

Cardiovascular Compendium

A Comprehensive Review of Heart and Vascular Innovations

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Dartmouth Health's Heart and Vascular Center is grounded in its deep relationships with the Geisel School of Medicine at Dartmouth. As a distinguished leader in clinical trials and advanced medical science, Dartmouth Hitchcock Medical Center is the #1 ranked hospital in New Hampshire, according to *U.S. News & World Report*, and is nationally recognized for its innovative approach to academic research and clinical care.



Heart and Vascular Center

Dear Colleagues,

The Dartmouth Health Heart and Vascular Center continues to provide leading-edge cardiovascular care—exemplified by *US News and World Report* and recognition in Becker's Hospital Review's top 100 health systems with great heart programs. In this edition of the Cardiovascular Compendium, we highlight several innovative technologies that are transforming the treatment of cardiovascular disease. Several of these technologies were developed at Dartmouth Health.

Our team is pioneering new therapies using pulse field ablation to treat atrial fibrillation, a common heart rhythm disorder that can impact quality of life and increase the risk of stroke. This minimally invasive, highly effective approach allows many patients to return home the same day as their procedure.

We are also proud to operate one of the few robotic heart surgery programs in New England. As featured in this compendium, robotic-assisted techniques enable select patients to undergo cardiac surgery with smaller incisions, shorter hospital stays, and faster recoveries.

We also highlight advanced minimally invasive technologies designed to prevent aortic aneurysm rupture, preserve limbs in patients with diabetes, and repair previously replaced or malfunctioning aortic valves.

While the rate at which these new technologies develop is breathtaking, it does not replace the personal, hands-on, relationship-based care that we strive to deliver to our patients and their families. We are proud of the cardiovascular care that we deliver at Dartmouth Health and we highly value the trust that patients, families, and providers place in us.



Sincerely,

Richard J. Powell, MD
Director, Heart and Vascular Center
Dartmouth Hitchcock Medical Center
Professor of Surgery and Radiology
Geisel School of Medicine at Dartmouth



U.S. News High-Performing Designations Underscore Culture of Excellence



Breakdown

- 45% Patient outcomes**
- 35% Other care-related indicators** (such as nurse staffing, patient volume, and professional recognitions)
- 12-15% Expert opinion** (determined based on the votes of board-certified physicians within the specialty area—weight reduced from 15 percent to 12 percent for Cardiology, Heart & Vascular Surgery)
- 5% Patient experience** (based on patient responses to the standardized, government-administered Hospital Consumer Assessment of Healthcare Providers and Systems [HCAHPS] survey)

In 2025-26, Dartmouth Hitchcock Medical Center earned High-Performing Hospital designations from *U.S. News & World Report* in seven of eight cardiovascular conditions and procedures, up from three in 2023-24 and four in 2024-25.

The team's 2025-26 High-Performing Hospital designations for Cardiology, Heart & Vascular Surgery include:



Comprehensive Care Combined with Clinical Innovation

Dartmouth Health's Heart and Vascular Center was also named one of the top 100 cardiology programs in the U.S. by *Becker's Hospital Review*.

"These recognitions represent a big step forward for our team," said Richard J. Powell, M.D., director of the Heart and Vascular Center at Dartmouth Health. "We are building a culture of innovation, excellence, accountability, quality, and patient-centered care that inspires camaraderie among our team members as we continue to grow and enhance the care we provide."

At the Heart and Vascular Center, Powell said the team continues to build its reputation by focusing on research, education, and outstanding patient care. With the goal of bringing the most advanced care to patients across New England, the team is now offering 48 ongoing clinical trials for cell therapy, drug therapy, devices, and more.



Offering 48 clinical trials for:

- Cell therapy
- Drug therapy devices
- And more

ENHANCING QUALITY OF LIFE THROUGH LEADING-EDGE ELECTROPHYSIOLOGY CARE



The electrophysiology (EP) team at Dartmouth Health is bringing some of the most advanced treatment options, technologies and clinical trials to New England—enhancing safety, increasing access to leading-edge care and improving quality of life for patients.

PULSED FIELD ABLATION: A NEW, MINIMALLY INVASIVE OPTION FOR A-FIB

Robert N. D'Angelo, MD, MS—who joined the EP team in 2024 after completing his EP fellowship at Beth Israel Deaconess Medical Center in Boston—said the team is now offering pulsed field ablation (PFA), a minimally invasive, catheter-based treatment for atrial fibrillation (A-Fib).

Unlike other ablation procedures that use heat or cold to destroy heart tissue and disrupt abnormal electrical signals, PFA uses short, non-thermal electrical pulses—allowing electrophysiologists to more accurately select tissue to be destroyed and reducing the risk of nerve or esophageal damage. Other benefits of PFA include shorter procedures, faster recovery and potentially longer-lasting results.

“Shorter procedure times mean that we can perform more PFA procedures per day, increasing patient access to EP care,” said D’Angelo. “We are also exploring the possibility of offering PFA using conscious sedation only, which would reduce the need for general anesthesia, lower the risk of related complications and increase procedural efficiency.”

The team also started combining ablation and left atrial appendage occlusion (LAAO) procedures, effectively treating A-Fib, reducing the risk of stroke, and eliminating the need for lifelong anticoagulant therapy during a single minimally invasive procedure.

“We also started performing Vein of Marshall (VoM) ethanol ablations to treat persistent A-Fib, injecting a small amount of alcohol into the vein to block abnormal electrical signals,” said D’Angelo. “We are applying the same ethanol ablation techniques

to the epicardium for the treatment of tough-to-reach ventricular arrhythmias.”

ADVANCING DEVICE CARE ACROSS NORTHERN NEW ENGLAND

The EP team is also leading the way in device care, ranking among the highest volume centers for leadless pacemaker implants in New England and operating a specialized lead management program for people experiencing complications related to traditional pacing devices.

Leadless pacemakers can be implanted during a minimally invasive catheter-based procedure and do not require leads that extend from the device in the heart to the pulse generator in the chest, reducing the risk of infection by about one-fifth compared with traditional pacemakers.

“We are now offering dual-chamber leadless pacemakers, allowing us to provide synchronized pacing in the right atrium and ventricle,” said D’Angelo, who has an undergraduate degree in biomedical engineering. “We can now extract a traditional pacemaker and its leads and implant a leadless pacemaker during the same procedure.”



Using traditional pacemaker devices, the team also offers left bundle branch pacing, which involves placing a pacemaker lead near the left bundle branch. This approach improves synchronization and offers an alternative to right ventricular lead placement and His bundle pacing.

RESEARCH ADVANCES EP CARE THROUGH CLINICAL TRIALS



As EP techniques and technology continue to evolve, the team at Dartmouth Health is bringing the latest innovations to patients across the region through participation in clinical trials, including:

■ **REMATCH**
Studying the safety and effectiveness of repeat ablation of persistent A-Fib using pulsed field ablation.

■ **SIMPLAIFY**
Studying the safety and effectiveness of medication regimens after a Watchman LAAO procedure.

D’Angelo’s team plans to publish papers on outcomes of ablation versus antiarrhythmic medications in patients over age 65, as well as their experience performing VoM ethanol ablation combined with an LAAO procedure.

“We are seeing more highly functional patients with heart rhythm disorders, and we want to help them preserve their quality of life,” said D’Angelo.

“Shorter procedure times mean that we can perform more PFA procedures per day, increasing patient access to EP care. We are also exploring the possibility of offering PFA using conscious sedation only, which would reduce the need for general anesthesia, lower the risk of related complications and increase procedural efficiency.”

— Robert N. D’Angelo, MD, MS



A Patient-First Approach to Robotic Cardiac Surgery Care

Dartmouth Health cardiac surgeons are expanding access to innovative treatment options that reduce recovery time and enhance quality of life.



Henry J. Tannous, MD, and Jose R. Rodriguez, MD, operating at DHMC with the da Vinci robot system

Dartmouth Health's Heart and Vascular Center is a national leader in advanced robotic cardiac surgery procedures. Led by Henry J. Tannous, MD, section chief of Cardiac Surgery, and Jose R. Rodriguez, MD, director of Minimally Invasive Cardiac Surgery and Quality at Dartmouth Health, the academic medical center is among only a few centers in New England to offer robotic procedures for mitral valve surgery (MVR), totally endoscopic coronary artery bypass (TECAB), and, in the near future, robotic aortic valve replacement (AVR).

Tannous and Rodriguez are using the hospital's da Vinci robotic technology to perform what were once considered major cardiac surgeries through small incisions—decreasing surgical risks and lengthy recovery associated with traditional procedures that involve opening the chest.

"As a rural health system, we are proud of our ability to offer the most advanced robotic cardiac surgery procedures that aren't even available in some larger cities," said Rodriguez. "We are the only center in New England currently performing TECAB, and we are preparing to offer robotic AVR—which is available at fewer than 10 centers in the U.S."

Technology and Techniques Deliver Outstanding Results

According to Rodriguez, the use of robotic technology enhances visualization and precision, and the technology and techniques continue to deliver outstanding results.

"Our team's extensive background in minimally invasive cardiac surgery has enabled us to seamlessly integrate robotic technology into our practice," said Rodriguez. "We are currently performing 10 minimally invasive valve procedures per month, and with the support of our skilled OR, ICU, and cardiac anesthesia colleagues, our patients are doing exceptionally well."

Rodriguez said that the faster recovery offered by minimally invasive and robotic surgical approaches provides tremendous patient benefit—enabling them to return to work and resume their normal activities sooner. The goal, according to Rodriguez, is to make these innovative procedures available to as many patients as possible by providing efficient, patient-centered care.

"We are taking steps to reduce the need for patients to travel to multiple appointments to access robotic cardiac surgery," said Rodriguez. "Patients can receive pre-op and follow-up care at a satellite Dartmouth Health campus, so only need to travel to Lebanon for their procedure and hospital stay."

To further improve access to care, Tannous and Rodriguez are now seeing patients for office visits in Manchester—and in many cases, patients can have their pre-op visit in as little as a week and schedule their surgical procedure within 4 to 6 weeks, depending on the pre-operative workup required.

Rodriguez said that the team looks forward to conducting research on robotic cardiac surgery outcomes and publishing their experiences, particularly related to the future use of robotic AVR.

"We want to restore our patients' quality of life by delivering great care with a patient-first approach," said Rodriguez. "It's an exciting time for robotic cardiac surgery, and patients in New England have access to very sophisticated treatment options right here at Dartmouth Health."

"Our team's extensive background in minimally invasive cardiac surgery has enabled us to seamlessly integrate robotic technology into our practice.

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— Jose R. Rodriguez, MD

Advanced Valve-in-Valve Replacement: Enhancing Safety, Improving Access



Henry Tannous, MD (Left), and Michael Young, MD (Right)

Several years ago, the Dartmouth Health Structural Heart Disease Program became the first in northern New England to adopt needle-through-leaflet electrosurgical techniques to treat failing surgical valves, providing advanced, specialized care close to home for a subset of patients who require valve-revision surgery, also known as transcatheter aortic or mitral valve-in-valve replacement.

Today, patients in New England continue to have local access to minimally invasive surgical valve-revision care at Dartmouth Health—delivered by some of the region's most experienced structural interventionalists and cardiac surgeons who use the latest electrosurgical techniques as an alternative to redo open valve surgery.

Creating a New, Minimally Invasive Surgical Replacement Option

Needle-through-leaflet electrosurgery uses an electrified guidewire during a minimally invasive transcatheter

valve-in-valve replacement to modify tissue valve leaflets and create space prior to insertion of the replacement valve. These sophisticated techniques reduce the risk of coronary artery occlusion or left ventricular outflow tract obstruction in select patients.

"In 2019, we performed our first transcaval alternative access electrosurgical procedure, and emerging techniques in recent years have allowed us to rethink the treatment of failing surgical valves," said Michael N. Young, MD, FACC, FSCAI, RPVI, director of the Structural Heart Disease Program at Dartmouth Health and associate professor of Medicine at the Geisel School of Medicine at Dartmouth. "In the past, these patients with failing surgical valves would not have had a minimally invasive transcatheter option. Some patients would undergo redo open valve surgery while others would not have any options due to their age, physical condition limiting recovery, and the inherent higher risk of complications."

According to Young, without electrosurgery, even minimally invasive valve-in-valve replacement procedures

"In the past, patients with failing surgical valves wouldn't have had a minimally invasive surgical option, and some would not have been candidates for open valve surgery due to the lengthy recovery and a higher risk of complications."

may not be feasible for this high-risk subset of patients. For example, when inserting a new transcatheter heart valve inside a failing surgical valve, old valve leaflets are pushed aside and can potentially block blood flow to the coronary arteries—increasing the risk of cardiac arrest or a heart attack. Electrosurgical techniques enable interventional cardiologists to modify old valve leaflets—typically by controlled laceration—to preserve coronary artery or left ventricular outflow, which then enhances safety and patient outcomes related to transcatheter valve-in-valve replacement.

Combining Knowledge and Experience for Ongoing Innovation

Young and his team are using some of the most advanced electrosurgery techniques available, including BASILICA and UNICORN for aortic valve replacement and LAMPOON for mitral valve replacement. The BA-BASILICA technique, as well as a modified UNICORN procedure known as LLAMACORN, incorporate balloon-tipped catheters to split the leaflets before laceration.

"In our experience treating a number of these very high-risk patients, the immediate outcomes so far are encouraging," said Young. "These sophisticated techniques have allowed us to avoid such complications, and most patients are discharged within 24 hours of their procedure."

The team is also using their knowledge and experience to further expand their treatment offerings, combining approaches to tailor procedures to the patient's anatomy and treatment needs. In a recent example, the team performed a hybrid BASILICA-LLAMACORN procedure and plans to follow these patients long-term.



James Devries MD, Michael Young MD, Henry Tannous MD and Nathan Crain PA-C in the Cath Lab at DHMC.

Strong Programs Support Leading-Edge Care

The keys to providing this advanced care, according to Young, are having strong structural heart and cardiac surgery programs—and selecting the right technique for the right patient.

"Transcatheter electrosurgical techniques are nascent in their evolution, but they are giving us an elegant way to solve specific anatomical problems for our patients," said Young. "I always say that structural heart care is a team sport, and with our forward-thinking surgical partners in cardiac surgery, vascular surgery, cardiac anesthesia, and advanced cardiac imaging, we are able to offer an innovative solution for patients who previously had no other option."

A National Leader in Complex Aortic Aneurysm Repair

DARTMOUTH HEALTH is a national leader in minimally invasive complex aortic aneurysm repair, offering a full range of endovascular devices that can be selected or customized to fit each patient's unique anatomy.

"Endovascular techniques for complex aortic aneurysm repair offer a minimally invasive alternative to open surgery," said Dartmouth Health vascular surgeon Bjoern D. Suckow, MD, MS.

"Dartmouth Health is a leading provider of complex endografts in New England, with outcomes, device options and expertise that is on-par with the care available in Boston."

A Full Range of Endograft Options for Every Anatomy

Since the 1990s, accessibility of "off-the-shelf" endografts with pre-configured designs has increased, with several devices now available to treat different sections of the aorta. But when an off-the-shelf solution isn't ideal, Dartmouth Health vascular surgeons work closely with companies that create customized endografts based on interactive 3D models to fit a patient's specific anatomy.

However, when an emergency arises and an off-the-shelf device can't provide the right fit, Suckow and his team have the ability to create customized, fenestrated branched endografts in-house under an investigational device exemption (IDE) from the U.S. Food and Drug Administration (FDA). The IDE allows Suckow and his team to modify standard, commercially available stent-grafts in their lab at DartmouthHitchcock Medical Center and offer potentially life-saving emergency care to patients across New England.

"We are one of fewer than 20 centers in the country with an IDE to modify endografts in-house," said Suckow. "We perform between 65 and 80 of these procedures each year, which is a high volume for our rural area."

As early adopters at a high-volume center, Suckow and his team are currently participating in 12 clinical trials of new devices, medications and interventions to slow aneurysm growth. The team is also involved in research on the psychological aspects of aortic aneurysm care—including how well patients understand their condition, the degree of anxiety or fearfulness patients experience as a result of their aneurysm, and how it affects quality of life.



Bjoern D. Suckow, MD

"We are one of fewer than 20 centers in the country with an IDE to modify endografts in-house," said Suckow. "We perform between 65 and 80 of these procedures each year, which is a high volume for our rural area."

"We can enroll any patient with an aneurysm in one of our clinical trials," said Suckow. "We are consistently among the top enrollers for our national clinical trials and are involved in educating other vascular surgeons on the use of innovative devices."

Strong Institutional Support Helps Create a Robust Program

In addition to the team's commitment to excellence, innovation and research, Suckow said that Dartmouth Health has the technology and support required to sustain a robust complex aortic aneurysm repair program.

"We have two state-of-the-art hybrid operating suites equipped with

intraoperative imaging that allows us to map the surgery and project real-time images onto previous x-rays," said Suckow. "As a result, we can see better and safely do more with less radiation."

Suckow said the hybrid OR suites are a demonstration site, where colleagues from across the nation and world come to learn how the hospital's innovative technology and best practices support high-quality patient care.

"We have a fully functional team that runs like a well-oiled machine," said Suckow.

In addition to collaborating with his colleagues in Lebanon, Suckow

works closely with referring vascular surgeons across the region to care for patients with complex aortic aneurysms and assists primary care providers with assessing and managing aneurysms over the long term.

"If a patient needs a higher level of care or ongoing monitoring, they can have their imaging and blood work done in their immediate community," said Suckow. "If they need surgical care, they only have to travel to Lebanon once for their procedure, where they have access to the same options available at any other academic medical center in the country. Most patients stay one night after surgery and can receive all their follow-up care locally."

Vascular Surgeons Take Multidisciplinary Approach to Limb Preservation Care

People with peripheral artery disease (PAD) and diabetes are at high risk of limb-threatening complications caused by slow-healing foot wounds. At Dartmouth Health, vascular surgeons work collaboratively with infectious disease, endocrinology, case management, hyperbaric medicine, podiatry, nutrition, and wound care experts to promote healing and prevent amputation.

“We perform everything from traditional lower extremity bypass procedures to minimally invasive endovascular procedures using wires and catheters to restore circulation to the feet and lower legs,” said Jocelyn Beach, MD, vascular surgeon at Dartmouth Hitchcock Medical Center. “During endovascular bypass, we perform the procedure through several small incisions.”

Beach said the vascular surgery team—including Philip P. Goodney, MD, MS, and Richard J. Powell MD—is also participating in clinical trials for two minimally invasive deep venous arterialization techniques.

“During this procedure, we redirect blood from the arteries to the veins to restore blood flow to the foot using catheters inserted through small skin punctures,” said Beach.

“Deep venous arterialization potentially creates a new treatment option for patients who are facing a major amputation, aren’t candidates for traditional vascular surgery, and previously had no other treatment options—and so far, we’ve been able to save a number of limbs using this technique.”



The team will soon launch new clinical trials designed to help patients recover more fully and stay healthier after interventions for PAD. These studies will explore structured exercise programs paired with beetroot juice to improve walking ability, as well as advanced lipid-lowering therapies, including PCSK9 inhibitors, to reduce the risk of future heart and limb complications.

According to Beach, this advanced, multispecialty approach to care is unique in northern New England. Through the team’s strong relationships with community physicians, patients can connect with PAD care earlier, often before a serious complication develops.

“From diagnostic, nonsurgical, and pre- and post-surgical care across various locations to advanced, limb-preserving surgery, Dartmouth Health has the resources and multidisciplinary expertise to provide outstanding PAD care,” said Beach.

Jocelyn Beach, MD



Expansion Brings Convenient, Consistent Cardiovascular Care to Southern NH

In 2025, Dartmouth Health expanded its cardiovascular services in southern New Hampshire to include cardiac PET, and CT imaging will be available starting summer 2026. The expansion also adds in-person cardiac surgery, vascular surgery, and electrophysiology clinics in Manchester, giving residents of Concord, Manchester, Nashua, and surrounding communities access to close-to-home cardiovascular care backed by the resources of an academic medical center.

“Our advanced cardiac imaging capabilities in southern New Hampshire enable our team to accurately diagnose coronary artery disease and microvascular disease, and perform coronary calcium scoring to predict heart attack risk,” said Richard J. Powell, MD, director of the Heart and Vascular Center at Dartmouth Health. “If a patient needs additional treatment—even for a complex problem—they may only need to travel to Lebanon one time for their procedure. Then they can receive all their pre- and post-surgical care, as well as ongoing follow-up, locally.”

Patients who travel to Lebanon for a surgical procedure have access to some of the most advanced treatments, including robotic coronary artery bypass grafts, advanced electrophysiology devices, complex aneurysm repair, and 48 ongoing clinical trials for a variety of cardiovascular conditions.

The Heart and Vascular Center also opened an Electrophysiology Device Clinic in Manchester, offering in-person care and remote monitoring for patients with pacemakers, implantable cardioverter-defibrillators, and loop monitors. Remote monitoring enables the electrophysiology team to monitor a patient’s condition by reviewing data transmitted by an implantable device—allowing them to identify and treat problems earlier and reduce the risk of hospitalization and serious complications.

According to Jason Lemire, FACHE, administrative director of the Heart and Vascular Center at Dartmouth Health, the expansion of services in southern New Hampshire enhances convenience and consistency of care.



Ambulatory Surgery Center (ASC), Manchester, NH

“Our cardiac surgeons, electrophysiologists and vascular surgeons have in-person clinics in Manchester, so when a patient travels to Lebanon for a procedure, they can receive care from the same provider within the Dartmouth Health network.”

– Jason Lemire, FACHE, administrative director, Heart and Vascular Center





Henry Tannous, MD (Left), and Nikolaos Zacharias, MD (Right)

Heart and Vascular Center BY THE NUMBERS

// Overall Volume (2025):

 35,500
Clinical patients

 1,100
Electrophysiology and pacemaker procedures

 2,150
Operative procedures

 \$2,621,130
Total funding awarded

 3,600
Cardiac catheterization procedures

 48
Clinical trials open for enrollment and follow up

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Heart and Vascular Center Locations

To refer a patient, call
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