Innovations in Cardiovascular Health
Knight Cardiovascular Institute by the numbers

### Physicians

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>Clinical faculty</td>
</tr>
<tr>
<td>22</td>
<td>Fellows</td>
</tr>
</tbody>
</table>

### Research Funding

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Full-time researchers</td>
</tr>
<tr>
<td>147</td>
<td>Clinical trials</td>
</tr>
<tr>
<td>$14.9 million</td>
<td>In research funding</td>
</tr>
</tbody>
</table>
Carrying the torch

Research
OHSU award dollars: $558 million
Amount of funding focused on clinical trials: more than $121 million
In 2019, OHSU disclosed 149 new innovations and filed 172 patent applications.
According to Nature Index 2020, OHSU is No. 89 of the top 100 in life sciences, and No. 258 of the top 500 academic institutions.

Facilities and employees
Employees: 18,480
OHSU occupies more than 8.7 million square feet of space on approximately 400 acres.

Community service
OHSU has more than 200 community health care programs, reaching out to vulnerable groups in urban areas as well as underserved rural communities throughout the state, and in fiscal year 2020 had a community benefit contribution of $498 million.

Education
OHSU helps educate over 5,000 students and trainees each year.
Quality, outcomes & awards

Ranked 47th in Cardiology and Heart Surgery by U.S. News & World Report

First-ever DNV center of excellence
DNV GL certification combines national and international standards, including those from the U.S. Centers for Medicare and Medicaid Services and the International Organization for Standardization.

Gold Plus – 2020 Get With The Guidelines®-Heart Failure
OHSU recognition and rankings

**Vizient**

The nation’s most respected health care performance organization ranks OHSU in the top 12 academic medical centers for quality and accountability measures, including safety, mortality, clinical effectiveness, efficiency and patient centeredness.

**Magnet**

The American Nurses Credentialing Center designates OHSU as a Magnet hospital, the highest recognition a nursing program can receive. Just 6 percent of U.S. health care organizations hold this designation that acknowledges having highly qualified nurses, physicians and specialists, fostering collaboration across disciplines, and improving patient care through high standards.

**NRC Health**

Consumer choice: NRC annually surveys 2,200 households in the Portland-area for the top hospital based on reputation, overall quality and skilled care. OHSU has held the top spot for nearly two decades.

**Health Equality Index**

The Healthcare Equality Index (HEI) is the national LGBTQ benchmarking tool that evaluates health care facilities’ policies and practices related to the equity and inclusion of their LGBTQ patients, visitors and employees. OHSU has earned this honor multiple times since 2011.
The soul of a heart institute

A vibrant environment is essential for translating possibilities in science to improving patient care. With a strong tradition of diverse, interdisciplinary teams, we believe OHSU Knight Cardiovascular Institute is uniquely positioned to advance cardiovascular health.

A review of our faculty list demonstrates how our demographic is different from the typical cardiovascular team at an academic center. OHSU Knight Cardiovascular Institute champions and actively recruits diverse individuals on the principle that innovation springs from collaboration and shared community. For example, we have 13 women in leadership roles among our clinical, research, education and administrative missions, and women constitute 33.3 percent of our current fellowship class.

► Abigail Khan, M.D., MSCE, associate chief of clinical cardiology
However, we recognize that there remains work to do to provide an equitable healing environment for all. OHSU has set out to train all 17,000 of our employees to recognize and mitigate unconscious bias. Within the Knight Cardiovascular Institute, we have a Diversity Action Committee with representation from clinical and research faculty, administrative staff and fellows and host Grand Rounds focusing on diverse populations.

As the only academic health system in Oregon, we are on a relentless pursuit of knowledge across the spectrum of cardiovascular health. From studying developmental and preventive influences on disease to pioneering minimally invasive options to enhance graceful aging, we are working to allow more people to remain healthy and vibrant. We are committed to finding breakthroughs for better health for Oregonians and contributing to science that will impact people far beyond our borders.
Pioneering first-ever percutaneous repairs in tricuspid and mitral valves

Earlier this year, an OHSU Knight Cardiovascular Institute team led a unique moment in human history — the first transcatheter transfemoral tricuspid valve replacement in a living person. A few days later, the patient checked out of the hospital.
The first tricuspid valve repair patient was part of the CLASP II TR clinical trial using the Edwards Lifesciences PASCAL transcatheter valve repair system and the first tricuspid valve replacement was performed using the Edwards Lifesciences EVOQUE transcatheter valve* as part of the TRISCEND trial. Since then, OHSU Knight Cardiovascular Institute has performed dozens of these procedures successfully.

In February 2020, an OHSU Knight Cardiovascular Institute team led by Zahr; Howard Song, M.D., Ph.D., co-director of the OHSU Complex Heart Valve Program; and Scott Chadderdon, M.D., performed the first implant of a Medtronic Intrepid mitral valve via a newly developed transfemoral-transeptal delivery system. Many national and international physician experts were present for this historic moment.

“This is a step forward for mitral valve repair and replacement,” Song said. “Because this is a percutaneous transcatheter procedure, we are able to treat a broader range of patients than ever before.”

OHSU Knight Cardiovascular Institute is the only center in Oregon that can repair or replace all four heart valves percutaneously. OHSU Complex Heart Valve Program has led the field in transcatheter valve therapy research and technology, with the highest enrollment in several trials and an experienced valve team.

*Investigational device not for sale in U.S.

“Having success in tricuspid valve therapy is a wonderful breakthrough. Previously, there haven’t been any good options for patients with severe tricuspid regurgitation. Many older or frail patients are not good candidates for open-heart surgery. But now we can repair or replace the tricuspid valve percutaneously.”

Firas Zahr, M.D.
“The technology has advanced to provide multiple options for all disease states and a variety of anatomical configurations, so we are able to help more people,” Zahr said. “Most patients who receive transcatheter valve therapy bypass the intensive care unit and only spend a couple of days in the hospital. There is very little blood loss or pain and few limitations after the procedure. Most patients go back to daily life in no time.”

These newer valve therapies represent the latest achievements in OHSU Knight Cardiovascular Institute’s history that began with Dr. Albert Starr, M.D., who developed and performed the world’s first successful mitral valve replacement at OHSU in 1960.

“We continue to build on the legacy of Dr. Starr with our efforts to innovate and expand percutaneous valve options while delivering excellence in patient care,” Zahr said.
Firas Zahr, M.D. (left), and Howard Song, M.D., Ph.D. (right), co-directors of the OHSU Knight Cardiovascular Institute’s Complex Heart Valve Program.
Leading discovery into the origins of valve disease before birth

The novel findings of cardiothoracic surgeon Frederick A. Tibayan, M.D., on the impact of sustained, elevated arterial pressure load on the fetal heart has important implications for the likelihood of developing valve disease in later life. Tibayan is now seeking to identify the epigenetic mechanisms coordinating this response.

“We are on the cusp of a better understanding of how abnormal hemodynamic stress in early life sets up an individual to develop valvular disease as an adult,” Tibayan said. “Our work is close to identifying the biomarkers that will serve as therapeutic targets for patients that develop valve disease as well as new technology to help us understand the compositional and architectural underpinnings of cardiovascular disease.”

To make the link from human epidemiology conditions in early life with valve disease in older life, Tibayan’s team is studying the lipidomic profiles of failing heart tissues with an innovative technology to better characterize the collagen architecture in the heart muscle and valve tissue. Recently published in the
Archives of Pathology, their investigation into the detection and quantification of myocardial fibrosis stain-free infrared spectroscopic imaging correlates very well with conventional histology and could become a faster way to analyze cardiovascular tissue.

“This is a wonderful and potentially groundbreaking ability to measure and thus understand how the building blocks of collagen and elastin are affected by the different disease processes,” he said. “This tool is still in the early stages, but the fact that we’ve shown it works in human tissue is exciting — not just for research but potentially for clinical detection in the future.”

OHSU Center for Developmental Health

OHSU is a leader in the study of the developmental origins of health and disease, or DOHaD. David Barker, M.D., Ph.D., FRS, first linked fetal nutrition to adult disease in the late 1980s, which created this new field of study. Barker spent the last 10 years of his life at OHSU working with Kent Thornburg, Ph.D., the M. Lowell Edwards Chair of Cardiovascular Research in the OHSU Knight Cardiovascular Institute. Today, the OHSU Center for Developmental Health is a major research group within the OHSU Knight Cardiovascular Institute, consisting of more than 60 scientists who study the developmental origins of health and disease at OHSU. Scientists within the Center for Developmental Health are organized into teams, with current major areas of research related to:

- Maternal nutrition intervention trials for cardiovascular disease
- Transgenerational epigenetic roots of cardiovascular disease
- Global studies of diabetes and cardiovascular disease
- New models of programming cardiovascular disease
The Advanced Heart Failure Program of the OHSU Knight Cardiovascular Institute delivers comprehensive and world-class care for patients with some of the most difficult clinical problems in cardiovascular health.

With more than 20 years of experience, Heart Failure and Transplant Program Director Deborah Meyers, M.D., leads OHSU’s comprehensive heart failure team, which includes advanced heart failure cardiologists Nalini Colaco, M.D., Ph.D., Luke Masha, M.D., M.P.H., and Johannes Steiner, M.D.; heart surgeons Howard Song, M.D., Ph.D., and Fred Tibayan, M.D.; and a large multidisciplinary team of social workers, nurse coordinators, pharmacists and other skilled clinicians with extensive expertise in providing advanced cardiovascular services.
Led by Deborah Meyers, M.D., the heart failure team has a dynamic new faculty, the result of a competitive national recruitment effort. As heart failure is often multifactorial, our team collaborates with other disciplines and specialists at OHSU to optimize patient health and seek innovative ways to improve outcomes. As examples, one of the faculty sits on the OHSU Complex Valve Team and another is contributing to the development of the first pulmonary hypertension program in the region. Meyers is working with several OHSU collaborators to standardize cardiogenic shock protocols to use in virtual ICU consultations with community hospitals.

“Our working to develop a Northwest Cardiogenic Shock Initiative as a true hub-and-spoke model, with OHSU acting as a repository of information,” she said.

OHSU Knight Cardiovascular Institute has a long history in heart transplantation, with more than 700 transplant surgeries accomplished (five transplants in the last year). Additionally, the Heart Failure Program offers a range of device therapies for both short-term and long-term durable support, extracorporeal membrane oxygenation on-site or emergency transport, medical management, coronary artery services, arrhythmia and pacemaker services.

700+ HEART TRANSPLANT SURGERIES BETWEEN 1985 AND 2020

OHSU performed Oregon’s first heart transplant in 1985, and more than 700 transplants later, remains the only program in Oregon approved by the United Network for Organ Sharing and the Centers for Medicare & Medicaid Services. Though the interdisciplinary expertise, sophisticated technical equipment and laboratories are in Portland, the OHSU Knight Cardiovascular Institute supports a shared care network of collaboration with physicians throughout the state in supporting transplant patients to receive more follow-up care in their home communities.
Aiming for early diagnosis of amyloidosis

Because transthyretin amyloidosis is grossly underdiagnosed, our clinician scientists are seeking early identification methods before the disease is fully manifested.

Strategies for early identification of transthyretin amyloidosis

Leveraging electronic health records
We validated an algorithm using artificial intelligence and machine learning to help uncover the probability of amyloidosis based on the electronic health record diagnosis codes. The algorithm alerts clinicians by providing a numerical probability of having amyloidosis, potentially arriving at the diagnosis earlier. Ahmad Masri, M.D., M.S., recently presented a validation of this tool at the American Heart Association.

Expanding existing tech
We are currently investigating using standard imaging methods, such as CT scan, to identify transthyretin amyloidosis before it manifests on the advanced disease spectrum. We are also using artificial intelligence and deep learning imaging techniques in echocardiograms to characterize patients with increased heart thickness, including amyloidosis.

Identifying biomarkers for preclinical disease
We have established a tissue, blood and urine biobank to help our efforts in identifying biomarkers of early disease.
Team-based care for amyloidosis

OHSU has the largest and longest-operating clinic in the Pacific Northwest focused on this rare and challenging disease. Designed to be patient-centric, the center exemplifies collaboration from multiple disciplines.
Creating a new tool for ablation using ultrasound

The OHSU Translational Electrophysiology Laboratory is engineering a novel therapeutic ultrasound catheter for clinical application in both ventricular arrhythmias and hypertrophic cardiomyopathy (HCM). Electrophysiologist Babak Nazer, M.D., director of the lab, and his team of acoustic physicists and biomedical engineers are designing and refining a high-intensity focused ultrasound (HIFU) device capable of creating deeper ablation lesions in thickened cardiac tissue, currently using preclinical models.

Given his clinical specialty of electrophysiology, Nazer initially chose to focus on using HIFU for ventricular arrhythmias because radiofrequency ablation is not always capable of making lesions at the depth necessary to treat the arrhythmias effectively and durably. In ventricular arrhythmias, about half of patients have recurrence after radiofrequency ablation. His early data in this application yielded the surprising finding that the thickness of the heart was significantly reduced by the deep lesions of HIFU. This led Nazer and his research group to investigate a second HIFU application in HCM.
Using continuous sound waves, the high-intensity focused ultrasound (HIFU) transducer produces a lesion of 10–12 mm in depth. The OHSU Translational Electrophysiology Laboratory designs and builds the HIFU catheter on-site, a unique resource for research. Engineers can quickly simulate, fabricate and modify prototypes to adapt to study results. “At OHSU, we are self-reliant and able to develop the methods and tests to give us the information and to move this forward as a medical therapy,” said David Giraud, acoustic physicist and principal engineer in the Nazer laboratory.

The experimental transfemoral HIFU device can ablate the tissue less invasively than surgical myectomy or alcohol septal ablation, the two existing therapies for septal reduction therapy in HCM. It may also reduce the need for permanent pacemakers, as HIFU has some features that may preserve the heart’s normal electrical conduction despite making large and deep lesions.

“Our goal is to be in an early feasibility study pathway for one or both of our applications by 2022,” Nazer said. “By creating a less invasive therapy with the ability to create deep lesions and shrink the abnormally thick heart muscle, we can make intervention more widely available and more effective in this patient population. We also believe this technology will allow us to intervene at an earlier stage of the HCM disease process, which could lead to better outcomes.”

“We’ve developed the ability to use our catheter for both ablation and imaging with the same transducer,” Nazer said. “We can assess our HIFU catheter’s contact with tissue, as well as follow our catheter on a 3D electrophysiology mapping system in real time. We believe this technology will have multiple applications as it evolves.”

High-intensity ultrasound

Conventionally used for diagnostic purposes, ultrasound also has utility for creating physiologic change by depositing heat via sound waves. Compared to radiofrequency ablation, high-intensity focused ultrasound (HIFU) can make deeper lesions while more effectively sparing surrounding tissues. Thus far, therapeutic ultrasound is mostly investigational. The Food and Drug Administration has approved MRI-guided focused ultrasound (MRgFUS) for uterine fibroids and EKOS Acoustic Pulse Thrombolysis for blood clots. In addition to Nazer’s work, OHSU’s therapeutic ultrasound research group has an interest in using this technology for a variety of disease processes, including stroke, myocardial infarction and peripheral arterial disease.
Driving clinical success through research

OHSU Knight Cardiovascular Institute is actively researching new methods to understand, prevent and treat cardiovascular disease for the people of Oregon and beyond. Areas of research excellence include cardiovascular imaging, cardiovascular device design, cardiac surgery and transplantation, and epigenetics.

Cherrie Abraham, M.D., director of the aortic program at the Knight Cardiovascular Institute in the operation room.
Investigating fetal and newborn cardiovascular physiology and developmental programming

An internationally recognized researcher in developmental cardiovascular health, Sonnet Jonker, Ph.D., focuses on preclinical models of heart growth and function before and around the time of birth. This technically challenging physiologic work provides insight into the proliferation of cardiomyocytes before birth and the perinatal pruning of these cells.

“The quantity of cardiomyocytes a person is born with is important because a deficit increases the stress on remaining cells,” Jonker said.

Jonker’s lab is also studying how the fetus responds to adverse challenges, such as placental insufficiency, anemia and congenital cardiac malformations, and whether it is possible to improve an individual’s lifelong health by stimulating beneficial adaptations in the perinatal period. Jonker’s lab is experimenting with agents that can be used therapeutically in humans that could positively impact cardiac outcomes. For example, IGF-1 and melatonin are both being studied for cardio protection in premature infants.

Additionally, Jonker is investigating how changes in fetal environment or health affecting heart muscle growth cause changes in coronary vasculature. This aspect of her research arose from interdisciplinary work with clinician colleagues.

“I love working in a clinical department; their perspectives and identification of real clinical problems via cases inspires and directs me to focus on important issues,” Jonker said.

Though it is too early to determine the translational impact of her research, Jonker envisions a future where new patient intake questions will include developmental risk factor assessments, such as birth weight and prenatal stress. Knowing a person’s early life risk factors may be more important than knowing their family history in judging risk for cardiovascular complications.
Defining racial differences in blood lipid risk factors

One of the goals of endocrine biologist Nathalie Pamir, Ph.D., is to improve the algorithm for scoring cardiovascular risk by focusing on ethnicity-based differences in the role of blood lipids. To uncover these differences, Pamir’s lab uses well-phenotyped epidemiological cohorts such as the REasons for Geographic and Racial Differences in Stroke (REGARDS) longitudinal cohort to identify the sex- and race-dependent interactions between novel HDL metrics and cardiovascular disease and stroke. This cohort includes 30,000 participants, 50 percent of whom are Black.

“What we discovered is that high-density lipoprotein’s cardioprotective effects depend on ethnicity,” she said. “The current clinical HDL classifications of low/normal/high and expected risk hold in white people but are inverted in Black people. When patients have low HDL, we tell them it is detrimental to their health, so they should modify their diet and exercise more. This precaution holds true in white patients, but in Black patients, it may not influence their risk of cardiovascular disease either way. This changes our current understanding of risk. These data suggest we need to reconsider our approach in the clinic when we say categorically that high HDL is a good thing — it might not be if you are Black.”

Further study and awareness of racial differences in cardiovascular disease is needed, Pamir believes. Similar cohort studies are needed for additional ethnicities to redefine the classification of lipoproteins to improve risk factor assessment for all people.
Correlating HDL biomarkers and recovery from stroke

In blood samples from an OHSU-based cohort of post-stroke patients, Nathalie Pamir, Ph.D., found a tremendous difference in HDL function and proteome within a 96-hour window following the stroke. The degree of changes tightly correlated with functional and cognitive recovery in patients at three months post-stroke.

“Monitoring HDL proteins may provide clinical biomarkers to provide insight into how well the patient is likely to recover functionally and neurologically from the stroke event, which has potential for informing treatment and therapy,” Pamir said. “We will be exploring this question via the large epidemiology study REGARDS, but our initial findings look very promising that HDL acts like an internal mirror that captures the biology of the stroke event.”
Innovation is one of our core values at the Knight Cardiovascular Institute. We’re rooted in a culture that questions the status quo and pushes the boundaries of what’s possible.

We are discovering new ways of understanding disease and quickly bringing new treatments to patients. We accomplish this by creating a culture in which translational science can thrive. With more than 90 clinical trials in progress, our clinician investigators collaborate with multidisciplinary research teams to make scientific progress to impact patient health today.

**Translating GPR39 discovery**

The G protein-coupled receptor GPR39 is a newly discovered receptor localized in contractile cells within small blood vessels. The discovery is based on earlier work by Nabil Alkayed, M.D., Ph.D., the director of research at OSHU Knight Cardiovascular Institute. Alkayed showed that a signaling molecule, epoxyeicosatrienoate (EET), is an important regulator of the small blood vessel function. However, the mechanism of action of this molecule was not known. Alkayed led a team of investigators in two years of intensive work to develop and validate a variety of innovative tools and approaches to identify GPR39 as the receptor for EET. Using mice genetically lacking GPR39, Alkayed has recently shown that the receptor plays a role in stroke and vascular dementia.

![GPR39: A novel protein that regulates coronary vascular tone](image-url)
Leading in hypertrophic cardiomyopathy

A robust research program runs in parallel with the Hypertrophic Cardiomyopathy Clinic at OHSU, the first and only clinic in the Pacific Northwest dedicated to treating this complicated disease and the only center in Oregon certified by the Hypertrophic Cardiomyopathy Association. OHSU has more than 10 ongoing clinical trials in HCM and has one of the highest number of patients in most of these trials.

As evidence of our commitment to patients and science, OHSU Knight Cardiovascular Institute has been instrumental in progressing mavacamten (a specific cardiac myosin inhibitor) through the clinical phases of development. We have the highest number of patients currently active on mavacamten in the world. The medication is now undergoing Food and Drug Administration review. A next-generation cardiac myosin inhibitor, CK-274, is currently being developed, and OHSU continues to be one of the highest enrollers, playing a pivotal role in the progress of this new medication. We are currently enrolling in REDWOOD-HCM and expect a phase III trial to open later in 2021.

“As part of our mission, we want to provide excellent care for our patients, which includes access to cutting-edge technology and newer, exciting therapeutic options,” said Ahmad Masri, M.D., M.S., the director of Hypertrophic Cardiomyopathy Clinic. “For those reasons, we have invested to create a robust research section within the Hypertrophic Cardiomyopathy Center. Our faculty are all strong clinicians and researchers, so we take it from the bedside to the bench by collaborating with basic scientists to find more solutions and have more discoveries.”

OHSU Hypertrophic Cardiomyopathy Bio Bank

In 2020, OHSU established a comprehensive bio bank of tissue, blood and urine generously donated by HCM patients to further our understanding of the mechanisms of the disease as well as to test new therapeutic approaches in the laboratory.
Demonstrating cardiometabolic benefits of weight loss interventions

Endocrinologist Jonathan Q. Purnell, the interim director of the OHSU Center for Preventive Cardiology, is one of the co-authors of the seven-year benchmark analysis of the Longitudinal Assessment of Bariatric Surgery (LABS) study. The results of the latest analysis of the multicenter cohort study show that though cardiometabolic health should have a foundation in weight loss management via lifestyle modification, clinicians should consider moving rapidly to other options, including weight loss surgery for patients with high body mass index.

“If you compare historic outcomes, there is a double to triple reduction in the mortality rate of patients with severe obesity who had surgery compared to, say, taking a statin, which is a mainstay of our current therapy,” Purnell said. “We are entering an era where weight management intervention will become a part of the cardiovascular risk management toolbox. Before, lifestyle changes would be where we stopped. But that is just the beginning now.”

<table>
<thead>
<tr>
<th>POST-GASTRIC BYPASS RESULTS FOR PATIENTS WITH BMI ABOVE 35 KG AT SEVEN YEARS OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% Average weight loss of initial body weight</td>
</tr>
<tr>
<td>40% Resolved without medication if hypertensive before surgery</td>
</tr>
<tr>
<td>60% Went into remission if diabetic before surgery</td>
</tr>
<tr>
<td>80–90% Resolution of abnormalities over time if high triglycerides and low HDL before surgery</td>
</tr>
</tbody>
</table>
Their results also showed that the capacity to secrete insulin nearly normalizes in patients with prediabetes after gastric bypass. However, the benefit did not extend to patients with diabetes.

“A highlight of our research is not to wait until patients with diabetes fail medical therapy before referring for weight loss surgery. The earlier they are referred, starting with prediabetes, the more likely they are to get the benefits,” Purnell said.

Purnell is also part of the OHSU Bariatric Services team that is working with the National Heart, Lung and Blood Institute's efforts to conduct a large-scale, randomized trial of bariatric surgery, the first of its kind to focus on cardiovascular outcomes.

### Roux-en-Y gastric bypass

<table>
<thead>
<tr>
<th>Follow-up year</th>
<th>Remission %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
</tr>
</tbody>
</table>

**Median (95% CI) %**

- **Diabetes**: 62 (219)
- **High LDL cholesterol level**: 21 (120)
- **High triglyceride level**: 354 (241)
- **Low HDL cholesterol level**: 342 (241)
- **Hypertension**: 782 (520)

<table>
<thead>
<tr>
<th>No. at risk</th>
<th>Diabetes</th>
<th>High LDL cholesterol level</th>
<th>High triglyceride level</th>
<th>Low HDL cholesterol level</th>
<th>Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>379</td>
<td>292</td>
<td>201</td>
<td>437</td>
<td>960</td>
</tr>
<tr>
<td>1</td>
<td>327</td>
<td>246</td>
<td>166</td>
<td>353</td>
<td>786</td>
</tr>
<tr>
<td>2</td>
<td>320</td>
<td>253</td>
<td>162</td>
<td>342</td>
<td>741</td>
</tr>
<tr>
<td>3</td>
<td>342</td>
<td>253</td>
<td>161</td>
<td>341</td>
<td>751</td>
</tr>
<tr>
<td>4</td>
<td>345</td>
<td>260</td>
<td>164</td>
<td>354</td>
<td>782</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Accelerating therapies for amyloidosis

OHSU Knight Cardiovascular Institute has played a pivotal role in offering access to new therapeutic options in transthyretin amyloidosis. Through our early participation, we had one of the highest enrollments for patients to receive Vyndamax (tafamidis) through the early access program, providing patients in the Pacific Northwest the ability to receive tafamidis even before its approval by the Food and Drug Administration in 2019. Now, 95 percent of our transthyretin patients are on tafamidis, despite only a minority being able to afford it, because of the dedicated efforts of our clinicians and pharmacists.

Other trials underway for amyloidosis include the CARDIO-TTRansform trial to compare silencers with stabilizers. OHSU has the greatest number of patients so far in this trial, which will be the largest amyloidosis trial yet, involving 750 patients. Other trials that we have participated in include phase II and III of AG10, NEURO-TTRansform and phase III of vutrisiran in hereditary amyloidosis.

“Our heavy involvement in clinical trials for amyloidosis opens doors for our patients to get newer therapeutics and for us to engage in further translational and clinical research, another example of how we take a problem from the clinic and work to bring about breakthroughs to improve the lives of our patients,” said Ahmad Masri, M.D., M.S., the director of the OHSU Amyloidosis Clinic.

Research groups

**Adult Congenital Heart Disease**
- Craig S. Broberg, Professor
- Grant Burch, Associate Professor
- Abigail Khan, Assistant Professor
- Adrienne Kovacs, Associate Professor

**Aortic Diseases**
- Cherrie Abraham, Associate Professor
- Amir Azarbal, Associate Professor
- Abigail Khan, Assistant Professor
- Cheryl L. Maslen, Professor
- Lynn Sakai, Professor

**Cardiothoracic Surgery**
- Castigliano Bhamidipati, Assistant Professor
- Gurion Lantz, Assistant Professor
- Howard Song, Professor
- Frederick Tibayan, Associate Professor

**Cardiovascular Imaging**
- Craig S. Broberg, Professor
- Scott Chadderdon, Assistant Professor
- Maros Ferencik, Assistant Professor
- Sanjiv Kaul, Professor
- Abigail Khan, Assistant Professor
- Elizabeth Le, Associate Professor
- Jonathan Lindner, Professor
- Hind Rahmouni, Assistant Professor
- Diana Rinkevich, Associate Professor
- Xubo Song, Professor
- Kevin Wei, Professor

**Cardiometabolic**
- Jonathan Lindner, Professor
- Jeanne Link, Professor
- Jonathan Q. Purnell, Professor
- Charles Roberts, Professor
Center for Developmental Health
Natasha N. Chattergoon, Assistant Professor
George Giraud, Professor
Sonnet Jonker, Associate Professor
Alina Maloyan, Associate Professor
Kent Thornburg, Professor

Electrophysiology
Beth Habecker, Professor
Charles A. Henrikson, Professor
Adrienne Kovacs, Associate Professor
Jonathan Lindner, Professor
Babak Naser, Assistant Professor
Eric Stecker, Associate Professor
Larisa Tereshchenko, Associate Professor
Zhengfeng Zhou, Professor

Genomics/Epigenetics
Andrew Adey, Assistant Professor
Lucia Carbone, Associate Professor
Meghan Mannello, Instructor
Cheryl Maslen, Professor

Hypertrophic Cardiomyopathy and Amyloidosis
Reyhaneh Akhavein, Assistant Professor
Rupalie Avasare, Assistant Professor
Chafic Karam, Associate Professor
Meghan Mannello, Instructor
Ahmad Masri, Assistant Professor
Eva Medvedova, Assistant Professor
Shoukhrat Mitalipov, Professor
Sarah Nagel, Assistant Professor
Rebecca Silbermann, Assistant Professor

Interventional Cardiology
Joaquin Cigarroa, Professor
Punag Divanji, Assistant Professor
Harsh Golwala, Assistant Professor
Firas Zahr, Associate Professor

Preventive Cardiology
P. Barton Duell, Professor
Nathalie Pamir, Assistant Professor
Jonathan Q. Purnell, Professor
Hagai Tavori, Assistant Professor

Center for Radiochemistry Research
Kenneth Krohn, Professor
Jeanne Link, Professor
Dexing Zeng, Assistant Professor

Vascular Biology
Nabil Alkayed, Professor
Joseph Aslan, Assistant Professor
Amir Azarbal, Associate Professor
Anthony Barnes, Assistant Professor
Sanjiv Kaul, Professor
Jonathan Lindner, Professor
Steven Mansoor, Assistant Professor

Vascular Surgery
Cherrie Abraham, Associate Professor
Amir Azarbal, Associate Professor
Enjae Jung, Assistant Professor
Gregory Landry, Professor
Timothy Liem, Professor
Greg Moneta, Professor
Clinical programs

Aortic conditions

Nationally and internationally recognized clinicians and researchers in vascular surgery, cardiothoracic surgery, interventional radiology, cardiovascular medicine and related disciplines partner to provide consultation, treatment and comprehensive surgical and medical management for any aortic condition. Services include the latest multimodality aortic imaging, medical monitoring, aneurysm repair, endovascular surgery, hybrid open/endovascular surgery and minimally invasive vascular surgery such as EVAR and TEVAR.

Cardiogenetics

This multidisciplinary team of experts provides personalized care and support to patients and families with hereditary cardiovascular diseases such as familial hypercholesterolemia, Marfan syndrome, familial amyloidosis, dilated and hypertrophic cardiomyopathy, and Long QT syndrome, among others. Genetic counselors consult with patients and families to understand the hereditary nature of cardiovascular diseases, provide genetic testing, address the physical and emotional implications of having an inherited cardiovascular condition, and connect patients to research opportunities.

Cardio-oncology

This unique program specializes in the cardiovascular care of patients currently undergoing or previously treated with chemotherapy, radiation therapy or bone marrow transplantation. To ensure long-term health and overall survival from cancer, experts provide care for prevention of chemotherapy-induced cardiotoxicity and radiation-induced heart damage. They also provide management of existing heart conditions during cancer treatment and of cardiac complications after cancer treatment, and assessment of long-term cardiovascular risk with optimization of preventive treatments for cancer survivors. The multidisciplinary program brings together cardiologists with a special interest in the cardiovascular effects of anti-cancer therapies and oncologists to provide comprehensive and personalized care for our patients.
Cardiothoracic surgery

We are a regional resource for patients with advanced heart diseases that require complex treatments. OHSU’s cardiac surgery team cares for adult patients with congenital and acquired heart diseases, including coronary artery disease, valvular heart disease, aortic aneurysms and heart failure, using innovative surgical techniques. Minimally invasive approaches are used whenever possible to give patients the best outcomes while minimizing discomfort and recovery time.

Center for Preventive Cardiology

For patients with increased risk of heart disease (e.g., dyslipidemia, diabetes and hypertension), the Center for Preventive Cardiology offers a combination of advanced medical intervention and lifestyle modification. We work with genetic counselors, behavioral health experts and lipid experts to offer specialized care for patients with complex lipid abnormalities such as familial hypercholesterolemia, intolerance to statins, and early family history or premature coronary artery disease. Our multidisciplinary team includes endocrinologists, cardiologists and nutritionists, who together offer a team approach to managing other high-risk factors. The center also includes OHSU’s three-phase inpatient/outpatient cardiac rehabilitation program, which is nationally certified by the American Association of Cardiovascular and Pulmonary Rehabilitation.

Congenital heart disease

One of only 32 institutions nationwide recognized by the Adult Congenital Heart Association and the only one in Oregon, our program is made up of a full-service team of adult, pediatric and interventional cardiologists, geneticists, psychologists and heart surgeons who specialize in the inpatient and outpatient care of adults with congenital heart disease, including the full spectrum from undiagnosed lesions to complex palliated patients. OHSU offers state-of-the-art diagnostics, catheter intervention, and electrophysiologic study and surgery, and patients have access to congenital heart disease clinical trials not available elsewhere in the state.

Heart failure and transplant

OHSU is Oregon’s first and only heart transplant program approved by the United Network for Organ Sharing and the Center for Medicare & Medicaid Services. A multidisciplinary team of cardiac surgeons, cardiologists, intensivists, clinical coordinators, advanced practitioners and social workers specializes in the care of patients with advanced heart failure and works together to provide the most appropriate advanced therapies available, including augmented medical therapy, inotropes, ventricular assist devices and other forms of mechanical circulatory support, and heart transplantation. OHSU has performed more than 700 heart transplants and more than 200 mechanical support device implants.
Heart rhythm disorders

We offer a full range of electrophysiology procedures, including pacemaker and defibrillator implantation; electrophysiology study and ablation of supraventricular tachycardia, atrial fibrillation and ventricular tachycardia; laser lead extraction; and epicardial access and ablation. OHSU is the first hospital in the region to offer a cryoballoon procedure to isolate, freeze and ablate the pulmonary veins, and is the only hospital in the region with a research protocol that permits safe MRI scans on patients with a permanent pacemaker or implantable cardioverter defibrillator.

Hypertrophic cardiomyopathy

The first program of its kind in Oregon, this multidisciplinary team from cardiology, medical genetics and pediatric cardiology provides expert care for a condition characterized by abnormal thickening of the left ventricular muscle. The program is registered with the Hypertrophic Cardiomyopathy Association and provides treatment that includes medical therapies (beta blockers, certain calcium channel blockers, disopyramide), septal reduction therapies (surgical or catheter-based), implantable cardioverter defibrillators and advanced heart failure therapies.

Ischemic heart disease

Advanced medical, interventional, diagnostic and surgical procedures to manage diseases of the coronary arteries, including percutaneous coronary intervention and coronary artery bypass grafting. OHSU is home to Oregon’s first accredited chest pain center and is one of the few hospitals in the country to offer myocardial contrast echocardiography to detect decreased blood flow quickly and accurately in arteries.

Maternal cardiac

Unique to the region, this clinical partnership between cardiology and maternal fetal medicine at OHSU provides comprehensive care for women with diagnosed or suspected cardiac disease who are pregnant or planning for a pregnancy. The program offers preconception counseling, cardiac monitoring during pregnancy, and early postpartum follow-up. Wherever possible, the program partners with local providers to give the best ongoing care available to our patients.
**Structural heart disease**

A multidisciplinary team, including imaging specialists, interventional cardiologists, nurses, advanced practitioners and surgeons, provides a comprehensive approach to valvular heart disease, congenital defects and acquired cardiovascular conditions. Catheter and surgical approaches are available to patients with all types of valvular heart disease, hypertrophic cardiomyopathy, coronary arteriovenous fistulae and other acquired heart defects. For patients with a patent foramen ovale, joint evaluation by neurologists and cardiologists determines whether closure might reduce the risk of future stroke. Active clinical trials are available to patients for the treatment of many of these conditions. This comprehensiveness of our structural heart program results in superior outcomes.

**Vascular disease**

OHSU’s vascular disease program includes nationally renowned experts specially trained to diagnose and treat the entire spectrum of arterial, venous and lymphatic disorders. A team of providers, including vascular, cardiothoracic and endovascular surgeons, treats the carotid artery and extracranial cerebrovascular system, aneurysms of the thoracic and abdominal aorta, intestinal and kidney arteries and veins, upper and lower extremity arteries and veins, patients with Raynaud’s syndrome, those requiring vascular access for hemodialysis as well as patients with varicose veins, venous thrombosis, lymphedema and vascular malformations.

**Women’s heart**

In collaboration with the OHSU Center for Women’s Health, the women’s heart program focuses on primary prevention to reduce risk in women without known cardiovascular disease, secondary prevention to improve the health of women diagnosed with disease, and cardio-oncology to manage heart risks in women who have undergone breast cancer treatment. By understanding the differences in how heart disease manifests in women and studying the disparities in treatment and response to medication, this program aims to provide a forum for providers to improve care and health outcomes using the most current evidence-based information.
Physicians by department

Anesthesiology and Perioperative Medicine
Mark Baskerville, M.D., J.D., MBA
Tonya Miko Enomoto, M.D.
Ryan Fink, M.D.
Alan J. Kovar, M.D.
Matthias Johannes Merkel, M.D., Ph.D.
Peter M. Schulman, M.D.
Michael Wollenberg, M.D.

Cardiovascular Medicine
Shaun Ageno, M.D.
Reyhaneh Akhavein, M.D.
Tami Atkinson, M.D.
Timothy Becker, D.O.
Bassel Beitinjaneh, M.D.
Craig S. Broberg, M.D.
S. Albert Camacho, M.D.
Scott Chadderdon, M.D.
Joaquin Cigarroa, M.D.
Nalini Colaco, M.D., Ph.D.
Khidir Dalouk, M.D.
Brian Davidson, M.D.
Punag Divanji, M.D.
P. Barton Duell, M.D.
Maros Ferencik, M.D., Ph.D.
Harsh Golwala, M.D.
Nandita Gupta, M.D.
Allan Harrelson, D.O., Ph.D.
Charles Henrikson, M.D.
Peter Jessel, M.D.
Sanjiv Kaul, M.D.
Abigail Khan, M.D.
Sena Kilic, M.D.
Adrienne Kovacs, Ph.D.
Matthew LaBarbera, M.D.
Elizabeth Le, M.D.
Jonathan Lindner, M.D.
Karen MacMurdy, M.D.
Conrad Macon, M.D.
Steven Mansoor, M.D., Ph.D.
Luke Masha, M.D., M.P.H.
Ahmad Masri, M.D.
Lidija McGrath, M.D.
Deborah Meyers, M.D.
Sriini Mukundan, M.D.
Edward Murphy, M.D.
Shashima Nakahara, M.D.
Babak Nazer, M.D.
Jonathan Purnell, M.D.
Hind Rahmouni, M.D.
Merritt Raitt, M.D.
Diana Rinkevich, M.D.
David Rutlen, M.D.
Evan Shalen, M.D.
Eric Stecker, M.D.
Johannes Steiner, M.D.
James Suero, M.D.
Sahar Taqui, M.D.
Yen Tibayan, M.D.
Kevin Wei, M.D.
Mrinal Yadava, M.D.
Firas Zahr, M.D.
Randy (Ignatius) Zarraga, M.D.

Cardiothoracic Surgery
Castiglano Bhamidipati, D.O., Ph.D., M.Sc.
Robert DuBose, M.D.
Michael Kilbourne, M.D.
Gurion Lantz, M.D.
Ashok Muralidaran, M.D.
Irving Shen, M.D.
Terry Shih, M.D.
Howard Song, M.D., Ph.D.
Frederick Tibayan, M.D.

Vascular Surgery
Cherrie Abraham, M.D.
Amir Azarbal, M.D.
Leo Daab, M.D.
David Griffin, D.P.M.
Enjae Jung, M.D.
Matthew Koopmann, M.D.
Gregory Landry, M.D.
Timothy Liem, M.D.
Robert McLafferty, M.D.
Gregory Moneta, M.D.
Khanh Nguyen, M.D.
Amani Politano, M.D., M.S.
Locations

Marquam Hill Campus
3181 S.W. Sam Jackson Park Road
Portland, OR 97239
503-494-1775

Center for Health & Healing
3303 S.W. Bond Ave., 9th floor
Portland, OR 97239
503-494-1775

Beaverton Cardiology Clinic
15700 S.W. Greystone Court
Beaverton, OR 97006
503-494-1775

Adventist Health Portland
10123 S.E. Market St.
Portland, OR 97216
503-257-2500

Hillsboro Medical Center
335 S.E. 8th Ave.
Hillsboro, OR 97123
503-681-1111

Community Collaborations

PeaceHealth
St. John Medical Center
1615 Delaware St.
Longview, WA 98632
360-414-2730

PeaceHealth
Southwest Medical Center
200 N.E. Mother Joseph Place
Vancouver, WA 98664
360-514-4444

Columbia Memorial Hospital
2095 Exchange St., Ste. 301
Astoria, OR 97103
503-338-4087

Mid-Columbia Medical Center
551 Lone Pine Blvd., Ste. 303
The Dalles, OR 97058
541-506-6530

Willamette Valley Medical Center
Northwest Regional Heart & Vascular
2700 S.E. Stratus Ave., Ste. 406
McMinnville, OR 97128
503-435-1200
Continuing medical education

OHSU offers accredited continuing medical education for medical professionals. OHSU School of Medicine is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

2021 Multidisciplinary Aortic Dissection Symposium
June 18–19, 2021 | OHSU Robertson Life Sciences Building | Portland, Oregon
www.ohsuknightheart.com/aorticsymposium

Eighth Annual Pacific Northwest Cardiovascular Summit
September 10–11, 2021 | Portland, Oregon
www.pnwcvsymposium.com