BRIGHAM HEALTH

BWH

BRIGHAM AND WOMEN'S
Division of Cardiac Surgery

2017 Update

Brigham and Women's Hospital
Division of Cardiac Surgery – 24/7 Access Information

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CARDIAC SURGERY AT BRIGHAM AND WOMEN'S HOSPITAL:

A historic past, a vibrant present, and an innovative future – a letter from the Chief

I would like to introduce you to the newest members of our team who bring depth and breadth of experience along with specialized skills. You will also learn more about our allied services, innovative programs and active research.

My senior partners, **Sary F. Aranki, MD, and James D. Rawn, MD, and I** have welcomed four new surgeons:

- **Tsuyoshi Kaneko, MD,** joined us in 2015. He leads our Aortic Program in collaboration with Cardiology and Vascular Surgery. He is an established TAVR surgeon, the Associate Residency Program Director, and the head of our Clinical Outcomes Research Program.
- **Hari R. Mallidi, MD,** joined us in 2015 as a senior mechanical circulatory support and transplant surgeon. He is the Executive Director of the ECMO Program and Surgical Director of the Right Heart Rescue and Pulmonary Thromboendarterectomy Program.
- **Marc P. Pelletier, MD,** joined us in 2016. He is the Surgical Director of the TAVR Program and specializes in transcatheter valve therapy, minimally invasive surgery, and research. Dr. Pelletier is currently the Chair of the Royal College of Surgeons of Canada's examination board in cardiac surgery.
- **Steve K. Singh, MD,** joined us in 2016 as the Surgical Director of the Mechanical Circulatory Support and Heart Transplant Program. Dr. Singh and Dr. Mallidi lead a comprehensive surgical program for state-of-the-art treatment for advanced cardiopulmonary disease.

"The BWH Division of Cardiac Surgery is poised to lead the way in shaping the future of heart surgery by developing exciting new surgical methods, participating in innovative clinical trials, and training the next generation of surgeons through our comprehensive fellowship programs."

The Division of Cardiac Surgery at Brigham and Women's Hospital (BWH) has a rich history dating back to 1923 when the world's first heart valve operation was performed by Elliot C. Cutler, MD. Since then, surgical giants, including Dwight E. Harken, MD, John J. Collins, Jr., MD, and Lawrence H. Cohn, MD, from BWH have dominated our field and launched the careers of many cardiac surgeons now practicing at major medical centers worldwide, including several division chiefs and department chairs. Dr. Aranki and I have had the distinct privilege and honor of being trained by Dr. Cohn, whose legacy of innovative and compassionate care transformed the field of cardiac surgery.

I would also like to share with you the allied services and divisions that make up our cohesive multidisciplinary team which is instrumental to our remarkable success. From screening through surgery and post-operative care, our multispecialty team continuously works together to provide the best care for our patients.

Recently, we led the MOMENTUM 3 trial that investigated the groundbreaking HeartMate 3™ left ventricular assist device, with Mandeep R. Mehra, MD, Executive Director of the Center for Advanced Heart Disease and Medical Director of the Heart & Vascular Center at BWH, serving as the national co-principal investigator and Chair of the Publications Committee for this study. In addition, we have participated in the PARTNER trials that have investigated transcatheter aortic valve therapies.

Our Division is strongly supported by **Calum A. MacRae, MD, PhD**, Chief of Cardiovascular Medicine at BWH, and his extraordinary team of renowned clinical and research cardiologists. I am grateful for the support from our senior hospital administration, particularly President **Elizabeth G. Nabel, MD**, Executive Vice President and Chief Operating Officer **Ron M. Walls, MD**, and Chair of Surgery **Gerard M. Doherty, MD**.

I welcome you to read further and learn more about our team and clinical and research platforms. Please do not hesitate to contact me at **pshekar@bwh.harvard.edu** or **(617) 732-7678**.

Prem S. Shekar, MD
Chief, Division of Cardiac Surgery,
Surgical Director, Heart & Vascular Center,
Brigham and Women's Hospital

OUR RICH HISTORY

Elliot C. Cutler, MD

Dwight E. Harken, MD

John J. Collins, Jr., MD

Lawrence H. Cohn, MD

For nearly a century, Brigham and Women's Hospital (BWH) has been at the epicenter for innovation and discovery in cardiovascular care and research. The surgical milestones include:

1923 Elliot C. Cutler, MD, performed the world's first successful heart valve operation. He was the second surgeon-in-chief of the Peter Bent Brigham Hospital (PBBH), a predecessor of BWH;

1948 Dwight E. Harken, MD, performed the first series of successful operations at PBBH for the repair of stenotic mitral heart valves;

1960 Dwight E. Harken, MD, completed the first valve replacement at PBBH with an artificial ball and cage prosthesis;

1964 Dwight E. Harken, MD, reported among the world's largest series of closed mitral commissurotomies with 1,571 procedures;

1972 Nina S. Braunwald, MD, joins the faculty and becomes among the first women certified by the American Board of Cardiothoracic Surgery;

1984 John J. Collins, Jr., MD, and Lawrence H. Cohn, MD, perform the first heart transplant in New England;

1992 Sary F. Aranki, MD, performs the first heart-lung transplant in New England;

1995 Surgeons at BWH perform three organ transplants from a single donor, the first time in New England;

1996 Lawrence H. Cohn, MD, performs the first minimally invasive valve operation in New England;

1999 Surgeons at BWH implant the first left ventricular assist device (LVAD) in New England;

2005 Surgeons perform the 500th heart transplant at BWH;

2007 BWH recognizes the accomplishment of 20,000 CABG procedures performed between 1972 and 2007;

2012 A team at BWH implants the first total artificial heart in New England.

OUR FACULTY

Prem S. Shekar, MD

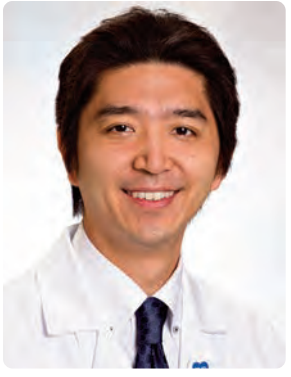
PREM S. SHEKAR, MD

Dr. Prem S. Shekar was appointed Chief of the Division of Cardiac Surgery and Surgical Director of the Brigham and Women's Heart and Vascular Center in 2015. An Assistant Professor of Surgery at Harvard Medical School, Dr. Shekar received his medical degree from Bangalore University, India, and completed his postgraduate training at the Command Hospital – Indian Air Force and Jawaharlal Institute of Post-graduate Medical Education and Research, India. Dr. Shekar completed cardiothoracic fellowships at the Fremantle and Royal Adelaide Hospitals in Australia and Brigham and Women's Hospital. He is also the Fellow of the Royal College of Surgeons of Edinburgh. Dr. Shekar's clinical practice encompasses the entire spectrum of adult cardiac surgery, including coronary artery bypass grafting, repair or replacement for valvular heart disease, and resection and replacement of aortic aneurysms. Dr. Shekar's specific clinical interests include minimally invasive valve surgery, surgery for hypertrophic cardiomyopathy, surgery for aortic root and mitral valve disease in Marfan's, Loeys-Dietz and other connective tissue disorders, surgery for adult congenital heart disease and radiation-induced heart disease. Dr. Shekar was the principal investigator in the CIMIT-funded Hybrid Cardiovascular Operating Room Project and the site principal investigator for the HeartMate II™ Pivotal trial, which studied the ventricular assist device as destination therapy for patients with advanced heart disease who are not candidates for transplantation. He participates in clinical outcomes research and has authored over 65 peer-reviewed publications. Since becoming a BWH faculty member in 2004, Dr. Shekar has held several leadership roles, including Interim Surgical Director of the Integrated Cardiovascular Services Program and Surgical Director of the BWH Patient Progression Initiative.

Sary F. Aranki, MD

SARY F. ARANKI, MD

Dr. Sary F. Aranki is the Associate Chief of the Division of Cardiac Surgery and an Associate Professor of Surgery at Harvard Medical School. He received his medical degree from the University of Baghdad College of Medicine. Dr. Aranki completed several training programs in the United Kingdom, including an emergency medicine residency at Guy's Hospital, general surgery residencies at Stoke Mandeville and Amersham Hospitals, and a cardiothoracic surgery residency and fellowship at Harefield Hospital. He then completed a cardiothoracic surgery fellowship at BWH. He specializes in adult cardiac surgery with special emphasis on complex procedures spanning the entire spectrum of adult cardiac surgery. This encompasses complex reoperative surgery, including aortic root, ascending aorta, and aortic arch surgery. He is a renowned expert on advanced coronary artery bypass procedures, such as coronary endarterectomy and transmyocardial laser revascularization, and innovative treatment for patients with severely diseased and unclampable ascending aortas. Dr. Aranki has authored over 150 peer-reviewed publications and numerous book chapters and co-edited a book on postoperative critical care for adult cardiac surgery patients. Dr. Aranki is on the editorial boards of numerous prestigious journals and is a reviewer for numerous others.



Tsuyoshi Kaneko, MD

TSUYOSHI KANEKO, MD

Dr. Tsuyoshi Kaneko is Director of Aortic Surgery, Associate Director of Endovascular Surgery, Director of Clinical Outcomes Research, Associate Program Director of the ACGME Residency Program, and an Assistant Professor of Surgery at Harvard Medical School. He received his medical degree from Keio University School of Medicine in Tokyo. He completed residency programs at Keio University and The University of Texas Health Science Center at Houston. Dr. Kaneko completed his ACGME cardiothoracic residency at BWH followed by a surgical transcatheter valve fellowship. He was the first surgical fellow in transcatheter valve therapies at BWH. He subsequently completed an aortic and endovascular surgery fellowship at Duke University. Dr. Kaneko specializes in endovascular approaches in cardiac surgery, including transcatheter aortic valve replacements and thoracic endovascular aortic aneurysm repairs for thoracic aortic aneurysms. In addition, he specializes in open aortic surgery and minimally invasive valve surgeries utilizing smaller incisions. His research focuses on the clinical outcomes of aortic and valvular disease.

Hari R. Mallidi, MD

HARI R. MALLIDI, MD

Dr. Hari R. Mallidi is the Executive Director of the ECMO Program, the Surgical Director of the Right Heart Rescue and Pulmonary Thromboendarterectomy Program, a senior surgeon in the Center for Advanced Heart Disease, and Associate Professor of Surgery at Harvard Medical School. Dr. Mallidi graduated with honors from the University of Toronto in 1997. He completed his cardiac surgical residency in Toronto and was certified by the Royal College of Physicians and Surgeons of Canada in 2005. After completing a Cardiothoracic Transplant and Mechanical Circulatory Support Device Fellowship at Stanford University, he remained on faculty and led the Stanford program in ventricular assist devices until 2012. From 2012-15, Dr. Mallidi was at the Baylor College of Medicine and Texas Heart Institute in Houston as the Lester and Sue Smith Chair in Surgery and led the Heart, Lung, Heart-Lung Transplantation services and Cardiac Support and Advanced Heart Disease Centers between the two institutions. In 2015, Dr. Mallidi joined BWH. His primary interests include lung, heart and heart-lung transplantation, mechanical circulatory support (VAD and ECMO), surgery for hypertrophic cardiomyopathy, pulmonary thromboendarterectomy for chronic thromboembolic pulmonary hypertension, valvular heart disease and complex cardiac surgery. Dr. Mallidi's research interests are primarily focused on evaluating the outcomes of surgical procedures and the clinical effectiveness of surgical interventions within cardiothoracic transplantation and mechanical circulatory support.

Brigham and Women's Cardiac Surgery Affiliation with Cape Cod Healthcare

Cardiothoracic Surgery Chief Paul Pirundini, MD, and cardiothoracic surgeon Dan Loberman, MD, lead a comprehensive cardiac program at Cape Cod Healthcare in affiliation with Brigham and Women's Hospital. This program for patients that live and work on Cape Cod, Massachusetts, provides expert, patient-centered care using the advanced technologies and innovative treatments you would expect from an academic medical center in a community setting. The team includes highly-trained and expert cardiovascular intensive care nurses who work cohesively and collaboratively with physicians, patients and their families to provide the best care.

Marc P. Pelletier, MD

MARC P. PELLETIER, MD

Dr. Marc P. Pelletier is the Surgical Director of the TAVR Program. A well-known cardiac surgeon who trained at McGill University, Dr. Pelletier graduated from Dalhousie University and completed both his general surgery and cardiac surgery training at McGill University and fellowship training in cardiothoracic surgery at Stanford University, specifically in cardiothoracic transplantation and ventricular assist devices. Dr. Pelletier joined BWH after nine years as head of cardiac surgery at the New Brunswick Heart Centre, which followed a period as an Assistant Professor at Stanford University. Dr. Pelletier's areas of specialty include TAVR procedures, minimally invasive valve surgery, aortic valve and aortic root surgery, surgery for heart failure and minimally invasive coronary bypass surgery. He has authored over 55 peer-reviewed publications, with over 100 abstracts accepted at scientific meetings and over 100 invited and local talks. He is currently chair of the Royal College of Physicians and Surgeons of Canada's examination board in cardiac surgery. He has been the principal investigator of several basic science grants, as well as clinical trials.

James D. Rawn, MD

JAMES D. RAWN, MD

Dr. James D. Rawn is a critical care specialist at Brigham and Women's Hospital and an Instructor in Surgery at Harvard Medical School. Dr. Rawn received his medical degree from Stanford University School of Medicine. He completed training programs in General Surgery and Thoracic Surgery at BWH. He also completed a cardiothoracic surgery fellowship at the West Roxbury Veterans Administration Hospital. He specializes in critical care following cardiac surgery. Dr. Rawn's clinical and research interests are primarily focused on cardiac surgery outcomes.

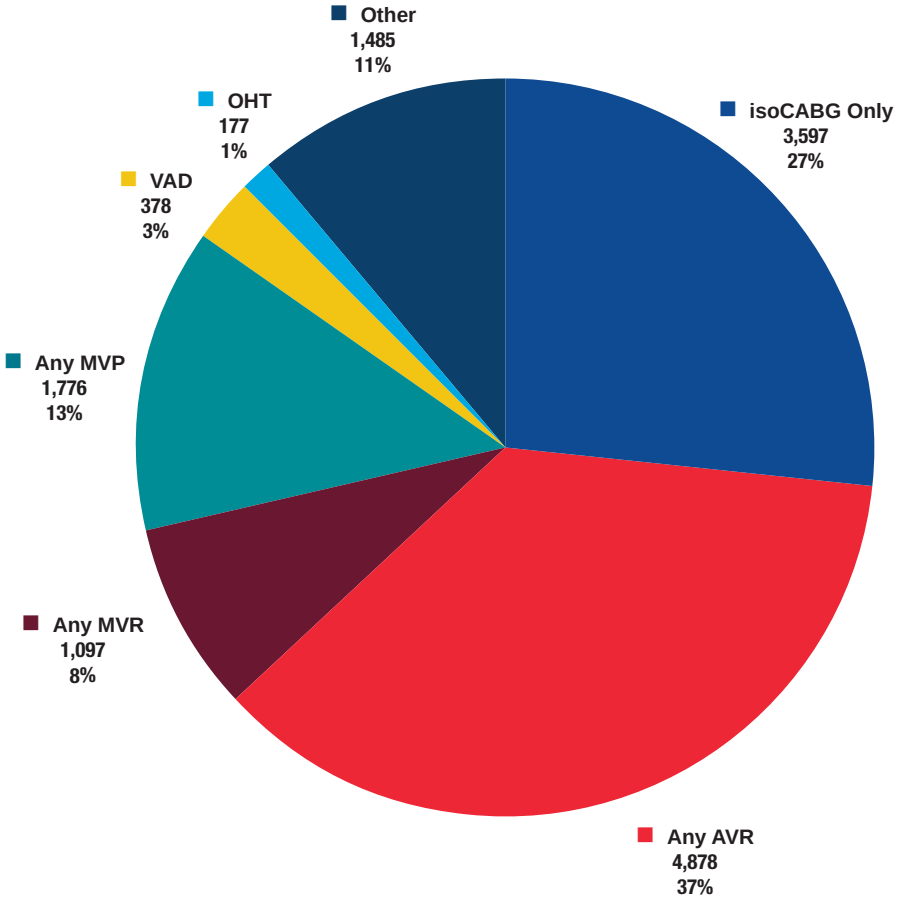
Steve K. Singh, MD

STEVE K. SINGH, MD

Dr. Steve K. Singh is the Surgical Director for Heart Transplantation and Mechanical Circulatory Support. He completed his undergraduate medical school training and cardiac surgery residency training at the University of Toronto. Dr. Singh began his professional career as an Assistant Professor of Surgery in the Division of Cardiac Surgery at McMaster University, Canada, where he was also Residency Program Director (2011-2013). Dr. Singh joined BWH from Baylor College of Medicine in Houston, where he served as Assistant Professor of Surgery, Surgical Director of Lung and Heart-Lung Transplantation, and the Interim Chief of the Division of Cardiothoracic Transplantation and Assist Devices. His clinical and academic interests are end-stage heart failure, mechanical circulatory support (VAD, ECMO), heart, lung and heart-lung transplantation, and adult cardiac surgery, including coronary surgery (on and off pump beating heart surgery), valvular repair and replacement, ascending aorta surgery, adult congenital heart disease, surgery for arrhythmias and reoperations. He has written over 45 peer-reviewed publications and book chapters and presented at numerous national and international meetings. He holds multiple peer-reviewed grants as a principal investigator.

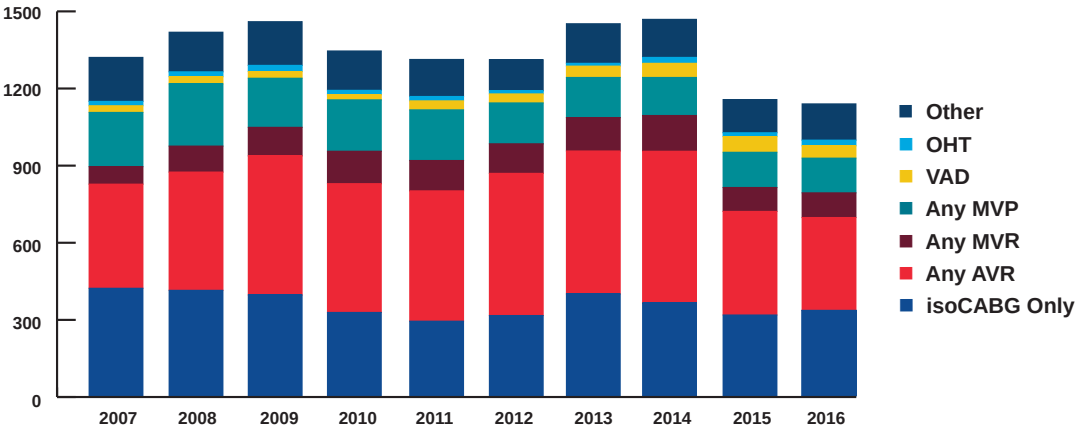
DIVISION OF CARDIAC SURGERY VOLUME DATA

PROCEDURES PERFORMED 2007-2016

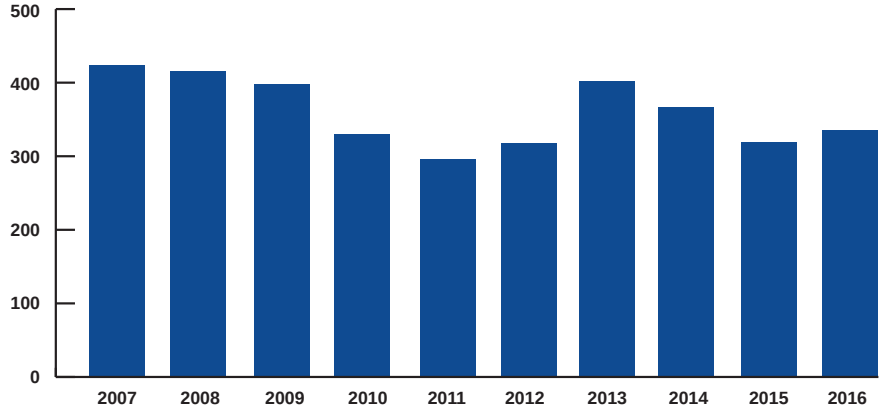


Source: The Society of Thoracic Surgeons, 2007-2016

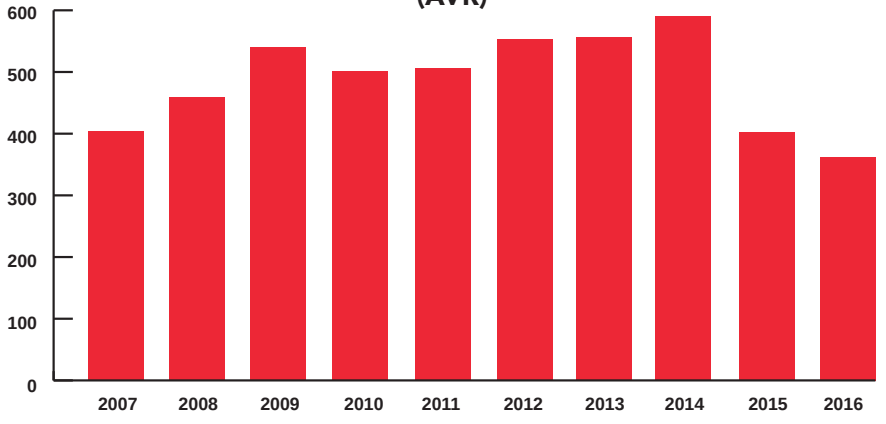
All Procedures



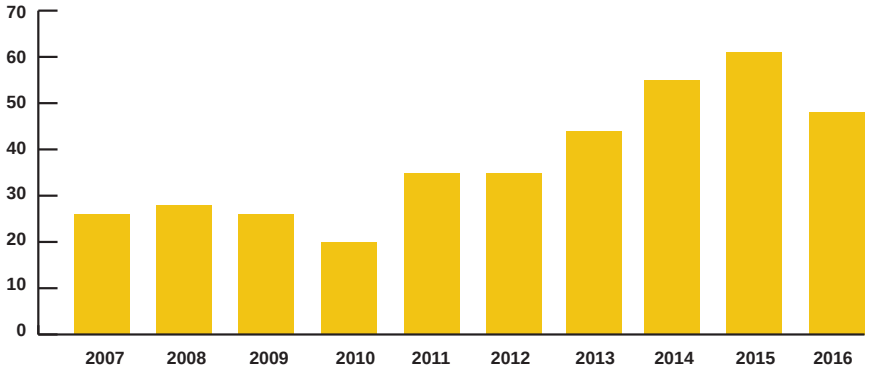
Isolated Coronary Artery Bypass Graft (IsoCABG)



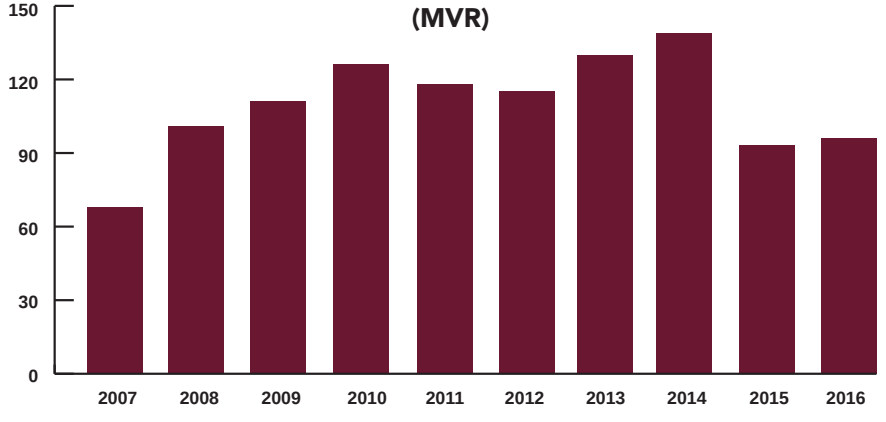
Any Aortic Valve Replacement (AVR)



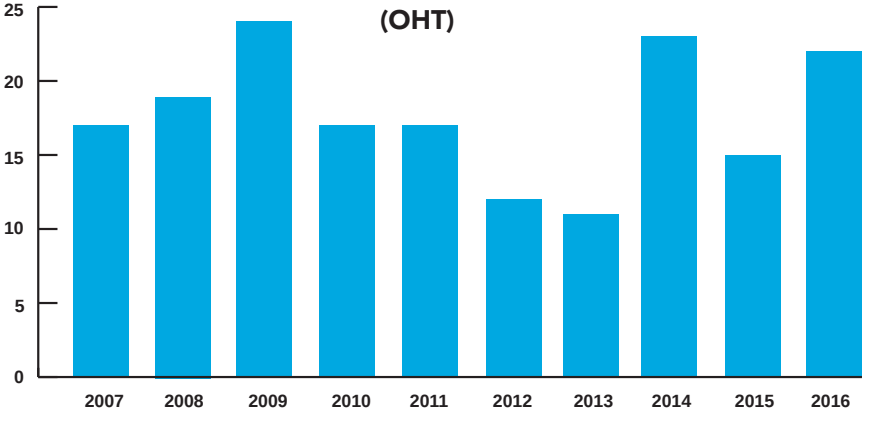
Ventricular Assist Device (VAD)



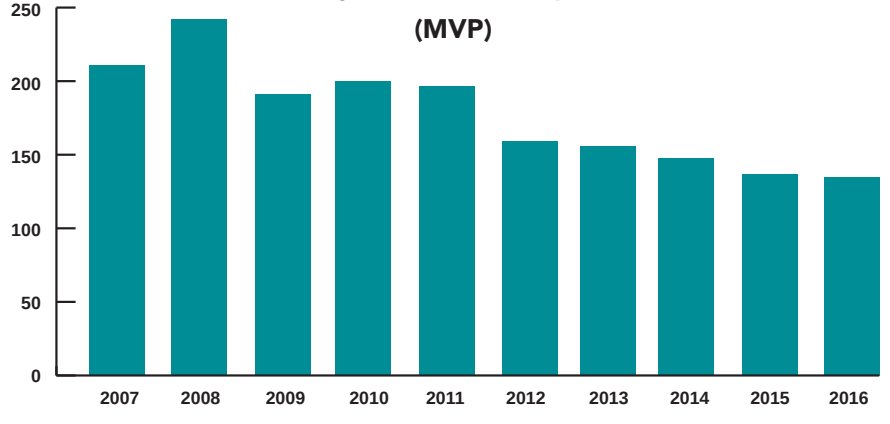
Any Mitral Valve Replacement (MVR)



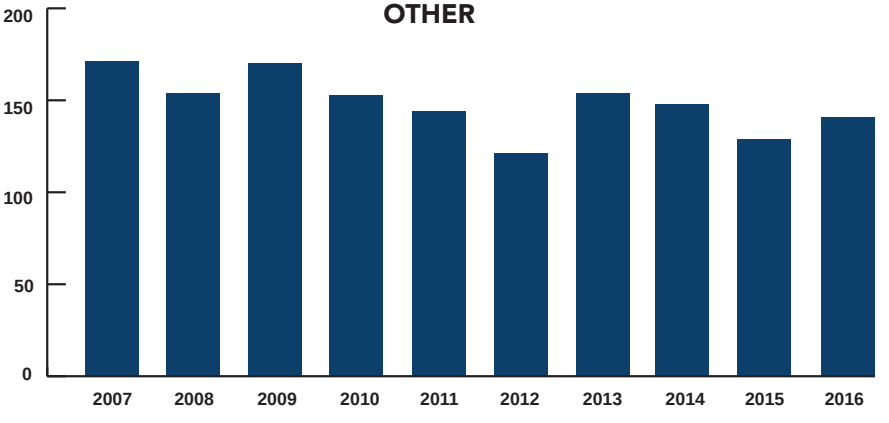
Orthotopic Heart Transplant (OHT)



Any Mitral Valve Repair (MVP)



OTHER



OUR EXPERTISE

Adult Congenital Heart Disease

The Boston Adult Congenital Heart and Pulmonary Hypertension Program was developed by experts at Brigham and Women's Hospital (BWH) and Boston Children's Hospital, one of the top pediatric hospitals in the world.

"When these children with treated congenital heart disease become adults, they still need specialized care. Because of our close proximity to Boston Children's Hospital, care for these young adults transitions to BWH through this program. The majority of these cases are complex, requiring a multidisciplinary team of cardiologists, adult and pediatric surgeons, imaging specialists and allied health professionals, to successfully manage treatment," says Dr. Steve K. Singh, Surgical Director for Heart Transplantation and Mechanical Circulatory Support who also specializes in adult congenital heart disease. In addition to CT and MRI, the team is also using advanced imaging technologies, such as 3-D printing, to visualize anomalies when in the heart.

"The average life expectancy for a transplant patient is roughly 10 years. Almost 20 percent of our patients transplanted before 1997 have survived at least 20 years post transplant."

— Steve K. Singh, MD

Several research programs underway at BWH are designed to elucidate the genetics of cardiac conditions such as hereditary cardiomyopathy and aortic syndromes. Michael J. Landzberg, MD, Director of the Boston Adult Congenital Heart and Pulmonary Hypertension Program adds, "Expansion of biobanking, individualized patient physiologic study, and novel patient engagement strategies will allow us to identify early and later life determinants of health and function over the course of the life of a patient with congenital heart disease."

Lawrence H. Cohn, MD, and John J. Collins, Jr., MD, perform the first heart transplant in New England

Advanced Heart Disease: Heart Transplantation and Assist Devices

The Brigham and Women's Hospital (BWH) Heart Transplant and Mechanical Circulatory Support (VAD and ECMO) Program has performed more heart transplants than any other center in New England. Since performing the first heart transplant in New England in 1984, it remains the oldest and largest program in New England, celebrating its 700th heart transplant in 2016.

Heart transplant outcomes at BWH consistently exceed regional and national averages. Compared to centers across the United States, BWH has a lower 30-day mortality rate and 30-day readmission rate for heart transplants, according to The Society of Thoracic Surgeons.

We have also been at the forefront of clinical and research investigations of novel temporary and durable

mechanical and circulatory assist systems, including the HeartWare®, Centrimag®, TandemHeart®, Impella®, Syncardia®, and HeartMate I™, II™ and 3™ ventricular assist devices.

To monitor for rejection and predict adverse events among heart transplant patients, BWH experts are using cardiac positron emission tomography (PET) imaging for quantification of myocardial blood flow and assessment of left ventricular ejection fraction (LVEF). In a recent study by BWH researchers, this technique was found to improve detection and gradation of cardiac allograft vasculopathy (CAV) when compared with invasive coronary angiography (*Circ Cardiovasc Imaging*. 2014;7:857-859).

Heart and lung transplant surgeons at BWH recently collaborated with infectious disease specialists to launch a study aimed at increasing the availability of donor organs by using hearts from Hepatitis C virus (HCV) donors. It is estimated that using organs from donors cured of HCV could increase organ availability by 20 percent or more.

At the International Society for Heart and Lung Transplantation in 2016, Dr. Mandeep R. Mehra, Executive Director of the Center for Advanced Heart Disease, presented results of the first primary endpoint from the MOMENTUM 3 clinical trial, the largest and fastest enrolling LVAD trial to date. In this six-month analysis, the HeartMate 3 magnetically levitated pump had encouraging results compared to the HeartMate II axial flow pump. Dr. Mehra is the national co-principal investigator of the MOMENTUM 3 trial.

Aortic Disease

While traditional open-heart aortic surgeries are performed routinely within the Division of Cardiac Surgery, our surgeons consider all available surgical options in the treatment of aortic diseases, including minimally invasive and percutaneous techniques.

Dr. Tsuyoshi Kaneko, Surgical Director of the Aortic Program, along with colleagues in Vascular Cardiology and Vascular Surgery, have created a collaborative Center for Aortic Disease, where comprehensive longitudinal care is the central theme.

Dr. Kaneko employs a hybrid approach in the treatment of aortic diseases. He utilizes a combination of open heart aortic surgery along with minimally invasive and percutaneous techniques. By increasingly using minimally invasive techniques in aortic procedures, he reduces the need for blood transfusions and reoperations for bleeding.

All comprehensive cardiovascular programs, organized within our Heart & Vascular Center, are within the walls of our state-of-the-art Carl J. and Ruth Shapiro Cardiovascular Center building. This enables patients with aortic disease to be scheduled for multiple same-day outpatient visits. Through this multispecialty, coordinated-care approach, patients spend a single day meeting with various aortic specialists, such as cardiac surgeons, vascular surgeons, cardiologists, and interventional radiologists, among others.

"We are one of few programs in the country to provide this type of service for patients with aortic disease. The patient benefits from the expertise of several specialists rather than the traditional approach of being evaluated and treated by one surgeon."

— Tsuyoshi Kaneko, MD

The Code Aorta Rapid Response team at BWH provides expeditious care to patients arriving at the hospital with an acute aortic syndrome, such as an aortic dissection or imminent rupture. Activation of the code automatically alerts the cardiac surgeons, vascular surgeons, cardiologists, imaging services, and the operating rooms, allowing for immediate evaluation, imaging, and treatment.

The Shapiro Cardiovascular Center also is home to one of the first hybrid ORs used for aortic surgeries.

Complex Cardiac Surgery

The Division of Cardiac Surgery at Brigham and Women's Hospital has been a leading referral center for complex cardiac cases for more than 30 years. With advanced training in complex surgeries, our cardiac surgeons routinely perform complex mitral valve repairs, aortic surgery including aortic root, arch and dissections, reoperations and operations on patients with infected valves. Our surgeons specialize in performing combination procedures in patients with multiple co-morbidities. BWH offers a unique platform for the management of difficult-to-treat patients, with world-renowned experts in other specialties available to provide consultative care.

- **Advanced Coronary Disease:** Dr. Sary F. Aranki, has specialized experience in performing coronary endarterectomies and transmyocardial laser revascularization for advanced forms of coronary artery disease. He has published widely on these techniques and other complex cases, such as severely diseased atherosclerotic "unclampable" ascending aortas.

- **Pregnancy and Cardiovascular Disease:** Surgeons at BWH, in collaboration with cardiologists and high-risk obstetric specialists, routinely care for patients with heart disease during pregnancy. "One of our cases involved a young woman who had a failing biological valve and an aortic aneurysm during her third trimester. The structural heart cardiologists, cardiac surgeons and obstetricians came up with a comprehensive plan for this patient. We delivered the baby in the hybrid OR with cardiologists standing by for an emergent TAVR, if necessary. The delivery was uneventful, however the mother developed heart failure in the days following the delivery. We performed a successful reoperative valve and aortic replacement. Both the mother and baby are doing well. It is this kind of team work by experienced specialists that makes BWH such a rewarding place to work," says Dr. Prem S. Shekar, Chief of the Division of Cardiac Surgery.

- **Radiation Heart Disease and Cardio-Oncology:** Through Dana-Farber/Brigham and Women's Cancer Center – our collaborative center with Dana-Farber Cancer Institute – cardiologists led by Anju Nohria, MD, specialize in radiation-induced heart disease. Our surgeons provide expert care to these patients when appropriate, collaborating with a multidisciplinary team of specialists.

"Many of these cases are technically demanding and require the support of multiple specialties to achieve good outcomes. We are well positioned to address these challenging cases."

— Marc P. Pelletier, MD

Minimally Invasive Valve Surgery

Surgeons in the Division of Cardiac Surgery have been performing minimally invasive aortic, mitral, and tricuspid valve surgeries since Dr. Lawrence H. Cohn performed the first procedure at BWH in 1996.

"We owe an enormous debt of gratitude to the late Dr. Cohn for his vision and pioneering work in minimally invasive valve surgery that is now becoming commonplace," says Dr. Prem S. Shekar, Chief of Cardiac Surgery.

Few cardiac centers offer a comprehensive minimally invasive mitral and aortic valve practice. We offer the minimally invasive upper hemisternotomy approach to aortic valve surgery and minimally invasive lower hemisternotomy and right thoracotomy approaches to mitral and tricuspid valve surgery. Surgeons at BWH have performed more than 2,600 minimally invasive valve surgeries to date and have published papers outlining the advantages of such minimally invasive techniques. BWH cardiac surgeons were among the first to use minimally invasive approaches for geriatric patients, providing lower risk than traditional open procedures.

"Using less invasive methods enables us to repair the mitral valve in patients traditionally considered too high risk for open valve repair surgery. I think repairing or replacing the mitral valve with minimally invasive surgery will become the gold standard in the next five to 10 years," says Dr. Pelletier, who also performs minimally invasive procedures.

Surgery for Genetically Acquired Heart Disease – Hypertrophic Cardiomyopathy and Marfan Syndrome

The Cardiovascular Genetics Program has made advances in understanding the genetic basis of inherited cardiovascular disorders. The Program's team of cardiologists and researchers are world renowned for their work in genetically triggered cardiovascular diseases, most notably hypertrophic cardiomyopathy (HCM) and connective tissue disorders.

"Much of the research on the genetic basis of HCM has been done by Dr. Christine Seidman, the Director of the Cardiovascular Genetics Center, and her colleagues Dr. Calum A. MacRae, Dr. Carolyn Y. Ho, Dr. Neil K. Lakdawala, Dr. Matthew P. Coggins, and Dr. Jason G. Homsy. They are applying their research knowledge to the clinical setting, enhancing the care of patients and their families," says Dr. Prem S. Shekar, Chief of Cardiac Surgery and Surgical Director of the Heart & Vascular Center at Brigham and Women's Hospital.

"For patients requiring surgery, our results with septal myectomies for HCM have been excellent," says Dr. Shekar, who specializes in the procedure. Interventional cardiologists in the Cardiac Catheterization Laboratory perform alcohol septal ablations, if surgical therapies are not an option due to high risk.

All the cardiologists within the Cardiovascular Genetics Program and the Boston Adult Congenital Heart and Pulmonary Hypertension Program – in particular Dr. Michael N. Singh – specialize in the evaluation, diagnosis, and management of patients with connective tissue diseases, particularly Marfan's, Ehlers-Danlos, and Loeys-Dietz syndrome.

"We perform surgery for the entire spectrum of aortic aneurysms associated with connective tissue disorders. We have extensive experience performing conventional aortic replacements as well as aortic valve sparing root replacement (David Procedure) for patients with aortic root aneurysmal disease due to these conditions," says Dr. Shekar.

Transcatheter Valve Therapies

As one of the early clinical trial sites, cardiologists and cardiac surgeons within the Heart & Vascular Center performed the first TAVR procedure in New England following FDA approval. We offer one of the largest programs in New England and have performed more than 700 cases, including 236 cases in 2016.

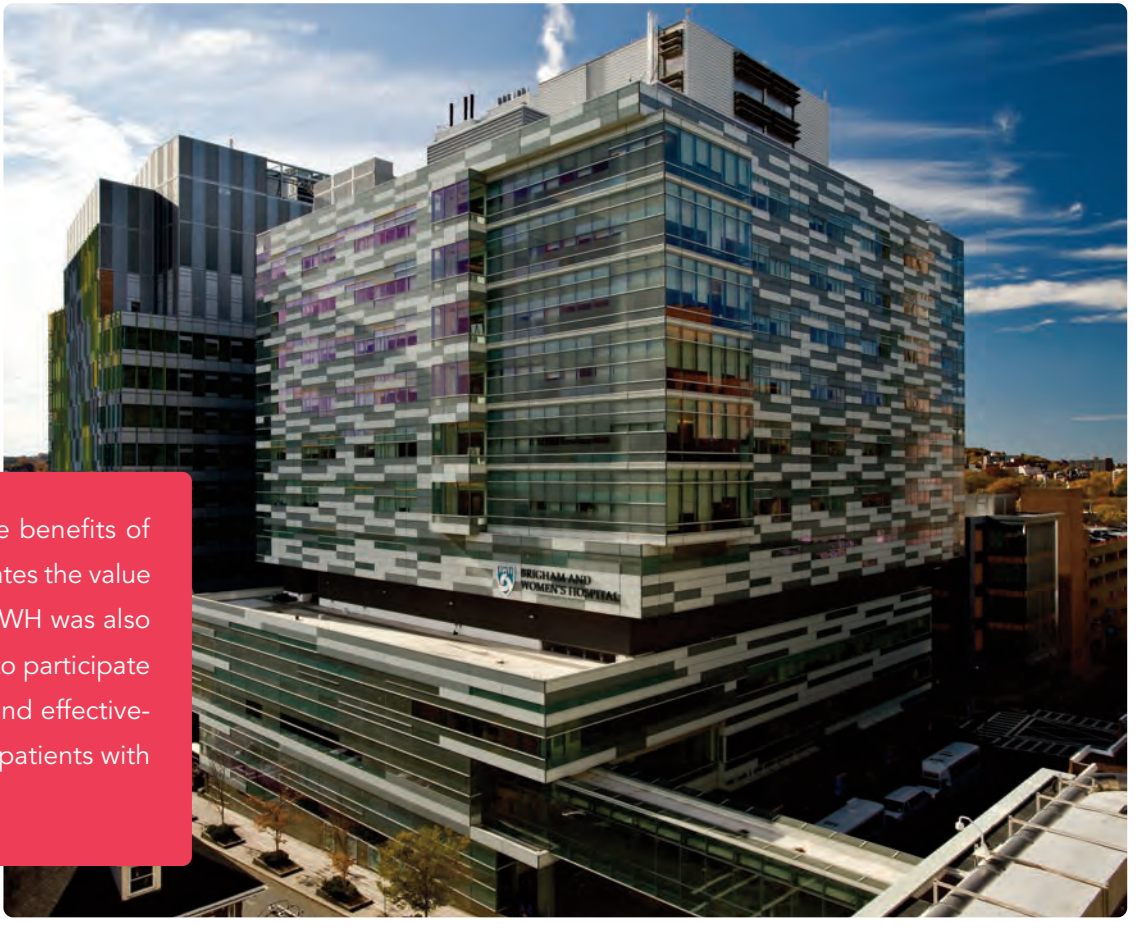
Unlike some cardiac centers which frequently provide only one valve option, our program offers several options, including the SAPIEN 3 Transcatheter Heart Valve (THV), and the Evolut™ R Transcatheter Aortic Valve. "By having several options, we can make sure each patient gets the valve that is right for them," says Dr. Pelletier, Surgical Director of the TAVR Program.

The structural heart team also utilizes the transcatheter technology to repair and replace the mitral valve, using a variety of innovative techniques. The team performs closures of atrial septal defect (ASD), patent foramen ovale (PFO) and paravalvular leaks.

"We routinely perform TAVR procedures without general anesthesia and have more recently performed alternate access trans-subclavian TAVRs without anesthesia using a complex local anesthetic block. This is particularly beneficial for frail patients who are at high risk for a general anesthetic. It also helps fast track recovery," says Dr. Tsuyoshi Kaneko, who is a proctor for alternate access TAVR procedures.

BWH was one of 24 hospitals nationwide to examine the benefits of TAVR as part of the PARTNER clinical trial, which demonstrates the value of TAVR for the treatment of severe aortic stenosis (AS). BWH was also recently selected as one of three centers in New England to participate in the latest PARTNER 3 trial, which evaluates the safety and effectiveness of the SAPIEN 3 transcatheter heart valve in low-risk patients with severe aortic stenosis.

Our Heart & Vascular Center is built upon the power of collaboration among more than 225 physician specialists in cardiovascular medicine, heart and vascular surgery, cardiovascular imaging, and cardiac and vascular anesthesia. Under the clinical leadership of Dr. Prem S. Shekar and Dr. Mandeep R. Mehra, our Heart & Vascular Center is home to life giving breakthroughs in heart and vascular care and research.



INTERDISCIPLINARY EXPERTISE ADVANCES CARDIAC SURGICAL CARE

Cardiac Anesthesia

Cardiac anesthesiologists at Brigham and Women's Hospital are world-renowned experts in anesthesia and care for complex surgical patients, in addition to being leaders in clinical and translational research and educational training.

Together with cardiac surgeons, interventional cardiologists, electrophysiologists, and other cardiovascular specialists, our cardiac anesthesia team plays an integral role in deploying new interventions and creating new and innovative patient care pathways. The Division of Cardiac Anesthesia pioneered the use of perioperative and interventional transesophageal echocardiography (TEE), showing the benefits of TEE in facilitating perioperative decision-making during cardiac surgery and guiding successful interventional cardiology procedures.

Our cardiac anesthesiologists are site investigators for multiple NIH and industry-sponsored trials. The team is currently leading studies that involve interventional valve procedures, focused cardiac ultrasound and large data TEE outcomes research. We are also leaders in perioperative genetics and outcomes research – exploring the genetic inputs into functional and structural heart disease with a concentration on the perioperative environment.

"The collaborative infrastructure between cardiac anesthesia and cardiac surgery results in an environment that provides optimal patient outcomes through the integration of new and innovative ideas and technology," says Dr. Douglas C. Shook, Division Chief of Cardiac Anesthesia.

Cardiac Surgery Physician Assistants

BWH Cardiac Surgery physician assistants have been instrumental in the implementation of minimally invasive endoscopic vein harvesting, radial artery harvesting, placement of intra aortic balloon pumps and peripheral cannulation. They are certified in the management of ventricular assist devices and extracorporeal membrane oxygenation (ECMO). We also have two physician assistants who work exclusively in the clinic setting, helping surgeons with preoperative and postoperative evaluations.

"We have a critical rapport and a synergistic relationship with the cardiac surgeons. We know their clinical preferences and management styles. These strong relationships help improve clinical outcomes and result in a seamless hospital experience," says Genina Salvio, PA-C, Chief Physician Assistant of Cardiac Surgery.

The PAs also play an integral role in the training programs for cardiac surgery residents, fellows and PA students.

The cardiac surgery team includes 16 certified physician assistants who routinely assist cardiac surgeons in all surgeries and provide postoperative care to patients in the ICU and step-down units.

Cardiac Surgery Intensive Care Specialists

The Division of Cardiac Surgery has robust intensive care and step-down units, led by a team of intensivists that provides family-centered care for post-operative patients as they transition from the OR to the ICU and then on to one of three step-down units before being discharged home or to an inpatient rehabilitation facility.

The ICU and step-down units are currently engaged in a fast-track initiative to accelerate the process by which patients transition from one level of care to another. These fast-track recovery pathways are being implemented for patients undergoing routine cardiac surgery, such as valve replacements or CABG, and also for special patient populations, such as those undergoing transaortic, trans-subclavian, and transapical TAVR.

"Our fast-track cardiac surgery recovery pathways are based on interdisciplinary teamwork and include physical therapy in the early recovery phase, so that we can discharge patients home or refer them to rehabilitation earlier, all while minimizing complications," says Dr. Martin Zammert, Director of the Cardiac Surgery Intensive Care Unit.

Cardiac Surgery Nursing

Different cardiac surgery nursing teams meet the patient at various points in their care to facilitate seamless care and a more rapid recovery.

OR Nursing

Our cardiac OR nursing team consists of professional, expert registered nurses and surgical technologists with a combined average of 18 years of cardiac experience.

The most recent procedures, including TAVR, present new challenges as they combine the services of cardiology, the Cardiac Catheterization Laboratory and specialists in interventional radiology. Respect for the various specialties involved, sharing of information, and working as a team are the keys to success.

"With the increased use of hybrid and other novel procedures, we have expanded our knowledge base," says Felicia Goodridge, RN, BSN, Assistant Nurse Director for Cardiac Surgery ORs. "It is the collaborative effort that allows each case to run smoothly and ultimately be a success."

ICU and Step-down Unit Nursing

With more than 200 highly trained nursing staff supported by patient care assistants, administrative staff and other members of the team, the Cardiac Surgery ICU and Step-down Unit staff have implemented many innovative technologies to facilitate better patient care. This includes non-invasive monitoring for patient comfort and earlier identification and intervention of potential complications.

Maria Bentain-Melanson, RN, BSN, MSN, CCRN, Nurse Director for the Cardiac Surgery ICU, Cardiac Surgery Intermediate Care Unit, and Mechanical Circulatory Support Unit, explains, "We employ a team-based decision making process related to the patient's care, including readiness to transition to step-down care, concerns about the patient's progress, and consultations with specialists in other disciplines to optimize the care of each patient."

Our nursing staff are supported by members of the care coordination services, pharmacy, physical therapy, occupational therapy and speech language pathology services. A four-member team of cardiovascular access nurses ensures that all patients needing emergent access to cardiovascular services are transferred expeditiously, and they continually work with the main admitting office and nurses-in-charge to ensure that beds are optimally utilized.

"Our nurses are empowered to propose changes to practice and conduct evidence-based research to drive improvements in patient care and care efficiency."

— MaryKate Hegarty, RN, BSN

Perfusion Services

Our 12-member experienced perfusion services team is a partner in care and innovation. The team recently developed a restricted transfusion protocol that limits the use of homologous blood products during cardiac surgeries, making operations safer and less complicated. In the blood gas and anticoagulation laboratory, the perfusionists monitor coagulation times, heparin levels, and anticoagulation parameters for patients. The lab allows the perfusionists to rapidly report lab results while patients are on heart-lung machines.

"We have fine-tuned our blood product transfusion practice, such that we transfuse about a tenth of blood products compared to other hospitals," says Michael Gilfeather, LP, CCP, Chief Perfusionist on the cardiac surgery team.

Additionally, the perfusion team is working with transplant cardiologists, cardiac surgeons, pathologists, and intensivists on research that will expand organ donation after cardiac death. Plans are underway to begin this ex vivo proof of concept study.

"If, through pre-clinical research, we can get donation after cardiac death (DCD) hearts to function well, it is plausible that we can adopt the same process in humans, which has been done in England and Australia and in a pediatric population in the United States. Once we validate the model, we hope to then transplant DCD hearts, which would make us the first center in the U.S. to do so in adult patients," says Gilfeather.

Cardiac Surgery Administration

The Division of Cardiac Surgery includes a dynamic 11-member administrative team, responsible for scheduling and preparing patients for heart surgeries, reporting and analyzing surgical outcome data, and coordinating post-operative care.

"Julie O'Malley, our Division Administrator, effectively leads the staff to provide the support and groundwork necessary for our surgeons to deliver the best care for our patients," says Dr. Prem S. Shekar, Chief of the Division of Cardiac Surgery and Surgical Director of the Heart & Vascular Center.

The Cardiac Surgery Database team, led by Linda Denning, reports surgical outcomes data to the Massachusetts State Department of Public Health and The Society of Thoracic Surgeons. "By collecting and analyzing the data, we can benchmark ourselves to ensure that we are continually improving," says Dr. Shekar.

"Patients want superior surgical care, but they also want the process before and after surgery to be thorough and effortless. Our administrative staff provides our patients with the information and reassuring care they deserve every step of the way," says Dr. Sary F. Aranki.

Physician assistants and nursing staff are available to patients, visiting nurses, and doctors when they call with medical questions related to a cardiac surgical procedure.

TRAINING THE NEXT GENERATION OF CARDIAC SURGERY INNOVATORS

Residency and Fellowship Programs

The Division of Cardiac Surgery, along with the Division of Thoracic Surgery and Boston Children's Hospital, offers three tracks to ACGME cardiothoracic residency. Our residency and fellowship programs are among the most sought after in the country. The first track is a two-year cardiac surgery residency that follows a five-year general surgical residency. The second track, known as the 4+3 program, is a three-year cardiac surgery residency that follows a four-year general surgery residency in an integrated fashion and allows for dual board certification. The third, and the latest, is the I6 program, a six-year track that allows students to enter cardiac surgery residency directly after medical school.

Additionally, the Division offers:

- TAVR Fellowship
- Transplant Fellowship
- Thoracic Surgery Fellowship
- Non-accredited advanced senior and junior fellowships.

The Division has attracted talented fellows worldwide who come to BWH for advanced training before returning to practice.

For more information, visit:
brighamandwomens.org/cardiothoracicsurgeryfellowship

"All of these programs expose physicians-in-training to surgical procedures, both routine and complex, including mitral valve, aortic, heart failure, TAVR, and heart transplant programs. By fostering interactions with cardiologists, vascular surgeons and others, we are preparing surgeons for the integrative and dynamic surgical room of the future."

— Tsuyoshi Kaneko, MD

Brigham and Women's Hospital Heart & Vascular Center

For more than a century, Brigham and Women's Hospital has been at the epicenter for innovation and discovery in cardiovascular care and research and today provides the most advanced care to patients from around the world.

Experts in our Heart & Vascular Center continue to set the pace and lead the way in shaping cardiovascular care. The way we deliver care to our patients within the Carl J. and Ruth Shapiro Cardiovascular Center – integrating all of our cardiovascular services in a truly collaborative environment – serves as a catalyst for groundbreaking research and for providing advanced heart and vascular patient care. BWH is consistently ranked among the top hospitals for Cardiology & Heart Surgery by *U.S. News & World Report*®.

Carl J. and Ruth Shapiro Cardiovascular Center

Reaching 10 stories high, the environmentally friendly Shapiro Center received LEED Silver certification from the U.S. Green Building Council. Featuring open spaces and extensive natural light, the 350,000 square foot building includes: 16 state-of-the-art operating suites; 2,500 square feet dedicated to patient and family education; the Watkins Cardiovascular Clinic for outpatient services; and 136 inpatient rooms, including 40 ICU rooms in the Samuel A. Levine Cardiac Intensive Care Unit.

In addition, the hybrid OR enables us to perform advanced hybrid therapies – combinations of catheter-based, conventional, and less invasive surgical procedures – and provide streamlined care for patients who need multiple procedures as part of their treatment.

The Shapiro Cardiovascular Center is also equipped with the latest, most advanced technology available for use in heart and vascular care, including a hybrid operating room and state-of-the-art noninvasive cardiovascular imaging, including:

- a computed tomography system that can take an image of the heart within one heartbeat;
- a hybrid 64-detector PET/CT scanner that combines imaging with data to enable physicians to better assess the degree of atherosclerosis in a patient, and;
- a 3 Tesla Magnetic Resonance Imaging (MRI) scanner, the world's premier cardiovascular MRI unit, which allows physicians to see finer details and a better view of arteries, abnormalities, and scarring.

Brigham and Women's Hospital
Division of Cardiac Surgery – 24/7 Access Information

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BRIGHAM HEALTH

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