologists with specialized training in advanced methods to treat CTO blockages. Only 1-2 percent of cardiac interventionalists in the U.S. can perform the full range of CTO PCI. During the procedure, a small mesh tube is placed in narrow or blocked arteries to widen and support the walls of the arteries and restore blood flow.
Structural Heart and Valve Disease
LEADERS IN STRUCTURAL HEART/VALVE DISORDERS

The Frankel CVC’s Structural Heart Program features a multidisciplinary team of cardiologists, cardiac surgeons, anesthesiologists and radiologists working together to provide innovative treatments to patients with valve and structural heart disorders.

Our services include all possible treatment options for valve and structural heart disorders. We specialize in managing the most complex cases and offer patients expert care through:

• Comprehensive management of aortic, mitral and tricuspid valve disease
• Prevention of atrial appendage embolic events with surgical occlusion, percutaneous atrial appendage occlusion and percutaneous trans-pericardial occlusion, combined with optimal anticoagulation strategies
• Patent foramen ovale (PFO), atrial septal defect (ASD), ventricular septal defect (VSD) and patent ductus arteriosus (PDA) closures
• Paravalvular leak (PVL) closures

Valve Disease
All treatment options — including both standard and emerging technologies — are available to treat dysfunction at all heart valve positions. Frankel CVC doctors are pioneering the future of valve dysfunction treatment, building on traditional surgical approaches with an expanding minimally invasive program and new transcatheter therapies. U-M treats more patients with valvular heart disease than anywhere else in the state and is a national leader in treating this disease.
Candice Tarter was only 16 when rheumatic fever led to serious heart issues that required four open-heart surgeries over the next 12 years.

It was a devastating blow to the young woman who had dreamed of taking her high school basketball talent to the college level.

But her life took a different path. Today, the determined 28-year-old is living another dream as a 5th grade teacher at Detroit’s Marion Law Academy.

Tarter’s rheumatic heart disease was detected by a heart murmur in 2006. A pediatric cardiac surgeon performed emergency open-heart surgery to replace her severely damaged aortic valve and mitral valve with bioprosthetic valves.

Two years later, while attending college, extreme fatigue led to the discovery of an infection that had damaged the new valves. In another open-heart surgery, both valves were again replaced, and a pacemaker was implanted to correct a newly diagnosed arrhythmia.

In December 2016, Tarter experienced ongoing chest pain, which proved to be an aortic pseudoaneurysm. She underwent a third open-heart surgery to repair the rupture.

After a series of fainting episodes and another operation to remove surgical fluid from her chest, Carter's doctors felt the only option was a heart transplant and referred her to the U-M Frankel Cardiovascular Center.

Tests there revealed her aortic root had ruptured from her heart. The blood was flowing underneath her breastbone, with scar tissue the only thing keeping the blood from free rupture.

The Michigan Medicine cardiac surgical team was confident they could treat Tarter’s condition, avoiding a heart transplant.

"We created a new left ventricle outflow tract, a new aortic root and aortic valve, preserved the mechanical mitral valve and performed a bypass graft on her right coronary artery, which was completely closed," says U-M cardiac surgeon Bo Yang, M.D. "The patient was discharged a few days after surgery without any complications. Today, she is doing very well and is living a normal life.”

Read more about Candice Tarter’s story at michmed.org/EXPzq.
Valve Disease
EXPERTISE IN OPTIMAL VALVE INTERVENTIONS

Aortic Valve Disease
Open Approach
Historically, open surgical aortic valve repair (SAVR) has been the standard treatment for severe aortic stenosis. For more than 25 years, the Frankel CVC has been a leader in aortic valve replacement in both volume and outcomes.

The Frankel CVC is one of only a few sites in the nation to conduct the TRANSFORM clinical trial for the INTUITY valve system developed by Edwards Lifesciences. This trial offers a potentially significant advancement in valve replacement surgery because it allows the surgeon to implant the valve with only three sutures, substantially decreasing the time required for the surgical intervention.

Transcatheter Approach
Transcatheter aortic valve replacement (TAVR) is a minimally invasive, catheter-based procedure to replace the aortic valve in patients with severe aortic stenosis. It is an alternative to SAVR. Originally developed for prohibitive and high-risk patients, TAVR is now available for patients at intermediate and low risk for surgery.

Michigan Medicine is one of the only health systems in the region to offer the full spectrum of valve options available through clinical trials as well as FDA-approved devices. U-M is also the only center in Michigan to test a novel TAVR valve for the treatment of aortic regurgitation.

Our interventional cardiologists and cardiac surgeons work together to seamlessly deliver these TAVR devices through a variety of access points, including: femoral, transapical, direct aortic, subclavian arteries and transcaval.

TAVR technology is also being used to restore the function of failing bioprosthetic valves in what is known as a “valve-in-valve” procedure. This may be the best valve replacement option for high-risk patients.

With new clinical trials focused on the treatment of aortic regurgitation as well as fourth-generation devices anticipated in the next few years, we hope to provide all patients with options for the latest available technological advances for aortic valve disease.

The U-M team is also breaking new ground in the treatment of bicuspid aortic valve (BAV) disease. Our surgeons are some of the most experienced in the world in treating patients with BAV disease. U-M has established a Bicuspid Aortic Valve registry to study patients and identify the genetic causes and long-term effects of this common congenital disease. The team is also participating in a study that is looking at the use of a self-expanding TAVR valve for the treatment of bicuspid aortic valves in low-risk patients.

Our multidisciplinary approach enables us to offer additional surgical and transcatheter options for patients with complex aortic valve conditions, including:

• Valve-sparing operations on the aortic root
• Treatment of paravalvular leaks
• Placement of stentless aortic valves
• Hypothermic circulatory arrest procedures in the management of combined aortic valve and aortic aneurysm disease
Aortic Valve Distribution

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPLACEMENT</td>
<td>345</td>
<td>378</td>
<td>318</td>
<td>417</td>
</tr>
<tr>
<td>TAVR</td>
<td>200</td>
<td>186</td>
<td>259</td>
<td>251</td>
</tr>
<tr>
<td>AV REPAIR OR RESUSPENSION</td>
<td>44</td>
<td>44</td>
<td>52</td>
<td>66</td>
</tr>
<tr>
<td>VALVE SPARING</td>
<td>19</td>
<td>13</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>

**CLINICAL TRIALS**

**TMVR - Apollo**
Evaluate transcatheter mitral valve replacement with the Medtronic Intrepid™ TMVR System in patients with severe symptomatic mitral regurgitation.

**Medtronic Low Risk Bicuspid Study**
Evaluate transcatheter aortic valve replacement with the Medtronic TAVR System in patients with severe bicuspid aortic valve stenosis and at low predicted risk of mortality with surgical aortic valve replacement.

**Low Risk TAVR: Continued Access**
Transcatheter aortic valve replacement with the Medtronic Transcatheter Aortic Valve Replacement System in patients at low risk for surgical aortic valve replacement (SAVR), Continued Access Trial.

**JenaValve AS EFS Study**
Assess the safety and effectiveness of the Transfemoral JenaValve Pericardial TAVR System in the treatment of patients with symptomatic severe aortic regurgitation.

**ReChord**
Determine if NeoChord DS1000 System, which delivers sutures to the mitral valve, is safe and effective to reduce mitral regurgitation when compared with open surgical repair.

For more information or to view additional trials, visit [UMHealthResearch.org](http://UMHealthResearch.org).

**U-M TAVR TICKER**
1,500 aortic valves replaced and counting
Mitral Valve Disease

Open Approach
The Mitral Valve Clinic at the Frankel CVC is one of the largest practices in the country focused on mitral valve repair. Our team’s extensive experience in the operating room is a direct result of high procedure volume, which translates into better outcomes for patients. Our Mitral Valve Clinic is also a leader in the treatment of mitral regurgitation associated with heart failure from both dilated and ischemic cardiomyopathies.

While open-heart surgery is the traditional method of mitral valve repair and replacement, our team also performs complex open surgical repair or replacement of the mitral valve using smaller incisions (two to three inches) between the ribs on the patient’s right side to gain access to the heart. This type of procedure has the potential to shorten a patient’s recovery time and hospital stay.

Transcatheter Approach
Our cardiac surgeons and interventional cardiologists work together to offer eligible patients the latest minimally invasive and endovascular options for mitral valve repair and replacement. A variety of techniques and devices can be used to repair or replace the mitral valve without opening up the heart:

- The commercially available MitraClip® device is indicated for high-risk patients with degenerative, functional or mixed mitral regurgitation.
- Valvuloplasty, a technique to treat mitral valve stenosis, involves using a thin catheter with a balloon tip to stretch or open the mitral valve.
- Valve-in-valve transcatheter technology is being used to restore the function of failing bioprosthetic mitral valves. This technique has become the preferred valve replacement option for high-risk surgical patients.
- Transcatheter mitral valve replacement (TMVR) has emerged as an exciting new frontier in the minimally invasive treatment of severe mitral regurgitation in patients at high risk for surgery. We are currently one of only a few health systems nationwide selected to participate in the Apollo clinical trial to evaluate this treatment.
- The NeoChord mitral valve repair system enables minimally invasive implantation of artificial chordae using a catheter-based approach to treat mitral regurgitation.

Tricuspid Valve Disease
Treatment for tricuspid valve disease varies depending on a patient’s condition. As symptoms progress, treatment may include certain medications such as diuretics, which promote urination and the release of excess fluids, and vasodilators, which help open blood vessels. If a patient’s condition is severe, surgery to repair or replace the damaged valve may be required. Valve-in-valve transcatheter technology is also being used to restore the function of failing bioprosthetic tricuspid valves.

Types of tricuspid valve disease include:

- Tricuspid regurgitation
- Tricuspid stenosis
- Tricuspid atresia
- Ebstein’s anomaly
Five-year mitral valve repair rate for degenerative mitral valve disease is 99.8%.

Source: STS National Database
Aortic Disease

EXPERTS IN COMPLEX CARE

As leading providers of complete care for all types of aortic disease, the Multidisciplinary Aortic Program (MAP) at the Frankel CVC brings together experts from cardiac surgery, vascular surgery, interventional cardiology, interventional radiology and diagnostic radiology to formulate the best comprehensive plan for each patient. Our mortality rates are among the lowest in the country, despite a high volume of complex cases.

Specialists at the Frankel CVC provide treatment and therapy — from management and medical therapies to minimally invasive and open surgical repairs — for all types of aortic-disease-related conditions, including:

• Ascending and arch aneurysms
• Descending thoracic aortic aneurysms (DTAA)
• Abdominal aortic aneurysms (AAA)
• Thoracoabdominal aortic aneurysms (TAAA)
• Iliac artery aneurysms
• Aortic dissection

MAP faculty are prolific researchers, leading numerous novel initiatives specific to aortic disease. Current platforms include FDA-regulated trials, NIH-funded trials, Department of Defense contracts and investigator-initiated projects.

Inherited Aortic Disease
The Frankel CVC’s MAP has expertise in treating complex aortic disease patients, particularly those with the following conditions:

• Connective tissue disorders such as Marfan Syndrome, Ehlers-Danlos Syndrome and Loeys-Dietz Syndrome
• Bicuspid aortic valve disease
• Suspected familial aortic/arterial disease
• Arteriosclerotic aortic disease

Comprehensive workup and care for these complex patients includes access to genetic testing and counseling as well as to experts from other relevant specialties such as high-risk obstetrics, orthopaedics, gastroenterology and ophthalmology.

Fenestrated and Branched Endograft Technology
New technology involving minimally invasive endovascular stent graft repair allows more patients to be treated for complex aortic disease. Fenestrated endograft technologies are covered stents with holes (called fenestrations) that correspond to the position of the major arteries branching out from the aorta. Branched endografts have smaller branch extensions that funnel into critical branches, preserving flow.

Historically, treatment of aortic aneurysms involving major branch vessels required an open surgical procedure. But Frankel CVC providers can now treat patients with minimally invasive fenestrated and branched endografts in the abdominal aorta, thoracoabdominal aorta and aortic arch.
CLINICAL TRIALS

Terumo Thoraflex Hybrid
Evaluate the Thoraflex Hybrid Device for use in the repair or replacement of the ascending aorta, aortic arch and descending aorta in an open surgical procedure.

Evaluation of the GORE® TAG® Thoracic Branch Endoprosthesis in the Treatment of DeBakey Type I/II Aortic Dissection
Assess the feasibility of the treatment of DeBakey Type I/II aortic dissections with the GORE® Ascending Stent Graft.

For more information or to view additional trials, visit UMHealthResearch.org.

<table>
<thead>
<tr>
<th>Aortic Dissection Operative Mortality</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACUTE TYPE A</td>
<td>8.8%</td>
<td>5.1%</td>
</tr>
<tr>
<td>ACUTE TYPE B</td>
<td>27.3%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Abdominal Aortic Aneurysm Treatment 2018

- OPEN 69.4%
- ENDO 30.6%
Aortic Disease

EXPERTS IN COMPLEX CARE (CONTINUED)

Examples of pending, current and previous trials available in our program include:

• Branched Arch Endograft Technology (GORE® TAG® Thoracic Branch Endoprosthesis Device)
• Branched Thoracoabdominal Technology (GORE® TAMBE® Trial)
• GORE® Excluder Iliac Branch Endoprosthesis (IBE) for aneurysms extending into the pelvis
• Zenith® Fenestrated AAA Endovascular Graft for aneurysms extending to the kidney area

Type A Dissection

In 2018, a first-of-its kind, FDA-sponsored early feasibility trial was launched at the Frankel CVC to evaluate a new thoracic endograft specifically designed to treat ascending aortic dissection (Type A dissection). This study evaluates the use of TEVAR in high-risk patients who present with a disease that currently carries a hospital operative mortality risk of 20 percent across the United States. We are proud to report a mortality rate of less than 6 percent and look forward to evaluating this potential paradigm shift in treatment of type A dissection.

EVAR and TEVAR

Endovascular aortic repair (EVAR) and thoracic endovascular aortic repair (TEVAR) have emerged as true alternatives to conventional surgery for many patients suffering from aneurysmal disease of the aorta. These are lifesaving minimally invasive options for some patients who are not optimal candidates for traditional open repair. These procedures can shorten hospital stays and recovery periods. With more than two decades of experience in performing EVAR and TEVAR procedures, our surgical team can provide comprehensive care to all aortic patients.

In addition, as clinical trials with lower profile versions of grafts are released, we often have access to these grafts for study in approved patients.

<table>
<thead>
<tr>
<th>All Aortic Surgical Volume</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCENDING/ARCH WITH OR WITHOUT AVR</td>
<td>192</td>
<td>198</td>
<td>241</td>
<td>298</td>
</tr>
<tr>
<td>DESCENDING THORACIC AORTIC ANEURYSM</td>
<td>27</td>
<td>29</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>THORACIC ENDOVASCULAR REPAIR</td>
<td>46</td>
<td>48</td>
<td>54</td>
<td>61</td>
</tr>
<tr>
<td>OPEN ABDOMINAL AORTIC ANEURYSM</td>
<td>54</td>
<td>49</td>
<td>57</td>
<td>38</td>
</tr>
<tr>
<td>ENDOVASCULAR ABDOMINAL AORTIC ANEURYSM</td>
<td>79</td>
<td>74</td>
<td>75</td>
<td>86</td>
</tr>
</tbody>
</table>
After years of struggling to become pregnant, Monique Lowes learned she was expecting her first child. But her excitement soon turned to fear.

The 37-year-old, nearly three months pregnant, was advised by her primary obstetrician to undergo an echocardiogram due to high blood pressure and her age, which put her in the high-risk pregnancy category. The test revealed a thoracic aortic aneurysm and aortic dissection.

Doctors explained the risks that aortic repair surgery could have on her unborn child — as well as the risk she herself might face if the necessary surgery was delayed.

In the end, she chose to delay surgery. “As a woman who has struggled with infertility, I wanted to do my best for me and my baby,” Lowes says.

She was admitted to Michigan Medicine, where she would spend two months at the Frankel Cardiovascular Center being observed by a cardiac surgical team and high-risk obstetrics doctors from Von Voightlander Women’s Hospital.

At 28 weeks pregnant, Lowes was finally able to go home before giving birth four weeks later to her daughter, Graysen Faith.

The team’s detailed plan included a cesarean delivery performed at the Frankel CVC, just in case Lowes’ aortic condition required immediate surgery.

The new mom was able to spend time with her infant at home before returning to the Frankel CVC for an open-heart procedure to repair her aorta.

“As a woman who has struggled with infertility, I wanted to do my best for me and my baby.”

She credits her heart and obstetrics care team as well as her sister, nephew and two nieces for keeping her strong through it all. It was a risky choice, Lowes now admits, but she’s thankful for the outcome. “I had faith that God had a plan for me and my baby.”

Read more about Monique Lowes’ story at michmed.org/eN7bj.
The Cardiac Arrhythmia Service at the Frankel CVC is a high-volume tertiary referral center for the management of complex arrhythmias, including atrial fibrillation, supraventricular and ventricular tachycardia, atrial flutter, premature ventricular contractions (PVCs) and Wolff-Parkinson-White (WPW) syndrome. We also specialize in the care of patients with complex implanted cardiac device conditions, including malfunction of devices and leads, infected devices and extraction of leads and devices.

Each year our dedicated electrophysiologists perform approximately 1,200 ablations and more than 800 device procedures, including pacemakers, ICDs and biventricular pacing devices. We are one of only a few centers in the country with this level of volume and experience. We are at the forefront of implanting MRI-compatible pacemakers, ICDs and subcutaneous ICDs. We are also pioneering the use of “leadless” pacer technology, one of the most remarkable pacing advances of the last decade, as described below.

Leaders in the Field

Our team of cardiac electrophysiologists is one of the first in the state to implant the Medtronic Micra™ Transcatheter Pacing System (TPS) in a patient. The Micra TPS is the world’s smallest pacemaker, delivered percutaneously via a minimally invasive approach directly into the right ventricle without the use of leads. The inch-long device uses small prongs to attach directly to the heart, where it delivers electrical pulses that help the heart beat more regularly. Avoidance of leads can overcome issues of inadequate vascular access, thereby providing novel pacing options for some of our most complex patients.
As an elite-level runner, cyclist and skier, Doug Heady has worn a heart rate monitor for nearly three decades to keep an eye on his body’s response to athletic training. So when he began to experience a faster heart rate and palpitations while training for the cross-country ski-racing season, the 60-year-old took notice.

After the palpitations became more frequent, Heady’s primary care physician ordered a treadmill stress test to record his heart rate.

“Toward the end, my heart went out of rhythm,” he recalls. “My primary physician advised me to see a cardiologist for a heart arrhythmia.”

The Ann Arbor, Michigan, resident chose Michigan Medicine, where he met with sports cardiologist Eugene Chung, M.D., at the U-M Frankel Cardiovascular Center.

Test data confirmed paroxysmal atrial fibrillation, an irregular heartbeat that in Heady’s case was triggered by intense exertion and typically stopped when the exertion ended.

Heady underwent a cryoballoon ablation procedure in which a catheter is threaded from the femoral vein to the pulmonary veins of the heart’s left atrium. The cryoballoon catheter is then inserted to cauterize the area where the Afib originates.

“I knew with the ablation I might not be able to compete like before, but I have worked back to a strong fitness level. It’s quite remarkable.”

Now off of all anti-arrhythmic medications and no detectable atrial fibrillation, he’s back to his active lifestyle, thankful for the success of his procedure.

“I knew with the ablation I might not be able to compete like before, but I have worked back to a strong fitness level. It’s quite remarkable.”

Read more about Doug Heady’s story at michmed.org/e07Kp.
Cardiac Arrhythmia
LEADERS IN ARRHYTHMIA THERAPY (CONTINUED)

Our team is also one of the first in the nation to use the FDA-approved WATCHMAN™ Left Atrial Appendage Closure Device, an alternative to blood thinners to prevent stroke in patients with non-valvular atrial fibrillation.

The WATCHMAN™ closes off the left atrial appendage where blood clots tend to develop, eliminating the need for long-term anticoagulation medication. Our multidisciplinary team of specialists evaluates patients to determine their eligibility for the device.

In addition to catheter ablations and device procedures, we provide cardiac resynchronization in patients with heart failure.

Research
On the research front, in partnership with the U-M Center for Arrhythmia Research, we are working to create new technologies to facilitate the mapping of complex arrhythmias such as atrial fibrillation and ventricular tachycardia. Our combined efforts are moving the field forward in our understanding and treatment of the most challenging and prevalent heart rhythm conditions.

CLINICAL TRIALS

ArcticLine Feasibility Study
Collect preliminary safety and effectiveness data on the ArcticLine Cardiac Cryoablation Catheter, indicated for creating endocardial linear lesions, subsequent to successful pulmonary vein isolation, during cardiac ablation procedures for treatment of patients with persistent atrial fibrillation and/or typical atrial flutter.

LESS-VT
Demonstrate the safety and effectiveness of ventricular ablation therapy using the FlexAbility Sensor Enabled Ablation Catheter in patients with drug-refractory monomorphic ventricular tachycardia in whom ventricular tachycardia recurs despite antiarrhythmic drug therapy or when antiarrhythmic drugs are not tolerated or desired.

Adapt Response Study
Test the hypothesis that Cardiac Resynchronization Therapy (CRT) devices that contain the AdaptivCRT® (aCRT) algorithm have a superior outcome compared to standard CRT devices in CRT indicated patients with normal atrio-ventricular conduction and left bundle branch block.

STOP AF First
Demonstrate the safety and effectiveness of the Arctic Front Advance Cardiac Cryoablation Catheter for the treatment of recurrent symptomatic paroxysmal atrial fibrillation, without the requirement that the subjects be drug refractory.

VISITAG SURPOINT COA
Demonstrate the safety and 12-month effectiveness of Tag Index-guided ablation using the VISITAG SURPOINT™ Module with External Processing Unit when used with the THERMOCOOL SMARTTOUCH® catheter for pulmonary vein isolation in the treatment of subjects with drug refractory symptomatic paroxysmal atrial fibrillation.

For more information or to view additional trials, visit UMHealthResearch.org.
The Frankel CVC Sports Cardiology Clinic offers a full range of services targeted toward individuals of all levels of activity, including high school, collegiate, professional and recreational.

Patients throughout the state benefit from a world-class multidisciplinary team that includes Frankel Cardiovascular Center cardiologists, sports medicine practitioners (trainers and physicians), family medicine and internal medicine specialists, geneticists, nutritionists, physical therapists and exercise physiologists.

Sports cardiology patients are athletes or highly active individuals with:
• Symptoms of cardiovascular disease, such as chest pain, palpitations, arrhythmia, syncope, shortness of breath or change in exercise capacity. Patients may or may not have a previous diagnosis of cardiovascular disease.
• A history of cardiovascular disease who are seeking guidance and reassurance in managing their cardiovascular disease and exercise goals.
• Results from recent screening tests (e.g., ECG and echocardiogram) who are seeking further interpretation or a second opinion.

The Sports Cardiology Clinic provides comprehensive consultation, evaluation and treatment of all athletes. Our doctors work with patients to understand the full spectrum of their needs and provide targeted services:
• Pre-participation screening
• Evaluation of potential cardiac symptoms

• Evaluation of changes in athletic performance, including cardiopulmonary testing, cardiovascular testing and review of medications
• Referrals to other subspecialties as needed
• Risk assessment for sudden cardiac death
• Evaluation of older individuals who wish to return to athletic activity

We also collaborate with other Michigan Medicine sports-related services and consult with all U-M athletic teams as well as with athletes from several Michigan schools.
The University of Michigan Anticoagulation Service is recognized as an “Anticoagulation Center of Excellence,” illustrating our strong commitment to providing the highest level of patient care and making our service one of fewer than 100 out of 3,000 nationally to receive this distinction. The Anticoagulation Centers of Excellence program helps healthcare professionals achieve the best possible outcomes for patients on anticoagulant medications. The Centers of Excellence program was created by the Anticoagulation Forum, the leading organization of healthcare professionals working to improve the quality of care for these patients.

The Anticoagulation Service is a collaboration of physicians, nurses and pharmacists who monitor and manage anticoagulant therapy for our patients with thrombosis or other disorders that increase the likelihood of blood clots. These include atrial fibrillation, venous thromboembolism, cardiovascular disease and stroke.

The Frankel CVC offers and supports a variety of anticoagulation treatment options, including the use of long-standing anticoagulants such as warfarin (Coumadin) and heparin as well as newer direct oral anticoagulants (DOACs) such as dabigatran (Pradaxa), rivaroxaban (Xarelto), apixaban (Eliquis) and edoxaban (Savysa), among others.

Our experienced team believes that selecting an anticoagulant requires weighing individual patient factors to determine the most appropriate choice. As a support service to the Frankel CVC clinical faculty, U-M’s Anticoagulation Service works to:

- Reduce the number of potential anticoagulant issues: gastrointestinal bleeding, cerebrovascular accident, transient ischemic attack, pulmonary embolism and intracranial bleed.
- Manage transitions and interruptions in anticoagulant care.
- Enable patients to assume greater responsibility for their care through health education about the safe use of anticoagulants, the physical signs and symptoms of bleeding and the importance of laboratory monitoring.
- Improve patient adherence to their prescribed regimens.

**Safety Measures**

Regardless of the anticoagulation option selected, anticoagulation management services at the Frankel CVC ensure specialized care for all patients on anticoagulation therapy, not just those on warfarin. All anticoagulant patients are offered comprehensive monitoring and management services as well as education. Our knowledgeable staff is available by phone to discuss any concerns or problems related to a patient’s medication.

**INFORMATION TOOLKIT FOR DOCTORS AND PATIENTS**

U-M is a part of the Michigan Anticoagulation Quality Improvement Initiative (MAQI²), a consortium of anticoagulation clinics and experts from across the state committed to improving the quality of anticoagulation care. One of the MAQI² efforts is to provide comprehensive information about anticoagulant therapy via an Anticoagulation Toolkit designed to assist providers and patients with comprehensive, continually updated information about anticoagulation care and anticoagulant selection.

We encourage you to use this up-to-date resource about anticoagulation therapy, and to share it with your patients. Visit [www.anticoagulationtoolkit.org](http://www.anticoagulationtoolkit.org) where you will find separate links to information for providers and patients, along with a free patient toolkit mobile app.
Inherited Cardiomyopathies
COORDINATED TREATMENT FOR PATIENTS AND FAMILIES

The Inherited Cardiomyopathy Clinic at the Frankel CVC offers state-of-the-art management for patients with hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), arrhythmogenic right ventricular cardiomyopathy (ARVC) and left ventricular noncompaction (LVNC).

Our pediatric and adult clinicians work closely with specialists in electrophysiology, heart failure, interventional cardiology, cardiac surgery and radiology to provide the most comprehensive care to patients living with these conditions. Our team also includes cardiac-trained genetic counselors, nurses and researchers, all dedicated to our mission of caring for patients and families with these conditions.

Serving a large volume of patients through our clinic, we provide the latest knowledge and treatment recommendations, including:

- Expert consultation and risk stratification
- Cardiac-specific genetic counseling and testing for individuals and families
- State-of-the-art imaging, including echocardiography and cardiac MRI
- Cardiopulmonary stress testing
- Electrophysiology, including complex ablations for atrial fibrillation and ventricular tachycardia
- Cardiac surgery, including myectomy and complex mitral repair
- Active involvement in clinical trials

In addition to individual patient management, our program emphasizes the importance of family evaluations. Our adult and pediatric specialists work to coordinate care between adult and pediatric clinics so multiple family members can be seen on the same day.

We are leaders in clinical research for inherited cardiomyopathies and have collaborated both nationally and internationally to further our understanding of these complex disease processes. In addition to maintaining one of the world’s largest registries for HCM of over 1,400 patients, we offer access to emerging clinical trials. We are committed to a vision of improved, personalized medicine for inherited cardiomyopathy.
CLINICAL TRIALS

Exercise in Genetic Cardiovascular Conditions (LIVE-HCM/LQT)
Determine how lifestyle and exercise impact the well-being of individuals with hypertrophic cardiomyopathy and long QT syndrome.

SHaRe (Sarcomeric Human Cardiomyopathy Registry)
Build a community of cardiovascular geneticists and research-based cardiologists to support the development of novel therapies for patients with heritable heart disease.

VANISH (Valsartan for Attenuating Disease Evolution in Early Sarcomeric HCM)
Evaluate the safety and effectiveness of Valsartan in early hypertrophic cardiomyopathy by assessing many domains that reflect myocardial structure, function and biochemistry.

EXPLORER-HCM
Evaluate Mavacamten in adults with symptomatic obstructive hypertrophic cardiomyopathy.

MAVERICK-HCM
Evaluate Mavacamten in patients with symptomatic non-obstructive hypertrophic cardiomyopathy and preserved left ventricular ejection fraction.

MAVA-LTE
A long-term safety extension study of Mavacamten in adults with hypertrophic cardiomyopathy who have completed the MAVERICK-HCM or EXPLORER-HCM trials.

For more information or to view additional trials, visit UMHealthResearch.org.
When 37-year-old Wendy Kwiatkowski went into cardiac arrest in her family’s home, her husband immediately began CPR as one of the couple’s three daughtersdialed 911.

Within minutes, emergency responders arrived. Kwiatkowski was alive and breathing, thanks to the quick action of her husband, Dan, a certified first responder. The emergency team took over, using an automated external defibrillator to shock Kwiatkowski’s heart three times before they arrived at the hospital.

When her oxygen level continued to drop and doctors discovered her condition was beyond their expertise, she was airlifted to the U-M Frankel Cardiovascular Center.

Kwiatkowski had been previously diagnosed with premature ventricular contractions (PVCs) — extra abnormal heartbeats that begin in one of the heart’s two lower pumping chambers. Beyond PVCs, she had no other heart problems.

“‘It’s critical to identify the root cause of the abnormal rhythm for future clinical treatment ...’

- Adam Helms, M.D.

Kwiatkowski now has an implantable cardioverter defibrillator to protect her from future arrhythmias.

The young mother was extremely fortunate that her husband had been trained in CPR, says Helms, adding, “Early defibrillation with an AED by emergency responders was the other key that led to Wendy’s survival.”

Read more about Wendy Kwiatkowski’s story at michmed.org/MoND6.

Genetic testing may also be helpful in cases like Kwiatkowski’s as inherited arrhythmia or heart muscle conditions, such as hypertrophic cardiomyopathy or dilated cardiomyopathy, can affect family members differently and may be overlooked. Testing can also identify other family members who may be at risk but may not have symptoms.
Heart Failure
EXTENSIVE EXPERTISE IN HEART FAILURE THERAPIES

The Heart Failure Program at the Frankel CVC focuses on the complex management of advanced heart failure, circulatory support and heart transplantation. Our team has extensive, high-volume experience in the treatment of patients with acute and chronic heart failure. We partner with referring physicians to help these patients survive and thrive with a better quality of life.

Heart Failure Management
Our team of physicians, nurses, pharmacists, social workers and advanced practice providers ensures safe, collaborative, patient-centered care. For patients managed outside the hospital, this experienced team monitors, supports and optimizes the care of patients with heart failure and complex medical illness. Patients are seen in ambulatory clinics at the Cardiovascular Center in Ann Arbor, and also in satellite clinics in Livonia, Canton, Northville, Brighton and Domino’s Farms locations.

We employ dedicated heart failure trained nurses to provide disease-specific education and telemanagement services to reduce the likelihood of hospital admission. The team is experienced in the evaluation of patients with advanced heart failure and is adept at identifying patients whose care is appropriately addressed with advanced therapies, such as heart transplantation and mechanical circulatory support. The team also provides expert management of patients with a variety of heart muscle conditions, including hereditary cardiomyopathy, valvular cardiomyopathy, myocarditis, cardiac sarcoidosis, muscular dystrophy and infiltrative heart disease.

Center for Circulatory Support
The Frankel CVC Center for Circulatory Support is one of only a few programs worldwide with access to many investigational and FDA-approved ventricular assist devices (VADs). These include the HeartMate II® and HeartMate III® left ventricular assist devices (Abbott Labs, Chicago, IL), the HVAD® (Medtronic Inc., Minneapolis, MN) and SynCardia Total Artificial Heart (SynCardia Systems, Inc., Tucson, AZ), which provide circulatory support for patients with advanced heart failure or cardiogenic shock. With more than 20 years of experience, Center For Circulatory Support Program specialists work closely with referring physicians in the evaluation and selection of the most appropriate treatment and device based on each patient’s needs. Find out more at med.umich.edu/cardiac-surgery/patient/adult/ccs/.

U-M cardiac surgeons have implanted 19 SynCardia total artificial hearts to date. The total artificial heart is often used when end-stage heart failure affects both sides of the heart and other more common heart-supporting devices are inadequate to keep patients alive. A 14-pound Freedom® Driver powers the total artificial heart with precisely calibrated pulses of air. The Frankel Cardiovascular Center is the only Michigan heart program to send patients home with the wearable technology.
The Frankel CVC Center for Circulatory Support was one of the first centers in the U.S. to be awarded Disease-Specific Care Certification for Advanced Ventricular Assist Devices by The Joint Commission. We have received recertification from The Joint Commission every two years, most recently in March 2018.

The CVC team of palliative care specialists also offers comprehensive support for patients with ventricular assist devices and their families by assisting them with complex decision-making, advanced care planning and symptom management.

**HFpEF Clinic**

Specialists in the Frankel CVC Heart Failure with Preserved Ejection Fraction (HFpEF) Clinic evaluate a patient’s HFpEF phenotype using data from history, physical examination, comorbidities, echocardiography, right heart catheterization, biomarkers and other laboratory data. This allows us to predict which therapies are most likely to benefit a patient with HFpEF. For all patients, we prioritize adequate blood pressure control and optimization of intravascular volume and evaluate for the presence of other cardiac and non-cardiac diseases that could contribute to a patient’s symptoms.

We promote lifestyle modification through our nurse educators, as exercise and dietary interventions can improve exercise capacity and quality of life. We also lead a number of research initiatives aimed at understanding why HFpEF develops and worsens, and we participate in a broad range of clinical treatment trials.

**Extracorporeal Life Support (ECLS)**

U-M is the world leader in ECLS, which was pioneered at the University. Our team has the most extracorporeal membrane oxygenation (ECMO) experience in the world and is capable of instituting ECMO within minutes or, under special circumstances, traveling to referring institutions to initiate ECMO for a safer transport to our center.

Patients can be supported on ECMO for days, weeks or even months, giving the heart and lungs time to recover or until an implantable replacement or transplant becomes available.
CLINICAL TRIALS

SCD
Assess the safety and efficacy of a Selective Cytophoretic Device to treat ICU patients with acute or chronic systolic heart failure with cardiorenal syndrome awaiting LVAD implantation.

SPIRIT-HFpEF
Assess whether the initiation of spironolactone plus standard care compared to standard care alone improves outcomes in patients with HFpEF.

REDUCE LAP-HF – II
Evaluate the Corvia Medical, Inc. IASD System II to reduce elevated left atrial pressure in patients with heart failure with preserved or mid-range ejection fraction with elevated left atrial pressures, who remain symptomatic despite standard guideline-directed medical therapy in order to improve quality of life and reduce heart failure-related symptoms and events.

Tafamidis Extension Study
Evaluate the safety of oral daily dosing of 20mg or 80mg tafamidis meglumine in patients with transthyretin genetic variants or wild-type transthyretin resulting in amyloid cardiomyopathy.

Momentum III - Continued Access Protocol
Continued evaluation of the safety and clinical performance of the HM3 LVAS for the treatment of advanced, refractory, left ventricular heart failure.

GUIDE-HF
Demonstrate the effectiveness of the CardioMEMS Heart Failure System in patients with heart failure who have an elevated N-terminal pro-brain natriuretic peptide and/or a prior heart failure hospitalization.

For more information or to view additional trials, visit UMHealthResearch.org.
Heart Failure
EXTENSIVE EXPERTISE IN HEART FAILURE THERAPIES (CONTINUED)

Cardiac Transplant Program
The Frankel CVC is the leading cardiac transplant center in Michigan, performing an average of 27 adult cardiac transplants each year. The Cardiac Transplant Program team has performed more than 1,000 heart transplants since 1984. Our transplant team includes multidisciplinary specialists with extensive experience in managing the complexities of transplant patients, including:

• Adult cardiac transplant surgeons
• Heart failure and transplant cardiologists with advanced training in transplantation
• Advanced circulatory support
• Cardiac critical care
• Nutritionists
• Social workers

Our team works closely with faculty who specialize in congenital heart disease, inherited cardiomyopathies and transplant infectious diseases to provide each patient with seamless, comprehensive care. We are also affiliated with MidMichigan Health. Headquartered in Midland, MidMichigan Health operates hospitals in Midland, Alma, Alpena and Gladwin, and outpatient locations throughout the center of the state.

Heart Transplant Survival

<table>
<thead>
<tr>
<th></th>
<th>Observed</th>
<th>Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 DAY</td>
<td>100%</td>
<td>97.3%</td>
</tr>
<tr>
<td>1 YEAR</td>
<td>96.4%</td>
<td>93.4%</td>
</tr>
<tr>
<td>3 YEAR</td>
<td>86.7%</td>
<td>85.6%</td>
</tr>
</tbody>
</table>

30 Day data and 1 Year data for 7/15 – 12/17
3 Year data for 1/13 – 6/15
Source: Scientific Registry of Transplant Recipients

Long-Term VAD Implant Volume

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Pediatric</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>
Includes 10 multi-organ transplants
Kristin Sterk is a wife, mother, blogger, author and advanced heart failure patient.

The 35-year-old’s health issue was detected 18 years ago during a high school sports physical when her family physician heard a faint heart murmur. An echocardiogram revealed a rare heart condition known as ALCAPA (anomalous left coronary artery from the pulmonary artery). Sterk’s pulmonary and coronary arteries were connected and the left side of her heart was only receiving deoxygenated blood.

Forced to give up her dream of playing college basketball, the 17-year-old underwent a successful open-heart surgery in 2001 and was back in school within two weeks. Over the next few years, she graduated from college, married and gave birth to a beautiful daughter. But a newly diagnosed mitral valve leak meant another open-heart surgery for Sterk, who by then had been referred to the U-M Frankel Cardiovascular Center.

Several days after her successful mitral valve repair, she began to feel ill. Follow-up tests revealed the tissue surrounding her sutures had calcified. “My valve was not working at all,” says Sterk. “As a result, I needed yet another open-heart surgery to replace the repaired valve.”

It was a grueling six days in the ICU before she was healthy enough to have surgery to replace her mitral valve and repair her tricuspid valve.

Following a month of recuperation, Sterk began cardiac rehab near her home in Holland, Michigan. “By the end of rehab, I was jogging and thought I had a new lease on life,” she says. “Little did we know that two months later, at a visit back at U-M, we learned that my ejection fraction was only 20 percent. It has been an uphill battle ever since.”

“I’m grateful to them for their persistent work to improve the function of my heart.”

In February 2019, Sterk was implanted with an ICD and underwent an ablation in May to address her frequent PVCs. She also may face a future heart transplant, but she and her U-M health care team are not giving up. “I’m grateful to them for their persistent work to improve the function of my heart,” she says.

Read more about Kristin Sterk’s story at michmed.org/q44A9. She has also documented her life story in a book entitled “A Heartbeat of Grace.”
An explosion of novel cancer therapies has revolutionized the field and dramatically altered cancer prognosis. However, these therapies have introduced unexpected cardiovascular complications beyond cardiomyopathy. Ironically, increases in cardiovascular morbidity and mortality now threaten to offset the advances in cancer-related survival. Moreover, the epidemiologic impact of cancer therapy-related cardiotoxicity is growing, as the number of cancer survivors as well as aging patients with various cardiovascular comorbidities at risk for cancer is increasing.

More patients than ever are experiencing cardiovascular side effects of cancer therapy, whether during treatment or in survivorship.

Addressing the cardiovascular health of patients with cancer is a top priority at Michigan Medicine. To that end, a dedicated Cardio-Oncology Clinic was established as a multidisciplinary partnership between the Frankel CVC and the Comprehensive Cancer Center. As one of a few institutions in the country to offer this level of coordinated care, we team with oncologists to support our patients from the time of diagnosis onto survivorship.

Through the Cardio-Oncology Clinic, cardiologists and oncologists collaborate to improve the quality of life for patients and eliminate barriers to effective treatment by:

- Optimizing the cardiovascular health of patients with known cardiac issues prior to cancer treatment.
- Assisting oncologists in selecting the safest cancer therapy regimen to minimize cardiovascular side effects.
- Preventing heart disease in patients who require chemotherapy or radiation therapy and are thereby at increased risk for heart disease.
- Closely monitoring patients who are receiving potentially cardiotoxic cancer treatments.
- Minimizing interruptions in cancer treatment by close monitoring and pre-emptive cardiovascular medical therapy.
- Using state-of-the-art imaging and biomarker testing to screen patients who are at high risk for heart disease due to cardiotoxic drugs.
- Following up with pediatric and adult cancer survivors — patients at higher risk than the general population for developing heart disease later in life.

Our cardio-oncology team is also dedicated to optimizing the heart function of cancer patients facing a bone marrow transplant. Our increasing patient volume in this area reflects a significant need to help protect the hearts of cancer patients and to prepare patients whose heart function has been compromised by the effects of cancer therapy for what is often considered a life-saving bone marrow transplant.

<table>
<thead>
<tr>
<th>Cardio-Oncology Clinic Volume</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL NEW PATIENT VOLUME</td>
<td>211</td>
<td>231</td>
<td>212</td>
</tr>
</tbody>
</table>
State-of-the-Art Research
A major challenge is identifying which cancer patients at risk of cardiovascular side effects of therapy would benefit from early intervention. A cross-discipline research program is bringing together oncologists and cardiovascular specialists to explore novel biomarkers of risk using state-of-the-art methods such as metabolomics and proteomics.

Cardio-oncology research includes efforts to better understand the mechanisms of cardiotoxicity at the cellular level, and participation in new chemotherapeutic drug studies aimed at minimizing the cardiotoxicity of future cancer drugs.

Cardiac Tumor Program
Our cardio-oncology specialists lead a nationwide U-M Cardiac Tumor Program that brings together multidisciplinary experts — including oncologists, surgeons, radiologists and cardiologists — from around the country via monthly videoconference to discuss complex cases. This multidisciplinary review board takes an individualized approach to determine whether surgery, chemotherapy, radiation or other therapies will yield the best patient outcome.

Through the Cardio-Oncology Clinic, cardiologists and oncologists collaborate to optimize the cardiovascular health of cancer patients and eliminate barriers to effective treatment.
At the Frankel CVC, we are focused on providing the best patient care experience. Our standard of excellence ensures the best possible vascular surgery outcomes, from initial clinic visits through subsequent follow-up appointments.

We participate in both the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2) and the Vascular Quality Initiative (VQI) to allow us to benchmark and improve outcomes.

Our surgeons specialize in open vascular surgery and the use of minimally invasive endovascular procedures for a wide range of vascular conditions, including:

- Abdominal aortic aneurysm
- Carotid artery disease
- Fenestrated aortic endograft
- Mesenteric artery disease
- Peripheral arterial disease
- Renal artery disease
- Thoracic and thoracoabdominal aortic aneurysm
- Varicose veins
- Venous thromboembolism (complicated)
- Venous insufficiency
- Vertebral artery disease

**Thoracic Outlet Syndrome**

Michigan Medicine vascular surgeons offer unparalleled expertise in the diagnosis and treatment of thoracic outlet syndrome (TOS), a group of conditions caused by compression of the nerves or blood vessels that pass through the thoracic outlet. The three subtypes of TOS — neurogenic, venous and arterial — are diagnosed using EMG, MRI, CT/MR venogram or CT/MR arteriogram. Treatment for these conditions ranges from physical therapy to open surgery and thoracic outlet decompression. Our multidisciplinary team includes specialists from physical and occupational therapy, physical medicine and rehabilitation, pain management, interventional pain, pain psychology, orthopedics and neurosurgery.
Transcarotid Artery Revascularization
Our vascular surgeons offer a safer method of carotid stenting known as transcarotid artery revascularization (TCAR). Early results suggest that TCAR has the lowest stroke risk among procedures for carotid stenosis, with lower risk of nerve injury than carotid endarterectomy. The minimally invasive procedure involves placing a stent through a small incision at the base of the neck to allow direct access to the common carotid artery. TCAR uses a transcarotid neuro-protection system (NPS) to reduce the risk of stroke during the stent insertion procedure. The system allows surgeons to access the carotid artery and initiate high-rate temporary blood flow reversal to protect the brain from plaque that may come loose as the stent is implanted.

Pediatric Vascular Disease Program
The pediatric vascular surgery program at U-M remains the country’s preferred destination for children in need of surgical management of occlusive or aneurysmal diseases of the abdominal aorta and its branches. A multidisciplinary team is led by vascular surgeons and includes specialists in interventional radiology, pediatric nephrology, intensive care and anesthesia, as well as nurses and social workers with broad knowledge of pediatric renovascular hypertension and childhood abdominal aortic coarctation.

CLINICAL TRIALS

CREST II
(Carotid revascularization for primary prevention of stroke) Two independent multicenter, randomized controlled trials of carotid revascularization and intensive medical management versus medical management alone in patients with asymptomatic high-grade carotid stenosis.

EXCLUDER AAA
(Assessment of the GORE EXCLUDER Conformable AAA Endoprosthesis in the treatment of Abdominal Aortic Aneurysms) Multicenter study comprised of two parallel sub-studies to assess the safety and effectiveness of the Gore Excluder-C AAA endoprosthesis to treat an infrarenal aneurysm located in the abdominal aorta.

PHOTO-V
(Post-market, prospective evaluation of PHOTO-oxidized decellularized bovine pericardium used as a patch in Vascular repair and reconstruction surgery) Post-market study to provide additional information on risks, benefits and optimal use for the CryoLife PhotoFix patch.

For more information or to view additional trials, visit UMHealthResearch.org.
Gehrig Elliott was wrapping up his typical workout routine when he noticed his right arm had swelled. The 16-year-old assumed it might be a pulled muscle, a likely concern for a young athlete active in football, basketball and baseball.

But when the swelling hadn’t subsided a few days later, Elliott’s parents took him to see the family physician. The doctor suspected venous thoracic outlet syndrome, or TOS, and referred Elliott to the emergency department at University of Michigan C.S. Mott Children’s Hospital.

“Within an hour of being in the emergency room, I was given an ultrasound and told I had a blood clot in my arm,” Elliott recalls.

A shocking diagnosis for the otherwise healthy student, the clot was caused by venous thoracic outlet syndrome.

TOS encompasses a group of conditions caused by compression of the nerves and blood vessels that pass through the thoracic outlet.

When compressed, these nerves, arteries and veins become compromised, causing pain or swelling in the neck, shoulder, arm or hand, depending on the type of TOS.

Elliott’s venous TOS was serious, says U-M Frankel Cardiovascular Center vascular surgeon Chandu Vemuri, M.D., an expert in diagnosing and treating the condition.

Vemuri and his team determined the necessary treatment would involve a series of procedures beginning with a venogram to deliver clot-dissolving drugs to the site of the clot via a catheter. In patients with a clotted subclavian vein, this procedure allows physicians to remove the clot and confirm a TOS diagnosis.

Vemuri then performed surgery, removing Elliott’s first rib, portions of his anterior scalene muscle and scar tissue. A second venogram confirmed the vein was fully functioning.

He’s thankful to the doctors and nurses involved in his care. So much, in fact, that he is reconsidering his future career.

“I’d like to study something in the medical field,” Elliott says. “This experience has opened my eyes to different careers out there.”

Read more about Gehrig Elliott’s story at michmed.org/e6Am0.
Vascular Disease
ADVANCED VASCULAR INTERVENTIONAL RADIOLOGICAL CARE

The multidisciplinary Interventional Radiology Vascular Program at the Frankel CVC is a leading and innovative partner in the diagnosis and treatment of vascular disease using cutting-edge diagnostic and minimally invasive, image-guided procedures to improve patient outcomes and reduce hospital stays.

We specialize in treating:
• Aortic aneurysms and dissections
• Inferior vena cava filter placement and management
• Lymphatic interventions
• Massive and sub-massive pulmonary embolism
• Mesenteric ischemia
• Pediatric vascular disease (cooperative with Vascular Surgery)
• Pelvic congestion syndrome and varicoceles

• Percutaneous transcatheter angioplasty
• Peripheral arterial disease
• Renal artery stenosis/secondary hypertension
• Varicose veins
• Vascular malformations
• Venous occlusive disease (thrombotic or congenital)
• Venous recanalization in patients with end-stage renal disease
• Venous thoracic outlet syndrome (cooperative with Vascular Surgery)

CLINICAL TRIALS

KNOCKOUT PE
Assess the safety and effectiveness of ultrasound-assisted catheter-directed thrombolysis in the management of patients with pulmonary embolism.

Medtronic Abre Venous Stent
Evaluate the safety and effectiveness of the Abre venous self-expanding stent system in patients with symptomatic iliofemoral venous outflow obstruction.

PRESERVE
(Predicting the safety and effectiveness of Inferior Vena Cava Filters) Evaluate the safety and effectiveness of commercially available IVC filters in patients with clinical need for mechanical prophylaxis of PE with an IVC filter.

For more information or to view additional trials, visit UMHealthResearch.org.
Vascular Surgery Volume (Open and Vascular)

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>1,250</td>
</tr>
<tr>
<td>2016</td>
<td>1,292</td>
</tr>
<tr>
<td>2018</td>
<td>1,436</td>
</tr>
</tbody>
</table>

Interventional Radiology Vascular Volume

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>870</td>
</tr>
<tr>
<td>2016</td>
<td>1,149</td>
</tr>
<tr>
<td>2018</td>
<td>1,162</td>
</tr>
</tbody>
</table>
Peripheral Arterial Disease
COLLABORATIVE PATIENT CARE

The Peripheral Arterial Disease Program at the Frankel CVC brings together a strong team of experts from interventional cardiology, interventional radiology, cardiovascular medicine, vascular medicine and vascular surgery all in one location.

Any PAD patient can be seen in our clinic, from those with mild cases to limb-threatening, disabling conditions. Our team meets regularly to discuss individual cases and develop optimal management strategies for every patient. We also work closely with podiatry and diabetes specialists to prevent amputations where possible. Few other centers offer such a complete PAD treatment program.

Collaborative Approach
Our coordination of a standardized outpatient experience, as well as increased access to wound care and pain management services, ensures the best care. Collaboration across physician specialties and coordination of quality improvement efforts translate into optimal revascularization strategies, fewer procedural complications and improved guideline-recommended medical therapy.

In addition, our PAD program provides:
- Comprehensive testing in an Intersocietal Accreditation Commission (IAC) vascular lab.
- Immediate access to all patients with any degree of PAD, from mild to severe.
- State-of-the-art angiographic equipment with access and expertise in multiple minimally invasive endovascularization modalities.
- Hybrid endovascular operating rooms for combined operative and minimally invasive procedures.
- Expertise in limb-sparing and limb-salvaging operative and endovascular procedures.
- Same-day evaluations, including imaging.
- Treatment interventions, including complicated angioplasty, stenting, endarterectomy, atherectomy and bypass graft surgery.
- Exercise rehabilitation, smoking cessation program, dietary counseling and prosthetics services.
- Consultative and educational programs for referring physicians.

2018 Percutaneous Peripheral Arterial Procedures

- **FEMORAL-POPLITEAL**: 37.3%
- **AORTO-ILIAC**: 14.8%
- **BELOW THE KNEE**: 30.5%
- **SMA/CELIAC**: 5.5%
- **RENAL**: 8.9%
- **SUBCLAVIAN/AXILLARY**: 3.0%
- **HYBRID PROCEDURES**: *18.3%*
Shared Decision-Making

Our PAD team is committed to enhancing communication with patients with the goal of making them an integral part of their individual treatment choices. To this end, we are focused on three areas that promote shared decision-making with our patients:

- **Choosing a treatment plan.** A values clarification tool, designed by PAD specialist Matthew Corriere, M.D., gives patients a bigger role in the treatment decision-making process. The tool helps physicians understand what matters most to patients and apply the information to help design a treatment plan consistent with patient values.

- **Exploring doctor/patient communication to ensure the patient voice is heard.** An observational study is exploring how doctors and patients communicate during clinic visits. By analyzing conversations, we can identify opportunities to ensure mutual understanding and engage patients and their families in shared treatment decisions.

- **Understanding how patients view and process educational materials.** Using eye-tracking technology, the PAD team is able to determine how patients view educational information related to PAD, including exercise habits, medications, etc. This technology will allow us to engage patients as co-designers of educational materials that are customized according to their needs.

CLINICAL TRIALS

**BEST-CLI**

Compare the effectiveness of best available surgical treatment with best available endovascular treatment in adults with critical limb ischemia who are eligible for both treatment options.

For more information or to view additional trials, visit [UMHealthResearch.org](http://UMHealthResearch.org).

**BEST-CLI**

Compare the effectiveness of best available surgical treatment with best available endovascular treatment in adults with critical limb ischemia who are eligible for both treatment options.

For more information or to view additional trials, visit [UMHealthResearch.org](http://UMHealthResearch.org).
The Venous Health Program at the Frankel CVC is a multidisciplinary, large-volume clinic that provides care for the entire spectrum of venous disease. Specialists from vascular surgery, vascular medicine and interventional radiology collaborate to establish uniform treatment recommendations and care plans for patients who are seen at the Frankel CVC.

The spectrum of venous disease involves treatment for conditions ranging from superficial venous disease, including spider vein injection, to treatment of reflux with minimally invasive endovenous therapy and removal of varicose veins. We also provide comprehensive treatment of deep venous disease, including May-Thurner syndrome and venous thromboembolism.

Our team consists of highly trained experts with years of experience in treating all varieties of venous conditions, regardless of complexity. We participate in the Society for Vascular Surgery Vascular Quality Initiative Varicose Vein Registry (VQI VVR), allowing tracking of results of superficial vein treatments.

Innovative treatments include:

- **Liquid and Varithena Foam Sclerotherapy** for treatment of spider, reticular and varicose veins.

- **Comprehensive treatment of superficial reflux with**: radiofrequency ablation, laser ablation and thermal and non-thermal ablative techniques.

- **Laser ablation** of perforator veins.

- **Phlebectomies** using powered phlebectomy, microphlebectomy, ambulatory phlebectomy, stab phlebectomy and foam sclerotherapy for removal of varicose veins.

- **Pharmacomechanical thrombolysis** for treatment of iliofemoral venous thrombosis.

- **Recanalization of central veins** to treat significant chronic venous insufficiency or obstruction.

We also offer consultative and educational programs for referring physicians, especially those who are some distance from Ann Arbor, to help them manage venous disease patients locally.

The Frankel CVC is dedicated to exploring new treatments, medical therapies and delivery of care options that improve the lives of patients living with venous disease.
1. May-Thurner Syndrome
2. Venous Insufficiency
3. Deep Vein Thrombosis

- Right iliac a.
- Left iliac v.
- Superficial vein
- Femoral vein
- Thrombosis
Cardiovascular Imaging

UNPARALLELED CARDIOVASCULAR IMAGING CAPABILITIES

The cardiovascular imaging services available at the Frankel CVC rival those at any top laboratory or center in the country. Our faculty, staff and technologists maximize our research facilities to bring state-of-the-art equipment and techniques into the clinic. Our team is able to serve large volumes of patients and provide unparalleled levels of detail, including imaging of complex and less common diseases. We collaborate with specialists throughout Michigan Medicine and beyond to ensure the most effective diagnosis, analysis and treatment for patients.

Our Services Include:

**Cardiac MR**

The high-resolution images obtained with cardiac MR enable us to skillfully demonstrate cardiovascular anatomy, make extremely accurate measurements of cardiac function and identify areas of cardiac scar, important steps in planning advanced cardiac procedures. These techniques make possible the evaluation and diagnosis of many cardiac diseases that are difficult to identify with any other non-invasive test.

**Cardiac and Vascular CT**

Our state-of-the-art CT scanners can image the entire heart in a single heartbeat and use advanced computer processing to reduce artifacts and improve image quality. We use multiple strategies simultaneously to minimize radiation dose and preserve image quality. Our advanced image-processing laboratory can create 3-dimensional models of the heart that help make diagnoses and plan interventional procedures. Our studies are interpreted by specialized readers with world-class expertise in cardiovascular imaging.
**Diagnostic Vascular Unit**
The U-M Diagnostic Vascular Unit (DVU) provides a full spectrum of arterial and venous examinations, including ultrasound, Doppler and plethysmography-based studies. The DVU services both the outpatient and inpatient areas of U-M. Accreditation by the Intersocietal Accreditation Commission is current and has been ongoing since 1993. Locations for DVU imaging include the University Hospital, Frankel CVC, Domino’s Farms, Briarwood, Northville, Brighton and Taubman Center.

**Echocardiography**
Our Echocardiography laboratories perform all types of conventional and advanced echocardiograms, including 2-D, 3-D, 3-D transesophageal, multidimensional strain imaging and stress.

**Nuclear Cardiology**
The Frankel CVC Nuclear Cardiology laboratory and PET imaging center are fully equipped with advanced SPECT/CT and PET/CT imaging systems. In addition to evaluating for myocardial viability and perfusion, we use novel approaches to detect cardiac sarcoidosis, myocardial inflammation and cardiac infection. Advanced cardiac PET imaging, for example, enables us to detect the active, inflammatory phase of cardiac sarcoidosis as well as the chronic phase, in which scarring and fibrosis are predominant. Advanced PET imaging also allows us to visualize cardiac infections that involve artificial heart valves, cardiac implantable electrical devices and left ventricular assist devices.

---

**CLINICAL TRIALS**

**CORE Study**
Assess the impact of thoracic aortic stent grafts on the cardiovascular system through non-invasive measurements.

**MRI in Cerebral Blood Flow**
Quantify cerebral blood flow and tissue perfusion in patients with cerebrovascular occlusive disease by combining imaging and computational methods.

For more information or to view additional trials, visit UMHealthResearch.org.

---

**Rb-82 Perfusion**

**F-18 FDG Inflammation**

Cardiac PET/CT Scan in Patient with Cardiac Sarcoidosis
Genetic Counseling and Testing
EXPERT RESOURCES FOR INHERITED HEART CONDITIONS

The Frankel CVC offers comprehensive genetic counseling and testing for individuals diagnosed with inherited cardiovascular conditions.

The U-M Cardiovascular Genetic Counseling and Testing program works hand in hand with a multidisciplinary Frankel CVC team made up of specialists in a variety of areas, including:

- Cardiomyopathy
- Arrhythmia
- Aortic disease (aneurysms and dissections)
- Heart failure
- Early-onset coronary artery disease (familial hyperlipidemia)
- Pulmonary arterial hypertension
- Other vascular/arterial diseases

**Counseling**

Our genetic counselors prepare individuals with familial cardiovascular disease for genetic testing, including how the testing might impact the patient and his or her family. Genetic counseling also helps families explore their health history to assess risks for a cardiovascular condition that may run in the family.

Consultation with a genetic counselor is offered to all patients diagnosed with a possible genetic cardiovascular condition. These are in-person appointments, generally 30-60 minutes in length, and can be coordinated with a patient’s other cardiology appointments.

Genetic counselors are also available to help referring physicians recognize signs of a patient’s potential genetic cardiovascular disorder, such as:

- Sudden cardiac arrest.
- Family history of sudden cardiac death, unexplained death at a young age or death by an unexplained accident or drowning.
- Heart failure at a young age (under 50).
- Palpitations or an abnormal heart rhythm at a young age.
- Fainting, blackouts or seizures that could not be treated with typical seizure medications.
- More than one relative with the same type of cardiovascular disease.

![Sample Family Pedigree](image-url)
Testing
Genetic testing is available for a number of hereditary cardiovascular conditions, including cardiomyopathies such as hypertrophic cardiomyopathy and arrhythmogenic cardiomyopathy, arrhythmia conditions such as long QT syndrome and Brugada syndrome, amyloidosis, aortic aneurysms and dissections, familial hyperlipidemia and pulmonary arterial hypertension.

Our team of experienced, board-certified genetic counselors is available to assist clinicians throughout the testing process to:

• Review patient cases that may benefit from genetic testing.
• Differentiate between genetic tests to select the one that is most suitable for the patient.
• Assist in interpreting results.
• Provide result-specific background regarding variants, genes and conditions.
• Evaluate, discuss and provide information for at-risk family members who can also be tested and followed through the program.
• Identify gene-specific information, including relevant literature and studies, published management guidelines and patient resources.

CLINICAL TRIALS

Bicuspid Aortic Valve Registry
Gather information on patients with BAVs to better understand and assess patterns of aortic dilation, responses to medical therapy based on serial imaging and the potential for genetic markers.

CHIP (Cardiovascular Health Improvement Project)
Establish a biorepository of DNA, plasma, serum and aortic tissue samples as well as an extensive clinical database of medical and family history information.

For more information or to view additional trials, visit UMHealthResearch.org.
The University of Michigan Comprehensive Stroke Center includes a wide-ranging, specially trained, multidisciplinary team of experts in emergency medicine, vascular surgery, cardiology, neurology, neurosurgery, neurocritical care, neurointerventional radiology, anesthesiology, internal medicine and physical medicine and rehabilitation. The Center offers patients the highest level of comprehensive stroke care that ranges from reducing the risk of stroke to the most advanced stroke treatments. The multidisciplinary team includes eight board-certified vascular neurologists who are active in national stroke guideline development and offer a depth of knowledge about all types of stroke.

**Emergency Stroke Care**
Our emergency response services — including Survival Flight, an internationally recognized flight program — transport patients to our hospital quickly and safely. Our tPA delivery timing surpasses the standards outlined in the American Stroke Association “Get With The Guidelines®” program, a testament to our well-trained and efficient emergency medicine staff. Each patient arriving at Michigan Medicine is evaluated in conjunction with our Acute Stroke Team.

Patients diagnosed with a large cerebral blood vessel occlusion are evaluated and treated by a specially trained neurovascular team in one of our neurointerventional suites. Unlike most other stroke centers in Michigan, our multidisciplinary stroke program has the ability to care for multiple critically ill stroke patients presenting to our emergency department simultaneously.

### Volumes

<table>
<thead>
<tr>
<th></th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACUTE ISCHEMIC STROKE</strong></td>
<td>410</td>
<td>447</td>
<td>502</td>
</tr>
<tr>
<td><strong>TRANSIENT ISCHEMIC ATTACKS (TIA)</strong></td>
<td>91</td>
<td>92</td>
<td>77</td>
</tr>
</tbody>
</table>

### Stroke Indicator

<table>
<thead>
<tr>
<th>Indicator</th>
<th>MI Benchmark</th>
<th>National Benchmark</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous Thromboembolism Prophylaxis By End of Hospital Day 2 (STK-1)</td>
<td>97.3%</td>
<td>97.6%</td>
<td>99.1%</td>
</tr>
<tr>
<td>Discharged on Antithrombotic Therapy (STK-2)</td>
<td>99.4%</td>
<td>99.5%</td>
<td>100%</td>
</tr>
<tr>
<td>Anticoagulation Therapy for Atrial Fibrillation/Flutter (STK-3)</td>
<td>95.1%</td>
<td>97.7%</td>
<td>100%</td>
</tr>
<tr>
<td>Thrombolytic Therapy (STK-4)</td>
<td>95.7%</td>
<td>92.4%</td>
<td>100%</td>
</tr>
<tr>
<td>Antithrombotic Therapy By End of Hospital Day 2 (STK-5)</td>
<td>98.1%</td>
<td>98.4%</td>
<td>99.7%</td>
</tr>
<tr>
<td>Discharged on Statin Medication (STK-6)</td>
<td>98.1%</td>
<td>98.4%</td>
<td>99.7%</td>
</tr>
<tr>
<td>Stroke Education (STK-8)</td>
<td>95.9%</td>
<td>96.5%</td>
<td>98.8%</td>
</tr>
<tr>
<td>Assessed for Rehabilitation (STK-10)</td>
<td>99.1%</td>
<td>99.3%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Benchmarking Source: AHA/GWTG
Inpatient Stroke Care
Unique to our region, stroke patients are cared for in our dedicated Stroke Unit and Neuro-Intensive Care Unit, which have been shown to decrease complications and improve survival and functional outcomes following stroke. Each stroke patient receives personalized guidelines for the best recovery strategies upon discharge.

Preventive Stroke Care
The Stroke Clinic provides screening and preventive care to high-risk patients. We work with patients to diagnose and treat conditions that increase the risk of stroke. Our location in the Frankel CVC promotes collaboration with cardiologists and vascular surgeons. Together, we put the best stroke prevention plan into action for each patient, which may range from lifestyle changes to the most sophisticated testing and treatment to decrease stroke risk.

Cutting-edge Treatment
For ischemic stroke patients, our team is highly experienced in thrombectomy, also known as clot retrieval. This surgical method of trapping and removing debilitating blood clots with technology known as a stent retriever has helped patients with major stroke recover more quickly and more thoroughly.

Inserted through an artery (typically in the groin), the collapsed stent can be expanded from inside a catheter once routed up to the brain’s blocked blood vessel. A wire-like cage then “traps” the clot and removes it from the body.

CLINICAL TRIALS

**ARCADIA**
A phase 3 clinical trial of apixaban versus aspirin in patients who have evidence of atrial cardiopathy and a recent stroke of unknown cause.

**Development of a Tailored Life-Sustaining Treatment Decision Support Intervention for Stroke Surrogate Decision Makers**
Develop a tailored web-based decision support intervention to prepare stroke surrogates to make decisions on use of life-sustaining treatments by improving understanding of stroke prognosis and clarifying values most important to the patient.

For more information or to view additional trials, visit [UMHealthResearch.org](http://UMHealthResearch.org).
Stroke
UNPARALLELED EXPERTISE AND PATIENT CARE (CONTINUED)

Stroke Research
In addition to providing cutting-edge therapies designed for the prevention and treatment of stroke, the U-M Comprehensive Stroke Center is a national leader in stroke research. Through active participation in several key international clinical research studies, our clinician researchers are helping to develop the next groundbreaking therapies in stroke. As a leader in research, the stroke program at Michigan Medicine provides its patients with the best opportunity to be at the leading edge of stroke care anywhere in the world today.

Stroke Rehabilitation
In 2017, the U-M Comprehensive Stroke Center became the first medical center in Michigan to achieve Joint Commission certification for both our Comprehensive Stroke Center and our Stroke Rehabilitation Program. Our stroke rehabilitation unit provides patients with a multidisciplinary team of rehabilitation physicians, nurses, therapists, speech-language pathologists and rehabilitation neuropsychologists with a goal of maximizing functional abilities after stroke. Additionally, joint efforts between the Comprehensive Stroke Center and Stroke Rehabilitation Program aim to ensure that stroke patients continue their path to recovery once they transition out of the hospital setting.

Our Commitment to Excellence
The U-M Comprehensive Stroke Center is accredited as such by The Joint Commission. Team members of the Stroke Center helped in authoring as well as participating in the American Stroke Association “Get With The Guidelines®” Quality Initiative. We have repeatedly been designated as an American Heart Association Gold Plus and Target Stroke Honor Roll hospital, the highest stroke quality designations. This award recognizes hospitals that provide consistently excellent care following evidence-based guidelines. The AHA has recognized the quality of stroke care provided at U-M since 2005. More recently, through our partnership, Metro Health Hospital has also been designated a Comprehensive Stroke Center.

Procedural Volumes

<table>
<thead>
<tr>
<th>Procedural Volumes</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV tPA</td>
<td>41</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>MECHANICAL THROMBECTOMY</td>
<td>49</td>
<td>61</td>
<td>129</td>
</tr>
</tbody>
</table>
October 9, 2018, began as a stressful day for Linda and Bill Sanders. But they had no way of knowing just how stressful that day would become.

The couple was visiting Bill’s brother, who was in the intensive care unit at the U-M Frankel Cardiovascular Center and not expected to live.

As the Flushing, Michigan, residents took a lunch break in the ICU visitors’ area, Linda noticed her 60-year-old husband was having difficulty eating. When she saw his left arm fall to his side, she knew they needed help. Bill was having a stroke.

“Before I knew it, there were 20 people surrounding us,” Linda recalls.

“They threw me on a gurney,” Bill says. “I still didn’t believe it was happening to me, but they told me: ‘You’ve had a stroke.’”

Bill was whisked away to the Emergency Department, where a CT scan detected a clot in a major blood vessel of his brain, causing an ischemic stroke.

The stroke team immediately evaluated Bill and explained next steps to Linda. Bill would be given a clot-busting medication called tissue plasminogen activator (tPA) to dissolve the clot. He would also undergo thrombectomy, a novel therapy that can benefit certain patients up to 24 hours after the onset of stroke symptoms.

“I was definitely in the right place at the right time,” Bill says. As a pharmaceutical delivery person, he probably would have been on the road at the time of the stroke if he hadn’t been visiting his brother in the hospital.

“Bob kind of saved my life,” he says as he warns, “If this could happen to me, it could happen to anybody.”

Read more about Bill Sanders’ story at michmed.org/Qbw8k.
Pulmonary Hypertension

UNPARALLELED EXPERTISE IN DIAGNOSIS AND TREATMENT

The Pulmonary Hypertension Program at the Frankel CVC is the largest and most experienced program in the state, and one of the largest in the country. The program was also one of the first in the country (and first in the state) to be accredited as a Center of Comprehensive Care (CCC) through the Pulmonary Hypertension Association’s Pulmonary Hypertension Care Centers (PHCC) program.

Pulmonary hypertension diagnosis and treatment are complex and require highly specialized expertise. Our team of physicians, nurse clinicians, research coordinators and support staff offers a comprehensive, single resource for the care and treatment of patients who live with various types of this challenging and difficult-to-diagnose disease.

Types of PH conditions include:

- **Pulmonary arterial hypertension (PAH):** A disease of the blood vessels of the lungs, which become thick and narrow, causing elevation in pressure.

- **Pulmonary venous hypertension (PVH):** An elevation in the pressure in the pulmonary veins, most often caused by congestive heart failure.

- **Chronic thromboembolic pulmonary hypertension (CTEPH):** Pulmonary hypertension associated with the body’s inability to clear blood clots from the lungs (known as chronic thromboembolic obstruction). The disease is sometimes present without any known history of previous pulmonary embolism.

- **Exercise-induced pulmonary hypertension:** A condition in which the pulmonary arteries are normal at rest, but increase abnormally with exertion.

**Treatment for Pulmonary Hypertension**

There are more than a dozen FDA-approved and several investigational treatment protocols for patients with PAH, and the treatment plan will be tailored to each patient’s disease and needs. We use high-dose calcium channel blocker therapy in select patients who demonstrate pulmonary vasodilator reserve to inhaled nitric oxide. We have extensive experience with all current FDA-approved treatments.

Patients with PAH may also be referred to a pulmonary rehabilitation program to enhance their breathing and help them become more active.

Heart failure with preserved ejection fraction (HFpEF) is recognized more and more as a cause for PVH. HFpEF treatment often starts with controlling blood pressure and relieving fluid overload that can cause swelling or shortness of breath. Since there isn’t a “cookbook” of treatments that work for all patients with HFpEF, we use information from diagnostic tests to design the best treatment plan for each patient’s particular situation. We also think carefully about how to improve the management of other conditions that might contribute to a patient’s HFpEF.

CTEPH patients may undergo a pulmonary thromboendarterectomy (PTE), a complex cardiac surgical procedure in which a surgeon removes blood clots from the pulmonary arteries. This operation can be curative for patients with CTEPH.
CLINICAL TRIALS

**Acceleron PULSAR**
Compare the efficacy and safety of Sotatercept (ACE-011) versus placebo when added to standard of care for the treatment of pulmonary arterial hypertension.

**PaRTAke-PH**
Examine the impact of home-based, moderate-intensity exercise training in patients with pulmonary arterial hypertension.

**Reata Catalyst**
Study the efficacy and safety of Bardoxolone Methyl in patients with connective tissue disease-associated pulmonary arterial hypertension.

For more information or to view additional trials, visit [UMHealthResearch.org](http://UMHealthResearch.org).
Partnership with Scleroderma Clinic

Early diagnosis of pulmonary arterial hypertension is key for scleroderma patients. The Pulmonary Hypertension Program regularly partners with U-M’s Scleroderma Clinic to investigate new and better screening techniques and treatments for systemic sclerosis-associated PAH. Some of our current projects include:

• A study on the novel, evidence-based DETECT algorithm for diagnosing PAH at earlier stages
• Phase II multi-center Rituximab trial
• Metabolomics screening

Pulmonary Hypertension Breakthrough Initiative

The University of Michigan serves as the Data Coordinating Center for the PHBI, a network of multidisciplinary, collaborative transplant and research centers that distributes stored clinical specimens and relevant data to researchers and for use in groundbreaking research to better understand the molecular basis of pulmonary arterial hypertension. Funding for this important network has been extended via a large NIH grant.
The multidisciplinary Frankel CVC pulmonary embolism team specializes in the treatment of patients with all forms of pulmonary embolic disease.

Pulmonary embolism (PE) is a blockage or interruption in blood flow through the pulmonary artery caused by a blood clot. Our pulmonary embolism program involves experts from various disciplines, including vascular medicine, cardiology-pulmonary hypertension, interventional cardiology, radiology (diagnostic and interventional), hematology and cardiothoracic surgery.

These nationally renowned experts work together to provide patients with comprehensive care throughout the entire spectrum of pulmonary embolic disease, including acute PE, chronic PE and chronic thromboembolic pulmonary hypertension (CTEPH). Frankel CVC patients have access to all available and upcoming novel investigations for the entire spectrum of pulmonary embolic disease.

**Treatment for PE**

Pulmonary thromboendarterectomy (PTE) is a complex cardiac surgical procedure in which a surgeon removes blood clots from the pulmonary arteries. This operation can be curative for patients with CTEPH. This procedure should be performed only by a highly experienced and skilled surgical team with proven outcomes. The Frankel CVC is currently the only institution in the state (and one of only a few in the nation) to offer PTE surgery with outstanding results.

For patients who are not candidates for surgical removal of blood clots, evidence-based medical management and balloon pulmonary angioplasty (BPA) are alternative treatments. BPA is an innovative, minimally invasive, catheter-based therapy offered at only a handful of medical centers throughout the world. Blockages from blood clots are treated with balloon dilatation of the pulmonary vessels resulting in gradual lowering of pulmonary artery pressures. Our specialized team is able to successfully perform BPA procedures with excellent outcomes.

Our dedicated 24-hour on-call pulmonary embolism response team (PERT) provides inpatient consultation and an outpatient pulmonary embolism clinic for post-discharge care of PE patients. Every patient undergoes an extensive and thoughtful multidisciplinary evaluation, and an individualized treatment plan is developed for continued care.

### Annual PTE Case Volume

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>3</td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
</tr>
<tr>
<td>2013</td>
<td>5</td>
</tr>
<tr>
<td>2014</td>
<td>5</td>
</tr>
<tr>
<td>2015</td>
<td>18</td>
</tr>
<tr>
<td>2016</td>
<td>22</td>
</tr>
<tr>
<td>2017</td>
<td>18</td>
</tr>
<tr>
<td>2018</td>
<td>23</td>
</tr>
</tbody>
</table>
Women’s Heart Disease

PREVENTIVE AND COMPREHENSIVE CARE FOR A WOMAN’S LIFESPAN

The Women’s Heart Program at the Frankel CVC is a vibrant research and clinical venue focused on addressing prevention, diagnosis and treatment of heart disease in women across the lifespan, from childbearing years through menopause and beyond. We offer a comprehensive program with cardiac rehabilitation, stress management, nutrition and exercise counseling, and many testing modalities all in the same building.

Our multidisciplinary team is comprised of experts who specialize in women’s heart health, including physicians, nutritionists and exercise physiologists. We coordinate cardiovascular care for women and act as a central point of contact for patients, other cardiovascular specialists within the Frankel CVC and referring physicians.

Conditions that arise during pregnancy, such as gestational diabetes, preeclampsia and gestational hypertension, are associated with increased risk of cardiovascular disease later in life. With this knowledge, we are able to provide preventive care earlier to these women in an effort to reduce the burden of cardiovascular disease as they age.

Pregnancy can also lead to complications for women with underlying heart disease and can even lead to a condition called peripartum cardiomyopathy (PPCM). Our multidisciplinary team includes obstetricians, anesthesiologists and cardiologists with expertise in pregnancy, congenital disease, electrical abnormalities and heart failure. We provide preconception counseling and cardiac monitoring during pregnancy and the early postpartum period. We work with local providers to maintain ongoing continuity of care.

Our team is also actively involved in peripartum cardiomyopathy research. One area of focus is on whether breastfeeding impacts the recovery of the heart. Another is on different blood tests and biomarkers that may identify women at risk for PPCM.

As we learn more about how cardiovascular disease presents differently in women than in men, we are expanding our knowledge and expertise in providing preventive care earlier in the lives of women, most notably during pregnancy.
Erika Mitchell was nearing her sixth month of pregnancy when she knew something was wrong. The feeling had started to build earlier in her pregnancy, but doctors assured her the breathing issues and exhaustion she was experiencing were normal.

With three healthy pregnancies in the past, Mitchell, 37, wasn’t convinced.

“I was having so much difficulty breathing that I couldn’t sleep,” she recalls. A lingering cough was diagnosed as bronchitis, but the prescribed medication didn’t improve her condition.

By July 2017, at seven months of pregnancy, Mitchell’s fluid retention in her legs was becoming unbearable.

“I couldn’t eat and was losing weight. My body felt so overworked,” she says. “I thought I was going to die.”

With fear mounting, Mitchell and her fiancé went to the emergency department of a local hospital, where she was admitted to the maternity ward for testing.

When an echocardiogram revealed a low ejection fraction, Mitchell was rushed to Michigan Medicine, known for its highly skilled team of experts in high-risk pregnancies and cardio-obstetrics.

Tests there confirmed peripartum cardiomyopathy (PPCM), a rare form of heart failure that develops toward the end of pregnancy or several months after giving birth. As the heart muscle weakens, fluid begins to back up in the lungs and legs, making it difficult to breathe and causing swelling. In severe situations, the heart may not be able to meet the demands of the body’s organs for oxygen.

“Peripartum cardiomyopathy often goes undiagnosed because there is so much overlap with the symptoms of a normal pregnancy,” says U-M Frankel Cardiovascular Center cardiologist Melinda Davis, M.D., who specializes in pregnancy and women’s cardiology.

“Peripartum cardiomyopathy often goes undiagnosed because there is so much overlap with the symptoms of a normal pregnancy.”

- Melinda Davis, M.D.

Similar to Mitchell’s experience, symptoms of PPCM include extreme fatigue, severe shortness of breath and swollen legs. Other symptoms may include heart palpitations, a rapid heartbeat and chest pain.

Read more about Erika Mitchell’s story at michmed.org/Qkj7j.
The Frankel CVC Adult Congenital Heart Disease Program provides expert care to adult patients living with congenital heart disease conditions present since childhood. Our multidisciplinary team of congenital heart disease specialists treats the full spectrum of these inherited conditions with extensive experience in imaging, electrophysiology, interventional catheterization and cardiac surgery, while our skilled clinical nurse coordinators oversee patient care between visits. Our goal is to provide expert, collaborative, patient-centered care for adults with congenital heart disease. We accomplish this by collaborating with experts across Michigan Medicine to optimize and individualize patient care.

Our board-certified adult congenital cardiologists specialize in the diagnosis, management and lifelong care for complex congenital heart disease conditions, including:

- Tetralogy of Fallot
- Transposition of the great arteries
- Single ventricle anatomy following the Fontan procedure
- Ebstein’s anomaly
- Pulmonary valve abnormalities
- Septal defects (atrial, ventricular, atrioventricular)

Pericutaneous interventions, among other treatments, offer patients more options for successful outcomes. U-M has performed more than 250 percutaneous pulmonary valve replacements in children and adults.

**Ongoing Coordinated Care**

Patients with congenital heart disease benefit from lifelong management and care. All of our physician providers are board-certified in adult congenital cardiology in addition to internal medicine. Our program partners with other specialists within Michigan Medicine to coordinate care across these disciplines as needed:

- Pregnancy and delivery care, including high-risk obstetrics
- Heart failure and transplantation
- Cardiac surgery
- Social work
- Electrophysiology/arrhythmia
- Pulmonary hypertension
- Aortic disease/aortic surgery

**An ACHA ACHD Accredited Comprehensive Care Center**

The Frankel CVC Adult Congenital Heart Disease Program is accredited by the Adult Congenital Heart Association as a Comprehensive Adult Congenital Care Center. The ACHA is dedicated to improving the quality of life and extending the lives of adults with congenital heart disease. The accreditation recognizes the Frankel CVC as a leader in the field and a provider of the highest quality of care for ACHD patients.

**Statewide Clinics**

The Adult Congenital Heart Disease Program participates in comprehensive pediatric and adult congenital cardiology clinics for families throughout the state of Michigan:

- Ann Arbor
- Kalamazoo
- Lansing
- Marquette
- Petoskey
- Traverse City
Preventive Cardiology
PROMOTING LIFESTYLE MODIFICATIONS

In keeping with the Frankel CVC’s mission to deliver comprehensive cardiovascular care, one of our most important efforts is to prevent coronary and other vascular diseases with early detection, risk stratification and evidence-based interventions and treatments to reduce the probability of recurrent events. Through our Coronary Risk Assessment, Lipid Management, Metabolic Fitness and Cardiac Rehabilitation programs we can provide patients with a level of care and resources not commonly available at other institutions.

Our Preventive Care team includes physicians, nurse practitioners, nutritionists and clinical exercise physiologists who specialize in the management of heart and vascular disease and risk factor modification. Together, they actively participate in patient care, research and education. The team has published a number of manuscripts with research emphasis on novel risk factors, air pollution, lipids, cardiac rehabilitation, psychological distress, hypertension and lifestyle interventions.

**Lipid Management:** This multidisciplinary service determines why the classic lipids (cholesterol, HDL, triglycerides) and lipoproteins are abnormal. Individualized assessment for heart attack and stroke risk is performed and appropriate lifestyle modification and drug treatment plans are put into place to reduce risk of disease in these patients.

In certain patients, genetic analyses can be performed to evaluate for inherited forms of high cholesterol or triglycerides. These analyses can be used to inform family members of their risks and provide consultation. Our team has expertise in prescribing new cholesterol and triglyceride lowering treatments and medications and extensive experience in treating patients with intolerance to statins.

For very severe lipid disorders, we are one of only a few centers in the U.S. to offer lipid apheresis, an FDA-approved treatment to lower LDL cholesterol. Other novel areas of expertise include identifying and treating patients with very low or very high levels of LDL and HDL cholesterol. While rare, the risk of cardiovascular disease in women and men with very high levels of HDL cholesterol can be difficult to assess. Our experts can assess the reasons for and functionality of lipids in patients with extremely high levels of HDL cholesterol.

**Hypertension:** The U-M Comprehensive Hypertension Center, designated as such by the American Society of Hypertension, is a national leader in the treatment of hypertension. We ensure patients get the proper diagnosis and an individualized treatment program to control both rare and common forms of hypertension.
As part of Cardiovascular Disease Prevention and Rehabilitation, our hypertension experts use traditional and more innovative approaches and have access to highly precise measurement devices available only in a specialty center.

Beyond identifying the optimal medical regimen for each patient, our Hypertension Center employs a team of experts, including nutritionists, clinical exercise physiologists and stress management counselors. We offer a comprehensive approach tailored for each individual that includes lifestyle recommendations, alternative therapies and traditional medications as needed. Often, we provide enrollment into clinical trials in hypertension for eligible and interested patients.

**Metabolic Fitness:** Our multidisciplinary team of specialists includes experts in cardiovascular disease, endocrinology, gastroenterology/hepatology, nutrition, exercise and stress management. We are focused on helping patients manage and reverse components of metabolic syndrome (pre-diabetes, hypertension, central obesity, elevated triglycerides and low HDL cholesterol). Through lifestyle changes implemented in our structured 12- or 24-week MetFit Program, participants are able to reduce the risk of cardiovascular disease and multiple other chronic conditions associated with metabolic syndrome, including diabetes, polycystic ovary syndrome (PCOS), sleep disordered breathing, non-alcoholic fatty liver disease (NAFLD) and hypertension.

The MetFit Program:
- Consists of weekly 45-minute educational sessions and 45 minutes of supervised exercise in our fitness center. Participants have free access to the exercise facility during their 12- or 24-week program.
- Includes dietitian guidance on the Mediterranean diet, as well as clinical exercise physiologists and clinical social workers who address behavior change.
- Is associated with significant improvements in blood pressure, triglycerides, glucose, insulin sensitivity, psychological profile, BMI/waist circumference and weight.
- Has been extended to include a low-cost follow-up option to keep patients committed to a healthy lifestyle through education and encouragement from our coaches. We also help patients assess their long-term goals and provide Internet-based information to those interested. The program will partner with referring physicians who can assist patients with necessary treatments.

While designed to reduce cardiovascular risk in patients with metabolic syndrome, NAFLD, pre-diabetes and diabetes, PCOS and dyslipidemias associated with obesity, we accept those with hypertension whose physicians would like a supervised lifestyle program (diet/exercise/stress reduction) prior to or to supplement anti-hypertensive therapy as recommended in recent hypertension guidelines.

**Cardiac Rehabilitation:** Our individualized Cardiac Rehabilitation program is designed to improve the cardiovascular health of patients following a heart attack, angioplasty or heart surgery, as well as patients with angina pectoris or heart failure, and prior to and following cardiac transplant. Our multidisciplinary team consists of clinical exercise physiologists, registered dietitians, registered nurses and cardiologists. We are focused on empowering patients by providing them with information on exercise, nutrition, stress management and cardiac risk factors to improve their lifestyle and reduce the chance of future cardiac events or procedures.
In addition to our Domino’s Farms location, we recently expanded our services to Brighton Center for Specialty Care. Approximately 396 patients made more than 9,000 visits to cardiac rehab in both locations last year, and 65 percent of those patients completed their cardiac rehab program.

If the distance to travel to our cardiac rehab program is a barrier for a patient, our team will assist them in finding a program closer to home. In 2018, our team assisted more than 1,550 such patients. When a patient is referred to cardiac rehab without a qualifying diagnosis but could benefit from having a structured exercise program, we offer an out-of-pocket exercise consultation. During the session our clinical exercise physiologist will tailor an individualized home exercise program to help the patient safely progress at home.

**Enhanced External Counter Pulsation (EECP):** This non-invasive treatment helps improve the quality of life for patients with angina. Eligible patients are those who have had coronary artery bypass or stents placed in the coronary arteries with ongoing angina, or those who are not candidates for bypass or stents, but continue to suffer from angina. These patients must have undergone all other possible medical therapies to be considered eligible for the procedure. The EECP treatment, which varies in length per patient, involves 3 to 7 weeks of continuous therapy requiring daily one-hour visits, Monday through Friday.

**CLINICAL TRIALS**

**Michigan Predictive Activity & Clinical Trajectories (MIPACT) Study**
Understand disease trajectories using Apple Watch sensors, electronic health records, blood pressure monitors, questionnaires of participant survey data and genomic information.

**TACT 2**
A clinical trial of edetate disodium-based chelation and high-dose oral vitamins and minerals to prevent recurrent cardiac events in diabetic patients with a prior myocardial infarction.

**ADAPTABLE**
Identify the optimal dose of aspirin for secondary prevention in patients with atherosclerotic cardiovascular disease (ASCVD).

**Low Salt 4 Life**
Study the effectiveness of the Low Salt 4 Life iPhone app to determine its influence on individuals with high blood pressure.

For more information or to view additional trials, visit UMHealthResearch.org.

**THE BRIDGE CLINIC**
The BRIDGE (Bridging the Discharge Gap Effectively) Clinic is a nurse practitioner-based transitional care clinic that partners with the discharging cardiologist to serve as an extension of the inpatient care team, providing patients discharged from the hospital with the ability to see a provider quickly to facilitate their outpatient care. The clinic aims to see patients within two weeks of discharge, connecting with them to alleviate concerns or fears after discharge, provide additional education about diagnosis and planned treatment, provide or change medications, stress the importance of diet and exercise and assess overall health status. Data from the BRIDGE registry has shown that patients who participate in the clinic are at a lower risk for hospital readmission or emergency room visits.
The Frankel CVC has a vast research enterprise reliant on sound strategy to maximize efficiencies, quality and research opportunities. The commitment to excellence through collaboration, teamwork and innovation is the basis for success for the Frankel CVC Research Programs. Our goal is to generate new knowledge and make significant advances in cardiovascular research to lead the fight against cardiovascular disease.

Our commitment to basic science and research is an important differentiator that keeps us at the cutting edge of science and discovery in the fight against cardiovascular disease and ensures patients have access to the hundreds of clinical research studies currently ongoing at the Frankel CVC.

The Frankel CVC recruits and retains promising scientists and clinicians who are not only successful in their fields, but who represent our mission, vision and values. The current membership total is 318 faculty.

**Basic Science & Translational Research Strengths**
- Arrhythmia
- Cardiac Myocyte Biology
- Cardiovascular Biomechanics
- Cardiovascular Genetics
- Tissue and Cell Regeneration
- Vascular and Thrombosis Biology

**Clinical Research Strengths**
- Acute and Chronic Cardiovascular Diseases
- Aging
- Aortic Disease
- Arrhythmia
- Cardiac Imaging
- Health Services and Clinical Effectiveness
- Heart Failure and LVAD
- Pulmonary Hypertension
- Stroke
- Structural Heart Disease
- Thrombosis and DVT

**Clinical Trials Support Unit**
The Heart Vessel Blood Clinical Trials Support Unit (HVB-CTSU) enhances performance of cardiovascular, coagulation and nonmalignant hematologic clinical trials across the lifespan, including industry-sponsored, federally-sponsored and investigator-initiated clinical trials of acute or chronic disease. Drawing from the successful clinical trials programs, which have driven both clinical business and research, meaningful synergies within the HVB-CTSU foster a culture of collaboration.
RESEARCH HIGHLIGHTS

Collaborative, multidisciplinary research endeavors continue to be an essential theme for cardiovascular Research Center investigators. Here is just a sample of the collaborative projects/programs we are spearheading:

Cardiovascular Health Improvement Project (CHIP)
CHIP is a biorepository of DNA, plasma, serum and aortic tissue samples as well as an extensive clinical database of medical and family history information. For more information about CHIP please visit: www.umcvc.org/cardiovascular-health-improvement-project-chip-study.

Multidisciplinary Aortic Program (MAP)
MAP is an interdisciplinary program with over 20 faculty representatives from cardiac surgery, vascular surgery, interventional radiology, cardiac imaging, medical genetics and cardiovascular medicine. MAP faculty are conducting innovative research across a wide spectrum, including FDA-regulated trials, NIH-funded trials, Department of Defense contracts and investigator-initiated projects, all specific to aortic disease.

Michigan Biology of Cardiovascular Aging Program (MBoCA)
The MBoCA multi-programmatic center has been established to enable multidisciplinary research to advance science on aging and cardiovascular disease under the leadership of Program Director Daniel R. Goldstein, M.D.

Michigan Biological Research Initiative on Sex Differences in Cardiovascular Disease (M-BRISC)
Aimed at understanding the scientific basis for why women often present with heart disease in different ways than men, why the pathology of cardiovascular disease in women is often different, and why their response to treatment differs from men as well. A multidisciplinary leadership team model positions this group for great success with the three major components of this program, which are seminars/symposia, recruitment and pilot grants.

Center for Advanced Models for Translational Sciences and Therapeutics (CAMTraST)
This Center strives to accelerate the “bench to bedside” process in biomedical research and drug development. For more information about CAMTraST please visit: camtrast.med.umich.edu./

Center for Arrhythmia Research
At the Center for Arrhythmia Research, scientists and physicians from a variety of disciplines work together to develop new methods of diagnosing and treating cardiovascular diseases, with the primary goal of preventing premature cardiac death. Already, our scientists have made major advances in understanding the molecular and cellular basis for and the fundamental mechanisms of complex, life-threatening arrhythmias and sudden cardiac death. Ultimately, we will be an international resource for the study of cardiovascular diseases, including ischemic heart disease, heart failure and sudden cardiac death.

There are currently 528 active research studies across 37 diverse divisions, departments, schools and institutions at the University of Michigan.
The Frankel CVC, and Michigan Medicine as a whole, has a robust Patient Safety Reporting System that promotes reporting of any event that is not consistent with the desired normal or usual medical care of the patient. All staff members are encouraged to report any patient- or staff-related safety issue. Our reporting philosophy is one that reflects our desired focus on improving processes and developing systems to prevent future harm. Events reported through the Patient Safety Reporting System are among the topics discussed at the University Hospital/CVC Daily Safety Huddle.

Our Daily Safety Huddle is a 10-15 minute Daily Check-In that allows the hospital units and departments to coordinate on issues that affect the safe operations of the hospital. The goal is to ensure communication and problem solving about key issues among all members of the UH/CVC team. Daily Safety Huddles allow for hospital leadership to be engaged with safety concerns and ensure that they are addressed in a timely manner. Real-time problem solving also occurs immediately after huddle when individual unit or department representatives connect to discuss an issue or process-related concerns. In our most recent annual survey of Safety Huddle participants (April/May 2018), 93 percent agreed or strongly agreed that connections made during and after Safety Huddle support safety.

This huddle process is just one component of our journey to becoming a high-reliability organization. Michigan Medicine has contracted with Healthcare Performance Improvement, a consulting firm dedicated to bringing high reliability processes into organizations by leveraging strategies used in other high-risk industries. Highly reliable organizations reduce the risk of patient harm through the use of reliable processes and continuous improvement efforts. A three-year work plan has been developed, with high-reliability training being held for all Michigan Medicine employees, beginning with leaders.

Faculty and staff in the Frankel CVC also have access to retrospective quality data through participation in state and national registries and consortiums. Cross-disciplinary sharing of data through our CVC Dashboard helps us review how we are doing within the Frankel CVC, as well as compared to state and national benchmarks. Our clinical leaders meet to review performance on a quarterly basis, providing an opportunity to discuss barriers to improvement and sharing of best practices. This discussion also leads to clinical collaboration among subspecialties.

For more information about our Quality and Safety measures, visit uofmhealth.org/quality-safety.
Education
A COLLABORATIVE CARDIOVASCULAR FOCUS

One of the main pillars of the Frankel CVC mission is education. Expanding our understanding of cardiovascular disease across the lifespan is a collaborative effort among clinicians and scientists, patients and their families. Our focus on the exploration of better treatments, disease mechanisms, genetics and myriad other factors impacting patient care supports our educational partnerships with you, our referring physicians, to improve outcomes for all.

Patient and Family Education
The Frankel CVC’s Mardigian Wellness Resource Center is available to provide top-quality, reliable information about cardiovascular health in patient-friendly language. Our goal is to help patients and families understand their health conditions, make informed decisions and become active members of their health care team.

CONTINUING EDUCATION
Throughout the year, the Frankel CVC offers physicians, mid-level and advanced practice providers a variety of continuing medical education courses and seminars taught by our faculty.

UPCOMING COURSES:
For upcoming courses, visit med.umich.edu/intmed/cme/calendar.htm

INFORMATIONAL DINNERS:
For the past year, Frankel CVC faculty have presented complimentary informational dinners on a variety of cardiovascular-related topics at locations throughout Michigan. This is a unique opportunity for our faculty to interact with doctors, mid-level and advanced practice providers, share their expertise and discuss various issues. Positive survey feedback from past attendees has demonstrated that these informational dinners are viewed as valuable and worthwhile. Past topics include heart failure, TAVR, stroke, hypertrophic cardiomyopathy, pulmonary hypertension and peripheral arterial disease.

U-M doctors look forward to sharing information with our referring physicians in an informal, interactive environment and welcome the opportunity to hear your thoughts on topics you’d like us to pursue in the future. Upcoming topics, based on referring physician feedback, include electrophysiology, mitral valve disease and many others.

For more information about the dates and locations of upcoming dinners, contact Erika Laszlo at 734-647-1164 or ellaszlo@umich.edu.
Research

Finding the Right Match

Our scientists and physicians are collaborating across disciplines to fulfill the Frankel CVC’s mission of discovering new and better ways to prevent, diagnose and treat cardiovascular disease. As part of the robust and top-funded research environment at U-M, every clinical department and program within the Frankel CVC is actively engaged in research. Early access to expanded treatment options, from drug therapies and devices to prevention and procedures, is available to referring physicians and patients through these studies.

Cardiovascular clinical trials need all types of volunteers, from those who live with or have a family history of specific conditions, to those who are healthy. As part of our efforts to continuously improve the volunteer experience, finding the right patients for each trial is central to our research. This is why partnering with you, our referring physicians, is critically important.

Rachael Privett
Clinical Research Recruitment Coordinator

Rachael collaborates with you and your patients to find the most appropriate match available in our cardiovascular clinical trials. She also provides you with additional information about individual trials and direct patient referral.

Please contact Rachael for answers to your questions or for additional information about our research programs. Call 1-888-286-4420, email CVCVolunteer@med.umich.edu or visit UMHealthResearch.org. Rachael welcomes your feedback to ensure the best possible service.

Patients and their families can sign up to be matched with research studies for specific health conditions through UMHealthResearch.org, the greater University’s research community website.

Physician Liaison Program

Your Frankel CVC Connection

Communication with you, our referring physicians, is central to improving coordination of patient care. The U-M Physician Liaison Program offers personalized service to community-based physicians in Ann Arbor and throughout the region.

Erika Laszlo
Outreach Manager for the Frankel Cardiovascular Center

Erika is here to provide you with the best possible service. She is available not only for on-site visits, but also to:

• Provide information about new cardiovascular services, treatment options and clinical trials.
• Assess your needs and determine how we can best meet them.
• Share outreach opportunities from our clinical faculty.

Please contact Erika for answers to your questions or for additional information about our services. Call M-LINE 800-962-3555 or email physicianliaisons@med.umich.edu. Erika welcomes your feedback, which enables her to provide top-quality service that meets your needs.

M-LINE

M-LINE is a single, 24-hour, toll-free number for you, our referring physicians, and your staff seeking access to clinical services and faculty at U-M. The M-LINE staff works closely with personnel across U-M to provide efficient and personalized service.
Admitting Officer of the Day
The Frankel CVC Admitting Officer of the Day (AOD) program gives referring physicians the opportunity to speak directly with a select group of senior cardiovascular attending physicians who have the authority to make quick decisions about accepting transfer patients from outside the hospital. In FY18, the average patient transfer acceptance time for UH/CVC was 20 minutes, a decrease from 27 minutes in FY17. Over the past year, the AOD process has helped staff identify the order in which patients are to be transferred based on the patient’s acuity and status at the outside hospital. In the past year, the AOD process has also provided the ability for multiple providers to conference with a referring physician to ensure the patient is transferred to the appropriate service upon arrival. Contact the AOD program via M-LINE at 800-962-3555 or call us directly at 734-936-7683.

Patient and Family Centered Care
Improving Patient Care
The U-M Patient and Family Centered Care (PFCC) initiative works to remove the barriers between medical professionals and patients by truly valuing the concerns, opinions and voices of patients and their families. Our “Nothing about me, without me” slogan represents the guiding principle for patient-centered care throughout U-M, where PFCC programs act as forums for patients and families to share their personal experiences with faculty and staff.

U-M has also established numerous Patient and Family Advisory Councils (PFACs) throughout hospital departments, which are an integral part of our PFCC initiative. For more information, call 734-232-4617, email cvc-pfcc-program@med.umich.edu or visit umcvc.org/patient-and-family-centered-care-program.

Direct Messaging
EHR-to-EHR Communication with Michigan Medicine
Direct messaging is a secure, standardized way that health care organizations can exchange patient health information and referrals directly between electronic health record (EHR) systems. This functionality allows practices to connect with Michigan Medicine without having to use fax machines or mail services.

Direct messaging can be used to securely send:
- Outpatient Referrals
- Automatic Discharge Notices
- Physician-to-Physician Messages
- Summary of Care Documents
- Continuity of Care Documents
- Other patient records and results

Connecting Providers to Patient Care
The Michigan Medicine Provider Portal is a secure, web-based application for referring physicians and their staff to access their patients’ medical information, including:
- Appointment notifications
- Admission notifications
- OR notes
- Emergency Department notes
- Progress notes
- Laboratory and radiological test results
- Medication lists
- Physician/clinic letters
- Problem list
- Allergies

Visit www.UofMHealth.org/providerportal to download a User and Site Agreement form or call M-LINE at 1-800-962-3555.
Clinical Physicians

**Adult Cardiac Surgery**
Steven F. Bolling, M.D.
G. Michael Deeb, M.D.
Shinichi Fukuhara, M.D.
Jonathan W. Haft, M.D.
Karen M. Kim, M.D.
Francis D. Pagani, M.D., Ph.D.
Himanshu J. Patel, M.D.
Paul C. Tang, M.D., Ph.D.
Bo Yang, M.D., Ph.D.

**Adult Congenital Cardiology**
Timothy B. Cotts, M.D.
Mark D. Norris, M.D.

**Cardiovascular Anesthesiology**
Jehad I. Albataineh, M.D.
Kimberly H. Burcar, M.D.
Matthew D. Caldwell, M.D.
Stephanie A.R. Callison, M.D.
Anna V. Dubovoy, M.D.
Timur Z. Dubovoy, M.D.
Neal M. Duggal, M.D.
Jordan L. Fenneman, M.D.
Ian M. Gannon, M.D.
Meghan P. Horn, M.D.
Alison M. Janda, M.D.
Amanpreet S. Kalsi, M.D.
Paul E. Kazanjian, M.D.
Kevin Loh, M.D.
Michael R. Mathis, M.D.
Mukilan S. Muthiswami, M.D.
Lauren V. Richey, M.D.
Brian J. Woodcock, M.D.
Bryant Wu, M.D.

**Congenital Cardiac Surgery**
Edward L. Bove, M.D.
Richard G. Ohye, M.D.
Jennifer C. Romano, M.D.
Peter Sassalos, M.D.
Ming-Sing Si, M.D.

**Cardiothoracic Imaging**
Prachi P. Agarwal, M.D.
Anil K. Attili, M.D.
Nicole M. Bhave, M.D.
Nicholas Burris, M.D.
Aamer R. Chughtai, M.D.
Paul Cronin, M.D.
Adam L. Dorfman, M.D.
Maryam Ghadimi Mahani, M.D.
Ella A. Kazerouni, M.D.
Aine M. Kelly, M.D.
Troy M. LaBounty, M.D.
Elizabeth Lee, M.D.
Jimmy C. Lu, M.D.
Venkatesh L. Murthy, M.D., Ph.D.
Smita Patel, M.D.
Perry G. Pernicano, M.D.
Leslie Quint, M.D.
Mohamed Sayyouh, M.D.
Jadranka Stojanovska, M.D.
Dharshan R. Vummidi, M.D.

**Critical Care Faculty**
Lauren E. Anderson, M.D.
Ross Blank, M.D.
Adam W. Carter, M.D.
Doug A. Colquhoun, M.D.
Ryan P. Davis, M.D.
Murtaza A. Diwan, M.D.
David J. Garcia, M.D.
Michael D. Maile, M.D.
Danielle Saab, M.D.
Matthew J. Sigakis, M.D.

**Electrophysiology**
Syeda A. Batul, M.D.
Frank M. Bogun, M.D.
Aman Chugh, M.D.
Eugene H. Chung, M.D.
Thomas C. Crawford, M.D.
Ryan T. Cunnane, M.D.
Hamid Ghanbari, M.D.
Michael M.J. Ghannam, M.D.
Krit Jongnarangsin, M.D.
Rakesh Latchamsetty, M.D.
Jackson J. Liang, M.D.
Fred Morady, M.D.
Hakan Oral, M.D.
Frank Pelosi Jr., M.D.
Mohammed Saeed, M.D.

**Echocardiography**
William F. Armstrong, M.D.
David S. Bach, M.D.
Nicole M. Bhave, M.D.
Jessica I. Gupta, M.D.
Peter G. Hagan, M.D.
Adam S. Helms, M.D.
Sarah Kohnstamm, M.D.
Theodore J. Klias, M.D.
Troy M. LaBounty, M.D.
Victor M. Moles, M.D.

**General Cardiology**
Geoffrey D. Barnes, M.D.
Eric R. Bates, M.D.
Mark R. Benson, M.D., Ph.D.
James B. Byrd, M.D.
Sunil K. Das, M.D.*
Melinda B. Davis, M.D.
Claire S. Duvernoy, M.D.
Kim A. Eagle, M.D.

*Active Emeritus Faculty*
Daniel T. Eitzman, M.D.
Peter M. Farrehi, M.D.
James B. Froehlich, M.D.
Santhi K. Ganesh, M.D.
Sascha N. Goonewardena, M.D.
Salim S. Hayek, M.D.
Richard W. Hennig, D.O.
Marion A. Hofmann-Bowman, M.D.
Yogendra M. Kanthi, M.D.
Fareed U. Khaja, M.D.*
Michael H. Lehmann, M.D.
Monika J. Leja, M.D.
Vallerie V. McLaughlin, M.D.
Victor M. Moles, M.D.
Venkatesh Murthy, M.D., Ph.D.
David J. Pinsky, M.D.
Bertram Pitt, M.D.*
Rosanne Rouf, M.D.
Melvyn Rubenfire, M.D.
Marschall S. Runge, M.D., Ph.D.
Michael J. Shea, M.D.
Adam B. Stein, M.D.
Scott H. Visovatti, M.D.
Denis R. Weinberg, M.D.
Richard L. Weinberg, M.D., Ph.D.
Reema Hasan, M.D.
Scott L. Hummel, M.D.
Todd M. Koelling, M.D.
Matthew C. Konerman, M.D.
Taylor A. Lebies, M.D.
John M. Nicklas, M.D.
Maryse Palaridy, M.D.
Supriya Shore, M.D.
Marty C.Y. Tam, M.D.
Audrey H. Wu, M.D.

Hypertension
Robert D. Brook, M.D.
James B. Byrd, M.D.
Kenneth A. Jamerson, M.D.
Stevo Julius, M.D.*
Ralph H. Stern, M.D.*
Alan B. Weder, M.D.*

Interventional Cardiology
Vikas Aggarwal, M.D.
Eric R. Bates, M.D.
Stanley J. Chetcuti, M.D.
Claire S. Duvernoy, M.D.
P. Michael Grossman, M.D.
Sarah K. Gualano, M.D.
Hitinder S. Gurum, M.D.
Daniel S. Menees, M.D.
Brahmajeek K. Nallamothu, M.D.
Devraj Sukul, M.D.
Nadia R. Sutton, M.D.
Michael P. Thomas, M.D.

Interventional Radiology
Kwang J. Cho, M.D.*
Kyle J. Cooper, M.D.
Narasimham L. Dasika, M.D.
Joseph J. Gemmete, M.D.
Marcus D. Jarboe, MD.
Minhaj S. Khaja, M.D.
Venkataramu N. Krishnamurthy, M.D.
Mamadou L. Sanogo, M.D.
James J. Shields, M.D.
Ravi N. Srinivasa, M.D.
David M. Williams, M.D.
Sara E. Smolinski-Zhao, M.D.

Interventional Neuroradiology
Neeraj Chaudhary, M.D.
Joseph J. Gemmete, M.D.
Aditya S. Pandey, M.D.
B. Gregory Thompson, M.D.

Nuclear Cardiology
James R. Corbett, M.D.
Venkatesh L. Murthy, M.D., Ph.D.
Richard L. Weinberg, M.D., Ph.D.

Stroke Neurology
Devin L. Brown, M.D.
James F. Burke, M.D.
Mollie L. McDermott, M.D.
Lewis B. Morgenstern, M.D.
Lesli E. Skolarus, M.D.

Vascular Surgery
Dawn M. Coleman, M.D.
Matthew A. Corriere, M.D.
Jonathan L. Eliason, M.D.
Katherine A. Gallagher, M.D.
Peter K. Henke, M.D.
Andrea T. Obi, M.D.
Nicholas H. Osborne, M.D.
James C. Stanley, M.D.*
Chandu Vemuri, M.D.
Thomas W. Wakefield, M.D.

Heart Failure/Transplant
Keith D. Aaronson, M.D.
Abbas Bitar, M.D.
Monica M. Colvin, M.D.
David B. Dyke, M.D.
Daniel R. Goldstein, M.D.

Michael M. Wang, M.D., Ph.D.
Darin B. Zahuranec, M.D.
Locations

1. **Frankel Cardiovascular Center**
   1500 E. Medical Center Drive
   Ann Arbor, MI 48109

2. **Domino’s Farms**
   4000 Ave Maria Drive
   Lobby A, Suite 1300
   Ann Arbor, MI 48106

3. **Briarwood Health Associates**
   325 Briarwood Circle, Building 5
   Ann Arbor, MI 48108

4. **Brighton Center for Specialty Care**
   7500 Chillis Road
   Brighton, MI 48116

5. **Brighton Health Center**
   8001 Chillis Road
   Brighton, MI 48116

6. **Canton Health Center**
   1051 N. Canton Center Road
   Canton, MI 48187

7. **Chelsea Health Center**
   14700 E. Old US 12
   Chelsea, MI 48118

8. **East Ann Arbor Surgery and Medical Procedures Center**
   4270 Plymouth Road
   Ann Arbor, MI 48109

9. **Northville Health Center**
   39901 Traditions Drive
   Northville, MI 48168

10. **West Ann Arbor Health Center**
    380 Parkland Plaza
    Ann Arbor, MI 48103

---

**Additional Locations in Michigan**

**Grand Rapids**
- **Mercy Health Physician Partners**
  Electrophysiology Clinic
  Cardiothoracic Surgery
  310 Lafayette SE, Ste. 310
  Grand Rapids, MI 49503

---

**Muskegon**
- **Mercy Health Physician Partners**
  Electrophysiology Clinic
  1212 E. Sherman Blvd, Ste. 2
  Muskegon, MI 49444

**Midland**
- **MidMichigan Health**
  Advanced Heart Failure Clinic
  4011 Orchard Drive, Ste. 1002
  Midland, MI 48640

**Wyoming**
- **Metro Health Village - Heart & Vascular**
  Metro Health Professional Building
  2122 Health Dr., SW, Ste. 133
  Wyoming, MI 49519
Executive Officers of the University of Michigan Medicine
Marschall S. Runge, M.D., Ph.D.
Executive Vice President for Medical Affairs, Dean,
University of Michigan Medical School, CEO, Michigan Medicine
David A. Spahlinger, M.D.
President, UMHS, and executive vice dean for clinical affairs,
University of Michigan Medical School
Patricia D. Hurn, Ph.D., R.N.
Dean, School of Nursing

The Regents of the University of Michigan
Jordan B. Acker
Michael J. Behm
Mark J. Bernstein
Paul W. Brown
Shauna Ryder Diggs
Denise Ilitch
Ron Weiser
Katherine E. White
Mark S. Schlissel, ex officio

The University of Michigan, as an equal opportunity/affirmative action employer, complies with all applicable federal and state laws regarding nondiscrimination and affirmative action. The University of Michigan is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, national origin, age, marital status, sex, sexual orientation, gender identity, gender expression, disability, religion, height, weight, or veteran status in employment, educational programs and activities, and admissions. Inquiries or complaints may be addressed to the Senior Director for Institutional Equity, and Title IX/Section 504/ADA Coordinator, Office for Institutional Equity, 2072 Administrative Services Building, Ann Arbor, Michigan 48109-1432, 734-763-0235, TTY 734-647-1388, institutional.equity@umich.edu. For other University of Michigan information call 734-764-1817.

© 2019 Regents of the University of Michigan.