

Sydell and Arnold Miller Family
Heart & Vascular Institute



Measuring Outcomes Promotes Quality Improvement





Measuring and understanding outcomes of medical treatments promotes quality improvement. Cleveland Clinic has created a series of Outcomes books similar to this one for its clinical institutes. Designed for a physician audience, the Outcomes books contain a summary of many of our surgical and medical treatments, with a focus on outcomes data and a review of new technologies and innovations.

The Outcomes books are not a comprehensive analysis of all treatments provided at Cleveland Clinic, and omission of a particular treatment does not necessarily mean we do not offer that treatment. When there are no recognized clinical outcome measures for a specific treatment, we may report process measures associated with improved outcomes. When process measures are unavailable, we may report volume measures; a relationship has been demonstrated between volume and improved outcomes for many treatments, particularly those involving surgical and procedural techniques.

In addition to these institute-based books of clinical outcomes, Cleveland Clinic supports transparent public reporting of healthcare quality data. The following reports are available to the public:

- Joint Commission Performance Measurement Initiative (qualitycheck.org)
- Centers for Medicare and Medicaid Services (CMS) Hospital Compare (medicare.gov/hospitalcompare), and Physician Compare (medicare.gov/PhysicianCompare)
- Cleveland Clinic Quality Performance Report (clevelandclinic.org/QPR)

Our commitment to transparent reporting of accurate, timely information about patient care reflects Cleveland Clinic's culture of continuous improvement and may help referring physicians make informed decisions.

We hope you find these data valuable, and we invite your feedback. Please send your comments and questions via email to:

OutcomesBooksFeedback@ccf.org.

To view all of our Outcomes books, please visit clevelandclinic.org/outcomes.



Dear Colleague:

Welcome to this 2016 Cleveland Clinic Outcomes book. Every year, we publish Outcomes books for 14 clinical institutes with multiple specialty services. These publications are unique in healthcare. Each one provides an overview of medical or surgical trends, innovations, and clinical data for a particular specialty over the past year. We are pleased to make this information available.

Cleveland Clinic uses data to manage outcomes across the full continuum of care. Our unique organizational structure contributes to our success. Patient services at Cleveland Clinic are delivered through institutes, and each institute is based on a single disease or organ system. Institutes combine medical and surgical services, along with research and education, under unified leadership. Institutes define quality benchmarks for their specialty services and report on longitudinal progress.

All Cleveland Clinic Outcomes books are available in print and online. Additional data are available through our online Quality Performance Reports (clevelandclinic.org/QPR). The site offers process measure, outcome measure, and patient experience data in advance of national and state public reporting sites.

Our practice of releasing annual Outcomes books has become increasingly relevant as healthcare transforms from a volume-based to a value-based system. We appreciate your interest and hope you find this information useful and informative.

Sincerely,

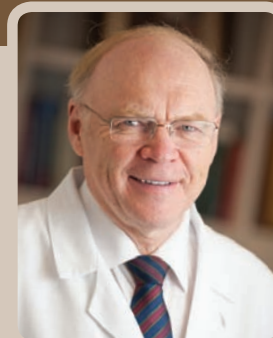
A handwritten signature in black ink, appearing to read 'DMC', with a stylized flourish at the end.

Delos M. Cosgrove, MD
CEO and President

what's inside

Chairman Letter_____	04	Heart Failure and Transplant	59
Introduction_____	05	Lung and Heart-Lung Transplant	62
Institute Overview_____	06	Peripheral Vascular Disease	64
Quality and Outcomes Measures		Cerebrovascular Disease	71
Surgical Overview	08	Thoracic Surgery	72
Ischemic Heart Disease		Preventive Cardiology and Rehabilitation	79
Interventional Treatment	13	Surgical Quality Improvement	86
Surgical Treatment	16	Patient Experience — Heart & Vascular Institute	90
AMI	21	Cleveland Clinic — Implementing	
Cardiac Rhythm Disorders	22	Value-Based Care	92
Valve Disease	32	Innovations_____	100
Aortic Disease	41	Contact Information_____	104
Hypertrophic Obstructive Cardiomyopathy	52	About Cleveland Clinic_____	106
Congenital Heart Disease	54	Resources_____	108
Pericardial Disease	57	Institute Resources_____	110

Chairman Letter



Dear Colleagues,

I am pleased to share this annual summary of outcomes from the Sydell and Arnold Miller Family Heart & Vascular Institute. This publication is a testament to Cleveland Clinic's commitment to tracking and reporting outcomes to help guide clinical decisions and continuously improve patient care.

Last year was a dynamic one for our institute. Noteworthy 2016 clinical and research accomplishments by our team included:

- Ranking among the 1.3% of US hospitals to earn a 3-star (highest) score in all 3 categories of the Society of Thoracic Surgeons' (STS) risk-adjusted quality ratings for adult cardiac surgery, as well as maintaining a 3-star STS ranking in lobectomy for lung cancer
- Leadership of several milestone studies published in premier journals, including the PRECISION, GLAGOV, and GAUSS-3 studies and major reports from the COMMENCE, PARTNER, and STAMPEDE trials
- Achievement of 0.3% procedural mortality across 374 transcatheter aortic valve replacement cases
- Implantation of a transcatheter tricuspid valved stent in a patient with severe tricuspid regurgitation, marking the world's first successful transcatheter tricuspid valve replacement
- Validation and publication of a novel sex-specific risk-scoring tool that improves mortality risk prediction in patients undergoing exercise treadmill testing
- Presentation of results from our first 1,000 robotically assisted mitral valve surgery cases, including a mortality rate of 0.1% (1/1,000) and a procedural success rate exceeding 99%
- Achievement of a 0% to 0.5% 30-day mortality outcome for isolated CABG, isolated AVR, isolated MV repair, and MV repair + CABG; this represents less than one-third the risk of death compared with other US hospitals
- Completion of our busiest year ever for procedures and patient volume

We are deeply grateful for the generosity of our many donors who allow us to continue our research mission to improve the care of our patients.

We continue to pursue our goals of innovating and dealing with changes; preserving practice, education and research; and achieving superb outcomes and safety for our patients.

We welcome your feedback, questions, and ideas for collaboration. Please contact me via email at OutcomesBooksFeedback@ccf.org and reference the Heart & Vascular book in your message.

Sincerely,

A handwritten signature in black ink, appearing to read 'L. Svensson'.

Lars G. Svensson, MD, PhD
Chairman, Miller Family Heart & Vascular Institute
Professor of Surgery, Cleveland Clinic Lerner College of Medicine

Introduction

Cleveland Clinic's Sydell and Arnold Miller Family Heart & Vascular Institute is home to many of the world's finest physicians practicing cardiovascular medicine and surgery. In 2017, Cleveland Clinic was named the No. 1 heart care program in America by *U.S. News & World Report* for the 23rd consecutive year.

More than 200 physicians and 1000 nurses work together in the institute to ensure that every patient receives the best outcome possible and an exceptional patient experience. Many individuals with cardiovascular diseases come to Cleveland Clinic after being told all treatment options have been exhausted and nothing more can be done for them.

The institute addresses a vast spectrum of conditions through its three broad departments — Cardiovascular Medicine, Thoracic and Cardiovascular Surgery, and Vascular Surgery. Patient needs are met through a structure of 12 umbrellas for various conditions under which 45 specialized centers are organized to foster collaborative, innovative approaches to care and advance research initiatives to improve patient outcomes.

By combining the core elements detailed above — a patient-centric, individualized approach to care, multidisciplinary collaboration, and unparalleled staff experience and expertise — the Miller Family Heart & Vascular Institute is able to achieve the extraordinary volumes and outcomes reported in the pages that follow.



Institute Overview

Heart & Vascular Institute Overview

2016

Patient visits	604,055
Admissions	13,525
Beds	421
Coronary intensive care	24
Heart failure intensive care	10
Cardiac, vascular, and thoracic surgery intensive care	76
Private patient rooms	283
Same-day recovery	28

Surgical Procedures

Cardiac Surgery

Cardiac surgeries	4284
Valve surgeries	3039
Coronary artery bypass grafting (isolated and combined)	1561
Aortic repairs	1228
Surgeries for septal myectomy	207
Congenital heart surgeries (adult and pediatric)	343
Robotically assisted cardiac surgeries	119

Transplant Surgery

Heart transplants	54
Lung transplants	110

Thoracic Surgery

General thoracic surgeries	1724
Esophageal surgeries	304

Vascular Surgery

Vascular surgeries (open and endovascular)	2796
Bypass surgeries	174
Arteriovenous access surgeries	421

The data reported in the Institute Overview reflect volumes at Cleveland Clinic's main campus only. Data in other areas of the book may reflect volumes for main campus and other Cleveland Clinic hospitals. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.



Aortic Surgery

Open ascending aorta and aortic arch repairs	709
Open descending aorta and thoracoabdominal repairs	34
Open abdominal aortic aneurysm repairs	102
Endovascular ascending aorta repairs	28
Endovascular descending aorta and thoracoabdominal repairs	265
Endovascular abdominal aortic aneurysm repairs	90

Cardiovascular Medicine Procedures

Interventional Cardiology

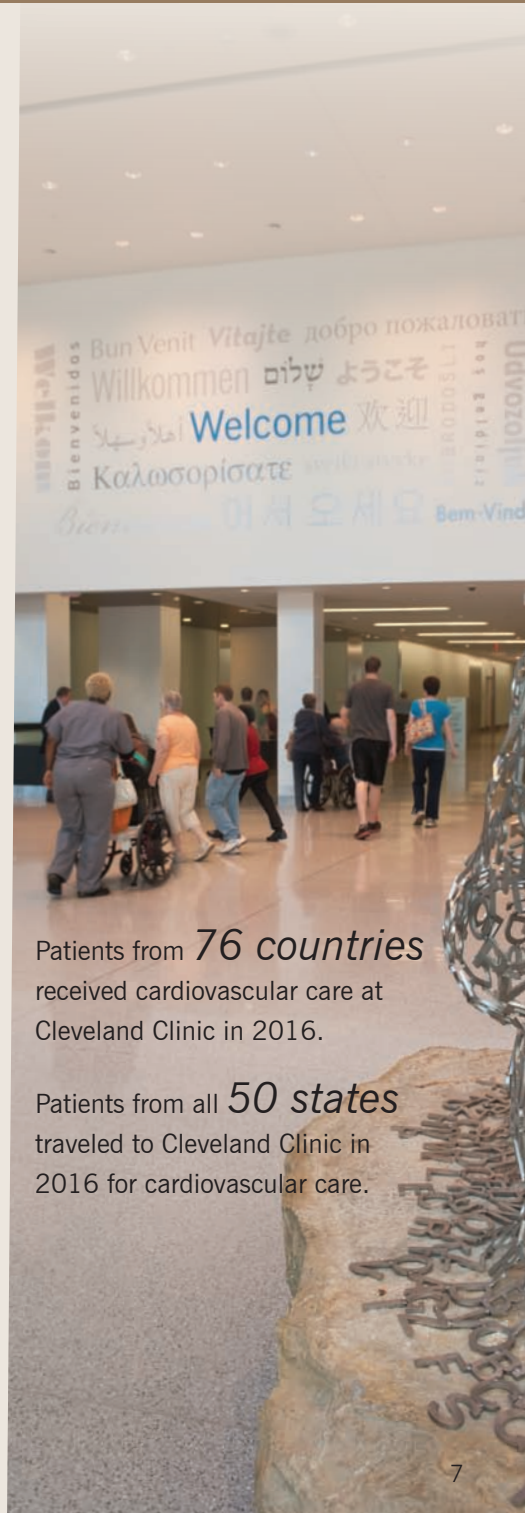
Diagnostic cardiac catheterizations	7831
Interventional cardiac procedures	1707
Percutaneous aortic valvuloplasties	59
Percutaneous mitral valvuloplasties	18
Percutaneous atrial septal defect and patent foramen ovale closures	46

Electrophysiology

Electrophysiology ablations	1583
Ablations for atrial fibrillation	935
Device implants	1457
Leads extracted	175

Diagnostic and Cardiac Imaging

Echocardiograms	79,575
Cardiac CT scans	8081
Cardiac MRI scans	3249
Stress tests	7999
Nuclear cardiology tests	
Tc-Myoview-rest	4271
Tc-Myoview-stress	4142
Rubidium heart (PET)	965
FDG heart (PET)	544
MUGA	58
N-13 ammonia heart	97



Patients from **76 countries**
received cardiovascular care at
Cleveland Clinic in 2016.

Patients from all **50 states**
traveled to Cleveland Clinic in
2016 for cardiovascular care.

Surgical Overview

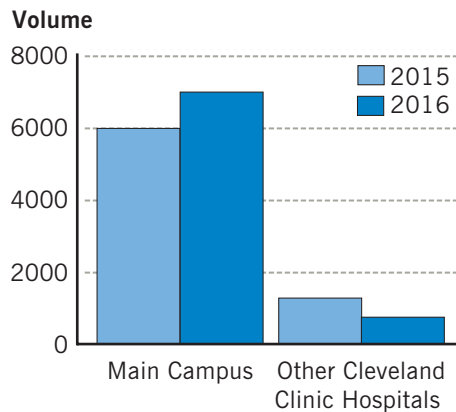
24%

A total of 24% of cardiac surgeries at Cleveland Clinic in 2016 were reoperations. These procedures are associated with more complexity and greater risk than primary (first-time) operations.



Thoracic and Cardiac Surgery Volume (N = 6996)

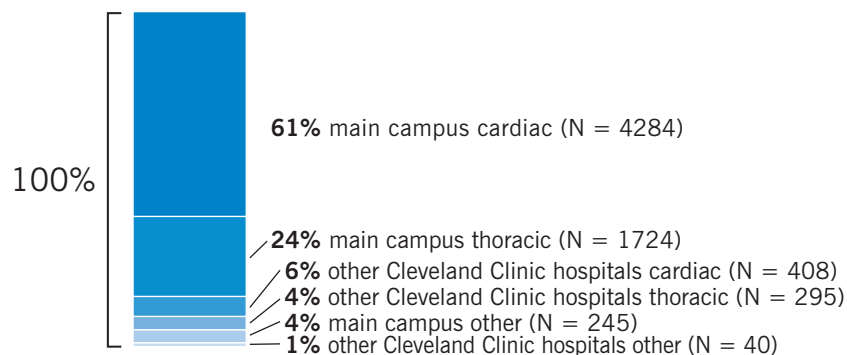
2015 – 2016



In 2016, Cleveland Clinic surgeons performed 6996 thoracic and cardiac procedures at Cleveland Clinic's main campus. A total of 743 procedures were performed at Cleveland Clinic's Hillcrest Hospital, Fairview Hospital, and Cleveland Clinic Florida. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.

Surgical Procedure Volume by Type and Location (N = 6996)

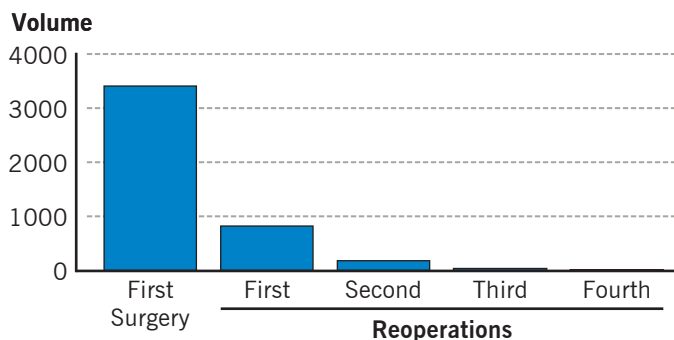
2016



Cleveland Clinic surgeons perform a large volume of cardiovascular and thoracic procedures. The 6996 surgeries in 2016 were performed at Cleveland Clinic's main campus, Fairview Hospital, Hillcrest Hospital, and Cleveland Clinic Florida. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.

Cardiac Surgery Volume: Cleveland Clinic Main Campus, Fairview Hospital, and Hillcrest Hospital (N = 4471)

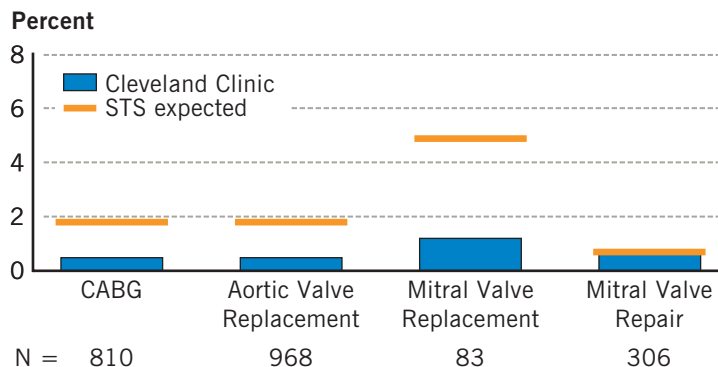
2016



A total of 24% of cardiac surgeries performed during 2016 were reoperations. Reoperations are more complex than primary (first-time) surgeries.

Isolated Procedures, In-Hospital Mortality (N = 2167)

2016



CABG = coronary artery bypass graft

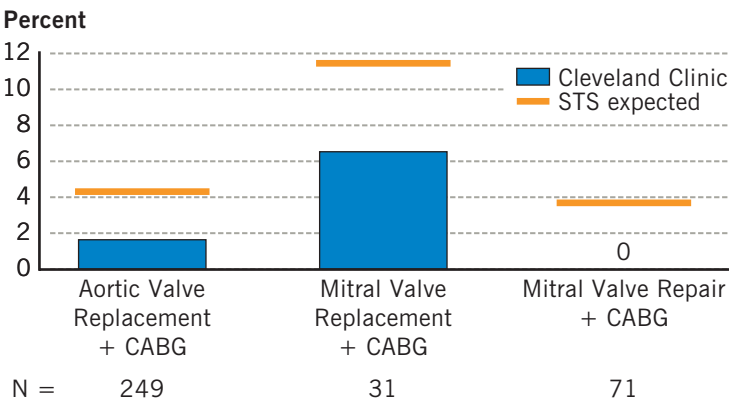
Cleveland Clinic's Heart & Vascular Institute surgeons achieved lower-than-expected in-hospital mortality rates for patients who had isolated procedures. Isolated procedures are those done without any other surgical procedure.

Source: Society of Thoracic Surgeons (STS)
National Adult Cardiac Surgery Database 2016

Surgical Overview

Combined Cardiovascular Procedures, In-Hospital Mortality (N = 351)

2016



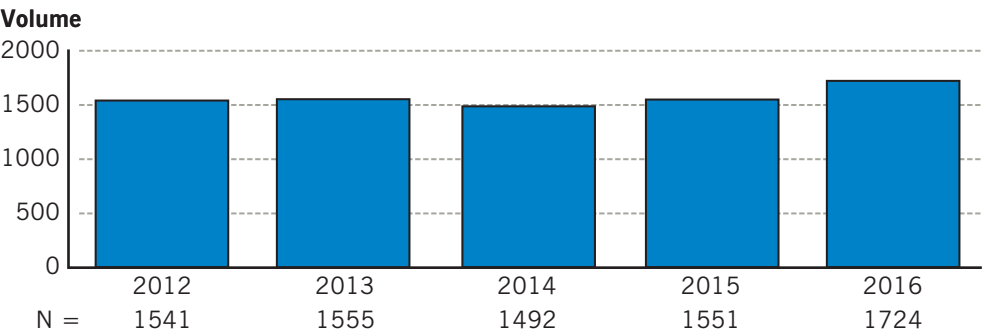
Combined procedures are those performed with another surgical treatment. These procedures are associated with greater risk and complexity than isolated procedures. Despite this, Cleveland Clinic's surgeons in the Heart & Vascular Institute achieved lower-than-expected in-hospital mortality rates. This graph reflects only procedures classified in categories by the Society of Thoracic Surgeons. Of the cardiac operations Cleveland Clinic surgeons perform, 45% cannot be classified by the Society of Thoracic Surgeons because of the complexity and/or rarity of the procedure.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

CABG = coronary artery bypass graft

General Thoracic Surgery Volume

2012 – 2016

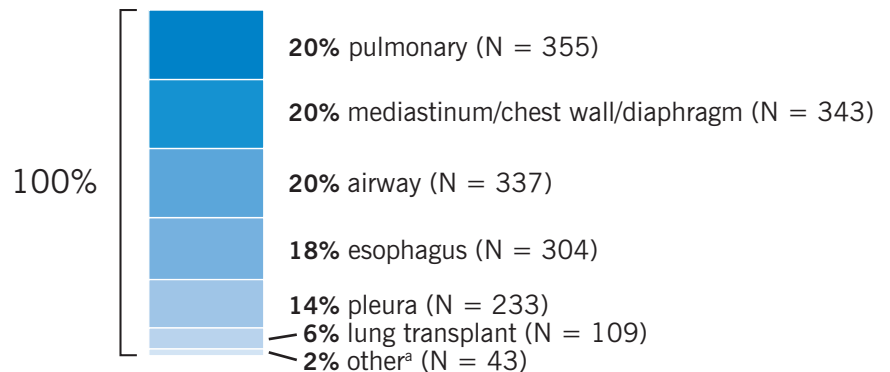


Cleveland Clinic surgeons performed 1724 general thoracic surgical procedures in 2016.

Major Thoracic Surgery by Type (N = 1724)

2016

Cleveland Clinic thoracic surgeons are experienced in all types of thoracic procedures. The majority of thoracic surgeries in 2016 involved the airway. Increasingly, these are done minimally invasively with robotic assistance.

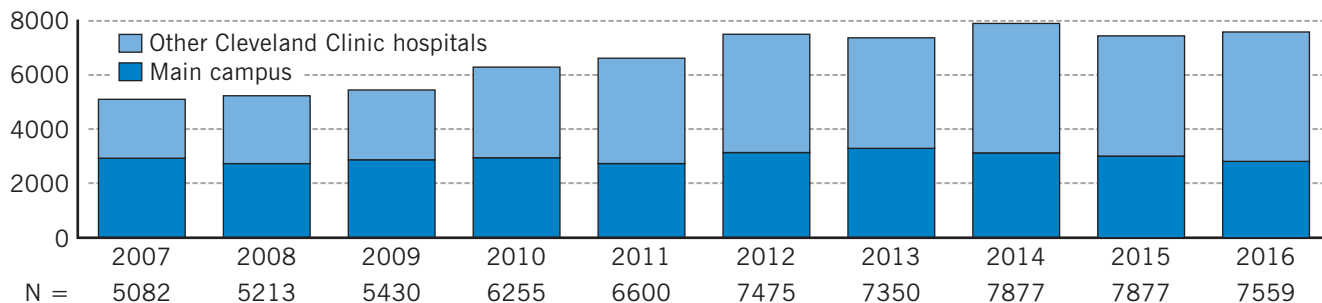


^a“Other” includes thymectomies, wedge resections, tumor surgeries, paraesophageal hiatal hernia repairs, and thyroidectomies.

Vascular Surgery Volume

2007 – 2016

Volume

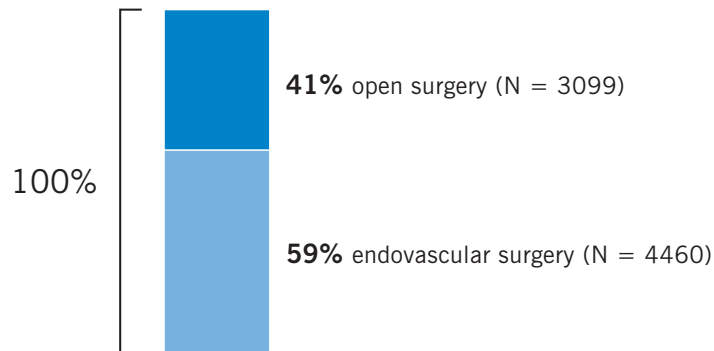


Cleveland Clinic surgeons performed 7559 vascular surgeries in 2016. A total of 2796 of these procedures were done at Cleveland Clinic’s main campus, and 4763 were performed at Cleveland Clinic hospitals throughout greater Cleveland. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.

Surgical Overview

Vascular Surgery by Approach: Cleveland Clinic Main Campus and Regional Hospitals (N = 7559)

2016



Cleveland Clinic surgeons use an endovascular approach whenever it is the best option for the patient. Endovascular surgery is associated with lower rates of morbidity and mortality, and patients have a shorter recovery compared with open approaches.



Ischemic Heart Disease – Interventional Treatment

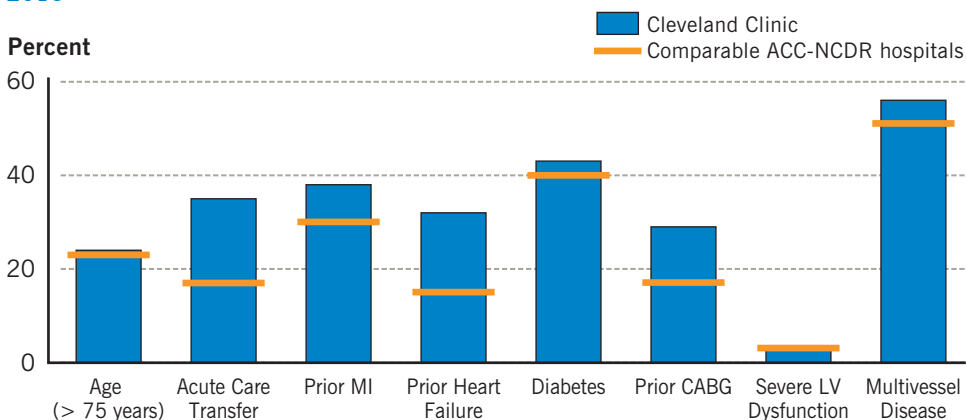
Cardiac Catheterization Laboratory Procedures (N = 8954)

Cleveland Clinic is a regional and national referral center for percutaneous coronary intervention (PCI). A total of 8954 cardiac catheterization procedures were done in 2016 to treat patients with simple and complex ischemic heart disease.

The data below demonstrate outcomes at Cleveland Clinic compared with those at hospitals included in the American College of Cardiology National Cardiovascular Data Registry (ACC-NCDR) CathPCI Registry® that perform more than 500 PCIs per year. Data are based on a 1-year rolling average; therefore, totals reported here may differ from those reported elsewhere in this book.

Medical Conditions Among Patients Undergoing PCI Procedures (N = 1552)

2016



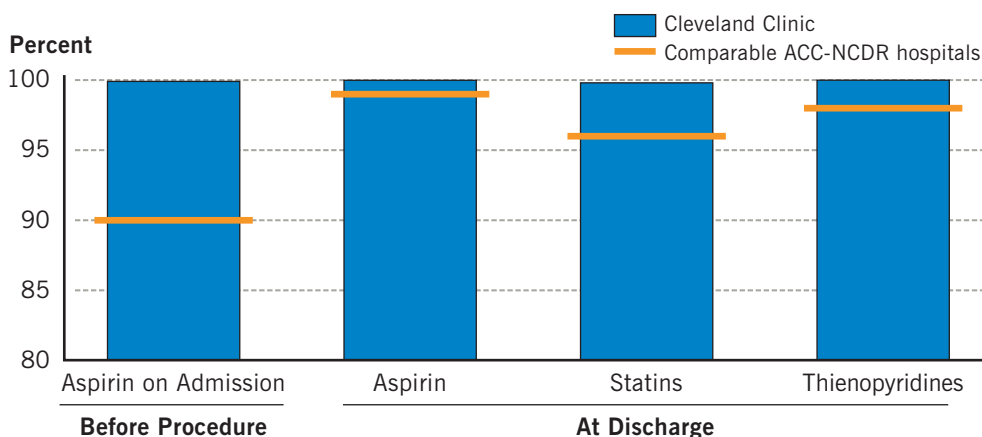
Patients with complex medical backgrounds present greater challenges for PCI procedures. In 2016, patients who had PCI at Cleveland Clinic had more complex backgrounds than patients at comparable hospitals.

CABG = coronary artery bypass graft, LV = left ventricular, MI = myocardial infarction

Source: ACC-NCDR database

Use of Appropriate Process Measures: Medications (N = 1552)

2016



One of the ACC-NCDR key performance measures is the use of appropriate adjunctive medications before and after PCI. Cleveland Clinic achieved 100% use for all medication categories, which exceeds rates at comparable hospitals.

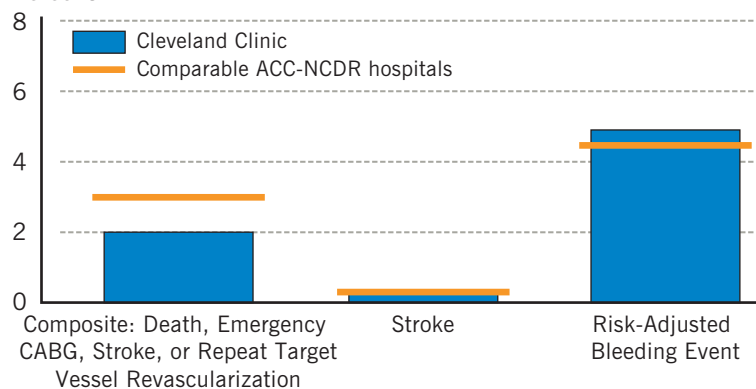
Source: ACC-NCDR database

Ischemic Heart Disease — Interventional Treatment

Complications (N = 1551)

2016

Percent



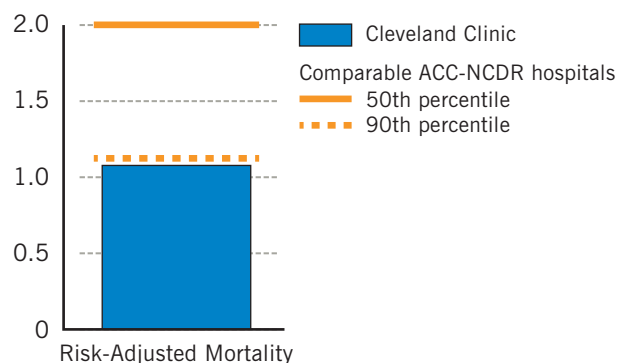
CABG = coronary artery bypass graft
Source: ACC-NCDR database

In 2016, the rates of major vascular complications and stroke associated with PCI procedures at Cleveland Clinic were better than the rates at comparable hospitals. The rate of risk-adjusted bleeding events was slightly higher due to the use of hybrid procedures, such as valve replacement plus PCI, that are performed less frequently at other hospitals. Cleveland Clinic is continuously striving to achieve the best possible outcomes for patients.

In-Hospital Mortality (N = 1551)

2016

Percent

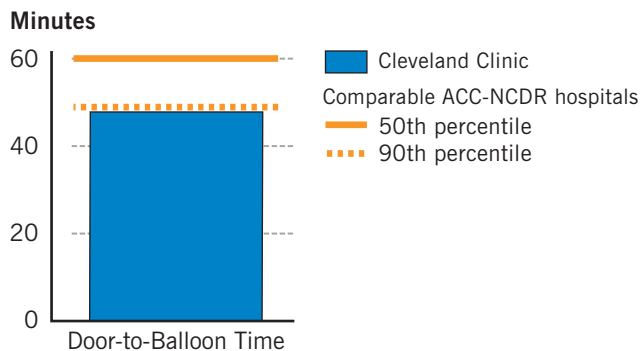


Source: ACC-NCDR database

The rate of in-hospital mortality among patients who had PCI procedures at Cleveland Clinic in 2016 was lower than rates at comparable hospitals.

Door-to-Balloon Time (N = 76)^a

2016



The American College of Cardiology/American Heart Association (ACC/AHA) guideline for PCI inflation for patients who come to the emergency department with ST-elevation myocardial infarction (STEMI) is 90 minutes. Cleveland Clinic continues to improve door-to-balloon time to reduce the risk of mortality and morbidity. In 2016, the median time at Cleveland Clinic was 48 minutes.

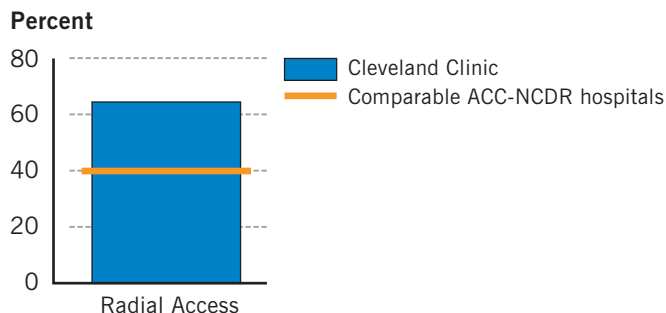
^aA total of 76 patients treated for myocardial infarction at Cleveland Clinic's emergency department met the ACC-NCDR reporting criteria for a primary diagnosis of STEMI. Among these patients, median time to reperfusion was 48 minutes.

Source: ACC-NCDR database

Use of Radial Access (N = 715)

2016

In 2016, Cleveland Clinic performed more PCI procedures using radial access than did comparable hospitals. The use of radial access is associated with reductions in bleeding complications, readmission rates, infection, and recovery time compared with PCI procedures done using a femoral approach.



Source: ACC-NCDR database

Ischemic Heart Disease — Surgical Treatment

Surgical Treatment for Ischemic Heart Disease

CABG Volume (N = 1561)

2016

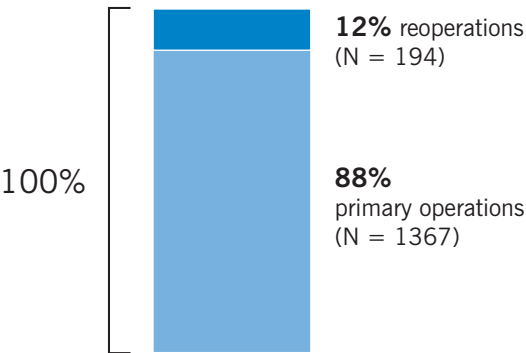
Cleveland Clinic surgeons performed 1561 coronary artery bypass graft (CABG) procedures in 2016. A total of 751 were in combination with another procedure, and 810 were isolated procedures, including reoperations.

Procedure	Volume
Isolated	810
CABG + other	751

CABG Volume, Primary and Reoperations (N = 1561)

2016

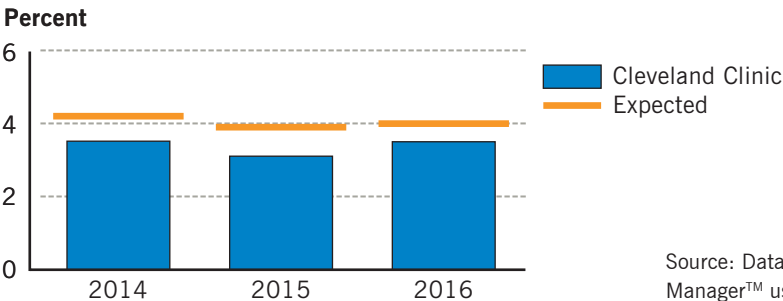
Cleveland Clinic surgeons perform more CABG reoperations than other hospitals. Despite the increased complexity of these procedures, outcomes remain excellent for these and primary (first-time) CABG surgery.



CABG Plus Other Procedure, In-Hospital Mortality (N = 751)

2014 – 2016

In-hospital mortality rates among patients who had CABG surgery plus another procedure at Cleveland Clinic in 2016 (primary and reoperations) were lower than expected.



Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

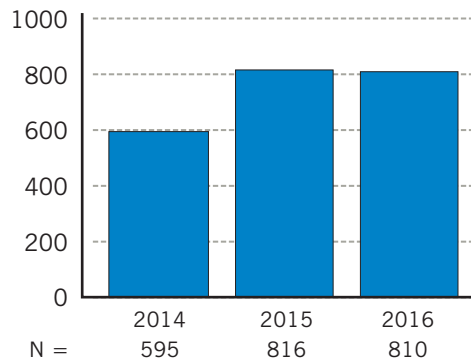
Isolated CABG Procedures

In-Hospital Mortality (N = 2221)

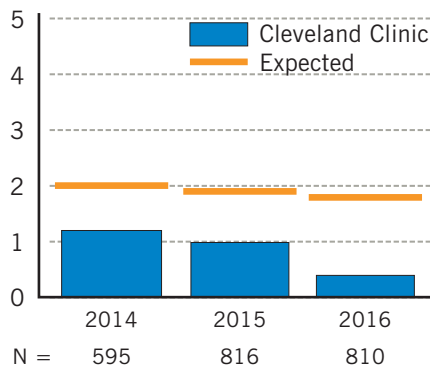
2014 – 2016

Cleveland Clinic surgeons performed 810 isolated CABG procedures in 2016. The overall in-hospital mortality rate was 0.4%, which was lower than the expected rate of 1.8%.

Volume



Percent



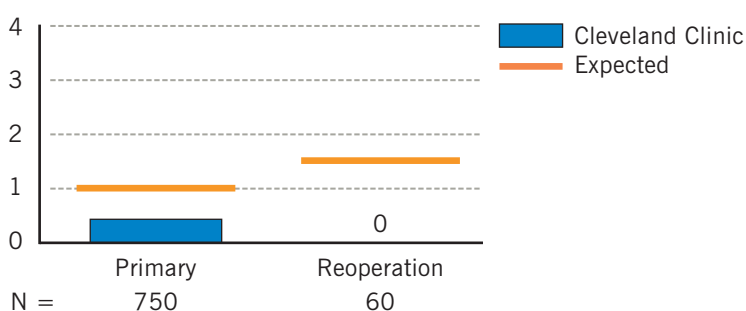
Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

In-Hospital Mortality, Primary and Reoperation (N = 810)

2016

Many patients who have CABG reoperations at Cleveland Clinic have very complex medical histories, which creates a higher risk of death. Despite these increased risks, the in-hospital mortality rates for primary operations and reoperations were lower than expected (0.4% and 0%, respectively).

Percent



Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

STS CABG Quality Ratings



Overall

Approximately 12% to 15% of US hospitals received the STS “3 star” rating for CABG surgery. This denotes the highest category of quality. In the current analysis of national data covering the period from Jan. 1, 2016, through Dec. 31, 2016, the CABG surgery performance at Cleveland Clinic was found to lie in this highest quality tier, thereby earning the STS 3-star rating.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

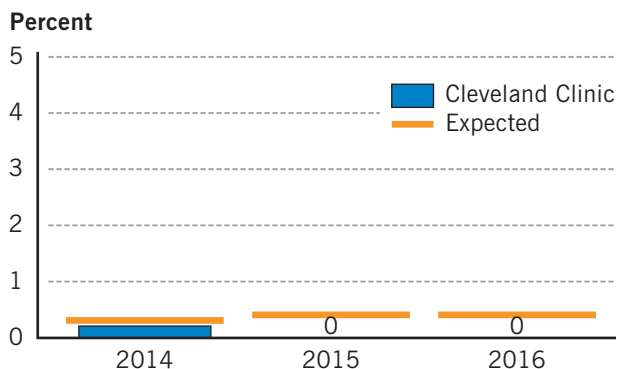
Ischemic Heart Disease — Surgical Treatment



Deep Sternal Wound Infection

2014 – 2016

The rate of deep sternal wound infection after CABG surgery was lower than expected at Cleveland Clinic in 2016. The rate at Cleveland Clinic was 0%, compared with the expected rate of 0.4%. The overall risk of deep sternal wound infection at Cleveland Clinic has been 1 in 1000 for the last 4 years.

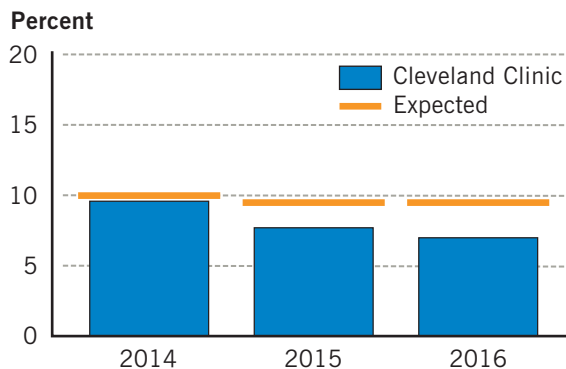


Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Ventilator Time > 24 Hours

2014 – 2016

A total of 7% of patients who had isolated CABG surgery at Cleveland Clinic in 2016 spent more than 24 hours on a ventilator. This is lower than the expected rate of 9.5%.

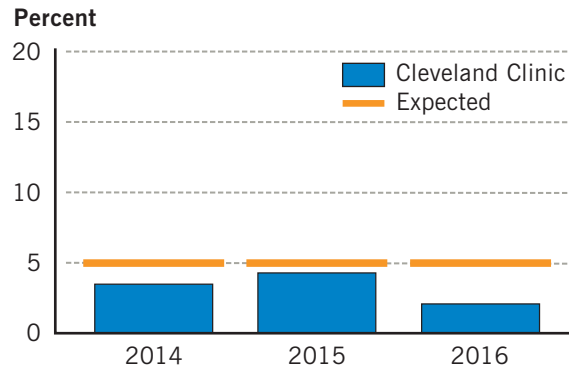


Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

In-Hospital Reoperation

2014 – 2016

The rate of in-hospital reoperation after isolated CABG surgery was lower than expected at Cleveland Clinic in 2016.

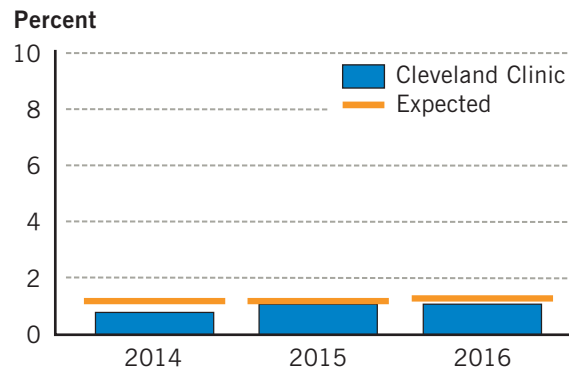


Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Postoperative Stroke

2014 – 2016

The expected rate of postoperative stroke after isolated CABG surgery was 1.3% in 2016. The rate was slightly lower (1.1%) at Cleveland Clinic.



Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Ischemic Heart Disease — Surgical Treatment

100%

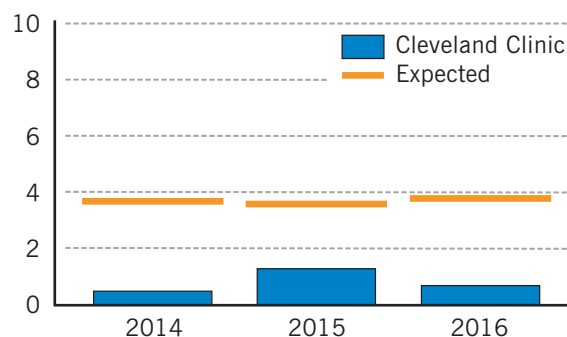
Cleveland Clinic was 100% compliant with all Society of Thoracic Surgeons' process measures in 2016. Measures include use of a perioperative beta blocker; use of a beta blocker, statin, and aspirin at discharge; and use of an internal mammary artery during isolated CABG surgery.

Source: Society of Thoracic Surgeons National Adult Cardiac Surgery Database 2016

Postoperative Renal Failure

2014 – 2016

Percent



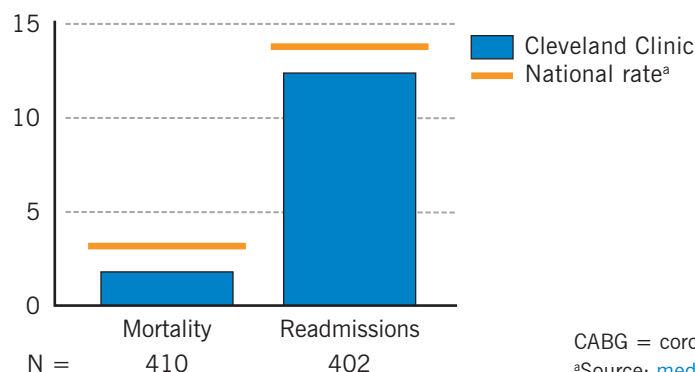
Postoperative renal failure occurred in 0.7% of patients who had isolated CABG surgery at Cleveland Clinic in 2016. This was lower than the expected rate of 3.8%.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

CABG All-Cause 30-Day Mortality and All-Cause 30-Day Readmissions

July 2013 – June 2016

Percent



CABG = coronary artery bypass graft

^aSource: medicare.gov/hospitalcompare

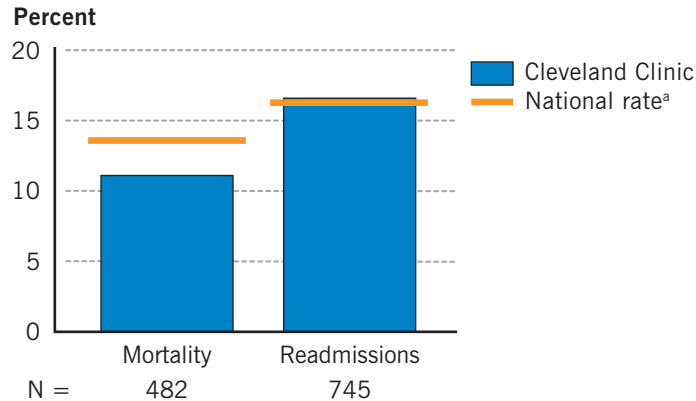
The Centers for Medicare & Medicaid Services (CMS) calculates 2 CABG outcomes measures based on Medicare claims and enrollment information. The most recent risk-adjusted data available from CMS are shown. Cleveland Clinic's CABG patient mortality rate is lower than the US national rate and CMS ranks Cleveland Clinic's performance as "better than" the US national rate. Although Cleveland Clinic's CABG readmissions rate is slightly lower than the US national rate, CMS ranks Cleveland Clinic's performance as "no different than" the US national rate. To further reduce avoidable readmissions, Cleveland Clinic is focused on optimizing transitions from hospital to home or postacute facility. Specific initiatives have been implemented to ensure effective communication, education, and follow-up.

Ischemic Heart Disease – AMI

Acute Myocardial Infarction (AMI)

All-Cause 30-Day Mortality and All-Cause 30-Day Readmissions

July 2013 – June 2016



^aSource: [medicare.gov/hospitalcompare](https://www.medicare.gov/hospitalcompare)

CMS calculates 2 AMI outcomes measures based on Medicare claims and enrollment information. The most recent risk-adjusted data available from CMS are shown. Although Cleveland Clinic's AMI patient mortality rate is lower than the US national rate, CMS ranks Cleveland Clinic's performance as "no different than" the US national rate. Cleveland Clinic's AMI readmissions rate is slightly higher than the US national rate and also ranked by CMS as "no different than" the US national rate. To further reduce avoidable readmissions, Cleveland Clinic is focused on optimizing transitions from hospital to home or postacute facility. Specific initiatives have been implemented to ensure effective communication, education, and follow-up.

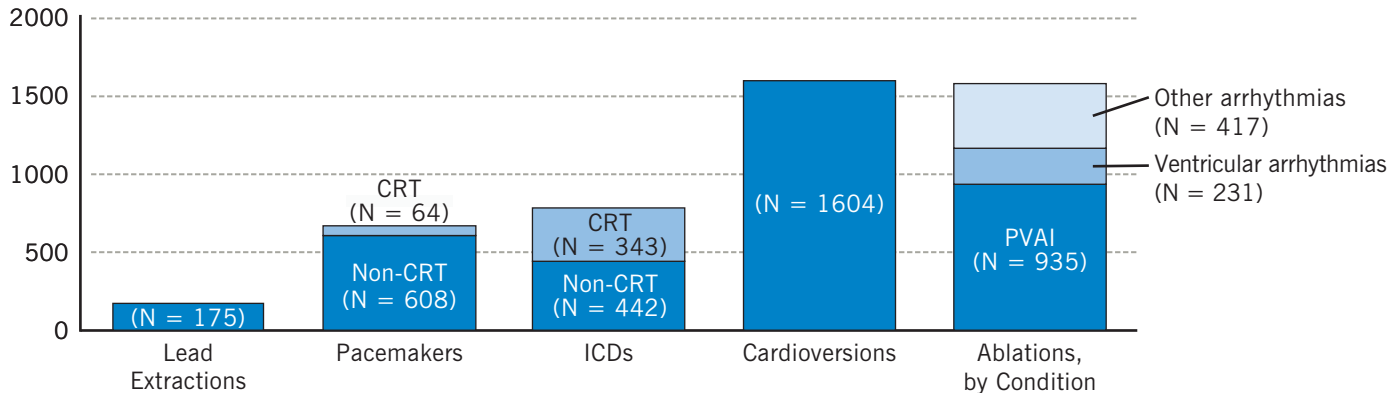
Cardiac Rhythm Disorders

Electrophysiology Laboratory Procedures by Type (N = 5445)^a

Cleveland Clinic electrophysiologists use specialized approaches to diagnose and treat patients with a wide variety of arrhythmias. They are noted for their expertise in ablation procedures and management of patients with pacemakers and defibrillators.

2016

Volume



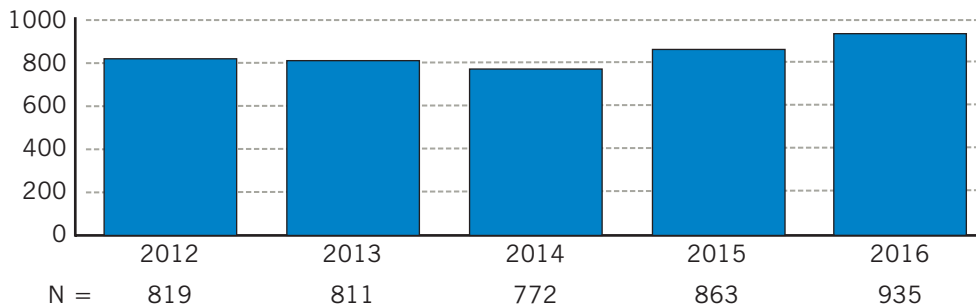
CRT = cardiac resynchronization therapy, ICD = implantable cardioverter defibrillator, PVAI = pulmonary vein antrum isolation

^aThe total number of procedures includes left atrial appendage occlusion procedures, electrophysiology studies, ICD testing, temporary pacers, loop recorders, and electrophysiology special procedures (endomyocardial biopsy, esophageal pacing, right heart catheterization, venography, and others). These are not included in the graph.

Pulmonary Vein Antrum Isolation Procedures (N = 4200)

2012 – 2016

Volume



Pulmonary vein antrum isolation (PVAI) essentially disconnects the pathway of the abnormal heart rhythm and prevents atrial fibrillation.

Success Rates

Success is defined as a restored sinus rhythm without recurrence of atrial fibrillation (AF) after the patient has stopped taking antiarrhythmic medications for at least 12 months after the procedure. This is influenced by a number of factors, including the length of time the patient has been in AF and the presence or absence of underlying heart disease.

In a recent study¹ of 831 patients who underwent pulmonary vein antrum isolation at Cleveland Clinic, 81% of patients with paroxysmal AF were arrhythmia-free while off antiarrhythmic drugs at 12 months postablation. Paroxysmal AF is defined as AF that terminates within days without cardioversion. A total of 7.8% of this patient population had AF after 1 year postablation (late-recurrence AF).

The success rate is lower for patients with persistent or long-standing persistent AF (65% for a single ablation procedure) and is affected by the presence of valvular heart disease or other underlying problems.

A total of 161 patients who had early recurrence of AF had a repeat ablation procedure. At 14 months after repeat ablation, 78.9% were arrhythmia-free while off antiarrhythmic drugs. Of the 27 patients who had late-recurrence AF and a repeat ablation, 74.1% were arrhythmia-free while off antiarrhythmic drugs at 17 months after repeat ablation.

Reference

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Cardiac Rhythm Disorders

Complications of PVAI

2016

Complication	N	Percent	Benchmark Rate ¹ (%)
Death	0	0	0.15
Tamponade	5	0.53	1.31
Pneumothorax	0	0	0.09
Hemothorax	0	0	0.02
Sepsis, abscesses, endocarditis ^a	1	0.11	0.01
Permanent diaphragmatic paralysis	0	0	0.17
Total femoral pseudoaneurysm	1	0.11	0.93
Total arteriovenous fistula	0	0	0.54
Valve damage/requiring surgery	0	0	0.07
Atrioesophageal fistula	0	0	0.04
Stroke	1	0.11	0.23
Transient ischemic attack	0	0	0.71
Pulmonary vein stenosis requiring intervention	3	0.32	0.29
Vascular access injury complications	2	0.21	–
Total^b	13	1.39	4.5

The overall risk associated with PVAI in 2016 was 1.39%.

^aSepsis, abscesses, and endocarditis requiring surgery were measured.¹ The Cleveland Clinic patient included in the 2016 complications (N = 1) did not require surgery.

^bThe total percentage was calculated by dividing the total number of complications (N = 13) by the total number of PVAI procedures (N = 935). Not represented here is 1 patient with a pulmonary vein stenosis > 70% who did not require intervention.

Reference

1. Cappato R, Calkins H, Chen SA, Davies W, Iesaka Y, Kalman J, Kim YH, Klein G, Natale A, Packer D, Skanes A, Ambrogi F, Biganzoli E. Updated worldwide survey on the methods, efficacy, and safety of catheter ablation for human atrial fibrillation. *Circ Arrhythm Electrophysiol*. 2010 Feb;3(1):32-38.

Pulmonary Vein Stenosis

2010 – 2016

It can take months or years for patients to develop pulmonary vein (PV) stenosis after a PVAI. The table details the incidence of PV stenosis after PVAI from 2010 through 2016, which is consistent with data previously published by Cleveland Clinic.¹ The data are updated annually.

Cleveland Clinic obtains a 3-month postablation CT scan to screen for PV stenosis. Most centers do not screen all PVAI patients for PV stenosis upon follow-up.² This may explain the higher percentages of PV stenosis at Cleveland Clinic, as routine screening results in the identification of more cases.

Year of PVAI	PV Stenosis (N)	PVAI Volume (N)	Percent
2010	8	693	1.15
2011	5	776	0.64
2012	7	819	0.85
2013	15	811	1.85
2014	3	772	0.39
2015	5	863	0.58
2016	4	935	0.43
7-year total	47	5669	0.83

References

1. Baranowski B, Saliba W. Our approach to management of patients with pulmonary vein stenosis following AF ablation. *J Cardiovasc Electrophysiol*. 2011 Mar;22(3):364-367.

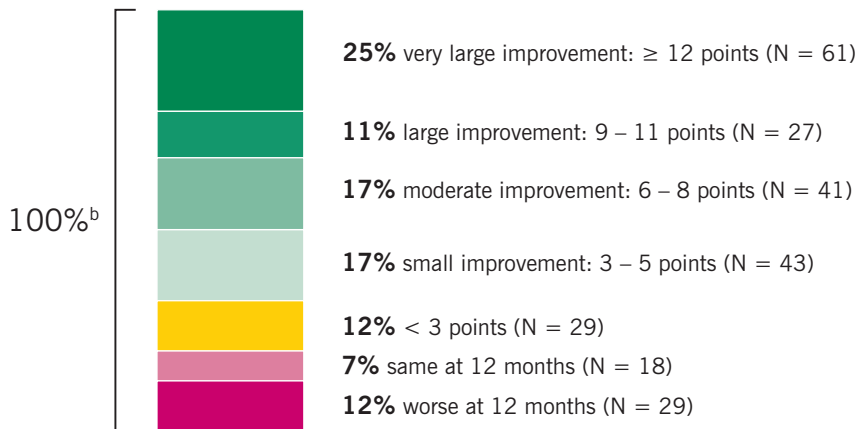
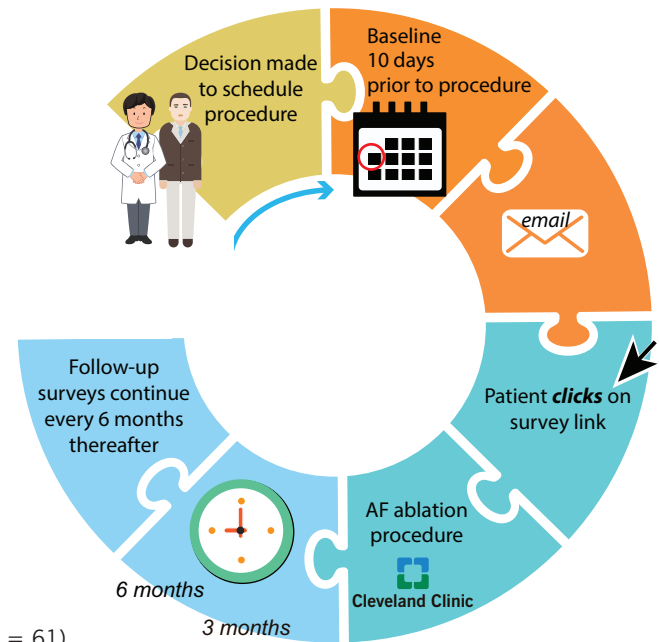
2. Calkins H, Kuck KH, Cappato R, Brugada J, Camm AJ, Chen SA, Crijns HJ, Damiano RJ Jr, Davies DW, DiMarco J, Edgerton J, Ellenbogen K, Ezekowitz MD, Haines DE, Haissaguerre M, Hindricks G, Iesaka Y, Jackman W, Jalife J, Jais P, Kalman J, Keane D, Kim YH, Kirchhof P, Klein G, Kottkamp H, Kumagai K, Lindsay BD, Mansour M, Marchlinski FE, McCarthy PM, Mont JL, Morady F, Nademanee K, Nakagawa H, Natale A, Nattel S, Packer DL, Pappone C, Prystowsky E, Raviele A, Reddy V, Ruskin JN, Shemin RJ, Tsao HM, Wilber D; Heart Rhythm Society Task Force on Catheter and Surgical Ablation of Atrial Fibrillation. 2012 HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation: recommendations for patient selection, procedural techniques, patient management and follow-up, definitions, endpoints, and research trial design: a report of the Heart Rhythm Society (HRS) Task Force on Catheter and Surgical Ablation of Atrial Fibrillation. Developed in partnership with the European Heart Rhythm Association (EHRA), a registered branch of the European Society of Cardiology (ESC) and the European Cardiac Arrhythmia Society (ECAS); and in collaboration with the American College of Cardiology (ACC), American Heart Association (AHA), the Asia Pacific Heart Rhythm Society (APHRS), and the Society of Thoracic Surgeons (STS). Endorsed by the governing bodies of the American College of Cardiology Foundation, the American Heart Association, the European Cardiac Arrhythmia Society, the European Heart Rhythm Association, the Society of Thoracic Surgeons, the Asia Pacific Heart Rhythm Society, and the Heart Rhythm Society.

Cardiac Rhythm Disorders

Patient-Reported Outcomes After PVAI

Atrial Fibrillation Tracker (N = 248)^a

Patient-reported outcomes (PROs) are paramount to assessing disease progression, treatment efficacy, and health-related quality of life (HRQoL). Cleveland Clinic uses a web-based survey system (Atrial Fibrillation Tracker) to collect longitudinal PROs for AF ablation patients. AF symptom severity scores (0–35; higher scores reflect more severe symptoms) are used to measure HRQoL. At 12 months post-PVAI, 69% of patients had an improvement in their AF Symptom Severity Score, ranging from 3–34 points, reflecting an improved HRQoL.



^aData collected from PVAI patients with date of service from November 2013 to January 2017 who completed a baseline, 6-month, and 12-month survey and answered all 7 symptom severity questions.

^bPercentage totals were rounded.

Reference

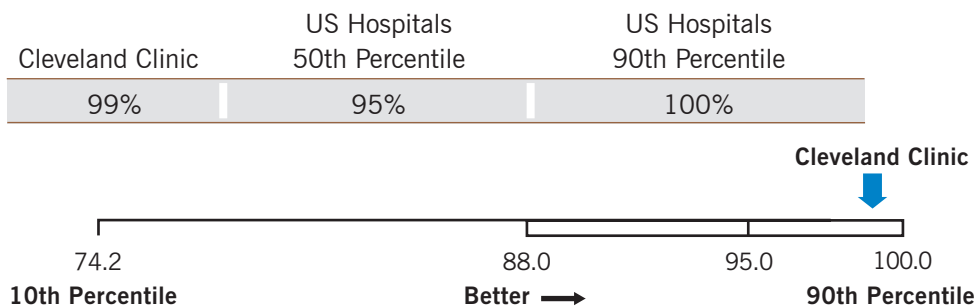
1. Interpreting changes in quality of life in atrial fibrillation: how much change is meaningful? Dorian P, Burk C, Mullin CM, Bubien R, Godejohn D, Reynolds MR, Lakkireddy DR, Wimmer AP, Bhandari A, Spertus J. *Am Heart J*. 2013 Aug;166(2):381-387 Epub 2013 Jul 1.

Left Atrial Appendage Occlusion (LAAO)

Patients with atrial fibrillation are at increased risk of stroke due to blood clots that form in the left atrial appendage (LAA). Cleveland Clinic's Atrial Fibrillation Stroke Prevention Center is staffed by specialists who have extensive experience in the use of devices to close off the LAA to reduce this risk. In 2016, 101 patients had LAA occlusion procedures at Cleveland Clinic, with a 99% success rate. The unsuccessful procedure (N = 1) was due to unsuitable LAA anatomy.

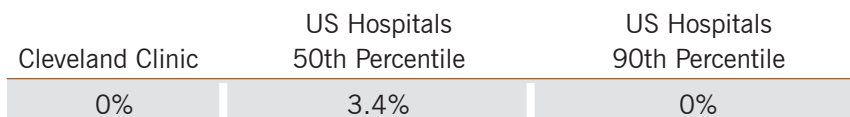
Procedures Successful

Rolling Four Quarters Ending 2016 4th Quarter



Patients With Any Intra- or Postprocedure Event Prior to Discharge

Rolling Four Quarters Ending 2016 4th Quarter



Source: National Cardiovascular Data Registry LAAO Registry™

Atrial Fibrillation Stroke Prevention Center

New Medications and Procedures = Reduced Stroke Risk

Cleveland Clinic's Atrial Fibrillation Stroke Prevention Center multidisciplinary team includes specialists in electrophysiology, vascular medicine, gastroenterology, and neurovascular medicine. The goal of the center is to help reduce the risk of stroke among patients with atrial fibrillation who cannot take anticoagulant medications because of a history of bleeding. Patients are evaluated and receive an individualized plan of care that may include medical or interventional treatments.



Cardiac Rhythm Disorders

Ablation of Ventricular Arrhythmia

Volume and Success Rates (N = 231)

2016

Cleveland Clinic is a national referral center for patients with ventricular arrhythmias. In 2016, a total of 231 ablations were done. Partial success means that among patients with multiple arrhythmias, at least 1 arrhythmia was ablated.

	N	Percent
Completely successful	194	84
Partially successful	24	10.4
Unsuccessful	5	2.2
Not targeted	3	1.3
Aborted	5	2.2
Total	231	

Complications

A major complication is defined as one that leads to prolongation of hospital stay or to another hospitalization, requires additional intervention for treatment, and/or results in significant injury or death.¹

Major Complications Among Patients With Ejection Fraction < 50% (N = 125)

Complication	N	Percent
Pericardial effusion with percutaneous intervention	1	0.8

Major Complications Among Patients With Ejection Fraction ≥ 50% (N = 106)

Complication	N	Percent
Pericardial effusion with percutaneous intervention	2	1.89
Stroke	1	0.94
Total	3	2.83

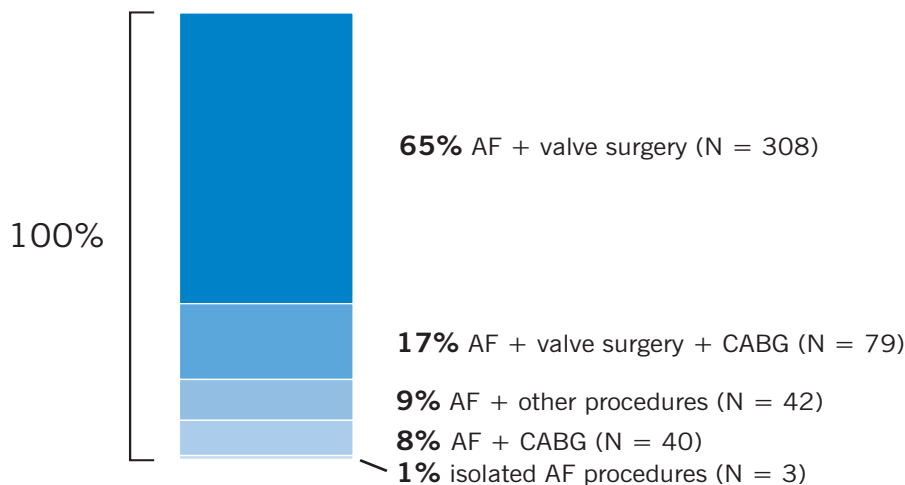
References

1. Aliot EM, Stevenson WG, Almendral-Garrote JM, et al.; European Heart Rhythm Association (EHRA); Registered Branch of the European Society of Cardiology (ESC); Heart Rhythm Society (HRS); American College of Cardiology (ACC); American Heart Association (AHA). EHRA/HRS Expert Consensus on Catheter Ablation of Ventricular Arrhythmias: developed in a partnership with the European Heart Rhythm Association (EHRA), a Registered Branch of the European Society of Cardiology (ESC), and the Heart Rhythm Society (HRS); in collaboration with the American College of Cardiology (ACC) and the American Heart Association (AHA). *Heart Rhythm*. 2009 Jun;6(6):886-933.

Atrial Fibrillation Surgical Procedures

Volume and Type (N = 472)

2016



In 2016, Cleveland Clinic surgeons performed 472 procedures, including minimally invasive approaches, to treat patients with atrial fibrillation.

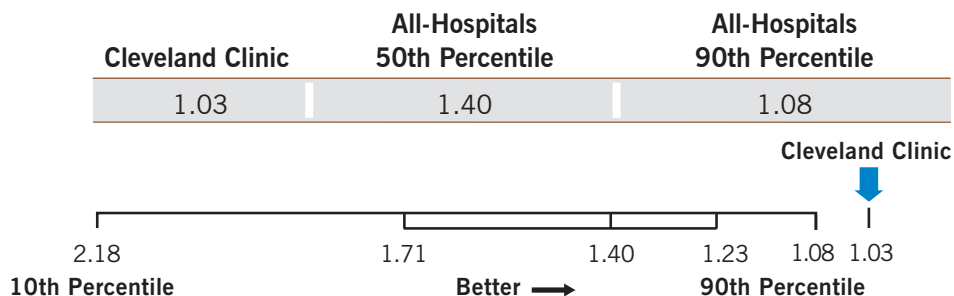
AF = atrial fibrillation, CABG = coronary artery bypass grafting

ICD Implants

In-Hospital Risk-Adjusted Complications (N = 716)

Rolling Four Quarters ending 2016 1st Quarter

The in-hospital risk-adjusted complication rate for implantable cardioverter defibrillator (ICD) implants at Cleveland Clinic was 1.03, which represents better outcomes than the all-hospitals 90th and 50th percentiles. Implants include initial implant and generator-change procedures. Exclusions are lead-only procedures, patients who also have epicardial lead implants placed during the procedure, and those who also have lead extractions at the time of implant. Complications include cardiac arrest, coronary venous dissection, device-related infection, myocardial infarction, pneumothorax, emergency cardiac surgery, set screw problems, cardiac perforation, hemothorax, lead dislodgement, pericardial tamponade, transient ischemic attack, hematoma, and death.



Source: National Cardiovascular Data Registry ICD Registry

Cardiac Rhythm Disorders

Initial Implantation Complications: Pacemaker and ICD^a

2016

	Pacemaker (N = 445) N (%)	ICD (N = 427) N (%)	Overall (N = 872) N (%)
Complications Measured for 30 Days			
Death	0 (0)	0 (0)	0 (0)
Pneumothorax or hemothorax plus a chest tube	5 (1.12)	1 (0.23)	6 (0.69)
Hematoma plus a blood transfusion or evacuation	0 (0)	0 (0)	0 (0)
Cardiac tamponade or pericardiocentesis	0 (0)	1 (0.23)	1 (0.12)
Complications Measured for 90 Days			
Mechanical complications requiring a system revision	13 (2.92)	7 (1.64)	20 (2.29)
Device-related infection	2 (0.45)	1 (0.23)	3 (0.34)
Additional device implantation	0 (0)	0 (0)	0 (0)
Total^b	20 (4.49)	10 (2.34)	30 (3.44)

ICD = implantable cardioverter defibrillator

^aInitial implant: No prior device had been implanted (includes all brady and tachy devices); excludes special devices such as laptop and loop recorders.

^bPercentage totals were rounded.

Secondary Implantation Complications: Pacemaker and ICD

2016

Procedure Type	N	Major Complications (%)	Benchmark (%) ¹
ICD with lead addition	74	4.05	17.40
ICD without lead addition	172	0.58	5.80
Pacemaker with lead addition	37	0	5.88
Pacemaker without lead addition	145	4.14	2.27

ICD = implantable cardioverter defibrillator

Reference

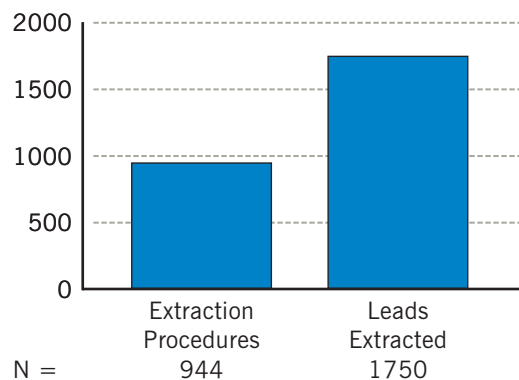
1. Poole JE, Gleva MJ, Mela T, et al.; REPLACE Registry Investigators. Complication rates associated with pacemaker or implantable cardioverter defibrillator generator replacements and upgrade procedures: results from the REPLACE registry. *Circulation*. 2010 Oct 19;122(16):1553-1561.

Lead Extraction Procedures (Leads in Place > 1 Year or Requiring Extraction Technology) (N = 944)

2012 – 2016

Electrophysiologists at Cleveland Clinic perform a high number of lead extractions. From 2012 through 2016, they extracted 1750 leads during 944 procedures. Many patients have complex conditions that result in referral to Cleveland Clinic physicians. Leads may need removal because of electrical malfunctions, blocked blood vessels, or infection. In most cases, the leads can be removed without opening the chest or heart. Major complications are defined as those causing death or intrathoracic bleeding.

Volume



Clinical success rate ^a	97.6%
Major complications	2.0%

^aSuccess is defined as removal of all the required leads without causing bleeding from the veins or heart.

Device Clinic Evaluations Volume (N = 47,970)

2016

Pacemaker evaluations	19,417
ICD evaluations	21,157
Implantable loop recorders	7396

ICD = implantable cardioverter defibrillator

Cleveland Clinic was the first hospital in the country to integrate a patient database for pacemaker and implantable cardioverter defibrillator follow-up with electronic medical records. This innovative approach to follow-up allows staff to keep track of patients' health conditions regardless of the patients' location. Remote monitoring is also associated with increased longevity and decreased need for in-person follow-up.

The institute uses the MyChart[®] function in Epic, Cleveland Clinic's electronic medical record system, to quickly notify patients of their device status.

2012 – 2016

1.8

average number of leads
extracted per procedure

98 months

average lead age at removal

83 months

median lead age at removal

Valve Disease

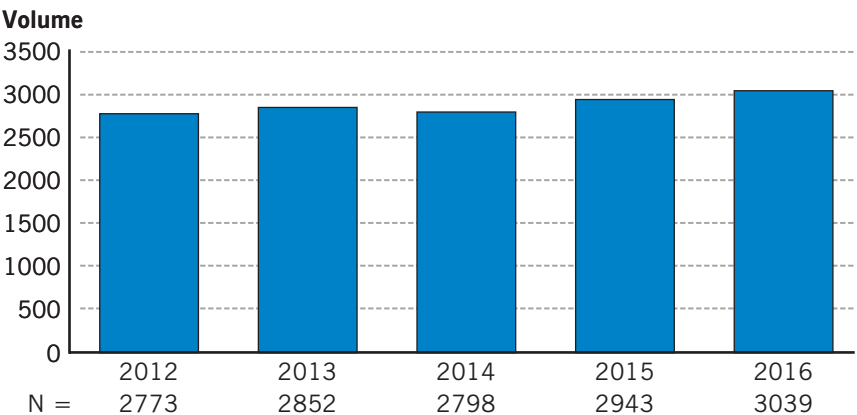


Cleveland Clinic surgeons have implanted more than 14,000 bioprosthetic aortic valves since the 1990s, with excellent short- and long-term outcomes.

Valve Surgery

Total Volume

2012 – 2016

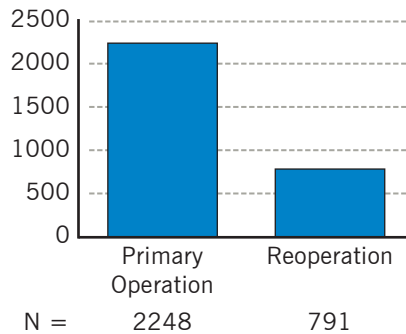


In 2016, Cleveland Clinic surgeons performed 3039 valve surgeries.

Primary Operation and Reoperation Volume (N = 3039)

2016

Volume

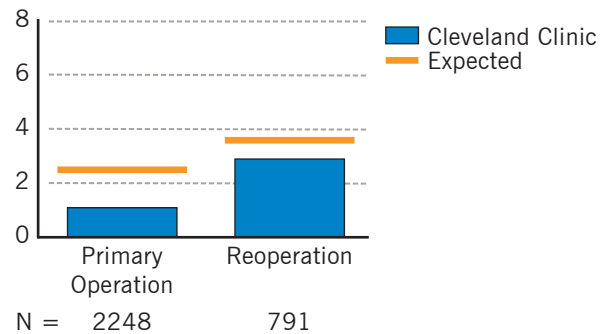


In 2016, Cleveland Clinic surgeons performed 2248 primary valve procedures and 791 valve reoperations.

Primary Operation and Reoperation In-Hospital Mortality (N = 3039)

2016

Percent



Patients who have valve surgery reoperations have a somewhat higher risk of death compared with patients who have a primary operation, due to the overall decrease in health over time. Despite this, the in-hospital mortality rates were lower than expected for both reoperations and primary procedures.

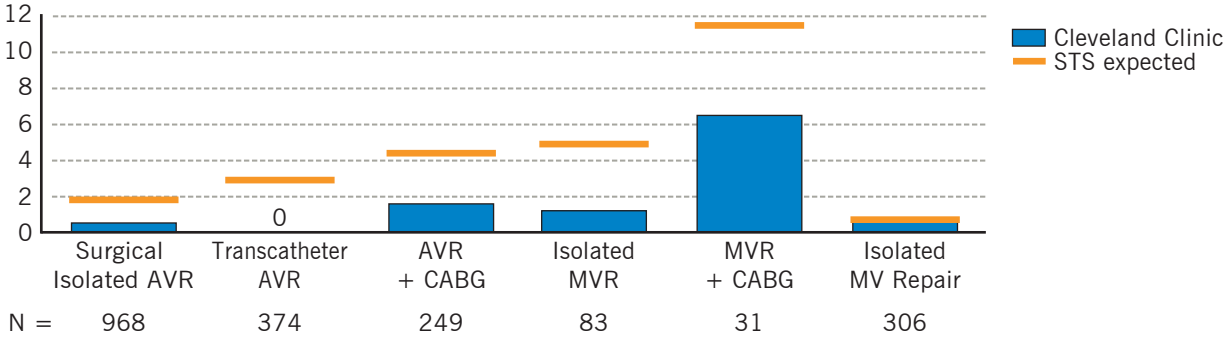
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Valve Disease

In-Hospital Mortality by Procedure Type (N = 2011)

2016

Percent



AVR = aortic valve replacement, CABG = coronary artery bypass graft, MV = mitral valve, MVR = mitral valve replacement

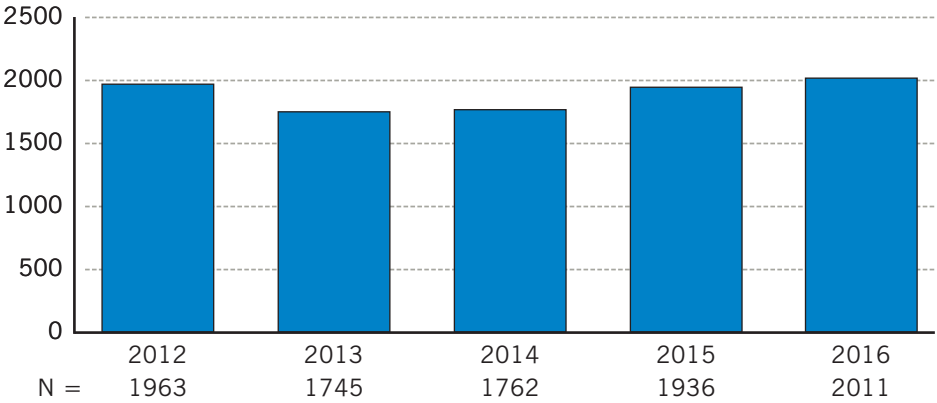
Cleveland Clinic surgeons performed a total of 3039 valve surgeries in 2016. However, the procedures included in this graph represent only those that are recognized by the Society of Thoracic Surgeons (STS). The mortality rates for valve surgery were lower than the STS-expected rates.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Aortic Valve Surgery

2012 – 2016

Volume

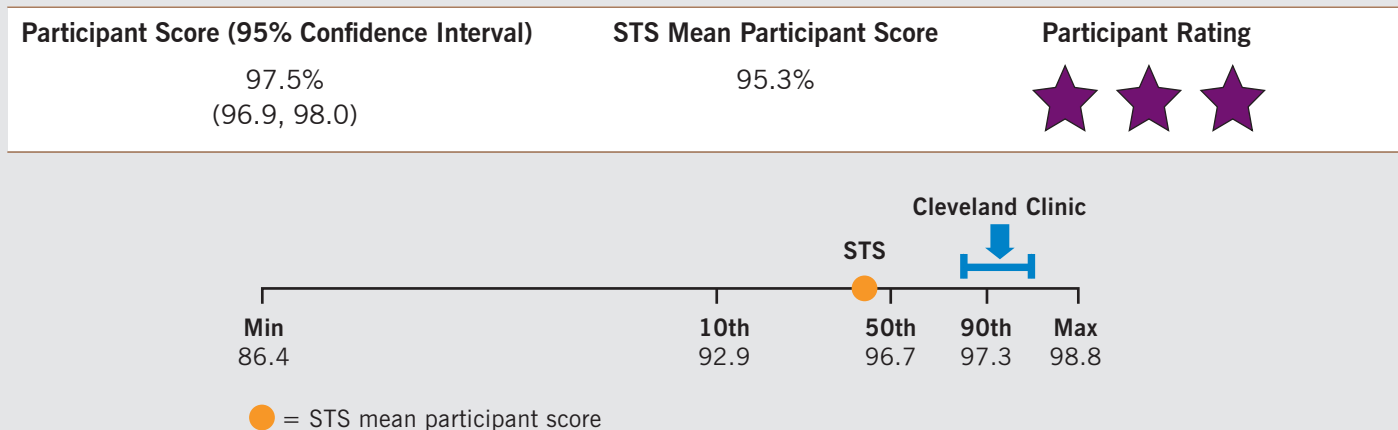


In 2016, 2011 aortic valve procedures were performed at Cleveland Clinic.

STS Rating for Aortic Valve Replacement

July 2013 – June 2016

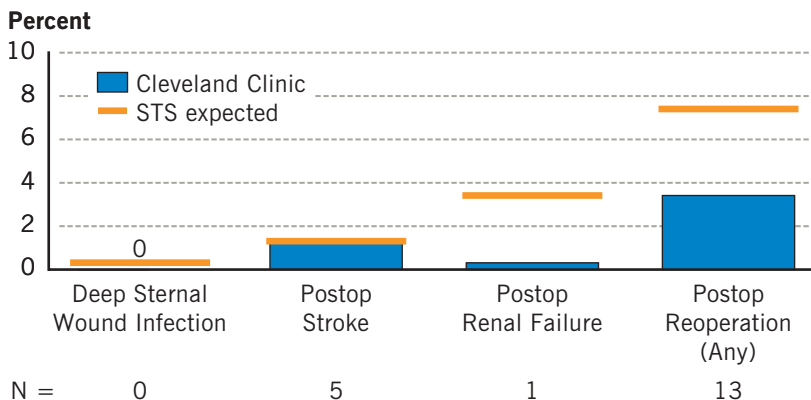
Cleveland Clinic ranked among the top 8% of US hospitals for aortic valve replacement (AVR) surgery, earning the Society of Thoracic Surgeons' (STS) 3-star rating for this category. This denotes the highest category of quality.



Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Isolated Aortic Valve Replacement Complications (N = 379)

2016



Cleveland Clinic had lower-than-expected rates of complications for isolated aortic valve replacement surgery.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

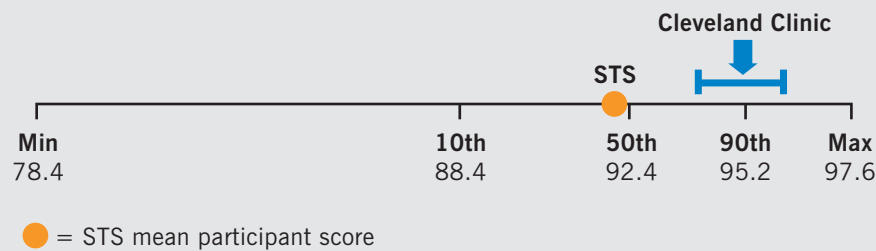
Valve Disease

STS Rating for Coronary Artery Bypass Graft and Aortic Valve Replacement

July 2013 – June 2016

Cleveland Clinic is ranked among top US hospitals for coronary artery bypass graft (CABG) surgery plus aortic valve replacement (AVR), earning the Society of Thoracic Surgeons' (STS) 3-star rating for this category (based on data from July 2013 through June 2016). This denotes the highest category of quality.

Participant Score (95% Confidence Interval)	STS Mean Participant Score	Participant Rating
95.1% (94.0, 96.0)	92.0%	☆☆☆

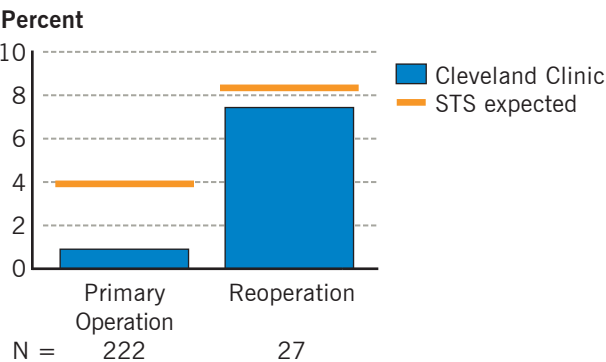


Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Combined AVR and CABG Surgery

In-Hospital Mortality (N = 249)

2016



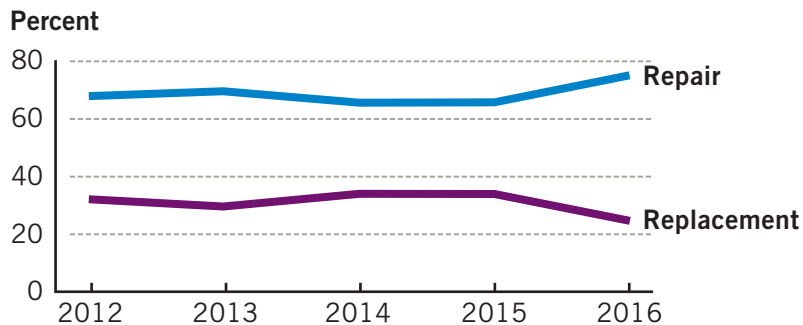
Aortic valve replacement, in combination with CABG surgery, is a complex operation. Despite this complexity and the associated increase in risks, in-hospital mortality rates for both primary operations and reoperations were low.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Mitral Valve Surgery (N = 1239)

Volume, Repair vs Replacement

2012 – 2016

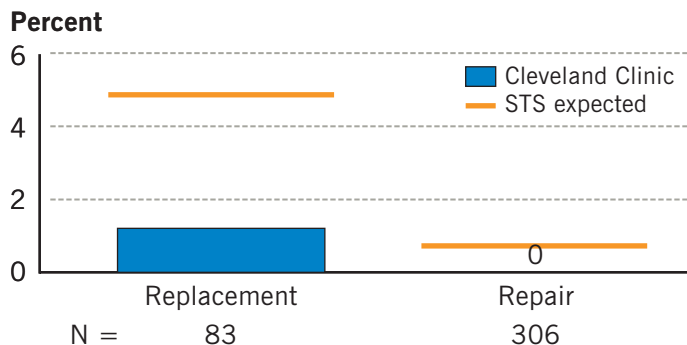


Cleveland Clinic performs mitral valve repair procedures rather than replacement whenever possible. Mitral valve repair is possible for more than 95% of patients who have mitral valve prolapse. The procedure is associated with better survival, improved lifestyle, better preservation of heart function, and a lower risk of stroke and infection (endocarditis) compared with mitral valve replacement. Repair procedures also do not require postprocedure anticoagulation therapy.

Isolated Mitral Valve Surgery

In-Hospital Mortality (N = 389)

2016



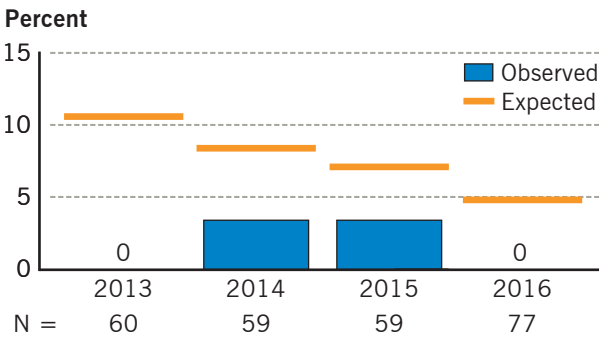
The 2016 in-hospital mortality rates for Cleveland Clinic patients who had isolated mitral valve surgery were lower than expected for both repair and replacement procedures.

Source: Society of Thoracic Surgeons (STS) National Adult Cardiac Surgery Database 2016

Surgical Treatment of Active Infective Endocarditis

Primary Operation, In-Hospital Mortality

2013 – 2016

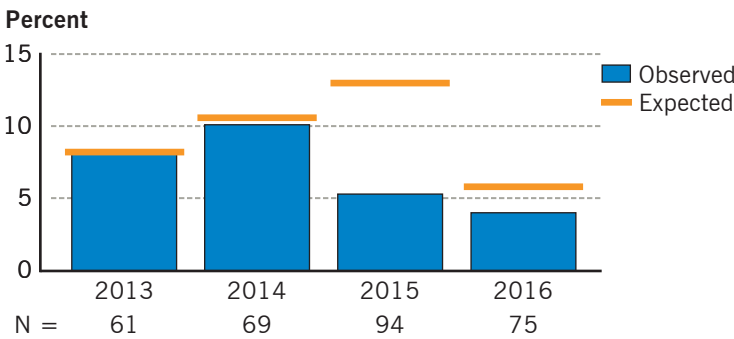


The in-hospital mortality rates for patients who had primary operations for infective endocarditis were lower than expected in 2016.

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Reoperation, In-Hospital Mortality

2013 – 2016



The in-hospital mortality rates for patients who had reoperations for infective endocarditis were lower than expected in 2016.

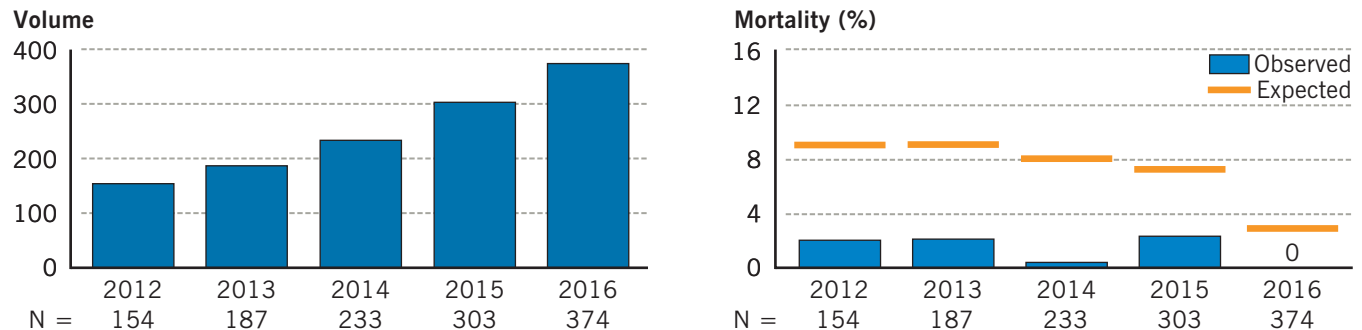
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Transcatheter Aortic Valve Replacement

Cleveland Clinic is a national leader in the use of percutaneous treatment options for patients with valve disease.

Volume and In-Hospital Mortality

2012 – 2016



A total of 374 patients had transcatheter aortic valve replacement procedures at Cleveland Clinic in 2016. The in-hospital mortality rate was 0% compared with an expected rate of 2.9%. The 30-day mortality rate was 0.3% (N = 1).

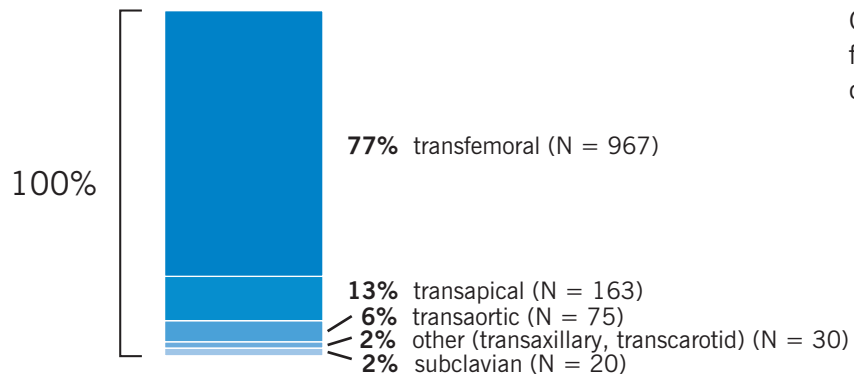
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Since the inception of the transcatheter aortic valve replacement (TAVR) program in 2006, Cleveland Clinic has become a world leader in the use of this specialized treatment in patients carefully selected based on stringent clinical criteria. A total of 1398 patients have had this procedure done from 2010 to 2016.

Source: STS/ACC TVT Registry™

Volume by Approach (N = 1255)

2012 – 2016



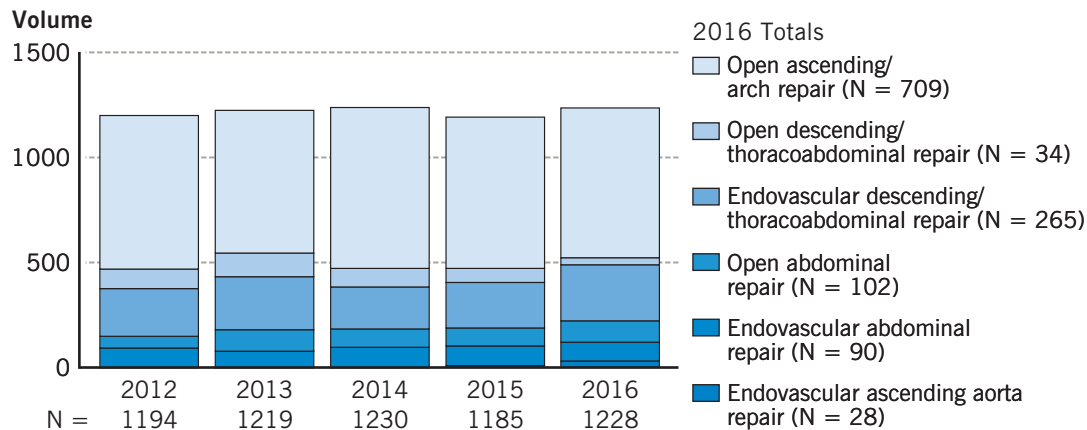
Of the 1255 TAVR procedures performed from 2012 through 2016, 77% have been done using a transfemoral approach.



Aortic Disease

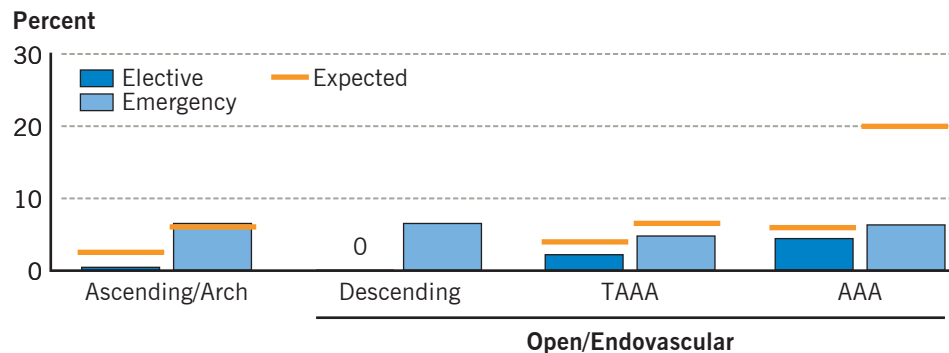
The Aorta Center in Cleveland Clinic's Heart & Vascular Institute is organized to optimize the care of patients and to facilitate collaboration across disciplines with a focus on conditions that affect all segments of the aorta. This multidisciplinary effort has resulted in the busiest aorta center in the US, leading the way in quality, innovation, and research.

Aortic Surgery Volume and Type 2012 – 2016



In-Hospital Mortality (N = 1228)

2016

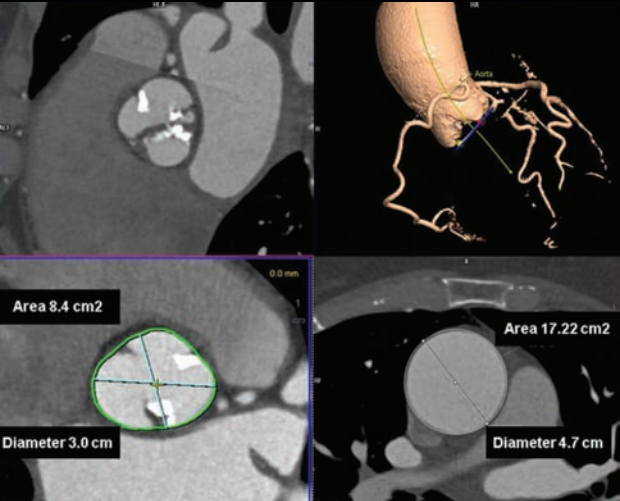


AAA = abdominal aortic aneurysm, TAAA = thoracoabdominal aortic aneurysm

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Cleveland Clinic's *Acute Aortic Treatment Center* provides rapid transport, treatment, and follow-up for patients with aortic dissection and impending aneurysm rupture. In 2016, 5634 patients were transported by Cleveland Clinic's Critical Care Transport team. More than 20% of the patients transported were treated in the Sydell and Arnold Miller Family Heart & Vascular Institute, and many had acute aortic syndromes. Call **877.379.CODE (2633)** to expedite the transfer of patients with acute aortic syndromes.

Redefining When to Operate

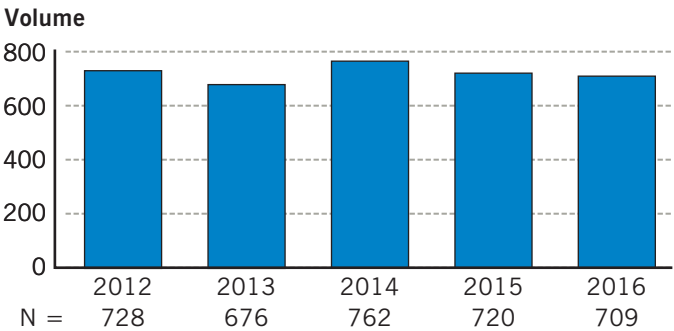


Two new studies from Cleveland Clinic's Aorta Center have explored the prognostic utility of indexing aortic diameter to patient height. Modern 3-dimensional tomographic imaging techniques were used for the data acquisition in both studies. In one study,¹ the risk of long-term mortality was analyzed in patients with a trileaflet aortic valve and a dilated proximal aorta. The second study² included 966 patients with a bicuspid aortic valve. Both studies confirmed improved prognostics when using the maximum aortic area/height ratio of $\geq 10 \text{ cm}^2/\text{m}$ over aortic diameter alone. The bicuspid valve study demonstrated better survival in patients who underwent proactive elective surgery.

References

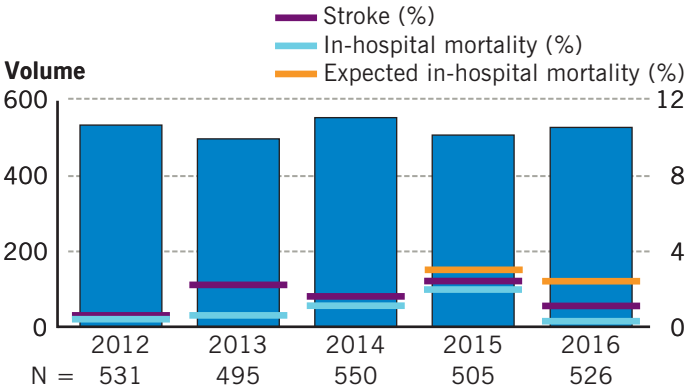
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2. Masri A, Kalahasti V, Svensson LG, Alashi A, Schoenhagen P, Roselli EE, Johnston DR, Rodriguez LL, Griffin BP, Desai MY. Aortic Cross-Sectional Area/Height Ratio and Outcomes in Patients With Bicuspid Aortic Valve and a Dilated Ascending Aorta. *Circ Cardiovasc Imaging*. 2017 Jun;10(6):e006249.

Ascending Aorta and Aortic Arch Open Surgery Volume 2012 – 2016



In 2016, Cleveland Clinic surgeons performed 709 open procedures to repair the ascending aorta and aortic arch.

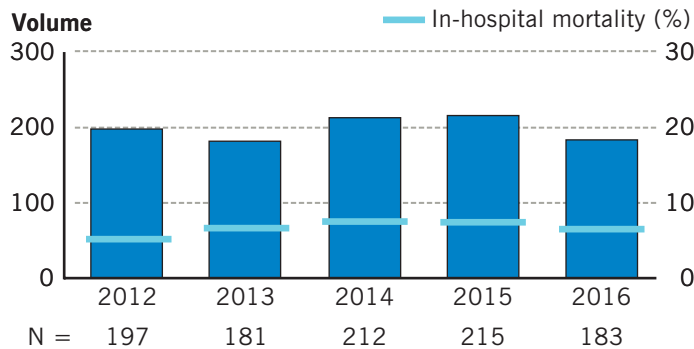
Elective Ascending Aorta and Aortic Arch Open Surgery Volume, Stroke Rate, and In-Hospital Mortality 2012 – 2016



In 2016, Cleveland Clinic surgeons performed 526 elective open procedures to repair the ascending aorta and aortic arch. The in-hospital mortality rate was 0.3%, and the rate of stroke was 1.1%.

Emergency Ascending Aorta and Aortic Arch Open Surgery Volume and In-Hospital Mortality

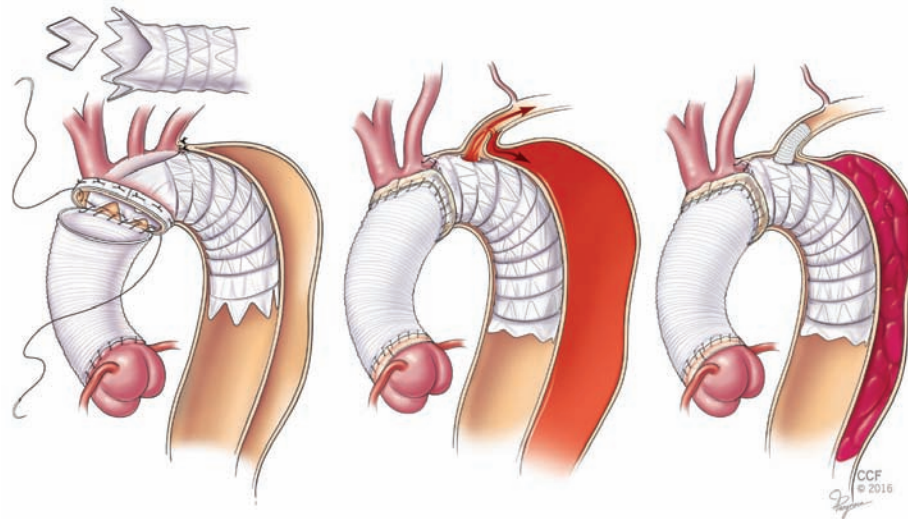
2012 – 2016



Cleveland Clinic surgeons performed 183 emergency open repairs of the ascending aorta and aortic arch in 2016, including acute aortic dissections and ruptures. These procedures are particularly urgent and challenging. The in-hospital mortality rate was 6.5% in 2016.

The B-SAFER Approach to Acute Ascending Aortic Dissection

Cardio-aortic surgeons at Cleveland Clinic's Aorta Center have developed a standardized and reproducible technique for performing extended aortic repair in patients who present with emergency type 1 aortic dissection. This branched single anastomosis frozen elephant trunk repair technique has evolved over the past 9 years and allows for a more extensive repair beyond the aortic arch without an increase in risk.



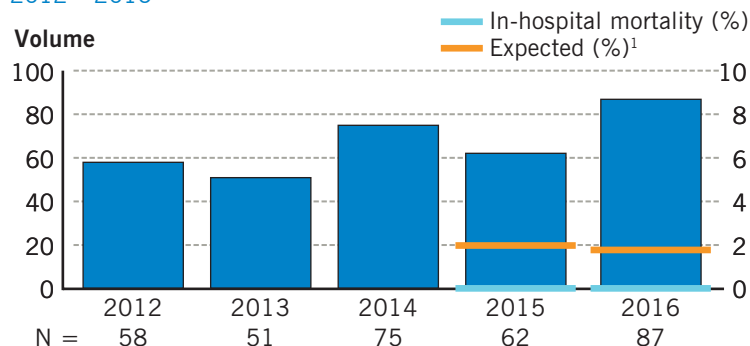
Aortic Disease

Valve-Preserving Operations

Cleveland Clinic cardio-aortic surgeons are among the most experienced in the world at performing valve-preserving aortic root aneurysm repairs (modified David's valve reimplantation procedure). They have performed 656 of these procedures, including 87 in 2016 (0% in-hospital mortality). In a recently published analysis of 178 patients with connective tissue disorder, freedom from reoperation at 6 years was 92%.¹ Cleveland Clinic surgeons also use this technique in patients who have bicuspid aortic valves (intraoperative photograph shown).

Modified David's Valve Reimplantation Procedure

2012 – 2016

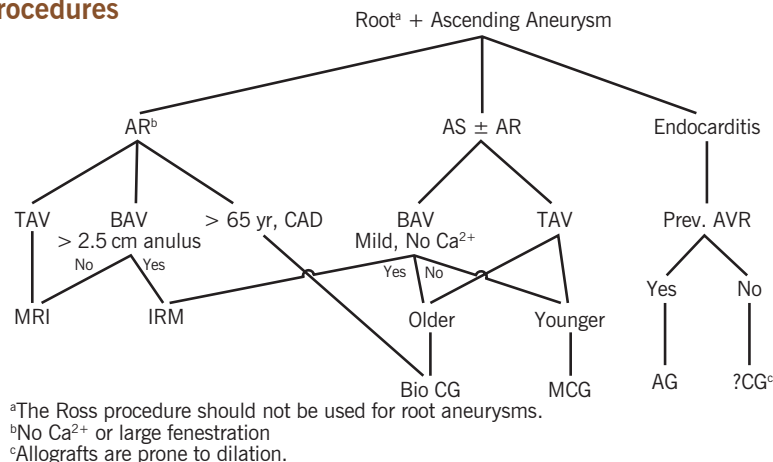


Reference

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An Algorithm for Choosing Among 4 Aortic Root Procedures

Safety, durability, long-term survival, and reoperations were recently analyzed in 957 patients who underwent elective root replacement operations for aneurysms of the aortic root and ascending aorta. Four aortic root procedures — valve preservation, mechanical or biologic composite grafts, and allografts — were shown to provide excellent survival and good durability. Valve-preserving and allograft procedures have the lowest gradients but more late regurgitation. Valve-preserving procedures are recommended for young patients while composite bioprostheses are recommended for elderly patients.



?CG = possible composite valve graft, depending on root abscess presence or active infection, AG = allograft, AR = aortic regurgitation, AS = aortic valve stenosis, AVR = aortic valve replacement, BAV = bicuspid aortic valve, Bio = biologic, Ca²⁺ = calcification, CAD = coronary artery disease, IRM = inclusion type of remodeling, MCG = mechanical composite graft, MRI = modified root-preserving reimplantation, Prev = previous, TAV = tricuspid aortic valve

Reference

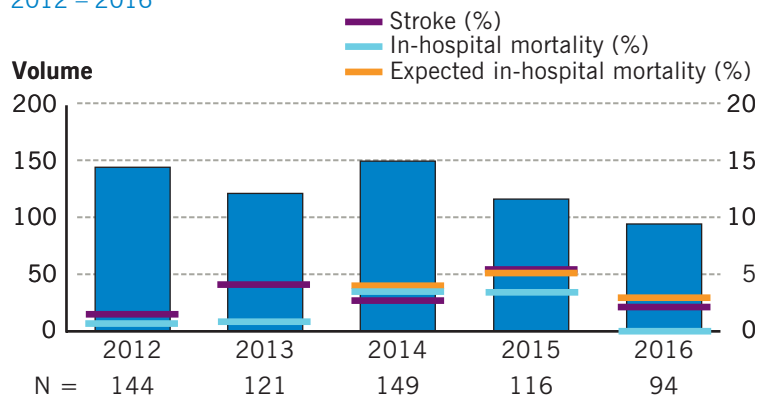
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Aortic Arch Aneurysm Repairs

At Cleveland Clinic in 2016, 94 patients had elective surgery to repair the aortic arch. The in-hospital mortality rate was 0%, compared with the expected rate of 2.9%.

Elective Aortic Arch Aneurysm Open Surgery Volume, Stroke Rate, and In-Hospital Mortality

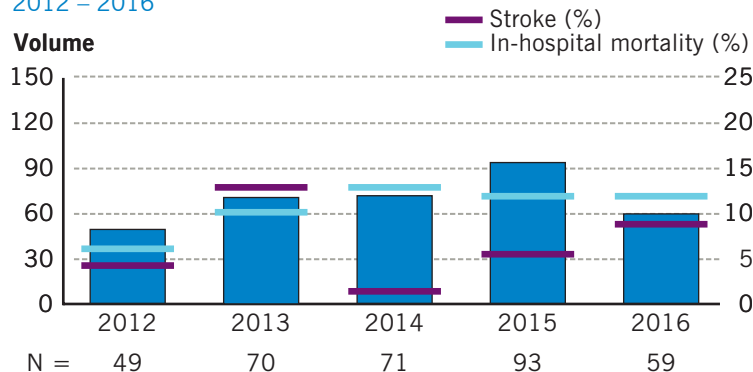
2012 – 2016



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Emergency Aortic Arch Aneurysm Open Surgery Volume, Stroke Rate, and In-Hospital Mortality

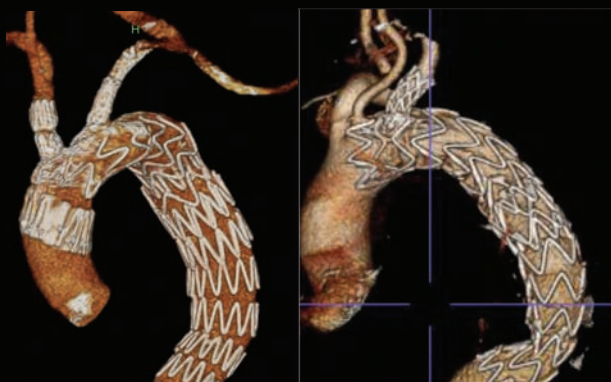
2012 – 2016



A total of 59 Cleveland Clinic patients had emergency open procedures to repair the aortic arch in 2016.

Redefining Zone Zero Stent Grafting

Because the vessels that supply the brain originate from the aortic arch, outcomes after surgery involving this segment are particularly dependent on experience. Even at high-volume centers, some high-risk patients may benefit from an alternative treatment. Cleveland Clinic aortic surgeons helped develop totally endovascular techniques to repair the arch. Both double-branched endovascular devices (left) and single-branched devices (right) are being investigated in trials at Cleveland Clinic.^{1,2}



References

1. Haulon S, Greenberg RK, Spear R, Eagleton M, Abraham C, Lioupis C, Verhoeven E, Ivancev K, Kölbel T, Stanley B, Resch T, Desgranges P, Maurel B, Roeder B, Chuter T, Mastracci T. Global experience with an inner branched arch endograft. *J Thorac Cardiovasc Surg.* 2014 Oct;148(4):1709-1716.
2. Roselli EE, Arko FR 3rd, Thompson MM; Valiant Mona LSA Trial Investigators. Results of the Valiant Mona LSA early feasibility study for descending thoracic aneurysms. *J Vasc Surg.* 2015 Dec;62(6):1465-1471.

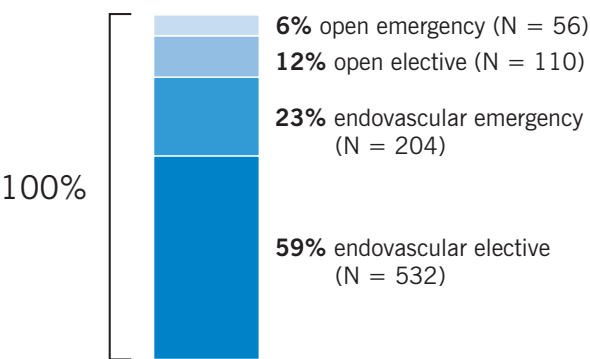
Aortic Disease

Descending Thoracic Aortic Disease

Aortic dissections and ruptured aneurysms commonly occur in the descending thoracic aorta (DTA). Patients with these conditions need prompt evaluation and treatment. Cleveland Clinic surgeons use open and endovascular repair techniques with excellent outcomes, and they tailor the choice to each patient's needs.

DTA Repair Volume and Type (N = 902)

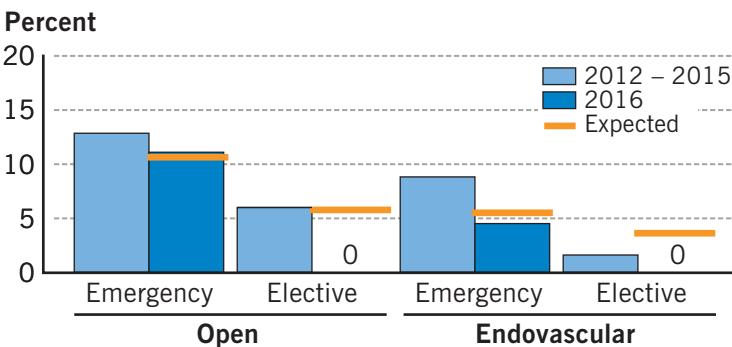
2012 – 2016



The majority of the 902 DTA repairs performed at Cleveland Clinic from 2012 through 2016 were done using an endovascular approach.

DTA Repair In-Hospital Mortality (N = 902)

2012 – 2016



Extensive experience with both open and endovascular treatment options for patients with descending thoracic aortic disease results in lifesaving therapy for patients. This includes even those who require high-risk emergency treatment.

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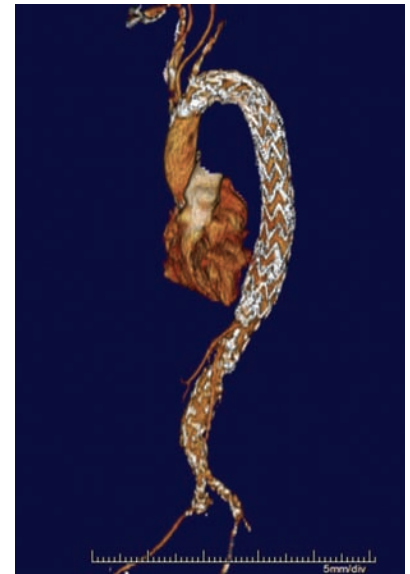
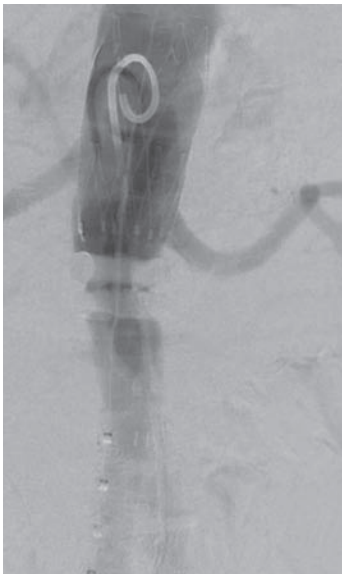
Thoracic Endovascular Aortic Repair for Descending Dissections



Physicians and surgeons in Cleveland Clinic's Aorta Center have the largest single-center experience in the US for treating patients with thoracic aortic dissection. A majority of these patients will develop late complications requiring an intervention. The multidisciplinary team works together to optimize the outcomes in these complex patients using the latest equipment in 1 of 5 innovative hybrid operating rooms.

Leading the Way in Endovascular Therapy for Aortic Disease

Cleveland Clinic surgeons continue to help advance the treatment of complex aortic disease by taking the lead in the evaluation and application of new technology. Cleveland Clinic physicians actively enroll patients in trials based on the development of advanced endovascular technology. This helps to improve care and speed recovery in patients with life-threatening aortic disease.



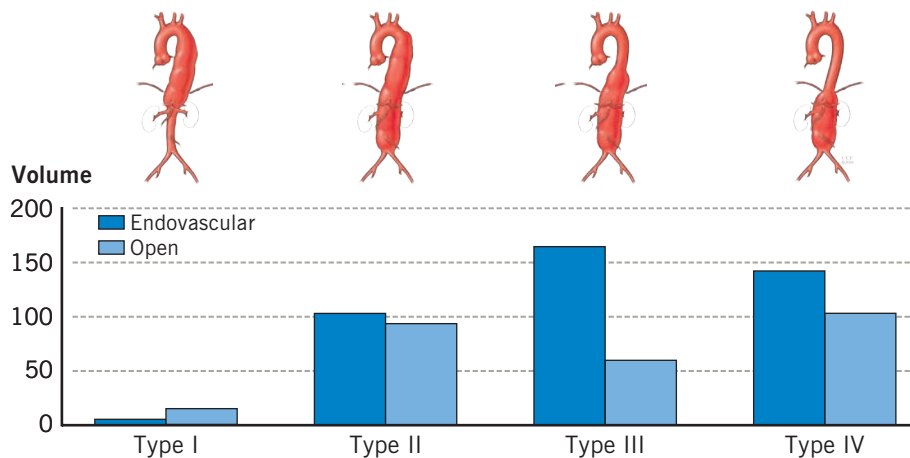
Aortic Disease

Thoracoabdominal Aortic Aneurysm Surgeries (N = 686)

The most challenging aortic procedures involve patients with thoracoabdominal aortic aneurysms (TAAAs). Cleveland Clinic surgeons have extensive experience using both open and endovascular techniques to treat these patients.

TAAA Surgeries by Crawford Classification of Aortic Aneurysms

2012 – 2016

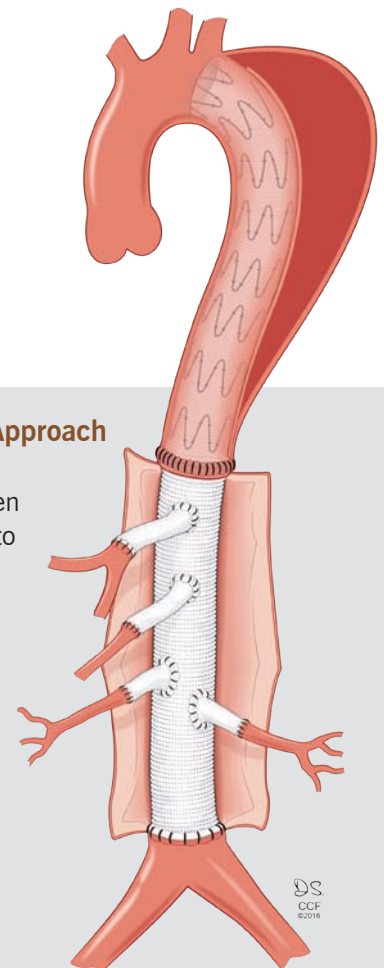


Thoracic Endovascular Repair First for Extensive Aortic Disease: The Staged Hybrid Approach

Open and endovascular approaches to aortic repair are complementary. Patients with the most extensive disease such as those with chronic aortic dissection or connective tissue disorders often require multiple operations staged over time. By combining open and endovascular procedures to completely replace the aorta, the overall risk can be lessened.^{1,2}

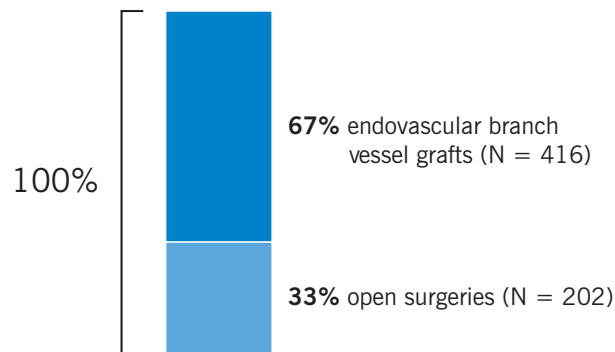
References

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TAAA Surgery Volume and Type (N = 618)

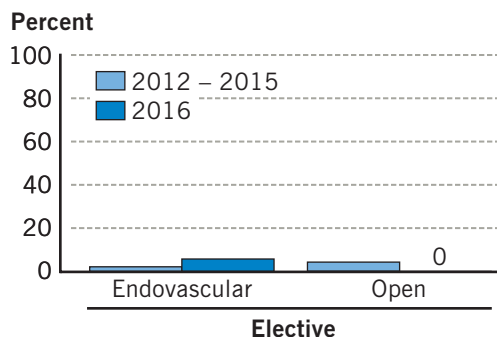
2012 – 2016



Cleveland Clinic surgeons performed 618 procedures to treat patients with TAAAs from 2012 through 2016.

TAAA Surgery In-Hospital Mortality (N = 618)

2012 – 2016



The complex nature of TAAA procedures is associated with a greater risk of death. Cleveland Clinic continuously strives to maintain the lowest mortality rates possible.

Less-Invasive Treatment of Complex Thoracoabdominal Aortic Aneurysms¹

Thoracoabdominal aortic aneurysms remain one of the most difficult and life-threatening problems cardiovascular surgeons address. Pioneers at Cleveland Clinic continue to help in the development of less-invasive endovascular methods to treat these diseases utilizing specialized stent grafts. Surgeons at Cleveland Clinic have treated more than 1500 patients during the past decade with this lifesaving technology. Their experience has helped to define how surgeons around the world approach this disease process and has contributed to the rescue of countless lives.

Reference

1. Eagleton MJ, Farivar B, Dias A. Large, single-center databases and the evolution of endovascular therapy for complex aortic aneurysms. *Surgery*. 2017 May 25. [Epub ahead of print].



Aortic Disease

Pelvic Blood Flow Preservation

Surgeons at Cleveland Clinic have helped to pioneer endovascular devices to treat abdominal and iliac artery aneurysms with endografts that incorporate branches to preserve pelvic circulation. While application of these devices has only recently become commercially available, physicians at Cleveland Clinic have been treating patients with novel devices for nearly a decade. This experience has allowed them to demonstrate that pelvic flow preservation in patients with aortic aneurysms is beneficial and durable and should be applied to patients with these complex diseases.¹

Reference

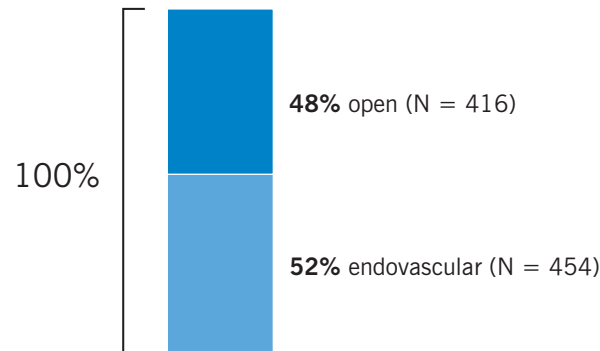
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Abdominal Aortic Aneurysms

The abdominal aorta is second to the ascending aorta for aneurysm repair volume at Cleveland Clinic. Surgeons treat patients with abdominal aortic aneurysms (AAAs) both below and adjacent to the renal arteries using both open and endovascular repair procedures.

AAA Procedure Volume and Type (N = 870)

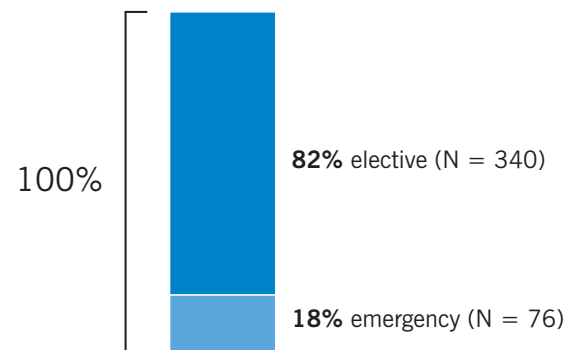
2012 – 2016



Cleveland Clinic surgeons performed 870 AAA repairs from 2012 through 2016. Outcomes at Cleveland Clinic are excellent for both types of surgery.

Open AAA Repair Volume and Type (N = 416)

2012 – 2016

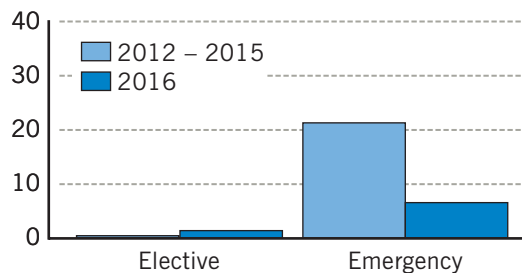


Cleveland Clinic surgeons performed 416 open AAA repairs from 2012 through 2016. The majority of these procedures were elective.

Open AAA Repair In-Hospital Mortality (N = 416)

2012 – 2016

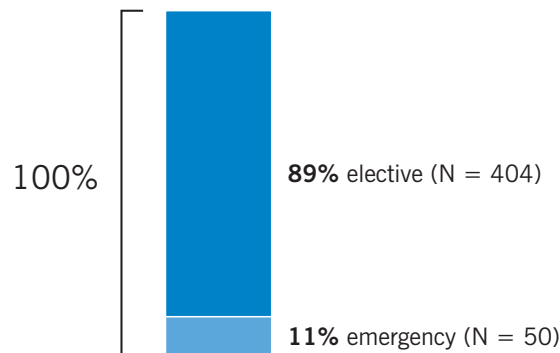
Percent



Despite the complexity of open AAA repair, Cleveland Clinic surgeons achieved low mortality rates for both elective and emergency procedures in 2016.

Endovascular AAA Repair Volume and Type (N = 454)

2012 – 2016

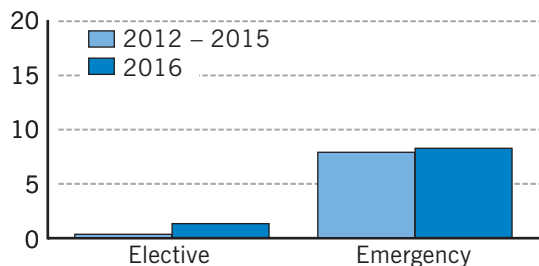


Cleveland Clinic surgeons performed 454 endovascular AAA repair procedures from 2012 through 2016.

Endovascular AAA Repair In-Hospital Mortality (N = 454)

2012 – 2016

Percent



Cleveland Clinic surgeons perform a high volume of endovascular AAA repairs and mortality rates are low.

Long-Term Outcomes for Aortic Endografting

Cleveland Clinic surgeons are expert at treating life-threatening aortic disease with both open and endovascular therapy. These physicians have helped to pioneer the development of this technology and define the best application of these tools to treat patients with complex, life-threatening aortic disease. Their dedication to their patients has allowed them to demonstrate that these new technologies are not only excellent at providing acute treatment of aortic lesions, but that treatment can provide long-term, durable outcomes prolonging patients' lives.

Reference

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Hypertrophic Obstructive Cardiomyopathy

Patient Volume

2016

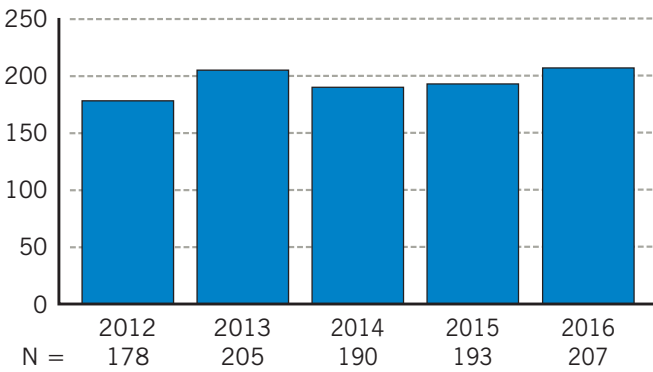
Hypertrophic obstructive cardiomyopathy (HOCM) is thickening of the lower chambers of the heart. The septal muscle, which divides the right and left chambers, is especially affected. The condition can impede blood flow from the heart to the aorta. Cleveland Clinic physicians use a comprehensive approach to diagnose and treat patients with HOCM. This approach includes a physical exam, EKGs, chest x-ray, echocardiogram, and MRI. Cleveland Clinic has a special interest in HOCM and is actively screening patients and their family members for genetic abnormalities associated with the disease.

Total HOCM outpatient visits	2531
New patients with HOCM	454

HOCM Surgical Volume (N = 973)

2012 – 2016

Volume



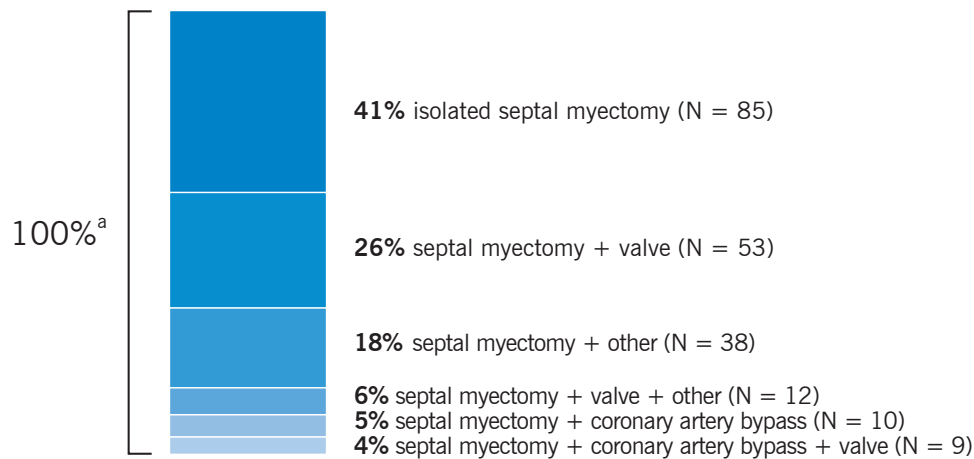
Cleveland Clinic continues to be one of the nation's leaders for volume and outcomes among patients with HOCM. In 2016, a total of 207 patients had surgical treatment for HOCM.

HOCM = hypertrophic obstructive cardiomyopathy

Surgical Procedure Distribution (N = 207)

2016

The largest subset of patients with HOCM who had surgical repair at Cleveland Clinic in 2016 had an isolated septal myectomy.

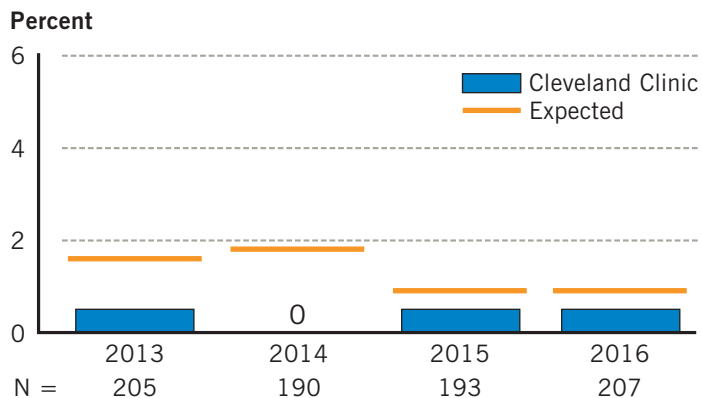


HOCM = hypertrophic obstructive cardiomyopathy

^aProcedural percentages are rounded.

Septal Myectomy In-Hospital Mortality

2013 – 2016



The expected in-hospital mortality rate for patients who had a septal myectomy in 2016 was 0.9%. The rate at Cleveland Clinic was lower (0.5%).

Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

3048

septal myectomies have been performed at Cleveland Clinic since 1967.

Congenital Heart Disease

Congenital heart disease affects an estimated 1 million people in America. Each year, approximately 1 in every 120 babies born in the US has a congenital heart defect. In some cases, the disease is life-threatening at birth. However, many people with a congenital heart condition do not know about it for years. Experts at Cleveland Clinic have extensive experience in the diagnosis and treatment of patients with all forms of congenital heart disease. The services of the Center for Pediatric and Adult Congenital Heart Disease are further enhanced by the Special Delivery Unit. The unit provides in utero diagnosis of complex heart conditions and immediate treatment after birth. Patients with more complex congenital heart disease who have surgery often require additional treatment or procedures throughout their lifetime and, therefore, need follow-up care from a team of experts in congenital heart disease. Cleveland Clinic Children's and Akron Children's Hospital have been collaborating since 2014 to provide the best care possible to patients with congenital heart disease.

Percutaneous Closure Procedures for Adult Congenital Heart Disease

Volume and Outcomes (N = 32)

2016

A total of 32 patients had percutaneous closure procedures at Cleveland Clinic in 2016. The success rate was 100%, and the mortality rate was 0% for both atrial septal defect and patent foramen ovale closures.

	N	Success	Mortality
Percutaneous ASD and PFO closures	32	100%	0%

ASD = atrial septal defect, PFO = patent foramen ovale

3-D Technology Advances Treatment for Complex Congenital Condition

The use of 3-D printing technology is enabling the advancement of care. One such case involves a 3-D printed model of a 9-year-old patient's heart. The patient was born with heterotaxy syndrome, which is a rare condition that causes compromised heart function and blood oxygen levels. Two prior surgeries did not result in adequate treatment. However, the 3-D model allowed the surgical team to fully develop a plan to divide the complex heart into 4 chambers. The surgery was a success and resulted in improved heart function and normal blood oxygenation.

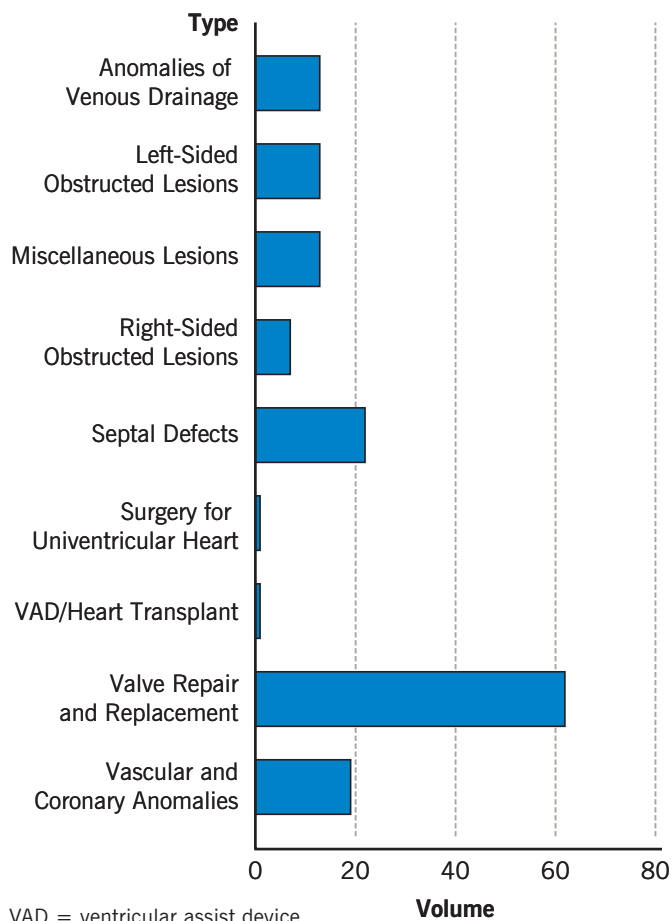


Adult Congenital Heart Surgery

Volume and Type (N = 151)

2016

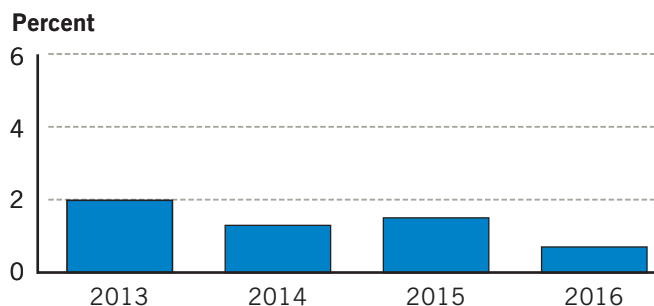
Cleveland Clinic cardiac surgeons performed 151 open heart surgeries on patients with congenital cardiac disease, excluding patients with bicuspid aortic valves and connective tissue disorders. With advances in medical care and better long-term survival of patients who had previous surgery as children, the volume of these adult patients is increasing.



In-Hospital Mortality (N = 151)

2013 – 2016

The in-hospital mortality rate for adult congenital heart surgery at Cleveland Clinic in 2016 was 0.7%. Many of these patients have very complex medical backgrounds and conditions and have had multiple surgeries.



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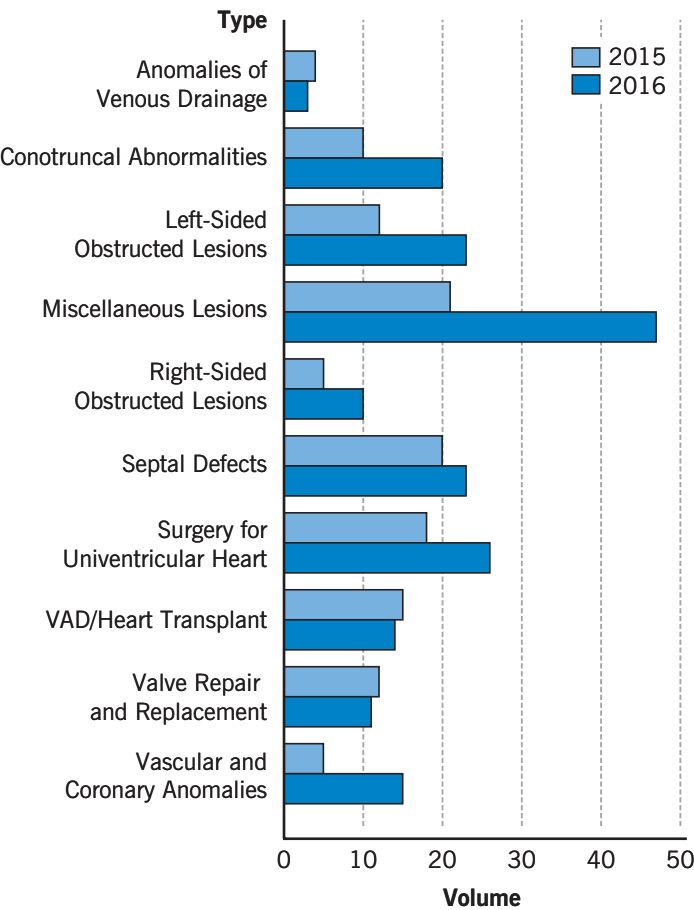
Congenital Heart Disease

Pediatric Congenital Heart Surgery

Volume and Type (N = 192)

2015 – 2016

Cleveland Clinic surgeons performed 192 pediatric congenital heart surgeries in 2016.

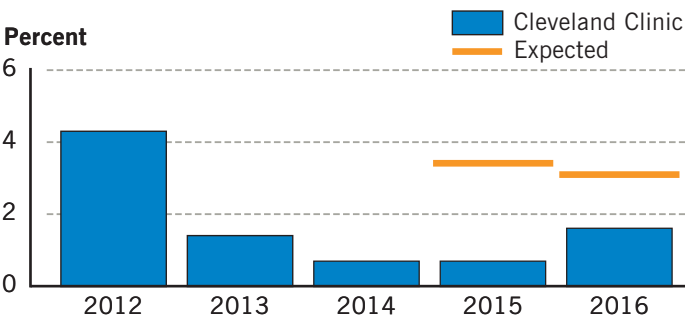


VAD = ventricular assist device

In-Hospital Mortality (N = 192)

2012 – 2016

Cleveland Clinic is committed to achieving the best possible outcomes for patients. The in-hospital mortality rate for pediatric congenital heart surgery patients in 2016 was well below the expected rate of 3.1%.



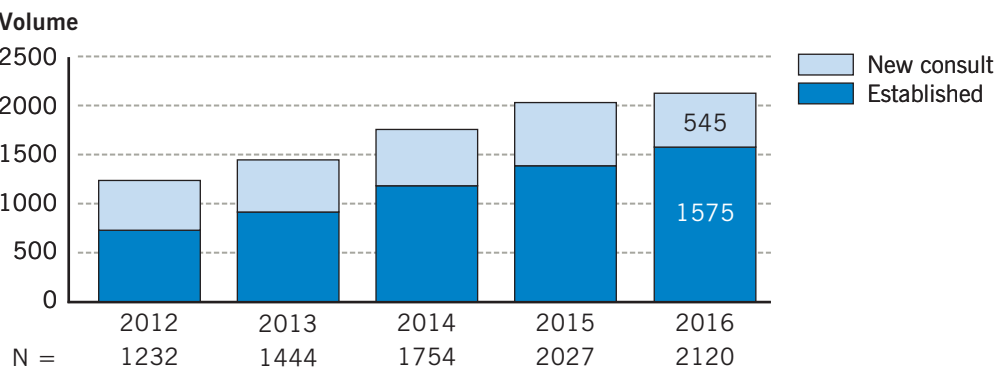
Source: Society of Thoracic Surgeons (STS) National Database 2016

Pericardial Disease

Pericardial disease includes a group of conditions that affect the pericardium, the double-layered sac that surrounds the heart. Cleveland Clinic's Center for the Diagnosis and Treatment of Pericardial Disease serves patients with a variety of pericardial syndromes. The multispecialty approach used at Cleveland Clinic involves cardiologists, surgeons, and imaging specialists, which enhances collaboration in the management of these diseases.

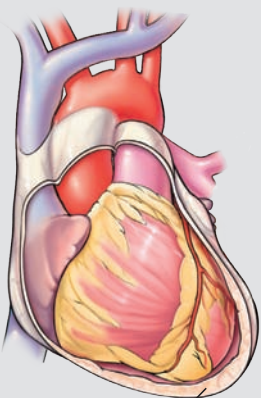
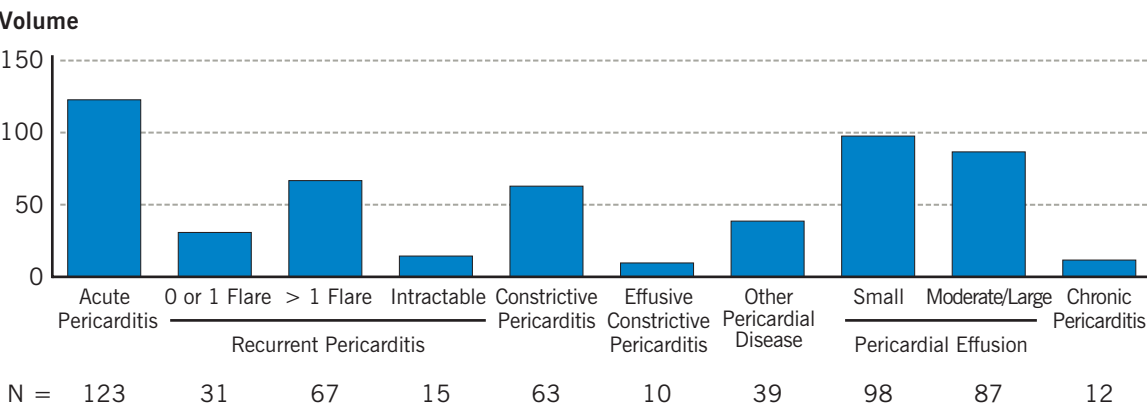
Patient Volume 2012 – 2016

In 2016, there were 2120 visits to the center.



Outpatient Clinic Volume, New Consult Patients, by Diagnosis (N = 545) 2016

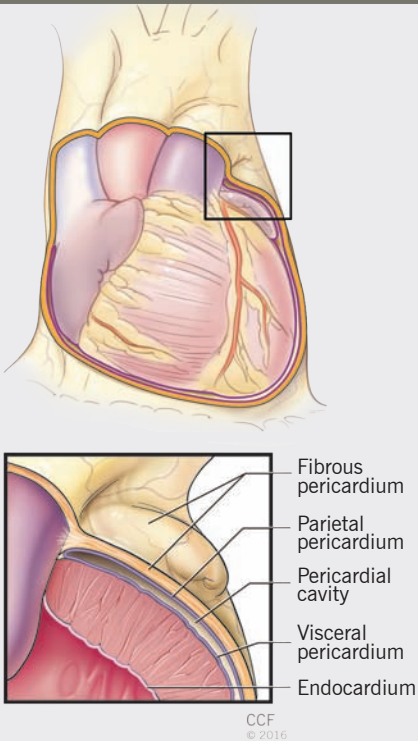
Cleveland Clinic treats patients with all types of pericardial disease. In 2016, the majority of new patients seen in Cleveland Clinic's pericardial disease outpatient clinic had acute pericarditis.



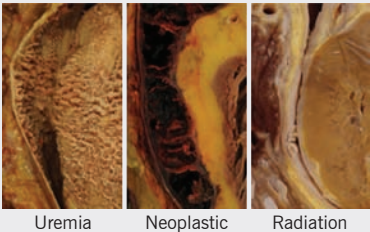
Thickened pericardium

The number of patients with pericardial disease who come to Cleveland Clinic for treatment continues to grow due to the unique diagnosis and treatment options available.

Pericardial Disease



Effect of Pericarditis

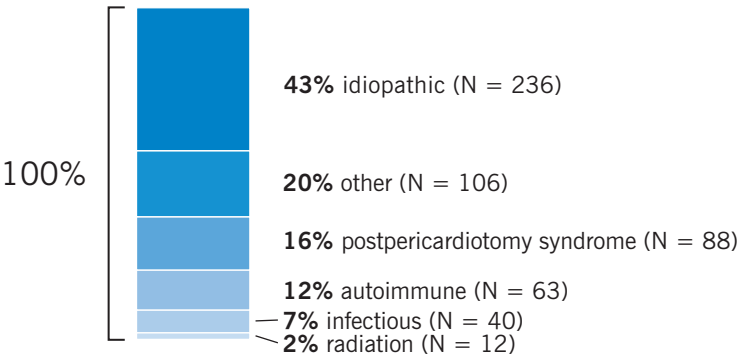


Source: Klein AL, Abbara S, Agler DA, Appleton CP, Asher CR, Hoit B, Hung J, Garcia MJ, Kronzon I, Oh JK, Rodriguez ER, Schaff HV, Schoenhagen P, Tan CD, White RD. American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with pericardial disease: endorsed by the Society for Cardiovascular Magnetic Resonance and Society of Cardiovascular Computed Tomography. *J Am Soc Echocardiogr.* 2013 Sep;26(9):965-1012.

Etiology (N = 545)

2016

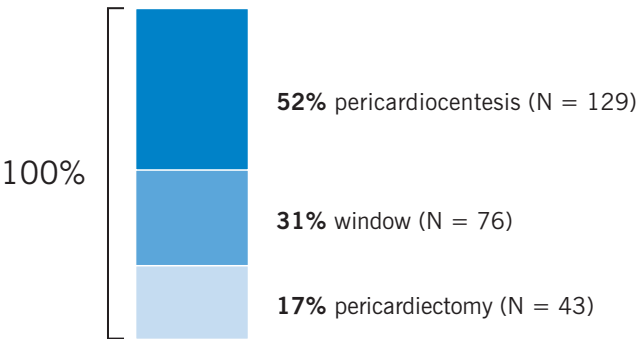
Pericarditis can be caused by a number of conditions; however, the cause is commonly unknown. In 2016, 236 new consult patients seen at Cleveland Clinic had pericarditis of unknown origin or possible viral etiology.



Pericardial Procedures (N = 248)

2016

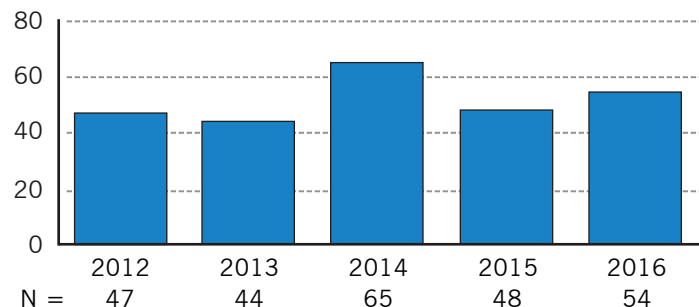
The majority of pericardial procedures performed at Cleveland Clinic in 2016 were pericardiocentesis procedures. This percutaneous treatment is used to drain large pericardial effusions. Echocardiography is used during the procedure to improve outcomes.



Heart Failure and Transplant

Heart Transplant Volume

Volume

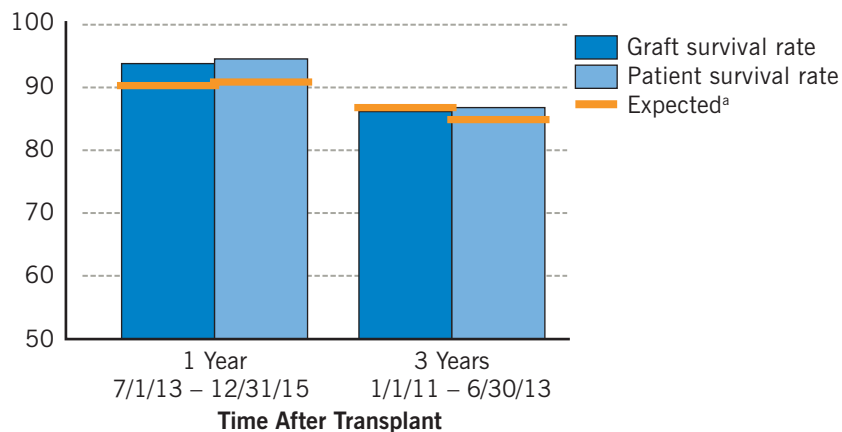


Cleveland Clinic's cardiac transplant program is one of the largest in the US and is the leading center in Ohio. Cleveland Clinic surgeons performed 54 heart transplant procedures in 2016.

Heart Transplant 1-Year and 3-Year Survival Rates

Cleveland Clinic is committed to achieving the best possible outcomes for patients. Our surgeons have more than 20 years of experience with heart transplantation. This level of expertise resulted in survival rates that were equal to or better than expected.

Survival (%)



Source: Scientific Registry of Transplant Recipients, January 2017. srt.org

^aExpected rate based on risk adjustment

1828

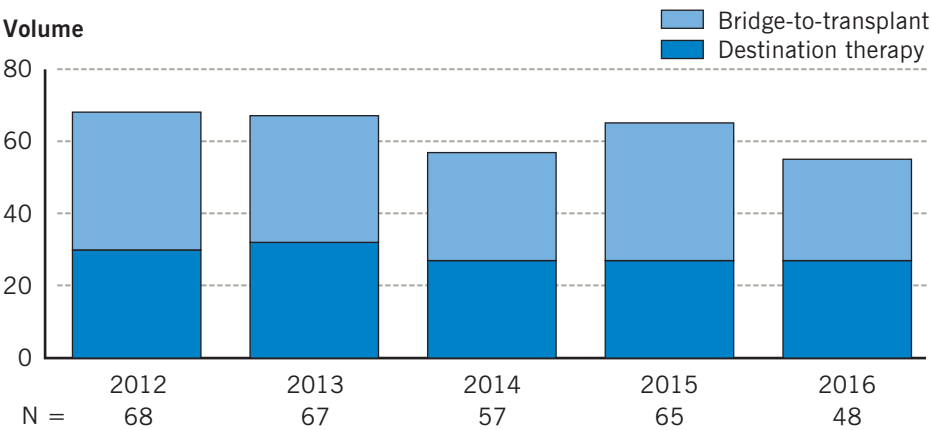
heart transplants have been performed at Cleveland Clinic since the cardiac transplant program began in 1984.

Heart Failure and Transplant

Ventricular Assist Device Implantation Volume^a

2012 – 2016 (N = 305)

Cleveland Clinic is a pioneer in the use of ventricular assist devices (VADs), having more than 25 years of experience. They can be used to help preserve heart function in patients who are awaiting transplant (bridge-to-transplant) or as a final treatment option (destination therapy). In 2016, VADs were used as bridge-to-transplant in 27 patients, and 21 patients received VADs as destination therapy.



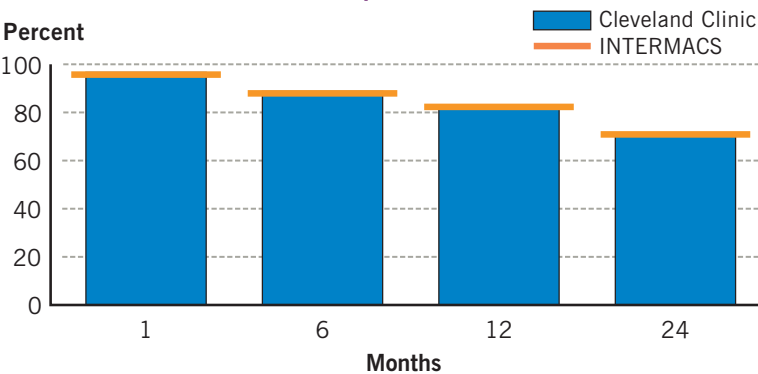
^a2012-2015 LVAD volumes revised to include pediatric devices, including Berlin Heart.

Ventricular Assist Device Implantation

2006 – March 2017

The Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) is a registry for patients with mechanical circulatory support devices. Compared with INTERMACS data, the survival rates for Cleveland Clinic patients with continuous flow LVADs were as expected or better. The incidence of post-implant adverse events was not statistically different for malfunction/thrombosis, infection, neurological dysfunction, and rehospitalization.

Continuous Flow LVAD Post-Implant Survival



INTERMACS = Interagency Registry for Mechanically Assisted Circulatory Support

Post-Implant Adverse Events

	Cleveland Clinic	INTERMACS
Bleeding	10.6%	13.2%
Device Malfunction and/or Pump Thrombosis	4.9% ^a	5.2%
Infection	14.3% ^a	13.8%
Neurological Dysfunction	4.9% ^a	4%
Rehospitalization	39.0% ^a	39.3%

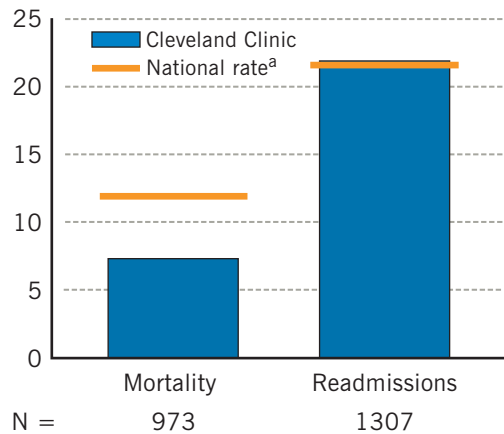
^aNo statistical difference

Heart Failure

Heart Failure All-Cause 30-Day Mortality and All-Cause 30-Day Readmissions

July 2013 – June 2016

Percent



CMS calculates 2 heart failure outcomes measures based on Medicare claims and enrollment information. The most recent risk-adjusted data available from CMS are shown. Cleveland Clinic's heart failure patient mortality rate is lower than the US national rate. CMS ranks Cleveland Clinic's performance as "better than" the US national rate. Although Cleveland Clinic's heart failure readmissions rate is slightly higher than the US national rate, CMS ranks Cleveland Clinic's performance as "no different than" the US national rate. To further reduce avoidable readmissions, Cleveland Clinic is focused on optimizing transitions from hospital to home or postacute facility. Specific initiatives have been implemented to ensure effective communication, education, and follow-up.

^aSource: [medicare.gov/hospitalcompare](https://www.medicare.gov/hospitalcompare)



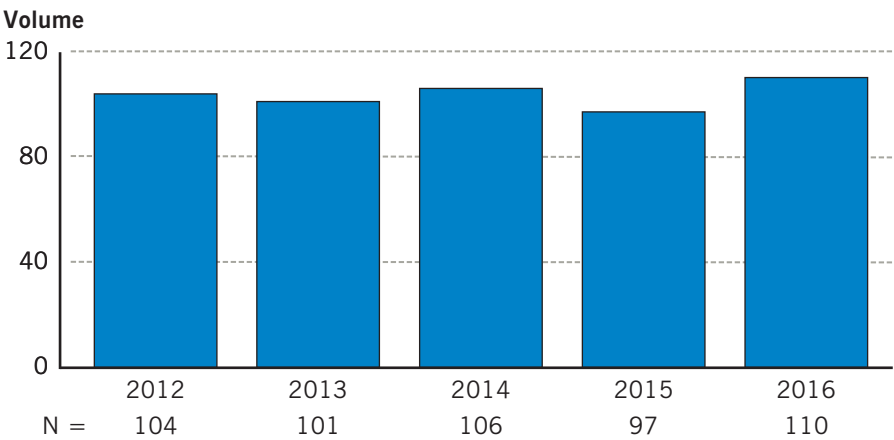
Lung and Heart-Lung Transplant



Cleveland Clinic performed 518 lung transplants from 2012 through 2016 and is one of the world's busiest centers. Cleveland Clinic surgeons performed 110 lung transplants in 2016 for patients from all over the country.

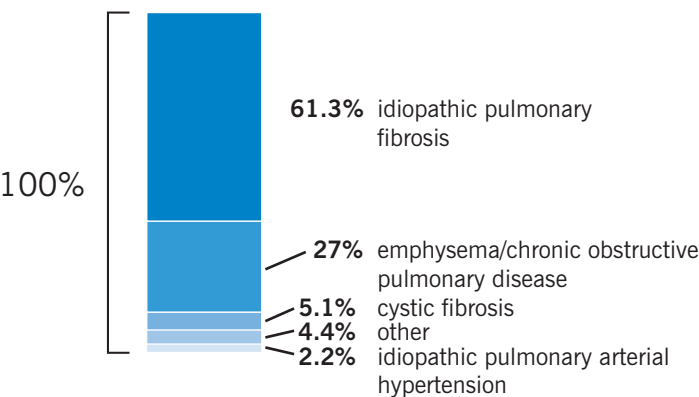
Lung Transplant Procedure Volume

2012 – 2016



Primary Disease of Lung Transplant Recipients (N = 137)

2016

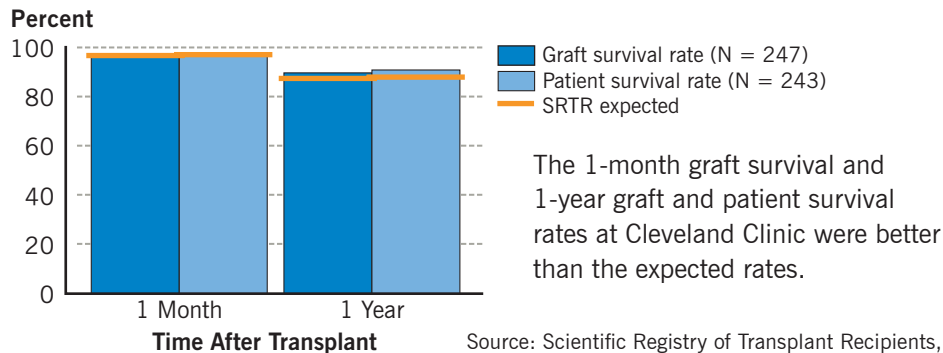


Idiopathic pulmonary fibrosis was the most common primary disease among patients who had lung transplant procedures at Cleveland Clinic in 2016.

Source: Scientific Registry of Transplant Recipients, July 2017. srrt.org

Lung Transplant 1-Month and 1-Year Survival

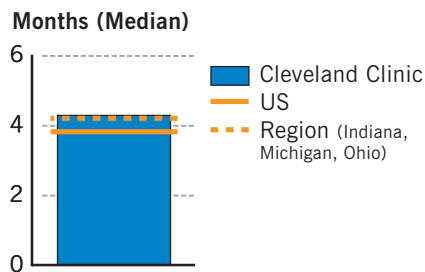
January 2014 – June 2016



Source: Scientific Registry of Transplant Recipients, July 2017. srtr.org

Wait Time for Lung Transplant

January 2011 – June 2016

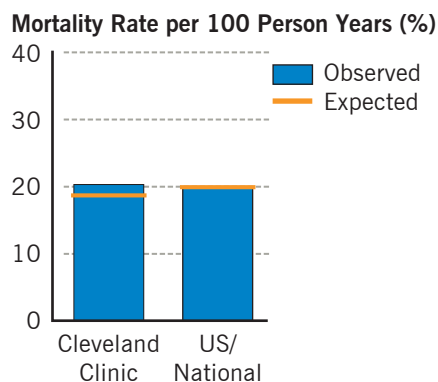


The wait time for a lung transplant at Cleveland Clinic was slightly higher than other programs in the region (4.3 vs 4.2 months) and the US as a whole (3.8 months). Most patients receive a transplant very quickly, but many patients at Cleveland Clinic have conditions that make it difficult to find suitable organs, thereby increasing the median wait time.

Source: Scientific Registry of Transplant Recipients, July 2017. srtr.org

Wait-List Mortality

2016

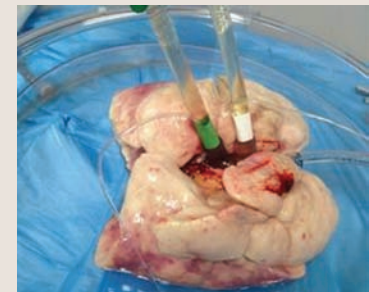


Cleveland Clinic strives to offer life-saving lung transplantation to as many patients as possible, and to achieve the best outcomes possible for patients waiting for the procedure. Because of an aggressive posture toward evaluating and listing extremely sick and high-risk candidates, Cleveland Clinic's wait-list mortality rate in 2016 was slightly higher than the national average.

Source: Scientific Registry of Transplant Recipients, July 2017. srtr.org

Ex Vivo Lung Perfusion

The majority (about 80%) of lungs donated for transplant are not usable due to infection, damage, or excess fluid. However, ex vivo lung perfusion allows many of these lungs to be converted to lungs that are transplantable, allowing more lives to be saved. Ex vivo perfusion was pioneered by Cleveland Clinic surgeons. The technique involves attaching the lungs outside of the body to a machine that perfuses them with a solution that helps remove excess water while they are being ventilated. If lung function improves, the lungs can be transplanted.¹



Reference

1. Cypel M, Yeung JC, Liu M, et al. Normothermic ex vivo lung perfusion in clinical lung transplantation. *N Engl J Med*. 2011 Apr 14;364(15):1431-1440.

Peripheral Vascular Disease

Peripheral artery disease (PAD) results from the buildup of plaque (atherosclerosis) in the arteries of the legs. For people with PAD, symptoms may be mild, requiring no treatment except modification of lifestyle (smoking cessation, diet modification, increased exercise, medications as indicated). In some people, the blockages may become more extensive, with accompanying pain and disability that limit walking. In the most advanced cases, individuals may be at risk for loss of limbs unless circulation is improved. For these patients with severe PAD, attempts to improve blood flow in the leg are usually indicated. The goals of improving blood flow to the limbs are to reduce pain, improve functional ability and quality of life, and prevent amputation.

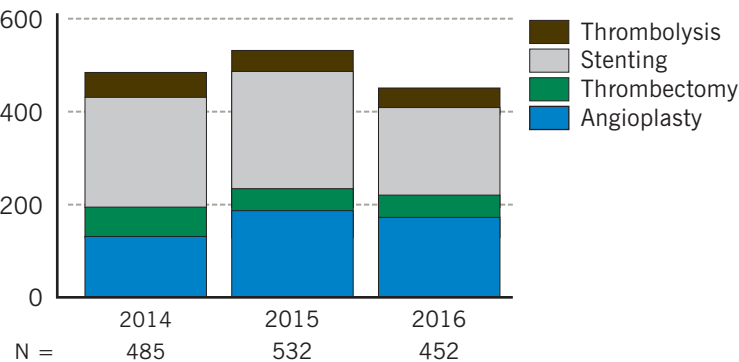
Lower Extremity Percutaneous Interventional Procedures (N = 452)

Cleveland Clinic's team of vascular surgeons and interventional cardiologists performs a high volume of complex percutaneous peripheral vascular interventional procedures.

Volume and Type

2014 – 2016

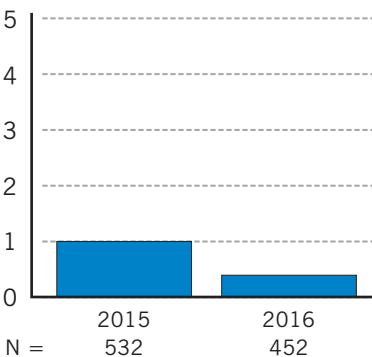
Volume



In-Hospital Overall Mortality

2015 – 2016

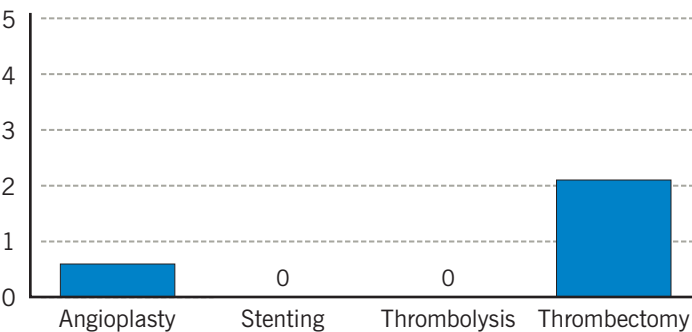
Percent



In-Hospital Mortality by Procedure (N = 452)

2016

Percent

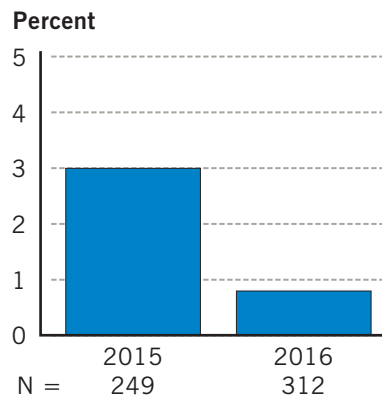


Lower Extremity Revascularization (N = 312)

A total of 312 lower extremity surgical procedures were performed at Cleveland Clinic in 2016. Mortality rates for all procedures were low.

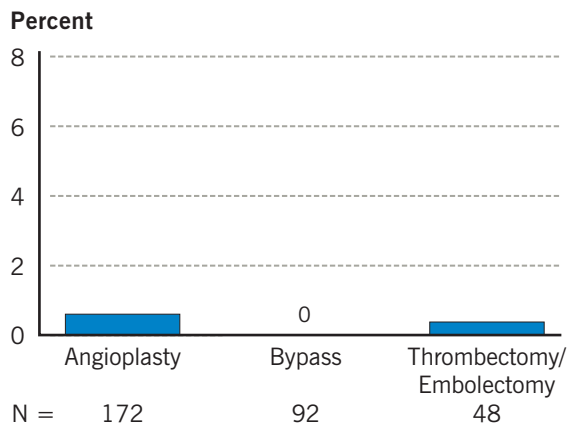
Overall 30-Day Mortality

2015 – 2016



30-Day Mortality by Procedure (N = 312)

2016



Femoral Artery Occlusion



The common femoral arteries, especially on the right, and the iliac arteries are severely diseased.

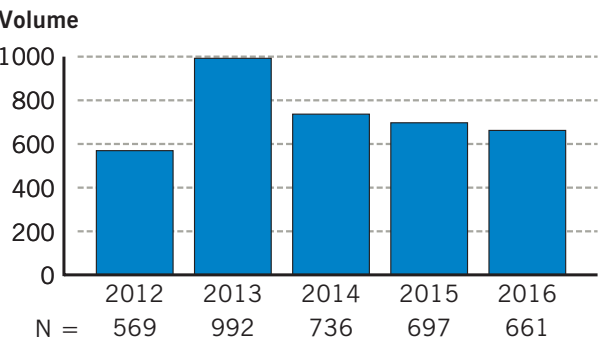


Inflow patency is restored with common femoral endarterectomy and iliac intervention.

Peripheral Vascular Disease

Executive Health Screening Program

2012 – 2016



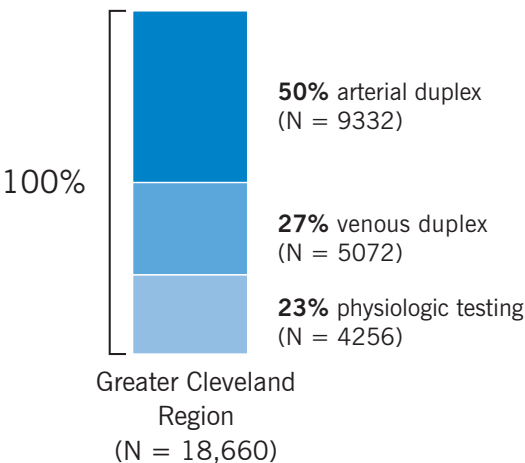
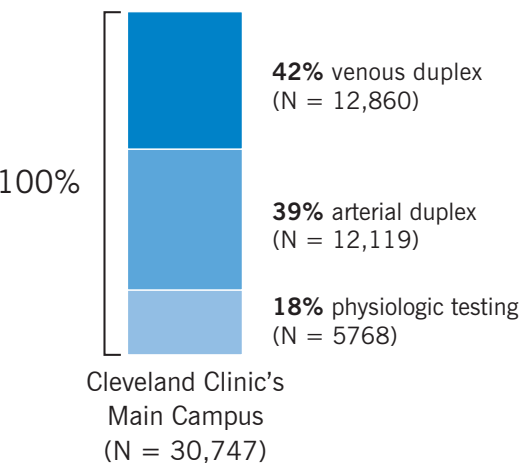
The Executive Health Screening Program is designed to identify any potential peripheral vascular disorders that can affect a patient's health and well-being. The exam can identify problems such as carotid artery stenosis, which is a risk factor for stroke; peripheral artery disease, which can indicate an increased risk of heart attack and stroke and impair function and quality of life; and abdominal aortic aneurysm (AAA). A ruptured AAA is almost entirely preventable if it is identified and the patient is monitored; however, about 15,000 people die each year in the US due to ruptured AAAs.

Noninvasive Vascular Lab Ultrasound Study

The Noninvasive Vascular Laboratory provides service 7 days a week to diagnose arterial and venous disorders throughout the vascular tree and for follow-up after revascularization procedures, such as bypass grafts and stents. In 2016, the staff performed 49,407 vascular lab ultrasound studies at Cleveland Clinic's main campus and throughout the greater Cleveland region. All Cleveland Clinic vascular lab technologists are certified registered vascular technologists, which exemplifies Cleveland Clinic's commitment to quality patient care.

Volume and Distribution (N = 49,407)^a

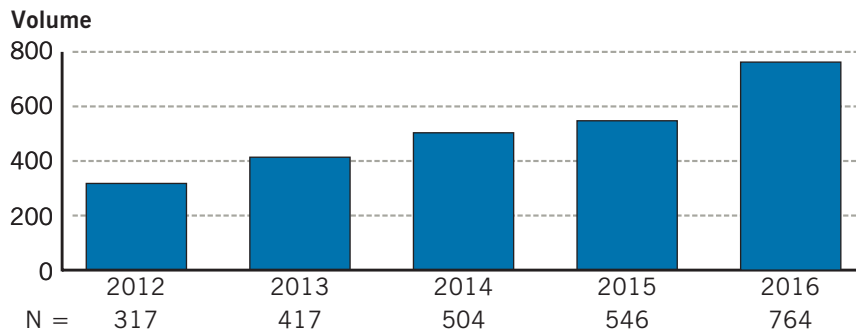
2016



^aPercentage totals were rounded.

Fibromuscular Dysplasia

2012 – 2016



Fibromuscular dysplasia (FMD) is a vascular condition in which there is abnormal cell growth in the walls of medium and large arteries. This can cause the arteries to become narrowed (stenosis) and can also lead to aneurysm and dissection. Cleveland Clinic's FMD program is dedicated to caring for and educating patients with FMD. It conducts research to better understand the condition and treatment options.

Thrombosis Center

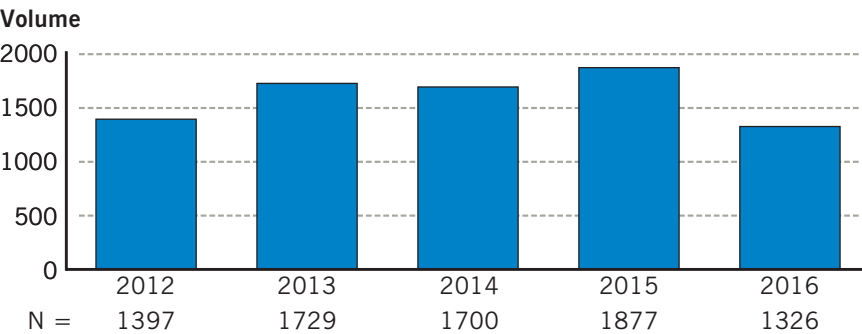
Cleveland Clinic's Thrombosis Center was established in 2009. It includes a multidisciplinary group of specialists in vascular medicine, vascular surgery, adult and pediatric care, hematology, interventional radiology, cardiology, cardiac surgery, and laboratory medicine. The group works together to provide the best possible treatment to patients with deep vein thrombosis, pulmonary embolism, and hypercoagulable states.



Peripheral Vascular Disease

Lower Extremity Wound Clinic

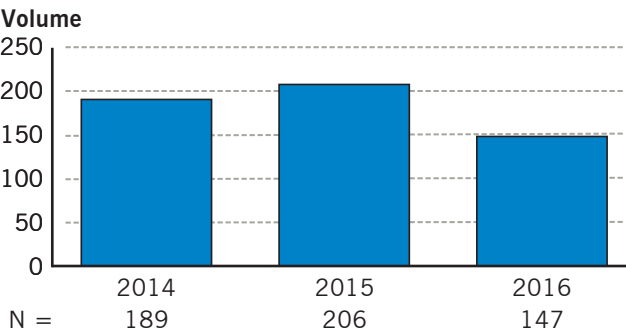
2012 – 2016



A total of 1326 patients received treatment in the Lower Extremity Wound Clinic at Cleveland Clinic in 2016.

Iliac Stenting

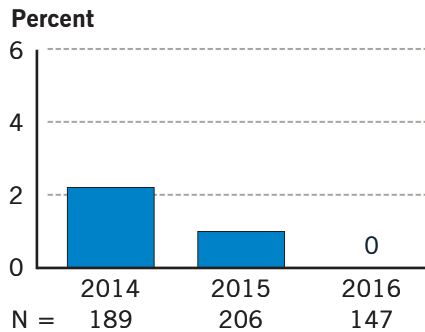
2014 – 2016



Cleveland Clinic physicians performed 147 iliac stent procedures in 2016. The use of stents to treat patients with iliac occlusive disease is associated with excellent outcomes that include restored blood flow and minimal complications.

Iliac Stenting, In-Hospital Mortality Rate

2014 – 2016



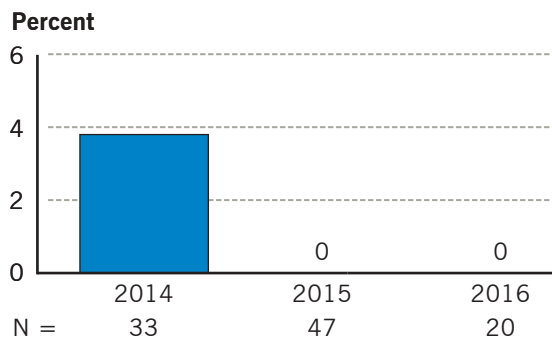
Cleveland Clinic achieved a 0% mortality rate for iliac stenting in 2016.

Femoral Endarterectomy With Stenting

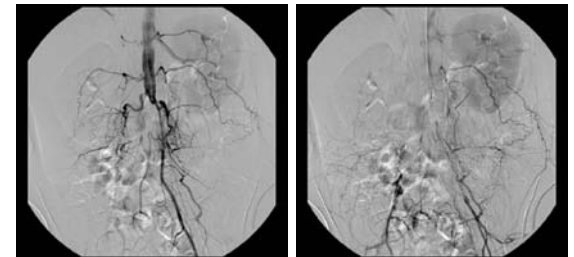
In 2016, Cleveland Clinic performed 20 femoral endarterectomy procedures with stenting. This hybrid procedure is used in place of an aortic femoral bypass for patients with complex aortoiliac occlusive disease.

In-Hospital Mortality

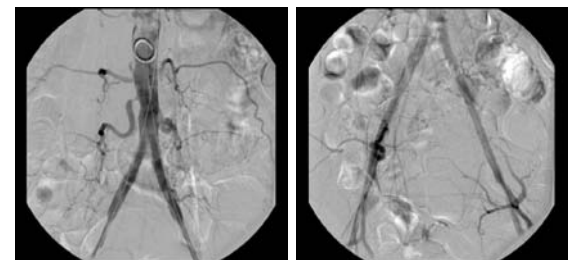
2014 – 2016



Femoral Endarterectomy With Stenting for Treatment of Aortic Occlusion



Before



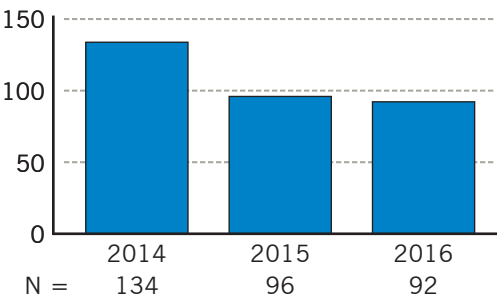
After

Peripheral Vascular Disease

Lower Extremity Bypass

2014 – 2016

Volume

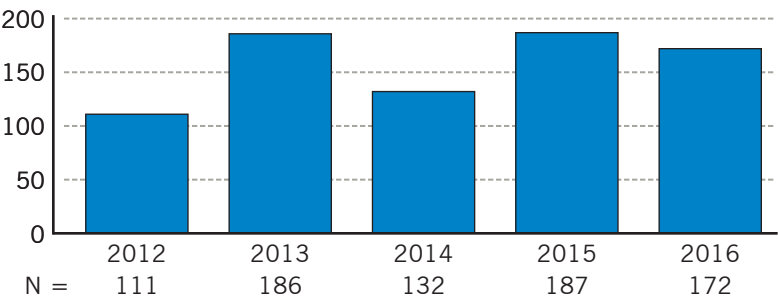


Lower extremity bypass restores blood flow in the legs of patients with symptomatic PAD. In 2016, Cleveland Clinic surgeons performed 92 bypass procedures.

Angioplasty

2012 – 2016

Volume



Angioplasty is used to widen the artery and clear blockages in some patients with advanced PAD. The procedure can be combined with stenting to support the cleared vessel and keep it open. In 2016, Cleveland Clinic performed 172 of these procedures.

Cerebrovascular Disease

Cleveland Clinic's commitment to innovation includes the use of the most advanced treatment options for patients. Carotid stenting and endarterectomy are 2 such options for patients with cerebrovascular disease. Cleveland Clinic is included in the Vascular Quality Initiative®, a nationwide prospective database used to collect and analyze outcomes of surgical and minimally invasive vascular procedures. Participation in the initiative allows collaboration within Cleveland Clinic and with other institutions to enhance cerebrovascular treatment outcomes and maintain quality reporting.

Procedural Complications

2012 – 2016

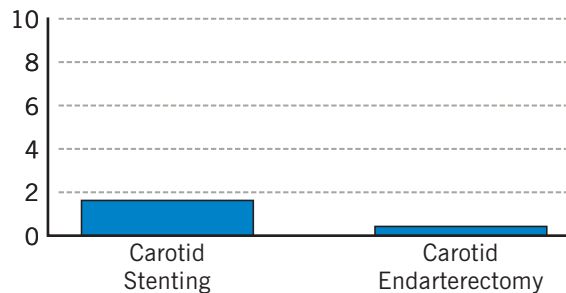
	N	MI (%)	Stroke (%)	In-Hospital Mortality (%)
Carotid stenting	316	0.9	1.9	1.6
Carotid endarterectomy	1354	0.7	2.0	0.4

MI = myocardial infarction

In-Hospital Mortality

2016

Percent



In-hospital mortality rates were low for patients who had carotid stenting (1.6%) and carotid endarterectomy (0.4%) at Cleveland Clinic in 2016.

Thoracic Surgery

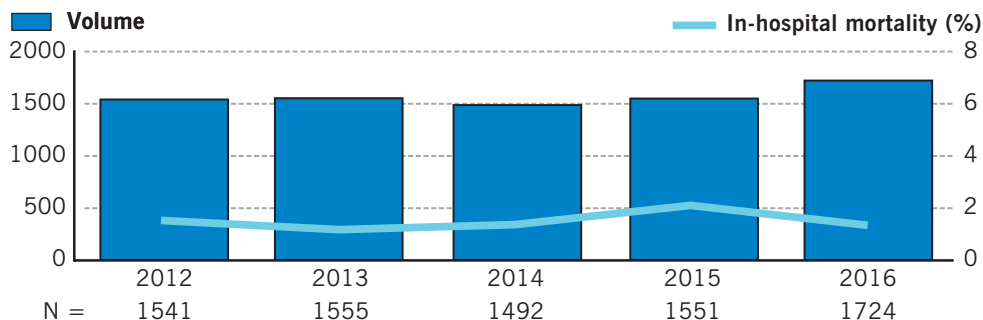


Cleveland Clinic thoracic surgeons treat patients with a wide variety of diseases of the lung and esophagus. The staff includes specialists in lung and esophageal cancer, lung failure, airway disease, swallowing disorders, and other diseases. Diagnosis and treatment approaches include the most advanced techniques, such as minimally invasive surgery.

General Thoracic Surgery

Volume and In-Hospital Mortality

2012 – 2016



In 2016, Cleveland Clinic surgeons performed 1724 thoracic procedures. The STS General Thoracic Surgery in-hospital mortality rate for 2016 is 1.3%.

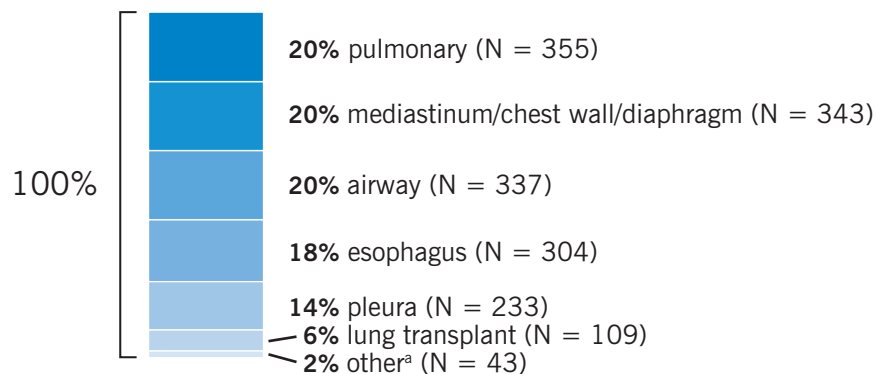
Note: Includes patients with various risk factors – data not risk-adjusted.

Source: Society of Thoracic Surgeons (STS) General Thoracic Surgery Database, July 2013 – June 2016

Major Thoracic Surgery

Distribution by Type (N = 1724)

2016

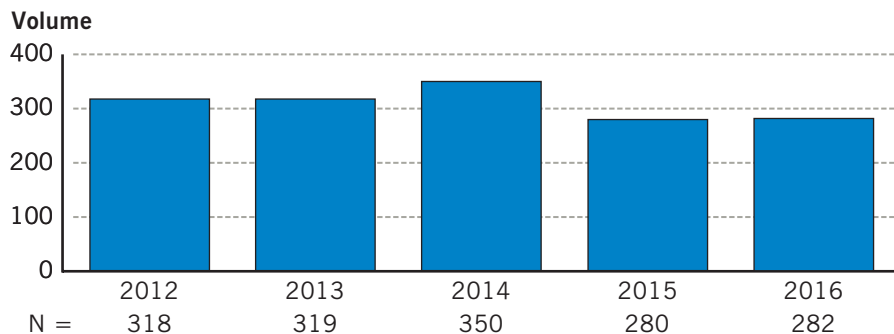


^a“Other” category includes thymectomies, wedge resections, tumor surgeries, paraesophageal hiatal hernia repairs, and thyroidectomies.

Cleveland Clinic thoracic surgeons perform a variety of procedures to treat patients with even the most complex diseases.

Pulmonary Resection

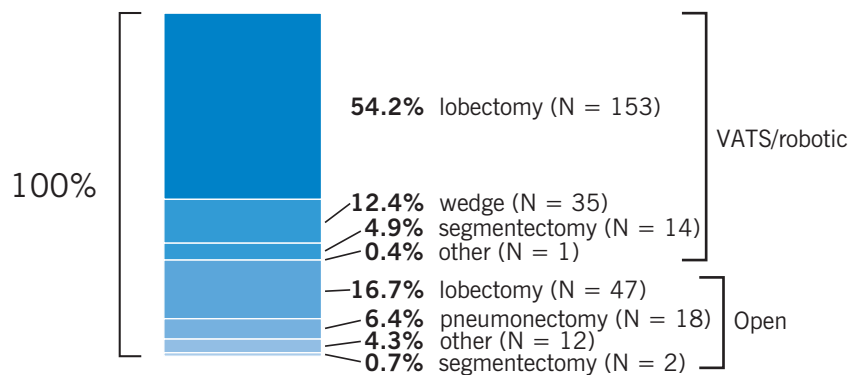
2012 – 2016



Cleveland Clinic surgeons performed 282 pulmonary resections in 2016.

Distribution by Type (N = 282)

2016



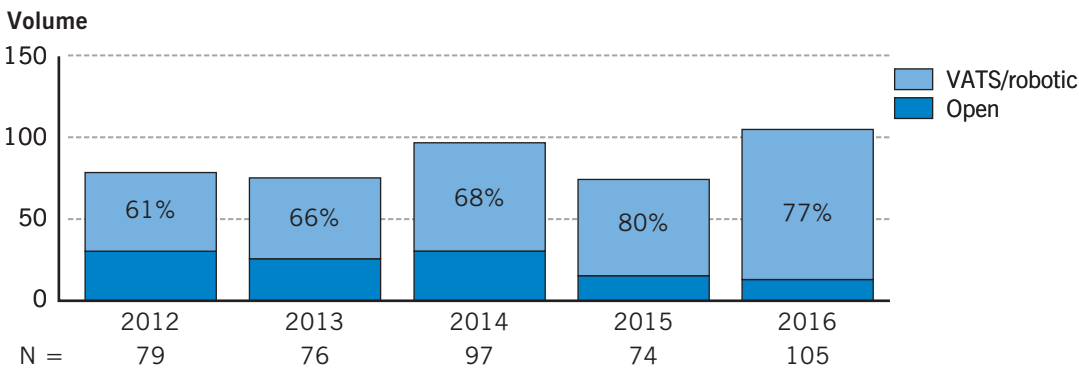
VATS = video-assisted thoracic surgery

The majority of pulmonary resections performed at Cleveland Clinic in 2016 were open and video-assisted lobectomies. Video-assisted thoracic surgery and robotic techniques are used when appropriate to yield the best possible outcomes for each patient.

Thoracic Surgery

Lobectomy for Stage I Lung Cancers

2012 – 2016

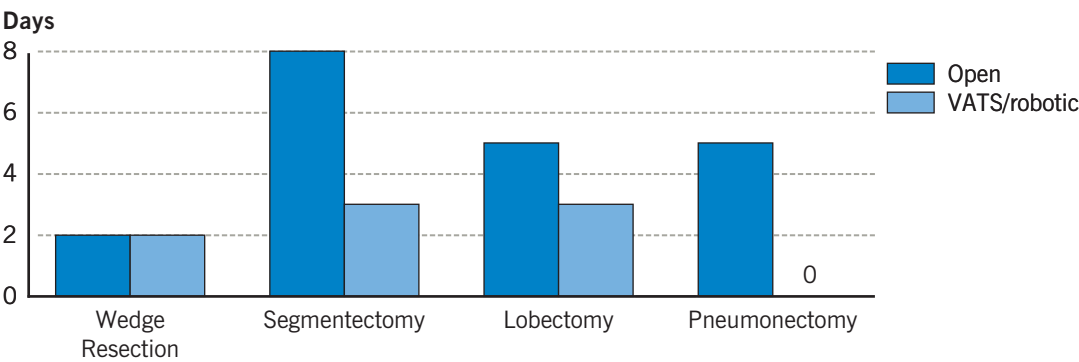


VATS = video-assisted thoracic surgery

Cleveland Clinic surgeons use video-assisted/robotic techniques whenever appropriate for patients having lobectomies. These procedures are less invasive than open procedures and can improve outcomes.

Postoperative Median Length of Stay (N = 282)

2016



VATS = video-assisted thoracic surgery

Many of the procedures Cleveland Clinic thoracic surgeons perform can be done using both open and video-assisted thoracic surgery (VATS) techniques. The use of VATS or robotic techniques is associated with less postoperative pain, a shorter length of stay, and faster return to normal activities.

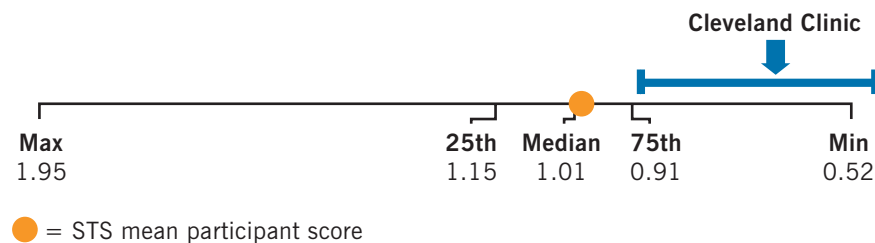
Pulmonary Resection for Lung Cancer

Combined Morbidity and 30-Day Mortality (N = 631)

July 2013 – June 2016

Cleveland Clinic surgeons performed 631 pulmonary resections for lung cancer from July 2013 through June 2016. The risk-adjusted rates for morbidity and 30-day mortality were among the best in the country.

Eligible Procedures	Unadjusted Rate	Risk-Adjusted Rate (95% Confidence Interval)	Standardized Incidence Ratio (95% Confidence Interval)
631	5.2%	4.8% (3.5, 6.4)	0.66 (0.48, 0.89)



STS = Society of Thoracic Surgeons

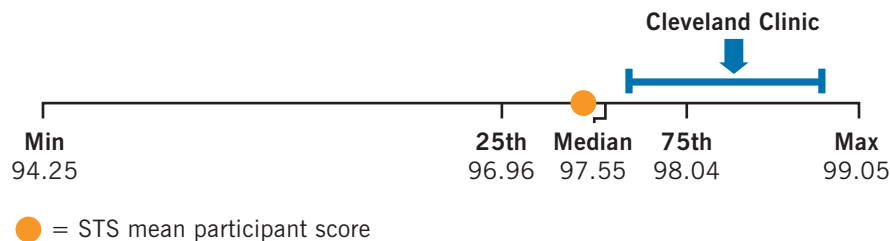
Source: Society of Thoracic Surgeons (STS) General Thoracic Surgery Database, July 2013 – June 2016

Lobectomy for Lung Cancer

Composite Quality Rating

July 2013 – June 2016

Participant Score (95% Confidence Interval)	STS Mean Participant Score	Participant Rating
98.3% (97.71, 98.84)	97.4%	☆☆☆



STS = Society of Thoracic Surgeons

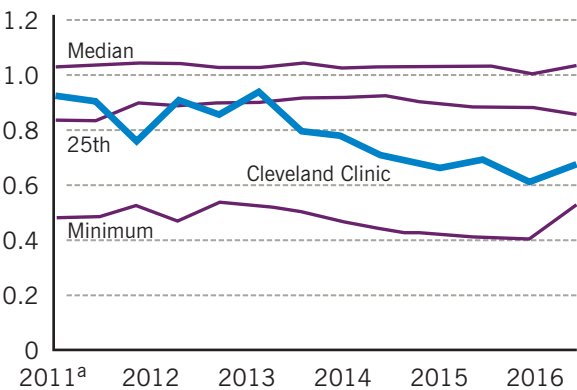
Source: Society of Thoracic Surgeons (STS) General Thoracic Surgery Database, July 2013 – June 2016

Thoracic Surgery

Combined Morbidity and 30-Day Mortality

2011 – 2016

Estimated Standardized Incidence Ratio

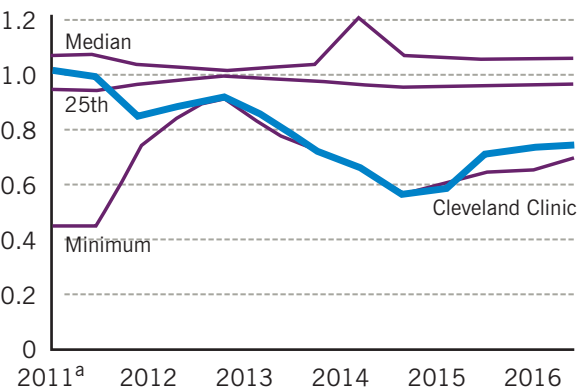


^aSingle quarter reported

30-Day Mortality

2011 – 2016

Estimated Standardized Incidence Ratio



^aSingle quarter reported

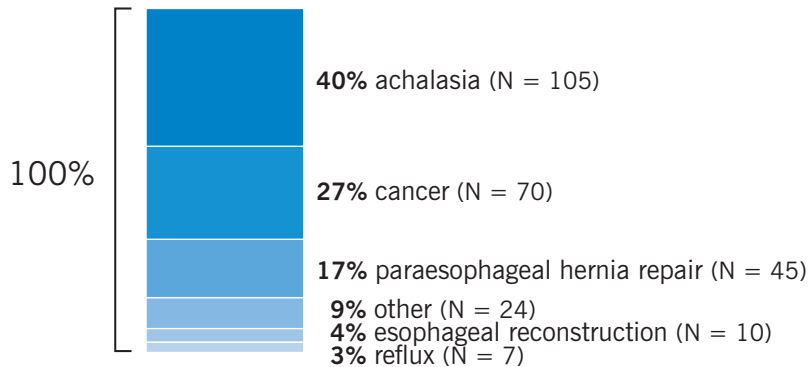
The standardized incidence ratio is a ratio of the participant's risk-adjusted rate divided by the overall observed outcome rate in the STS database, which includes all participants. The lower the ratio, the better the performance. Median performance, 25th percentile, and minimum (or best performance) among STS database participants are provided here, along with Cleveland Clinic data. Cleveland Clinic has consistently ranked in the top 10% and achieved an STS 3-star rating every year since the inception of the ranking system.



Esophageal Surgery

Distribution by Indication (N = 261)

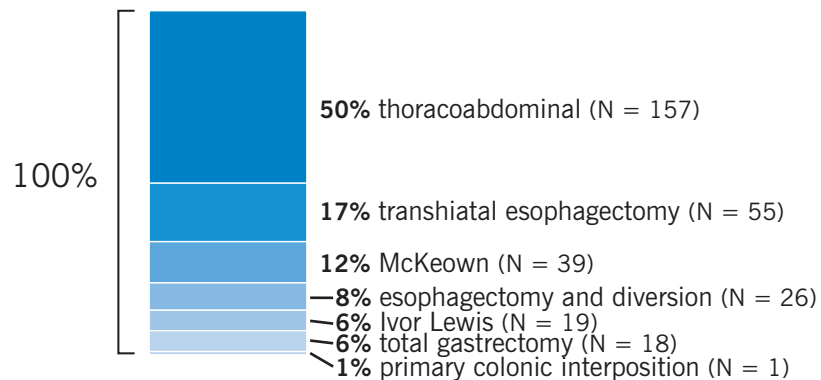
2016



Cleveland Clinic thoracic surgeons treat patients with a diverse range of conditions, including malignant and benign diseases. Cleveland Clinic is a quaternary referral center for complex esophageal disease.

Esophagectomy by Type (N = 315)

2016



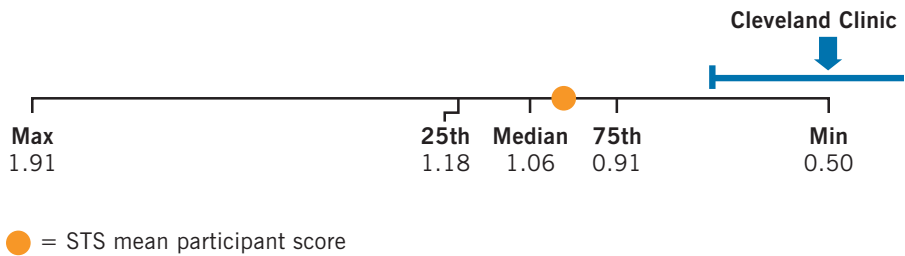
Thoracic Surgery

Esophagectomy for Esophageal Cancer

Combined Morbidity and 30-Day Mortality (N = 153)

July 2013 – June 2016

Eligible Procedures	Unadjusted Rate	Risk-Adjusted Rate (95% Confidence Interval)	Standardized Incidence Ratio (95% Confidence Interval)
153	14.4%	14.7% (10.1, 19.8)	0.55 (0.38, 0.75)

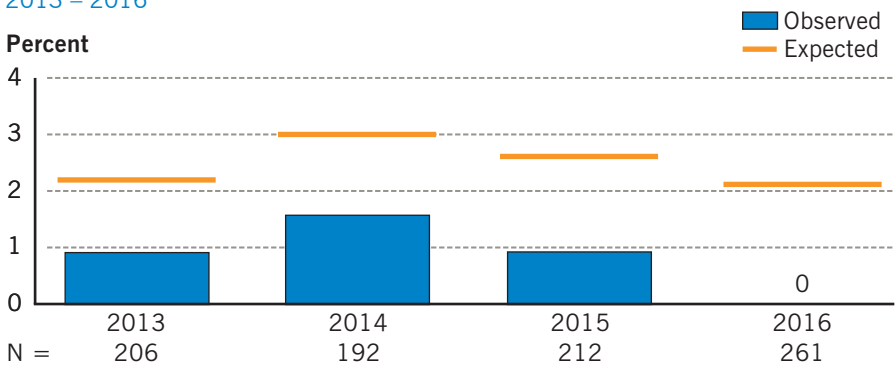


Source: Society of Thoracic Surgeons (STS) General Thoracic Surgery Database, July 2013 – June 2016

Cleveland Clinic surgeons performed 153 esophagectomy procedures for patients with esophageal cancer from July 2013 through June 2016. The combined morbidity and 30-day mortality risk-adjusted rate was among the best in the country.

In-Hospital Mortality

2013 – 2016



Cleveland Clinic thoracic surgeons performed 261 esophageal procedures in 2016 and achieved a lower-than-expected in-hospital mortality rate (0% vs 2.1%).

Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

Preventive Cardiology and Rehabilitation

2016 Volume

Prevention outpatient visits	10,662
Phase I rehab	7713
Phase II rehab	4036
Phase III rehab	4395

The Section of Preventive Cardiology and Rehabilitation at Cleveland Clinic provides patients with a comprehensive assessment to identify traditional and emerging nontraditional cardiovascular risk factors. The section collaborates with referring physicians to create individualized treatment plans. Patients typically have a limited number of visits and return to their primary care or referring physician for care.

LDL Levels Among Statin-Tolerant Adults

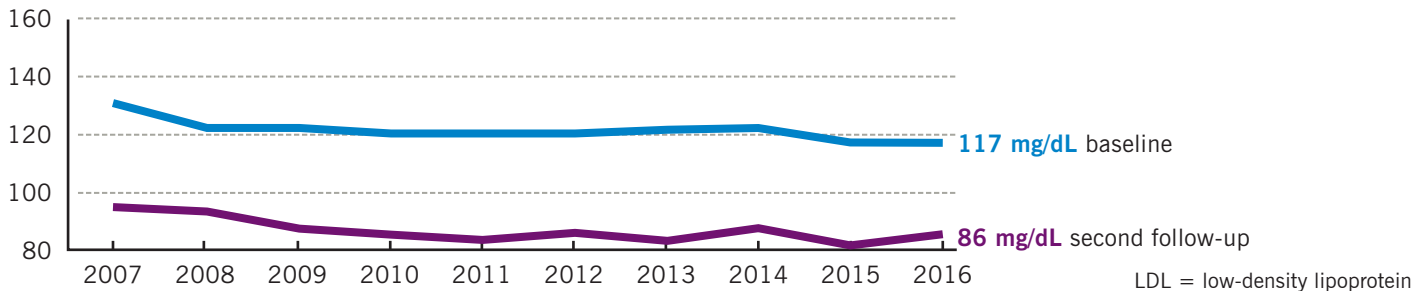
Patients taking statins for both primary and secondary prevention experienced reductions in low-density lipoprotein (LDL) cholesterol levels. Patients were seen at baseline, defined as their first visit, and had at least 2 follow-up visits within the past 2 years. The time between visits varied from patient to patient.

Primary Prevention, Statin-Tolerant Adults

2016 Volume (N = 1394)

2007 – 2016

LDL Median Value

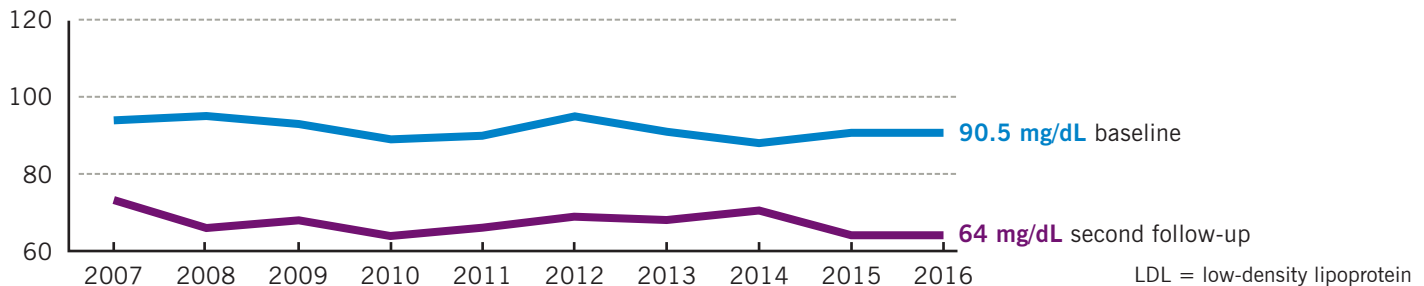


Secondary Prevention, Statin-Tolerant Adults

2016 Volume (N = 853)

2007 – 2016

LDL Median Value



Preventive Cardiology and Rehabilitation

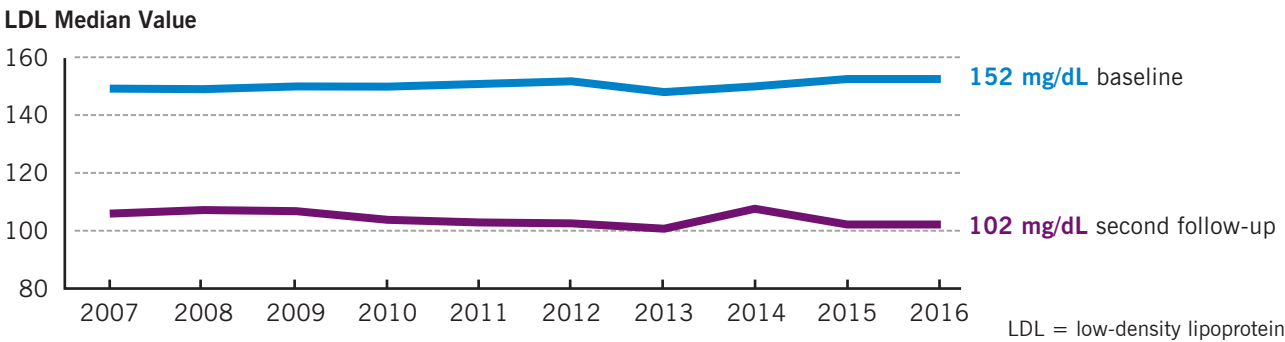
LDL Levels Among Statin-Intolerant Adults

Patients referred to the prevention clinic who could not tolerate statins still experienced reductions in LDL levels. Patients included in these data had at least 2 follow-up visits within the past 2 years.

Primary Prevention, Statin-Intolerant Adults

2016 Volume (N = 485)

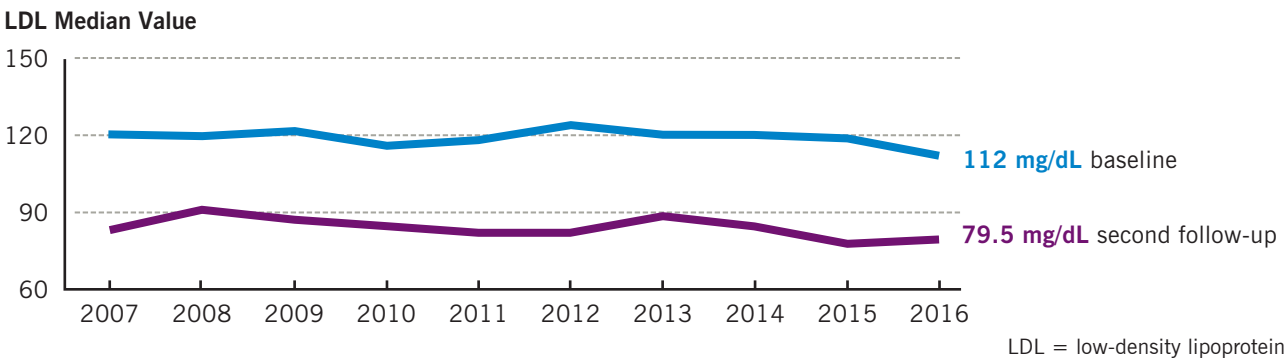
2007 – 2016



Secondary Prevention, Statin-Intolerant Adults

2016 Volume (N = 545)

2007 – 2016

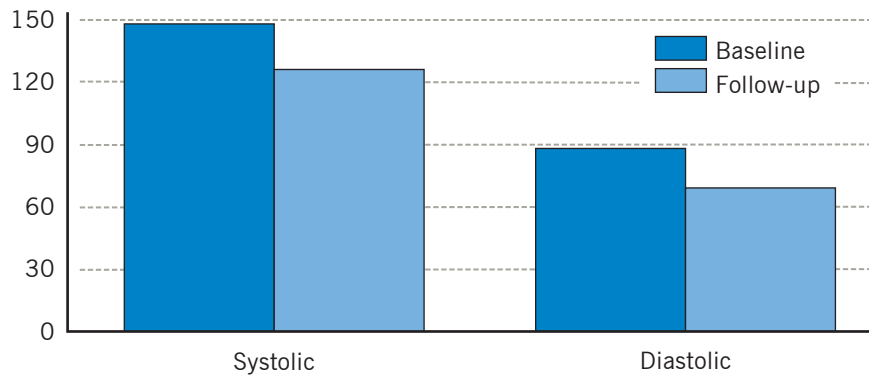


Impact of Preventive Cardiology on Blood Pressure Among Patients With Diastolic Blood Pressure ≥ 90 mm Hg or Systolic Blood Pressure ≥ 140 mm Hg (N = 1052)

Baseline is defined as patients' first visit. Follow-up data are from the most recent visit. Patients included in these data had at least 2 follow-up visits in the last 2 years.

2016

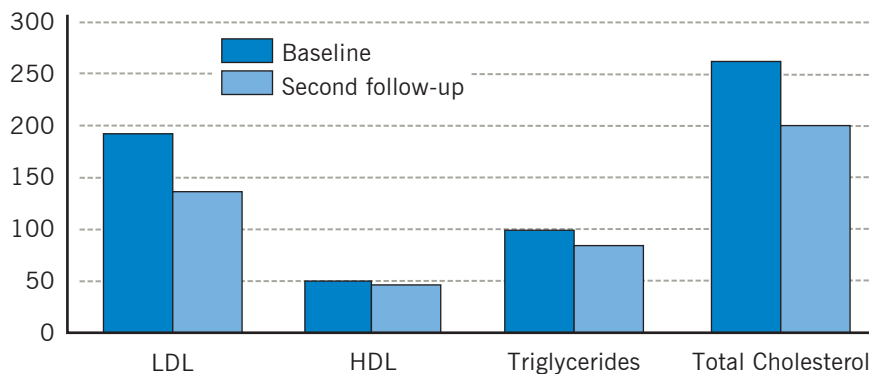
Median Value (mm Hg)



Pediatric Preventive Cardiology and Metabolic Clinic Lipid Levels (N = 111)

2016

Median Value (mg/dL)



HDL = high-density lipoprotein, LDL = low-density lipoprotein

The Pediatric Preventive Cardiology and Metabolic Clinic offers expert assessment, lifestyle management advice, medication, and monitoring for patients aged < 21 years with cardiometabolic dyslipidemia as well as genetic dyslipidemia. Data are for patients with genetic dyslipidemia who had at least 1 follow-up visit in 2016.

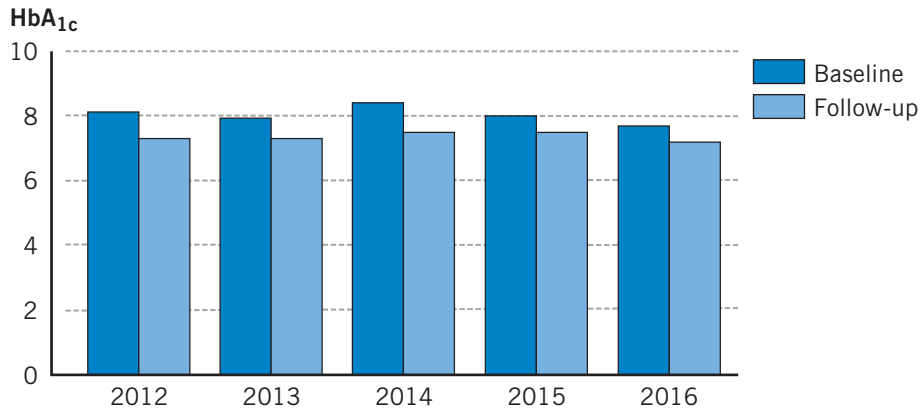
Preventive Cardiology and Rehabilitation

Impact of Preventive Cardiology on HbA_{1c} Levels Among Patients With Diabetes and HbA_{1c} ≥ 7 at Baseline

Baseline is defined as first visit. Follow-up data are from the most recent visit. Patients included in these data had at least 2 follow up visits in the last 2 years.

2016 Volume (N = 1636)

2012 – 2016



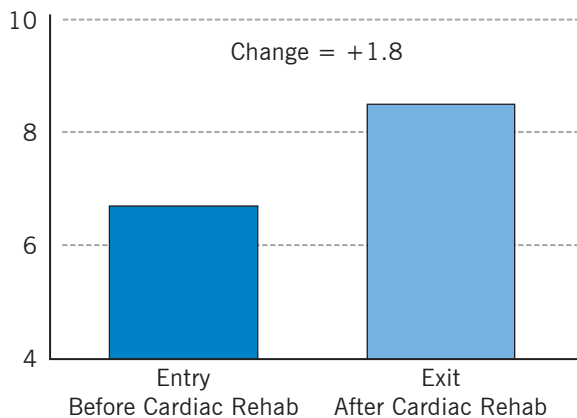
Cardiac Rehabilitation

Outcomes measured in the Cardiac Rehabilitation Program include those related to functional capacity, quality of life, blood pressure, and weight.

Improvement in Exercise Capacity by Exercise Stress Test (N = 210)^a

2016

METs



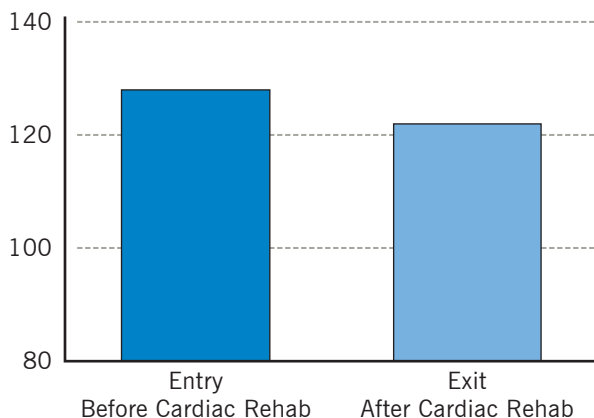
The metabolic equivalent of task (MET) is the ratio of the working metabolic rate to the resting metabolic rate. Each 1-MET increase in functional capacity reduces the risk of mortality by 8% to 12%. The median predicted reduction in all-cause mortality for patients in the program based on improvement in functional capacity (METs) was approximately 15%.

^aData represent all cardiac rehab patients with entry visit in 2016.

Improvement in Systolic Blood Pressure (N = 210)^a

2016

Median Systolic Blood Pressure (mm Hg)



The median systolic blood pressure for patients entering rehab is already well controlled. After rehab, the median systolic blood pressure decreased by 6 mm Hg.

^aData represent all cardiac rehab patients with entry visit in 2016.

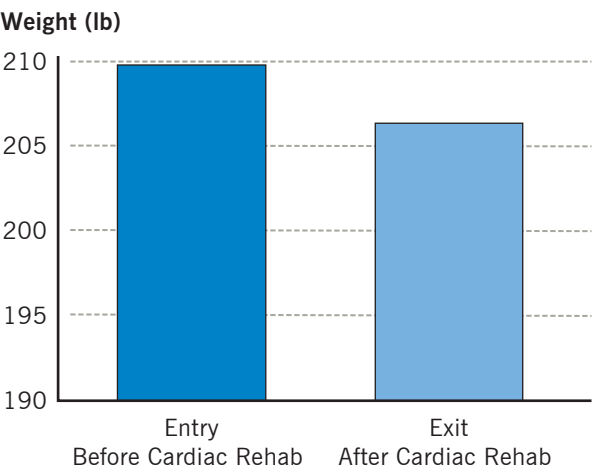
Preventive Cardiology and Rehabilitation



Improvement in Weight (N = 210)^a

The median weight loss for patients who completed the Cardiac Rehabilitation Program was 3.4 pounds.

2016



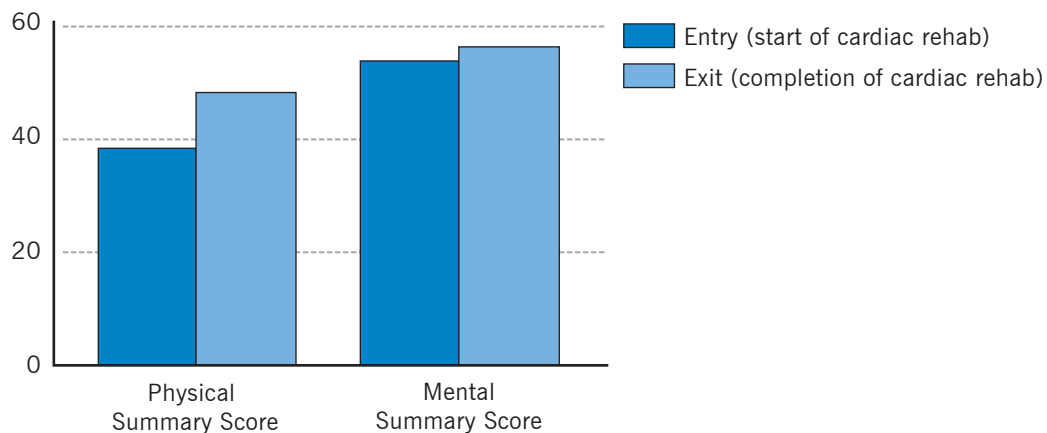
^aData represent all cardiac rehab patients with entry visit in 2016.

Improvement in Quality of Life Assessment (N = 210)

Patients who completed the Cardiac Rehabilitation Program experienced improved physical and emotional quality of life. Quality of life is measured using the SF-36® Health Survey. This is a validated measure that tracks overall wellness of patients in cardiac rehabilitation.

2016

SF-36 Score



Surgical Quality Improvement

American College of Surgeons National Surgical Quality Improvement Program

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP®) objectively measures and reports risk-adjusted surgical outcomes based on a defined sampling and abstraction methodology. These outcomes data reflect Cleveland Clinic's vascular surgery ACS NSQIP performance benchmarked against 578 participating sites.

Vascular Surgery Outcomes

July 2015 – June 2016

Outcome	N	Observed Rate (%)	Expected Rate (%)
30-day mortality	267	0.75	1.93
30-day morbidity	267	10.49	9.75
Cardiac event	267	4.49	2.08
Pneumonia	267	0.00	1.42
Unplanned intubation	267	1.87	1.47
Ventilator > 48 hours	267	2.25	1.39
Deep vein thrombosis/pulmonary embolism	267	0.00	0.65
Renal failure	267	0.37	0.97
Urinary tract infection	267	0.75	0.86
Surgical site infection	267	3.75	2.81
Sepsis	267	2.63	1.15
<i>C. difficile</i> colitis	267	0.75	0.49
Return to operating room	267	7.87	6.01
Readmission	267	8.99	9.72

In addition to overall vascular ACS NSQIP outcomes data, data specific to open and endovascular lower extremity vascular surgery are provided, benchmarked against 101 and 63 sites, respectively, and data specific to esophagectomy are benchmarked against 230 participating sites.

Open Lower Extremity Vascular Surgery Outcomes

July 2015 – June 2016

Outcome	N	Observed Rate (%)	Expected Rate (%)
30-day mortality	30	0.00	1.10
30-day morbidity	30	13.33	19.03
Cardiac event	30	0.00	3.01
Unplanned intubation	30	0.00	1.63
Ventilator > 48 hours	30	3.33	1.42
Renal failure	30	0.00	0.77
Surgical site infection	30	10.00	10.26
<i>C. difficile</i> colitis	30	3.33	0.28
Return to operating room	30	13.33	11.25
Readmission	30	20.00	17.14
Amputation	30	0.00	3.09
Bleeding	30	10.00	11.22
Myocardial infarction or stroke	30	0.00	2.69
Major reintervention on the bypass	30	0.00	4.46
Major untreated loss of patency	30	0.00	1.94
Wound	30	20.00	14.28

Surgical Quality Improvement

Endovascular Lower Extremity Vascular Surgery Outcomes

July 2015 – June 2016

Outcome	N	Observed Rate (%)	Expected Rate (%)
Renal failure	38	0.00	0.49
Sepsis	38	2.63	1.19
Return to operating room	38	13.16	6.19
Amputation	38	7.89	3.81
Bleeding	38	13.16	5.78
Major reintervention of treated arterial segment	38	13.16	3.74
Major untreated loss of patency	38	2.63	1.92
Wound	38	0.00	1.49

Esophagectomy Outcomes

July 2015 – June 2016

Outcome	N	Observed Rate (%)	Expected Rate (%)
30-day morbidity	72	27.78	34.38
Pneumonia	71	4.23	10.92
Unplanned intubation	71	14.08	13.22
Deep vein thrombosis/pulmonary embolism	72	6.94	5.05
Surgical site infection	71	12.68	14.88
Sepsis	71	12.68	15.42
Return to operating room	72	15.28	17.20
Readmission	72	6.94	9.24

Patient Experience — Heart & Vascular Institute

Keeping patients at the center of all that Cleveland Clinic does is critical. Patients First is the guiding principle at Cleveland Clinic. Patients First is safe care, high-quality care, in the context of patient satisfaction, and high value. Ultimately, caregivers have the power to impact every touch point of a patient's journey, including their clinical, physical, and emotional experience.

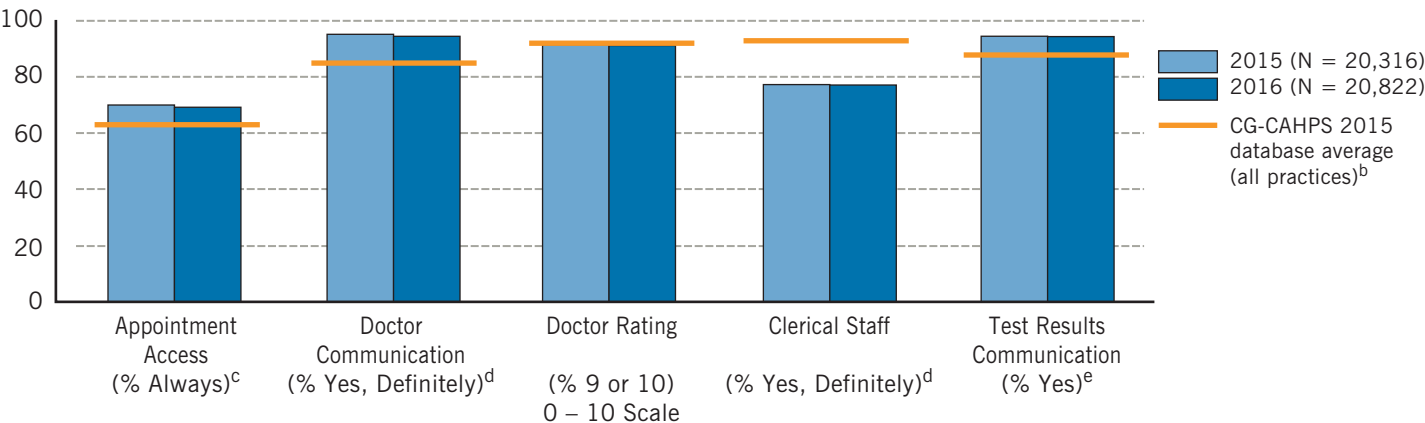
Cleveland Clinic recognizes that patient experience goes well beyond patient satisfaction surveys. Nonetheless, sharing the survey results with caregivers and the public affords opportunities to improve how Cleveland Clinic delivers exceptional care.

Outpatient Office Visit Survey — Heart & Vascular Institute

CG-CAHPS Assessment^a

2015– 2016

Percent Best Response



^aIn 2013, Cleveland Clinic began administering the Clinician and Group Practice Consumer Assessment of Healthcare Providers and Systems surveys (CG-CAHPS), standardized instruments developed by the Agency for Healthcare Research and Quality (AHRQ) and supported by the Centers for Medicare & Medicaid Services for use in the physician office setting to measure patients' perspectives of outpatient care.

^bBased on results submitted to the AHRQ CG-CAHPS database from 2829 practices in 2015

^cResponse options: Always, Usually, Sometimes, Never

^dResponse options: Yes, definitely; Yes, somewhat; No

^eResponse options: Yes, No

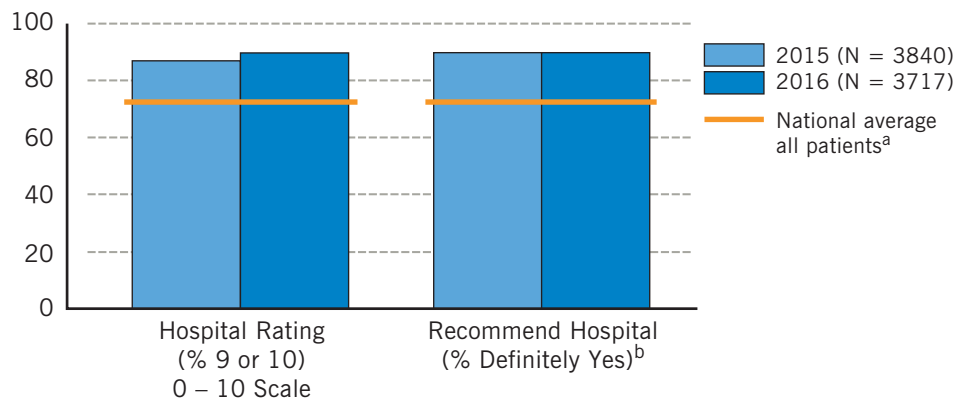
Source: Press Ganey, a national hospital survey vendor

Inpatient Survey — Heart & Vascular Institute

HCAHPS Overall Assessment

2015 – 2016

Best Response (%)



^aBased on national survey results of discharged patients, January 2015 – December 2015, from 4172 US hospitals. medicare.gov/hospitalcompare

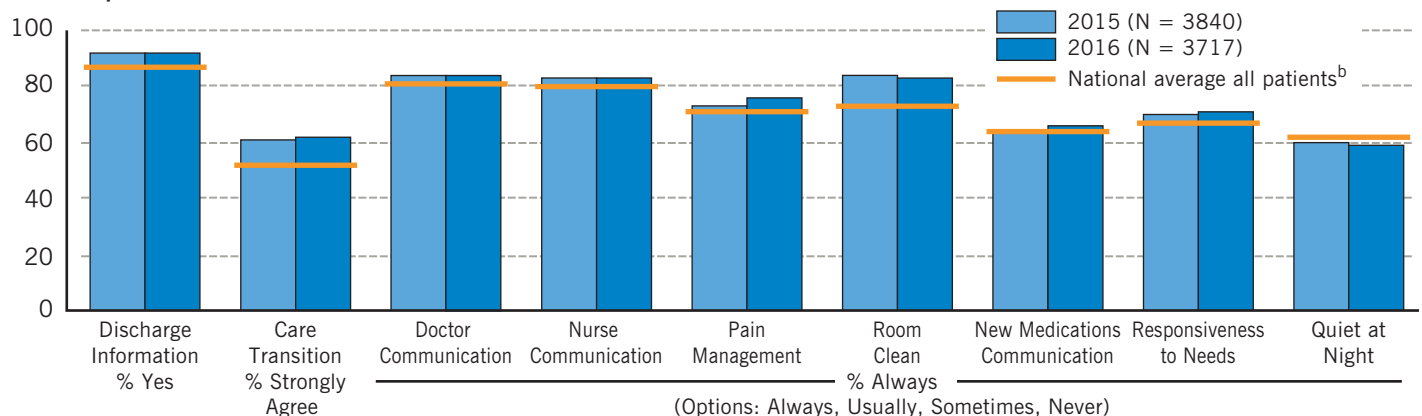
^bResponse options: Definitely yes, Probably yes, Probably no, Definitely no

The Centers for Medicare & Medicaid Services requires United States hospitals that treat Medicare patients to participate in the national Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, a standardized tool that measures patients' perspectives of hospital care. Results collected for public reporting are available at medicare.gov/hospitalcompare.

HCAHPS Domains of Care^a

2015 – 2016

Best Response (%)



^aExcept for "Room Clean" and "Quiet at Night," each bar represents a composite score based on responses to multiple survey questions.

^bBased on national survey results of discharged patients, January 2015 – December 2015, from 4820 US hospitals. medicare.gov/hospitalcompare

Source: Press Ganey, a national hospital survey vendor, 2016

Cleveland Clinic — Implementing Value-Based Care

Overview

Cleveland Clinic health system uses a systematic approach to performance improvement while simultaneously pursuing 3 goals: improving the patient experience of care (including quality and satisfaction), improving population health, and reducing the cost of healthcare. The following measures are examples of 2016 focus areas in pursuit of this 3-part aim. Throughout this section, “Cleveland Clinic” refers to the academic medical center or “main campus,” and those results are shown.

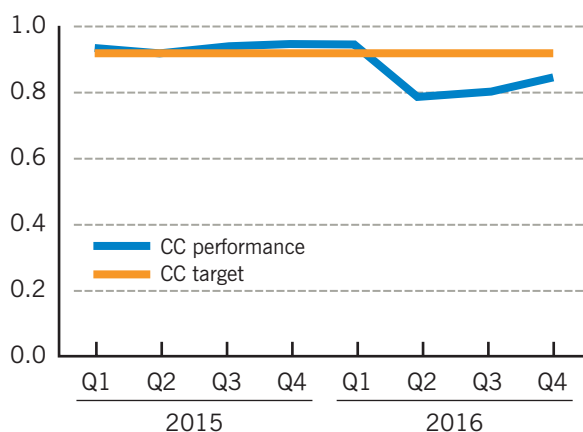
Real-time data are leveraged in each Cleveland Clinic location to drive performance improvement. Although not an exact match to publicly reported data, more timely internal data create transparency at all organizational levels and support improved care in all clinical locations.

Improve the Patient Experience of Care

Cleveland Clinic Overall Mortality Ratio

2015 – 2016

O/E Ratio



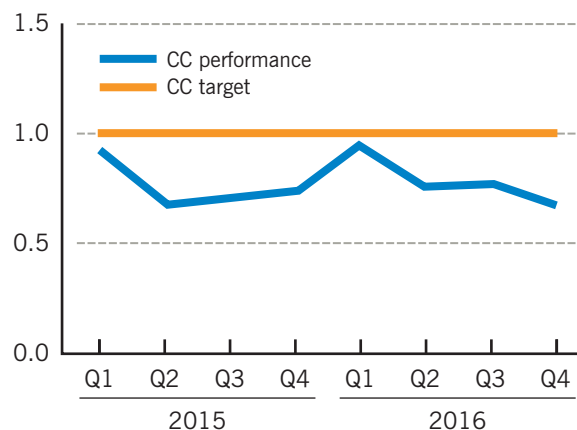
Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

Cleveland Clinic’s observed/expected (O/E) mortality ratio outperformed its internal target derived from the Vizient 2016 risk model. Ratios less than 1.0 indicate mortality performance “better than expected” in Vizient’s risk adjustment model.

Cleveland Clinic Central Line-Associated Bloodstream Infection, reported as Standardized Infection Ratio (SIR)

2015 – 2016

Rate per 1000 Line Days

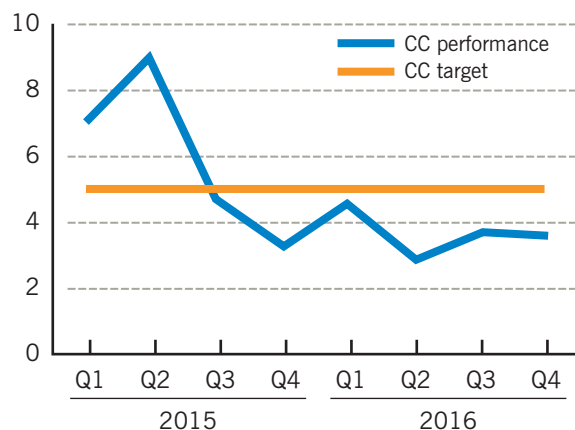


Cleveland Clinic has implemented several strategies to reduce central line-associated bloodstream infections (CLABSIs), including a central-line bundle of insertion, maintenance, and removal best practices. Focused reviews of every CLABSI occurrence support reductions in CLABSI rates in the high-risk critical care population.

Cleveland Clinic Postoperative Respiratory Failure Risk-Adjusted Rate

2015 – 2016

Rate per 1000 Eligible Patients



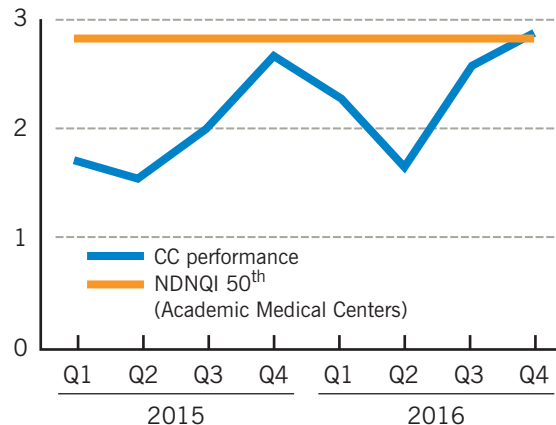
Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

Efforts continue toward reducing intubation time, assessing readiness for extubation, and preventing the need for reintubation. Cleveland Clinic has leveraged the technology within the electronic medical record to support ongoing improvement efforts in reducing postoperative respiratory failure (AHRQ Patient Safety Indicator 11). Prevention of respiratory failure remains a safety priority for Cleveland Clinic.

Cleveland Clinic Hospital-Acquired Pressure Ulcer Prevalence (Adult)

2015 – 2016

Percent



Source: Data reported from the National Database for Nursing Quality Indicators® (NDNQI®) with permission from Press Ganey.

A pressure ulcer is an injury to the skin that can be caused by pressure, moisture, or friction. These sometimes occur when patients have difficulty changing position on their own. Cleveland Clinic caregivers have been trained to provide appropriate skin care and regular repositioning while taking advantage of special devices and mattresses to reduce pressure for high-risk patients. In addition, they actively look for hospital-acquired pressure ulcers and treat them quickly if they occur.

Cleveland Clinic strategies to mitigate the risk of these pressure injuries include routine rounding to accurately stage pressure injuries, monthly multidisciplinary wound care meetings, and ongoing nursing education, both in the classroom and at the bedside.

Cleveland Clinic — Implementing Value-Based Care

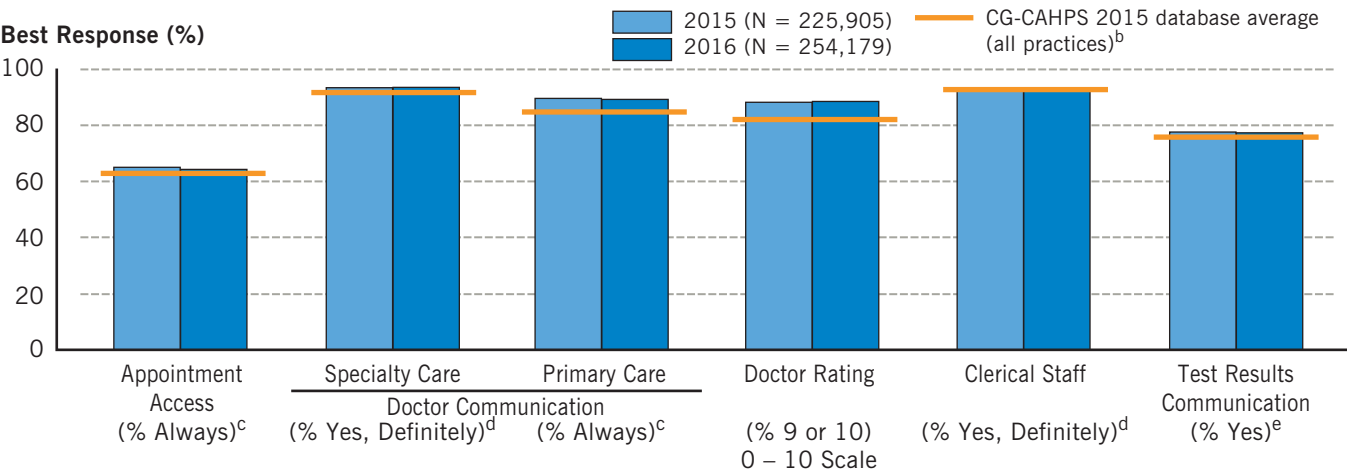
Keeping patients at the center of all that we do is critical. Patients First is the guiding principle at Cleveland Clinic. Patients First is safe care, high-quality care, in the context of patient satisfaction, and high value. Ultimately, our caregivers have the power to impact every touch point of a patient's journey, including their clinical, physical, and emotional experience.

We know that patient experience goes well beyond patient satisfaction surveys. Nonetheless, by sharing the survey results with our caregivers and the public, we constantly identify opportunities to improve how we deliver exceptional care.

Outpatient Office Visit Survey — Cleveland Clinic

CG-CAHPS Assessment^a

2015 – 2016



^aIn 2013, Cleveland Clinic began administering the Clinician and Group Practice Consumer Assessment of Healthcare Providers and Systems surveys (CG-CAHPS), standardized instruments developed by the Agency for Healthcare Research and Quality (AHRQ) and supported by the Centers for Medicare & Medicaid Services for use in the physician office setting to measure patients' perspectives of outpatient care.

^bBased on results submitted to the AHRQ CG-CAHPS database from 2829 practices in 2015

^cResponse options: Always, Usually, Sometimes, Never

^dResponse options: Yes, definitely; Yes, somewhat; No

^eResponse options: Yes, No

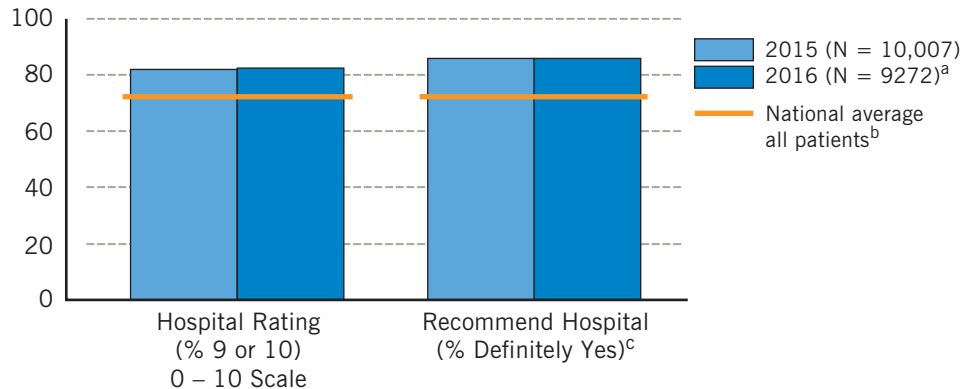
Source: Press Ganey, a national hospital survey vendor

Inpatient Survey — Cleveland Clinic

HCAHPS Overall Assessment

2015 – 2016

Best Response (%)



^aAt the time of publication, 2016 ratings have not been reported by the Centers for Medicare & Medicaid Services and ratings are not adjusted for patient mix.

^bBased on national survey results of discharged patients, January 2015 – December 2015, from 4172 US hospitals. medicare.gov/hospitalcompare

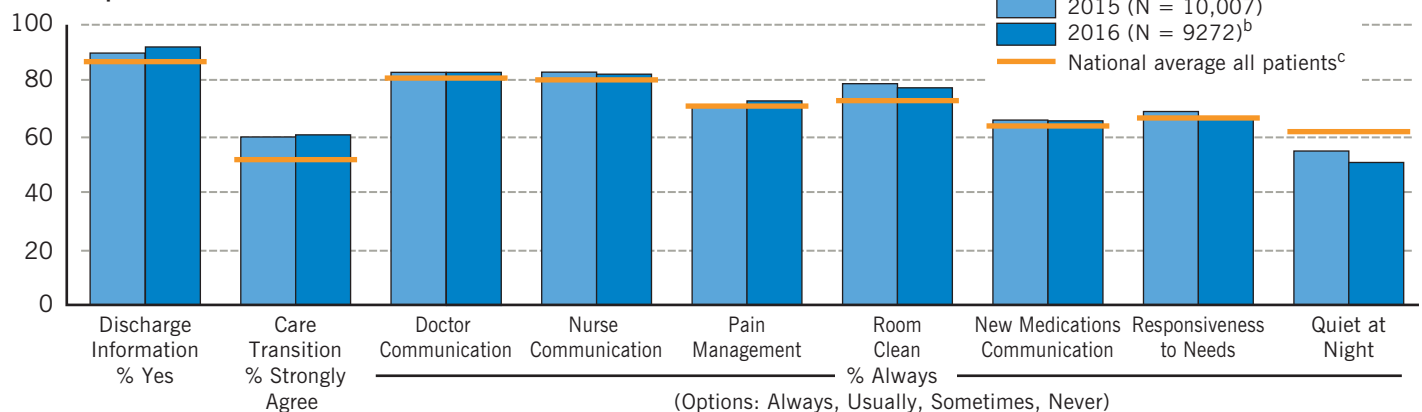
^cResponse options: Definitely yes, Probably yes, Probably no, Definitely no

The Centers for Medicare & Medicaid Services requires United States hospitals that treat Medicare patients to participate in the national Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, a standardized tool that measures patients' perspectives of hospital care. Results collected for public reporting are available at medicare.gov/hospitalcompare.

HCAHPS Domains of Care^a

2015 – 2016

Best Response (%)



^aExcept for "Room Clean" and "Quiet at Night," each bar represents a composite score based on responses to multiple survey questions.

^bAt the time of publication, 2016 ratings have not been reported by the Centers for Medicare & Medicaid Services and ratings are not adjusted for patient mix.

^cBased on national survey results of discharged patients, January 2015 – December 2015, from 4172 US hospitals. medicare.gov/hospitalcompare

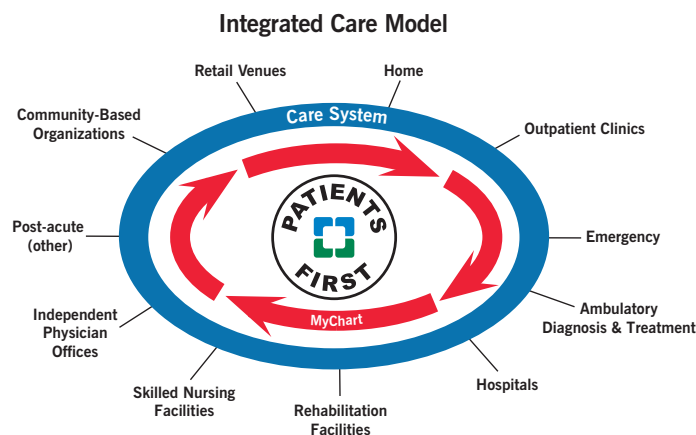
Source: Centers for Medicare & Medicaid Services, 2015; Press Ganey, a national hospital survey vendor, 2016

Cleveland Clinic — Implementing Value-Based Care

Focus on Value

Cleveland Clinic has developed and implemented new models of care that focus on “Patients First” and aim to deliver on the Institute of Medicine goal of **S**afe, **T**imely, **E**ffective, **E**fficient, **E**quitable, **P**atient-centered care. Creating new models of Value-Based Care is a strategic priority for Cleveland Clinic. As care delivery shifts from fee-for-service to a population health and bundled payment delivery system, Cleveland Clinic is focused on concurrently improving patient safety, outcomes, and experience.

What does this new model of care look like?



The Cleveland Clinic Integrated Care Model (CCICM) is a value-based model of care, designed to improve outcomes while reducing cost. It is designed to deliver value in both population health and specialty care.

- The patient remains at the heart of the CCICM.
- The blue band represents the care system, which is a seamless pathway that patients move along as they receive care in different settings. The care system represents integration of care across the continuum.
- Critical competencies are required to build this new care system. Cleveland Clinic is creating disease- and condition-specific care paths for a variety of procedures and chronic diseases. Another facet is implementing comprehensive care coordination for high-risk patients to prevent unnecessary hospitalizations and emergency department visits. Efforts include managing transitions in care, optimizing access and flow for patients through the CCICM, and developing novel tactics to engage patients and caregivers in this work.
- Measuring performance around quality, safety, utilization, cost, appropriateness of care, and patient and caregiver experience is an essential component of this work.

Improve Population Health

Cleveland Clinic Accountable Care Organization Measure Performance

2016

National Percentile Ranking

90th	<ul style="list-style-type: none">• Falls Screening• Heart Failure• Ischemic Vascular Disease• BMI Screening• Tobacco Screening
80th	<ul style="list-style-type: none">• Coronary Artery Disease• Diabetes• Breast Cancer Screening• Pneumonia Vaccination
70th	<ul style="list-style-type: none">• Colorectal Cancer Screening• Influenza Vaccination• Blood Pressure Screening• Hypertension
50th	<ul style="list-style-type: none">• Depression Screening

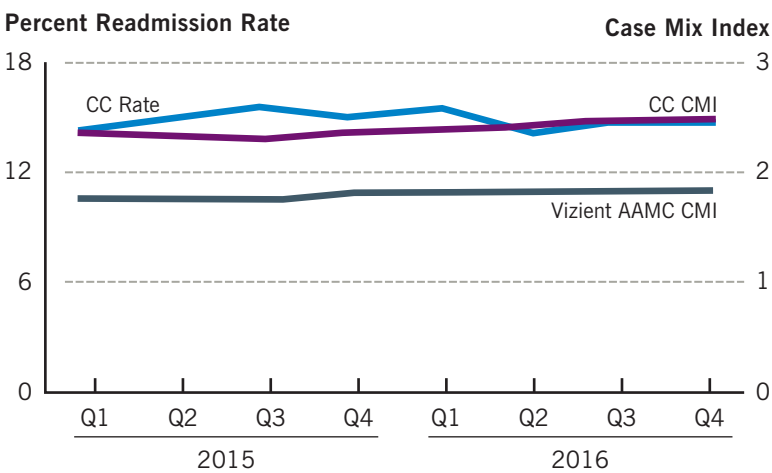
Higher percentiles are better

As part of Cleveland Clinic's commitment to population health and in support of its Accountable Care Organization (ACO), these ACO measures have been prioritized for monitoring and improvement. Cleveland Clinic is improving performance in these measures by enhancing care coordination, optimizing technology and information systems, and engaging primary care specialty teams directly in the improvement work. These pursuits are part of Cleveland Clinic's overall strategy to transform care in order to improve health and make care more affordable.

Cleveland Clinic — Implementing Value-Based Care

Reduce the Cost of Care

Cleveland Clinic All-Cause 30-Day Readmission Rate to Any Cleveland Clinic Hospital 2015 – 2016

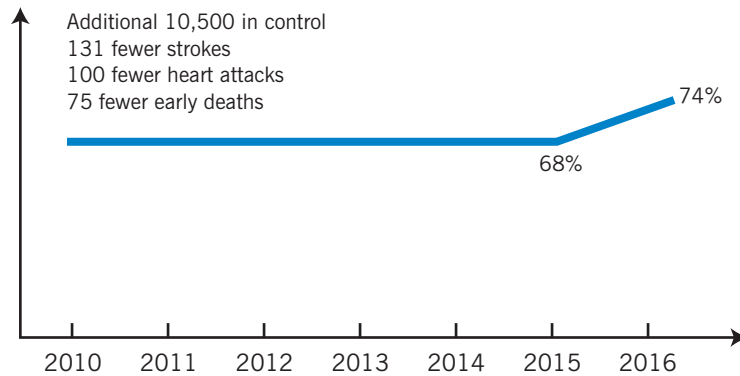


CMI = case mix index

Source: Data from the Vizient Clinical Data Base/Resource Manager™ used by permission of Vizient. All rights reserved.

Cleveland Clinic monitors 30-day readmission rates for any reason to any of its system hospitals. Unplanned readmissions are actively reviewed for improvement opportunities. Comprehensive care coordination and care management for high-risk patients has been initiated in an effort to prevent unnecessary hospitalizations and emergency department visits. Sicker, more complex patients are more susceptible to readmission. Case mix index (CMI) reflects patient severity of illness and resource utilization. Cleveland Clinic's CMI remains one of the highest among American academic medical centers.

Accountable Care Organization (ACO) Improving Outcomes and Reducing Costs



Cleveland Clinic was one of the top performing new ACOs in the United States (for 2015 performance as determined in 2016) due to efficiency, cost reduction, and improvements in effectiveness of chronic disease management such as treating hypertension, reducing preventable hospitalizations through care coordination, and optimizing the care at skilled nursing facilities through its Connected Care program.

For example, a system-wide effort to improve the control of blood pressure for patients with hypertension was begun in 2016 and resulted in an additional 10,500 patients with blood pressure controlled. This will translate to many fewer strokes, heart attacks, and preventable deaths.

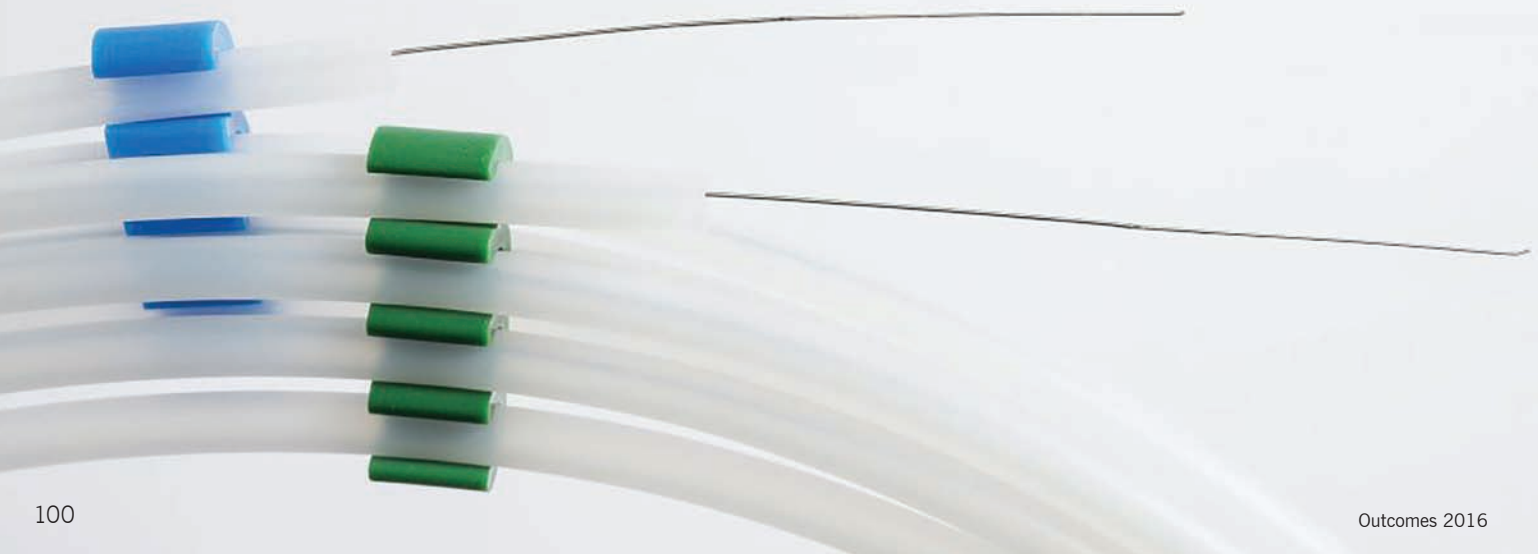
Perceval Sutureless Valve

Cleveland Clinic surgeons were the first in the world to perform an in-human implant of a Perceval valve. The valve is a sutureless biological aortic replacement valve that allows patients with aortic valve disease to have more surgical options, including minimally invasive approaches. Use of the valve allows surgeons greater visibility of critical structures during the surgery, and the procedure can be completed faster and more efficiently. The valve also helps reduce recovery time in the intensive care unit, ventilator time, and need for blood transfusions, even for high-risk and complex cases.



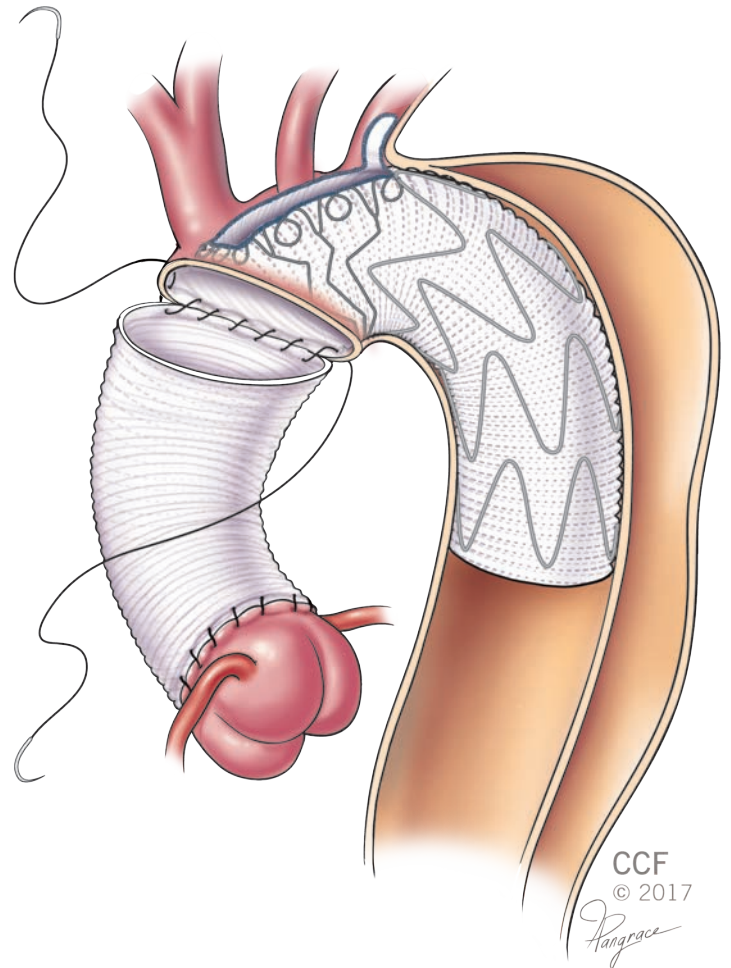
Tatara Vascular

Cleveland Clinic continues to develop a family of preshaped coronary guidewires to facilitate placement of balloon dilation catheters during percutaneous transluminal coronary angioplasty and percutaneous transluminal angioplasty. Cleveland Clinic Innovations office's new product development model received 510(k) regulatory clearance on the guidewires, which allows researchers to further test the product clinically.



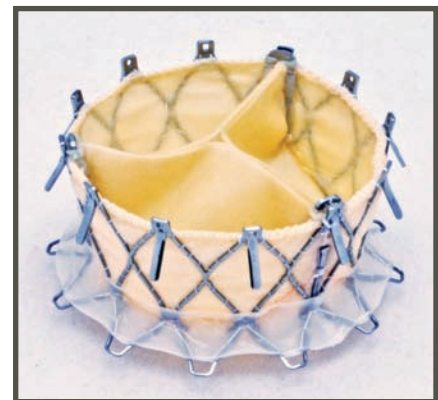
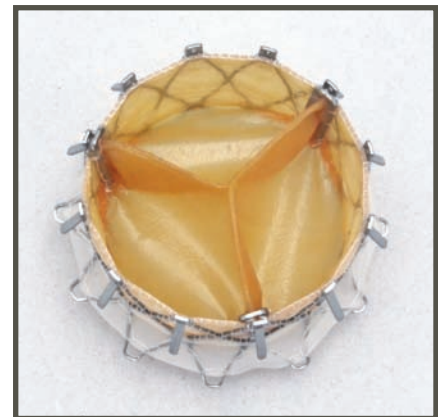
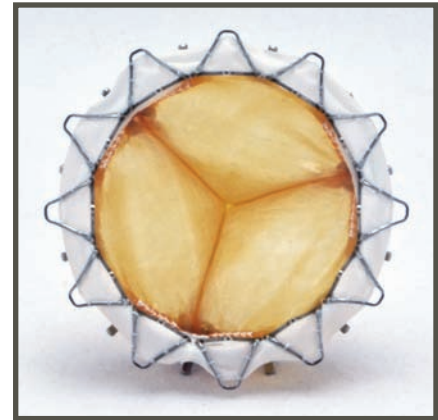
PHASTER

The Proximal Hybrid Aortic Stent graft for Thoracic Extended Repair (PHASTER) is a novel technology developed by Cleveland Clinic's cardiothoracic surgeons for use in hybrid repair procedures. Cleveland Clinic has developed a model and is working with the FDA to obtain regulatory classification for a Class II device.



First-In-Human Catheter-Delivered Tricuspid Valved Stent

The world's first transcatheter tricuspid valved stent was implanted at Cleveland Clinic in a patient presenting with massive incompetence of the tricuspid valve. The stent is based on seminal research conducted and intellectual property developed at Cleveland Clinic. Cleveland Clinic implanted the valved stent with catheter-guided technique under a compassionate plea from the patient. After the implantation, the valve demonstrated excellent valvular function, indicating correction of the massive regurgitation problem. The novel device is designed in the form of a diffuser, resulting in a low-height profile which allows it to reside in the native valve without protrusion into either of the adjacent chambers (atrium or ventricle) for mitral or tricuspid valves. In addition, the valve is prepared using tissue-preservation techniques that remove the toxic tissue fixatives and allow for the device to be shipped in the “dry form.”



MATADORS Dissection Collaboration Project

The Multidisciplinary Study of Ascending Tissue Characteristics and Hemodynamics for the Development of Novel Aortic Stentgrafts (MATADORS) is a novel partnership involving the FDA, Cleveland Clinic surgeons, industry engineers, medical device experts, and research and development leadership from the top 5 endovascular stent graft medical device companies. With this newly forged relationship, the team has the unique ability to better understand connective tissue disease that causes aortic dissection and to develop improved verification and validation measures for innovative devices undergoing regulatory testing.

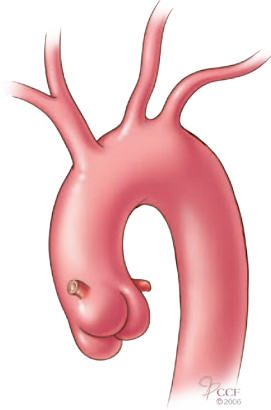
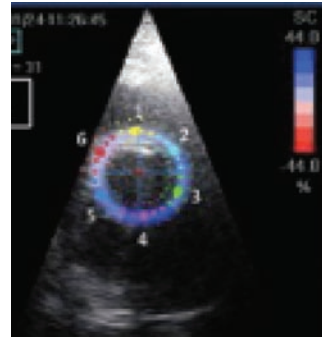


Illustration of project's target area – the ascending aorta, which is the landing zone for TEVAR devices



Computational modeling of simulated flow and compliance of the ascending aorta



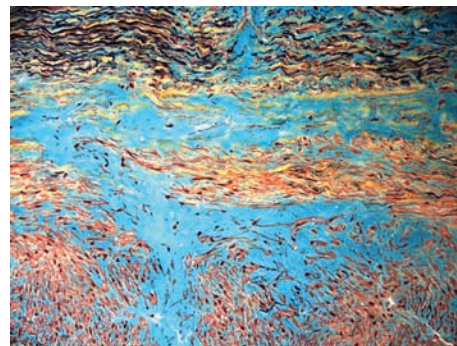
In vivo compliance data is obtained (IRB # 16-900) in 3 target areas of the ascending aorta



Uniaxial testing of extracted specimens to compare the in vivo and ex vivo mechanical properties of ascending aortic tissue in acute dissection vs nondissected tissue



Resected samples obtained from aortic dissection and aneurysm patients to evaluate histopathology and biomechanical properties of regions within the ascending aorta



Histopathology slide of histopathologic features of dissected aortic tissue to look at proteoglycan/glycosaminoglycan content and ratio within treatment groups, as well as within regions of the aorta

Contact Information

Sydell and Arnold Miller Family Heart & Vascular Institute

General Information and Appointments

800.659.7822

Cardiovascular Medicine Appointments/Referrals

216.444.6697 or
800.223.2273, ext. 46697

Thoracic and Cardiovascular Surgery Evaluation

Nurse practice managers will expedite patient record review with a Cleveland Clinic surgeon and address questions.

Cardiothoracic Surgery: 216.445.9288 or
866.289.6911

Thoracic Surgery: 216.445.6860 or
800.223.2273 ext. 56860

Vascular Medicine Appointments/Referrals

216.444.4420 or
800.223.2273, ext. 44420

Vascular Surgery Appointments/Referrals

216.444.4508 or
800.223.2273, ext. 44508

Sydell and Arnold Miller Family Heart & Vascular Institute Resource Center

Nurses are available Monday through Friday, 8:30 a.m. to 4:00 p.m., Eastern time, to answer patient questions and concerns about heart and blood vessel disease.

216.445.9288 or 866.289.6911
or email heartcenter@ccf.org

On the Web at clevelandclinic.org/heart

Staff Listing

For a complete listing of Cleveland Clinic's Miller Family Heart & Vascular Institute staff, please visit clevelandclinic.org/staff.

Publications

The Heart & Vascular Institute published 359 articles in 2016 as indexed within Web of Science.

Locations

For a complete listing of Cleveland Clinic's Miller Family Heart & Vascular Institute locations, please visit clevelandclinic.org/heartlocations.

Additional Contact Information

General Patient Referral

24/7 hospital transfers or
physician consults
800.553.5056

General Information

216.444.2200

Hospital Patient Information

216.444.2000

General Patient Appointments

216.444.2273 or 800.223.2273

Referring Physician Center and Hotline

855.REFER.123 (855.733.3712)

Or email refdr@ccf.org or visit
clevelandclinic.org/refer123

Request for Medical Records

216.444.2640 or
800.223.2273, ext. 42640

Same-Day Appointments

216.444.CARE (2273)

Global Patient Services/ International Center

Complimentary assistance for
international patients and families
001.216.444.8184 or visit
clevelandclinic.org/gps

Medical Concierge

Complimentary assistance for
out-of-state patients and families
800.223.2273, ext. 55580, or
email medicalconcierge@ccf.org

Cleveland Clinic Abu Dhabi

clevelandclinicabudhabi.ae

Cleveland Clinic Canada

888.507.6885

Cleveland Clinic Florida

866.293.7866

Cleveland Clinic Nevada

702.796.8669

For address corrections or
changes, please call

800.890.2467



About Cleveland Clinic

Overview

Cleveland Clinic is an academic medical center offering patient care services supported by research and education in a nonprofit group practice setting. More than 3500 Cleveland Clinic staff physicians and scientists in 140 medical specialties and subspecialties care for more than 7.1 million patients across the system annually, performing nearly 208,000 surgeries and conducting more than 652,000 emergency department visits. Patients come to Cleveland Clinic from all 50 states and 185 nations. Cleveland Clinic's CMS case-mix index is the second-highest in the nation.

Cleveland Clinic is an integrated healthcare delivery system with local, national, and international reach. The main campus in midtown Cleveland, Ohio, has a 1400-bed hospital, outpatient clinic, specialty institutes, labs, classrooms, and research facilities in 44 buildings on 167 acres. Cleveland Clinic has more than 150 northern Ohio outpatient locations, including 10 regional hospitals, 18 full-service family health centers, 3 health and wellness centers, an affiliate hospital, and a rehabilitation hospital for children. Cleveland Clinic also includes Cleveland Clinic Florida; Cleveland Clinic Nevada; Cleveland Clinic Canada; Cleveland Clinic Abu Dhabi, UAE; Sheikh Khalifa Medical City (management contract), UAE; and Cleveland Clinic London (opening in 2020). Cleveland Clinic is the largest employer in Ohio, with more than 51,000 employees. It generates \$12.6 billion of economic activity a year.

Cleveland Clinic supports physician education, training, consulting, and patient services around the world through representatives in the Dominican Republic, Guatemala, India, Panama, Peru, Saudi Arabia, and the United Arab Emirates. Dedicated Global Patient Services offices are located at Cleveland Clinic's main campus, Cleveland Clinic Abu Dhabi, Cleveland Clinic Canada, and Cleveland Clinic Florida.

The Cleveland Clinic Model

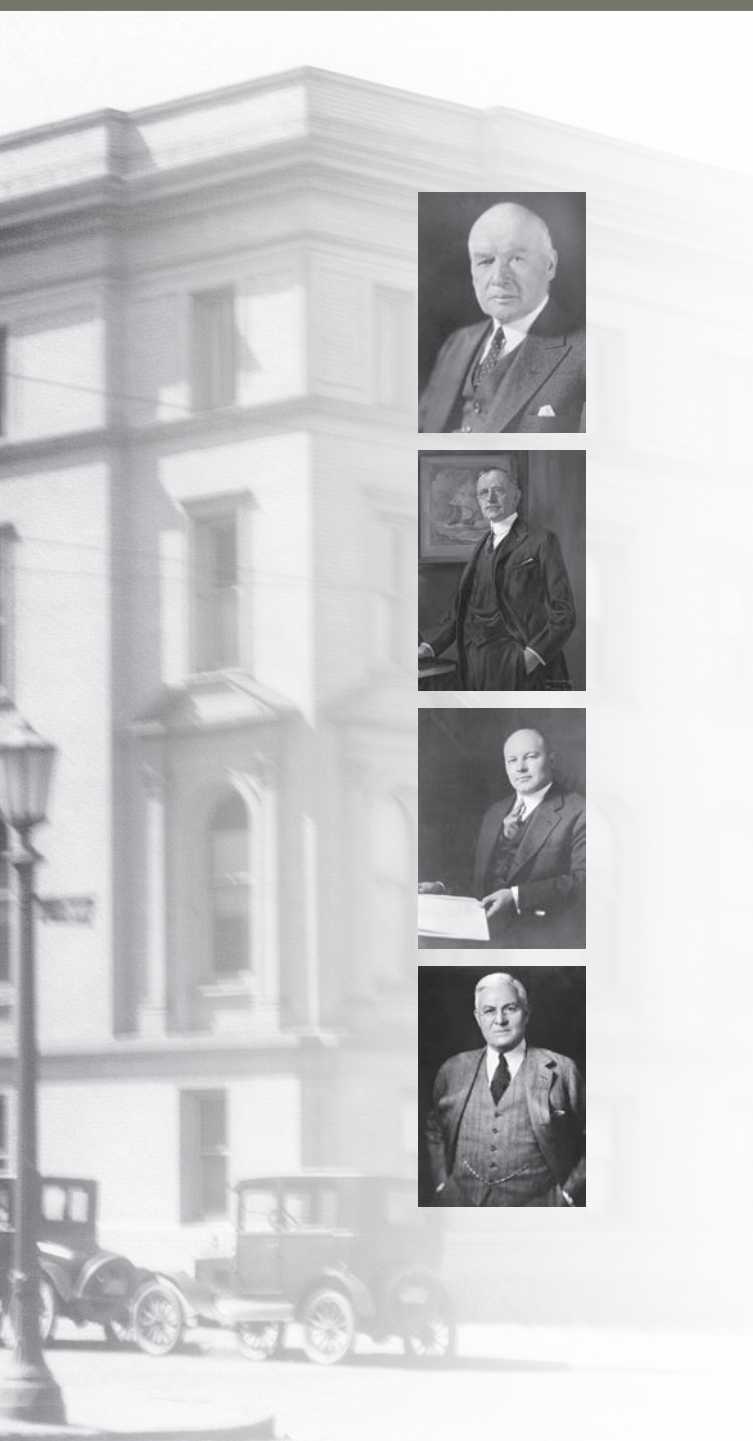
Cleveland Clinic was founded in 1921 by 4 physicians who had served in World War I and hoped to replicate the organizational efficiency of military medicine. The organization has grown through the years by adhering to the nonprofit, multispecialty group practice they established. All Cleveland Clinic staff physicians receive a straight salary with no bonuses or other financial incentives. The hospital and physicians share a financial interest in controlling costs, and profits are reinvested in research and education.

Cleveland Clinic Florida was established in 1987. Cleveland Clinic began opening family health centers in surrounding communities in the 1990s. Marymount Hospital joined Cleveland Clinic in 1995, followed by regional hospitals including Euclid Hospital, Fairview Hospital, Hillcrest Hospital, Lutheran Hospital, Medina Hospital, South Pointe Hospital, and affiliate Ashtabula County Medical Center. In 2015, the Akron General Health System joined the Cleveland Clinic health system.

Internally, Cleveland Clinic services are organized into patient-centered integrated practice units called institutes, each institute combining medical and surgical care for a specific disease or body system. Cleveland Clinic was among the first academic medical centers to establish an Office of Patient Experience, to promote comfort, courtesy, and empathy across all patient care services.

A Clinically Integrated Network

Cleveland Clinic is committed to providing value-based care, and it has grown the Cleveland Clinic Quality Alliance into the nation's second-largest, and northeast Ohio's largest, clinically integrated network. The network comprises more than 6300 physician members, including both Cleveland Clinic staff and independent physicians from the community. Led by its physician members, the Quality Alliance strives to improve quality and consistency of care; reduce costs and increase efficiency; and provide access to expertise, data, and experience.



Cleveland Clinic Lerner College of Medicine

Lerner College of Medicine is known for its small class sizes, unique curriculum, and full-tuition scholarships for all students. Each new class accepts 32 students who are preparing to be physician investigators. In 2015, Cleveland Clinic broke ground on a 477,000-square-foot multidisciplinary Health Education Campus. The campus, which will open in July 2019, will serve as the new home of the Case Western Reserve University (CWRU) School of Medicine and Cleveland Clinic's Lerner College of Medicine, as well as the CWRU School of Dental Medicine, the Frances Payne Bolton School of Nursing, and physician assistant and allied health training programs.

Graduate Medical Education

In 2016, nearly 2000 residents and fellows trained at Cleveland Clinic and Cleveland Clinic Florida in our continually growing programs.

U.S. News & World Report Ranking

Cleveland Clinic is ranked the No. 2 hospital in America by *U.S. News & World Report* (2016). It has ranked No. 1 in heart care and heart surgery since 1995. In 2016, 3 of its programs were ranked No. 2 in the nation: gastroenterology and GI surgery, nephrology, and urology. Ranked among the nation's top five were gynecology, orthopaedics, rheumatology, pulmonology, and diabetes and endocrinology.

Cleveland Clinic Physician Ratings

Cleveland Clinic believes in transparency and in the positive influence of the physician-patient relationship on healthcare outcomes. To continue to meet the highest standards of patient satisfaction, Cleveland Clinic physician ratings, based on nationally recognized Press Ganey patient satisfaction surveys, are published online at clevelandclinic.org/staff.

Referring Physician Center and Hotline

Call us 24/7 for access to medical services or to schedule patient appointments at 855.REFER.123 (855.733.3712), email refdr@ccf.org, or go to clevelandclinic.org/Refer123. The free Cleveland Clinic Physician Referral App, available for mobile devices, gives you 1-click access. Available in the App Store or Google Play.

Remote Consults

Anybody anywhere can get an online second opinion from a Cleveland Clinic specialist through our MyConsult service. For more information, go to clevelandclinic.org/myconsult, email myconsult@ccf.org, or call 800.223.2273, ext. 43223.

Request Medical Records

216.444.2640 or 800.223.2273, ext. 42640

Track Your Patients' Care Online

Cleveland Clinic offers an array of secure online services that allow referring physicians to monitor their patients' treatment while under Cleveland Clinic care and gives them access to test results, medications, and treatment plans. my.clevelandclinic.org/online-services

DrConnect (online access to patients' treatment progress while under referred care): call 877.224.7367, email drconnect@ccf.org, or visit clevelandclinic.org/drconnect.

MyPractice Community (affordable electronic medical records system for physicians in private practice): 216.448.4617.

eRadiology (teleradiology consultation provided nationwide by board-certified radiologists with specialty training, within 24 hours or stat): call 216.986.2915 or email starimaging@ccf.org.

Medical Records Online

Patients can view portions of their medical record, receive diagnostic images and test results, make appointments, and renew prescriptions through **MyChart**, a secure online portal. All new Cleveland Clinic patients are automatically registered for **MyChart**. clevelandclinic.org/mychart

Access

Cleveland Clinic is committed to convenient access, offering virtual visits, shared medical appointments, and walk-in urgent care for your patients. clevelandclinic.org/access

Critical Care Transport Worldwide

Cleveland Clinic's fleet of ground and air transport vehicles is ready to transfer patients at any level of acuity anywhere on Earth. Specially trained crews provide Cleveland Clinic care protocols from first contact. To arrange a transfer for STEMI (ST-elevation myocardial infarction), acute stroke, ICH (intracerebral hemorrhage), SAH (subarachnoid hemorrhage), or aortic syndrome, call 877.379.CODE (2633). For all other critical care transfers, call 216.444.8302 or 800.553.5056.

CME Opportunities: Live and Online

Cleveland Clinic's Center for Continuing Education operates the largest CME program in the country. Live courses are offered in Cleveland and cities around the nation and the world. The center's website (ccfcme.org) is an educational resource for healthcare providers and the public. It has a calendar of upcoming courses, online programs on topics in 30 areas, and the award-winning virtual textbook of medicine, The Disease Management Project.

Clinical Trials

Cleveland Clinic is running more than 2200 clinical trials at any given time for conditions including breast and liver cancer, coronary artery disease, heart failure, epilepsy, Parkinson disease, chronic obstructive pulmonary disease, asthma, high blood pressure, diabetes, depression, and eating disorders. Cancer Clinical Trials is a mobile app that provides information on the more than 200 active clinical trials available to cancer patients at Cleveland Clinic. clevelandclinic.org/cancertrialapp

Healthcare Executive Education

Cleveland Clinic has programs to share its expertise in operating a successful major medical center. The Executive Visitors' Program is an intensive, 3-day behind-the-scenes view of the Cleveland Clinic organization for the busy executive. The Samson Global Leadership Academy is a 2-week immersion in challenges of leadership, management, and innovation taught by Cleveland Clinic leaders, administrators, and clinicians. Curriculum includes coaching and a personalized 3-year leadership development plan. clevelandclinic.org/executiveeducation

Consult QD Physician Blog

A website from Cleveland Clinic for physicians and healthcare professionals. Discover the latest research insights, innovations, treatment trends, and more for all specialties. consultqd.clevelandclinic.org

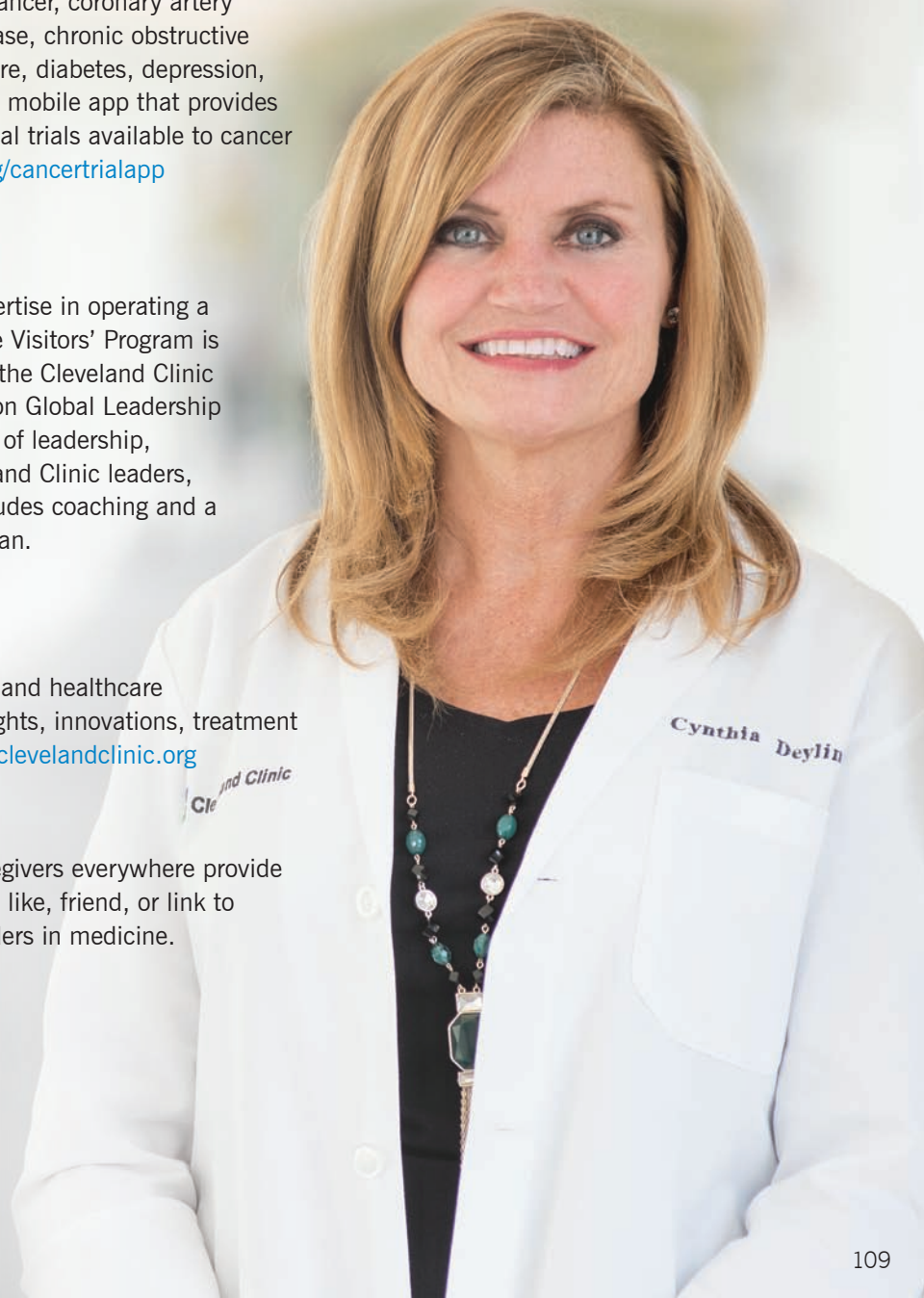
Social Media

Cleveland Clinic uses social media to help caregivers everywhere provide better patient care. Millions of people currently like, friend, or link to Cleveland Clinic social media — including leaders in medicine.

Facebook for Medical Professionals
facebook.com/CMEclevelandclinic

Follow us on Twitter
[@cleclinicMD](https://twitter.com/cleclinicMD)

Connect with us on LinkedIn
clevelandclinic.org/MDlinkedin



Treating the Whole Patient

The Miller Family Heart & Vascular Institute works with the Office of Patient Experience, Spiritual Care Department, Healing Services, and the Arts & Medicine Institute to provide a wide array of complimentary services to patients and visitors to enhance their total well-being.

Services include manual therapies, Reiki, Healing Touch™, art and music therapy, and guided imagery.

The chapel and Muslim prayer room are available to everyone throughout their time at Cleveland Clinic.

Cleveland Clinic offers live musical performances throughout the year, and patients and visitors can enjoy guided tours of the extensive collection of modern and contemporary art.

The rooftop plaza provides a beautiful view of the city and offers daily activities such as chair massages, labyrinth walk meditation, reiki, and tea.

Patient and Family Health and Education Center

800.223.2273, ext. 43771
healthl@ccf.org

The Patient and Family Health and Education Center offers complimentary access to computers with internet access, audio and video education programs, and health screenings.

Heart & Vascular Institute Resource Nurses

866.289.6911
heartcenter@ccf.org

The Heart & Vascular Institute Resource Center is staffed by dedicated, experienced nurses who answer inquiries about cardiovascular- and thoracic-related topics. The nurses provide information about conditions, treatments, procedures, and Cleveland Clinic's experience and services. In 2016, there were 18,793 total contacts, which included 3332 webmails, 6573 phone calls, and 8888 contacts that included in-person contacts, online chats, and emails.

The nurses also staff a 24/7 post-discharge line for patients who have questions or concerns after they leave Cleveland Clinic. In 2016, the nurses answered 9087 calls and MyChart messages.

All patients in the Heart & Vascular Institute receive a follow-up phone call from a registered nurse to discuss any symptoms, complications, or concerns they have once they are home.

Staying in Touch

There are many ways to stay connected to the Heart & Vascular Institute.



Stay in Touch :)

For physicians:

- **eCardiac Consult**, a biweekly physician e-newsletter that provides perspectives on breaking research and practical patient care insights. To subscribe, visit clevelandclinic.org/CardiacConsult.
- **Consult QD**, a website for healthcare professionals offering news and perspectives on heart, vascular, and thoracic care from Cleveland Clinic experts. Visit clevelandclinic.org/ConsultQDHeart.

For patients:

- **Webcasts and videocasts**. Transcripts and a list of upcoming chats are posted at clevelandclinic.org/webchats.
- **YouTube channel**, youtube.com/clevelandclinic.
- **Facebook specialty groups**, including LVAD, Lung Transplant, and Women's Cardiovascular Health.
- **Monthly e-newsletter** for the latest in heart and vascular disease prevention, treatments, and research, along with helpful tips, videos, and recipes. Subscribe at clevelandclinic.org/heartenews.
- **Health Essentials**, a site exploring the most useful and fascinating aspects of health news, with perspectives from Cleveland Clinic experts. Visit health.clevelandclinic.org.

This project would not have been possible without the commitment and expertise of a team led by Umesh Khot, MD; Mouin Abdallah, MD; Sandra Hays; and Jagina McIntyre.

Graphic design and photography were provided by Brian Kohlbacher and Cleveland Clinic's Center for Medical Art and Photography.





Every life deserves world class care.

9500 Euclid Avenue, Cleveland, OH 44195

ClevelandClinic.org