This project would not have been possible without the commitment and expertise of a team led by Dr. Umesh Khot, Pam Goepfarth, Sandra Hays, and Candë McCame. Graphic design and photography were provided by Brian Kohlbacher, Robin Bova, and Cleveland Clinic’s Center for Medical Art and Photography.
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 data on patient volumes and outcomes 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 (hospitalcompare.hhs.gov), and Physician Compare (medicare.gov/PhysicianCompare)
- Ohio Department of Health (ohiohospitalcompare.ohio.gov)
- 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 or scan here.

To view all our Outcomes books, please visit Cleveland Clinic’s Quality and Patient Safety Institute website at clevelandclinic.org/outcomes.
Dear Colleague:

Welcome to this 2013 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 a summary 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 around 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 Report (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 reports has received favorable notice from colleagues and healthcare observers. We appreciate your interest and hope you find this information useful and informative.

Sincerely,

Delos M. Cosgrove, MD
CEO and President
what’s inside

Chairman Letter........................................4
Introduction........................................5
Institute Overview........................................6

Quality and Outcomes Measures

Surgical Overview........................................8
Ischemic Heart Disease
  Interventional Treatment..........................13
  Surgical Treatment................................15
AMI........................................20
Cardiac Rhythm Disorders..........................21
Valve Disease........................................28
Aortic Disease.........................................38
Hypertrophic Obstructive Cardiomyopathy........48
Congenital Heart Disease............................50
Pericardial Disease....................................53

Heart Failure and Transplant..............................55
Lung and Heart-Lung Transplant.........................58
Peripheral Vascular Disease..............................60
Cerebrovascular Disease................................66
Thoracic Surgery.........................................67
Preventive Cardiology and Rehabilitation................76
Surgical Quality Improvement............................84
Patient Experience — Heart & Vascular Institute...............86
Cleveland Clinic — Implementing Value-Based Care..............88
Innovations..............................................94
Contact Information....................................100
About Cleveland Clinic................................102
Resources..............................................104
Institute Resources....................................106

Prefer an e-version?
Visit clevelandclinic.org/OutcomesOnline, and we'll remove you from the hard-copy mailing list and email you when next year's books are online.
The Sydell and Arnold Miller Family Heart & Vascular Institute has shared patient outcomes with the public since 1998. Our mission is to offer transparent data to provide a clear picture of the work we do to help guide the healthcare decisions of our patients and also to help us understand how we are doing so we can create new challenges and goals for ourselves. The importance of outcomes is becoming even more significant as we travel into an era of value-based healthcare.

Our focus is not only on volume, but also on the quality of care we provide and access to that care. The Miller Family Heart & Vascular Institute has consistently been the leader in volume, quality outcomes, and access to the highest quality cardiovascular care. This combination is a powerful one that we are proud of, but we are always striving to improve.

As we continue to work toward developing and implementing innovative methods and strategies to treat our patients, we are also working toward innovative solutions to ensuring access to affordable, quality care.

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

Sincerely,

Bruce W. Lytle, MD
Chairman, Miller Family Heart & Vascular Institute
Cleveland Clinic is the nation’s leader in cardiovascular care and is home to many of the world’s best heart, vascular and thoracic specialists. They work with referring physicians to coordinate care and achieve the best possible outcomes and experience for every patient.

The Sydell and Arnold Miller Family Heart & Vascular Institute is located at Cleveland Clinic’s main campus. A total of 189 staff physicians, 121 residents and fellows, and 1,400 nurses are dedicated to the care of patients with cardiovascular, thoracic and vascular disease. The comprehensive care they provide includes collaboration with 54 vascular surgery and cardiovascular intensive care anesthesiologists and 3,000 Cleveland Clinic staff physicians in 120 medical and surgical specialties and subspecialties.
### Heart & Vascular Institute Overview

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Visits</td>
<td>448,229</td>
</tr>
<tr>
<td>Admissions</td>
<td>13,767</td>
</tr>
<tr>
<td>Beds</td>
<td>422</td>
</tr>
<tr>
<td>Coronary Intensive Care</td>
<td>24</td>
</tr>
<tr>
<td>Heart Failure Intensive Care</td>
<td>10</td>
</tr>
<tr>
<td>Cardiac, Vascular and Thoracic Surgery Intensive Care</td>
<td>76</td>
</tr>
<tr>
<td>Private Patient Rooms</td>
<td>283</td>
</tr>
<tr>
<td>Same-Day Recovery</td>
<td>29</td>
</tr>
</tbody>
</table>

### Surgical Procedures

#### Cardiac Surgery

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac Surgeries</td>
<td>4405</td>
</tr>
<tr>
<td>Valve Surgeries</td>
<td>2852</td>
</tr>
<tr>
<td>Coronary Artery Bypass Grafting (Isolated and Concomitant)</td>
<td>1296</td>
</tr>
<tr>
<td>Surgeries for Septal Myectomy</td>
<td>205</td>
</tr>
<tr>
<td>Congenital Heart Surgeries (Adult and Pediatric)</td>
<td>306</td>
</tr>
<tr>
<td>Robotically Assisted Cardiac Surgeries</td>
<td>167</td>
</tr>
</tbody>
</table>

#### Transplant Surgery

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Transplants</td>
<td>44</td>
</tr>
<tr>
<td>Lung Transplants</td>
<td>98</td>
</tr>
</tbody>
</table>

#### Thoracic Surgery

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>General Thoracic Surgeries</td>
<td>1555</td>
</tr>
<tr>
<td>Esophageal Surgeries</td>
<td>293</td>
</tr>
</tbody>
</table>

#### Vascular Surgery

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular Surgeries (Open and Endovascular)</td>
<td>3291</td>
</tr>
<tr>
<td>Bypass Surgeries</td>
<td>228</td>
</tr>
<tr>
<td>Arteriovenous Access Surgeries</td>
<td>416</td>
</tr>
</tbody>
</table>

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-area Cleveland Clinic hospitals. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.
In 2013, patients traveled from all 50 states to Cleveland Clinic for their cardiovascular care.

Patients from 75 countries came to Cleveland Clinic for their cardiovascular care in 2013.

### Aortic Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Ascending Aorta and Aortic Arch Repairs</td>
<td>676</td>
</tr>
<tr>
<td>Open Descending Aorta and Thoracoabdominal Repairs</td>
<td>113</td>
</tr>
<tr>
<td>Open Abdominal Aortic Aneurysm Repairs</td>
<td>101</td>
</tr>
<tr>
<td>Endovascular Descending Aorta and Thoracoabdominal Repairs</td>
<td>250</td>
</tr>
<tr>
<td>Endovascular Abdominal Aortic Aneurysm Repairs</td>
<td>79</td>
</tr>
</tbody>
</table>

### Cardiovascular Medicine Procedures

#### Intervventional Cardiology

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic Cardiac Catheterizations</td>
<td>7463</td>
</tr>
<tr>
<td>Interventional Cardiac Procedures</td>
<td>1594</td>
</tr>
<tr>
<td>Percutaneous Aortic Valvuloplasties</td>
<td>223</td>
</tr>
<tr>
<td>Percutaneous Mitral Valvuloplasties</td>
<td>7</td>
</tr>
<tr>
<td>Percutaneous Atrial Septal Defect and Patent Foramen Ovale Closures</td>
<td>52</td>
</tr>
</tbody>
</table>

#### Vascular Intervention

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventional Carotid Procedures</td>
<td>344</td>
</tr>
<tr>
<td>Interventional Vascular Procedures</td>
<td>1043</td>
</tr>
</tbody>
</table>

#### Electrophysiology

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrophysiology Ablations</td>
<td>1427</td>
</tr>
<tr>
<td>Ablations for Atrial Fibrillation</td>
<td>811</td>
</tr>
<tr>
<td>Device Implants</td>
<td>1445</td>
</tr>
<tr>
<td>Leads Extracted</td>
<td>334</td>
</tr>
</tbody>
</table>

#### Diagnostic and Cardiac Imaging

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echocardiograms</td>
<td>74,552</td>
</tr>
<tr>
<td>Cardiac Computed Tomography (CT) Scans</td>
<td>7836</td>
</tr>
<tr>
<td>Cardiac Magnetic Resonance Imaging (MRI) Scans</td>
<td>5989</td>
</tr>
<tr>
<td>Nuclear Cardiology Tests</td>
<td></td>
</tr>
<tr>
<td>Tc-Myoview-Rest</td>
<td>4275</td>
</tr>
<tr>
<td>Tc-Myoview-Stress</td>
<td>4222</td>
</tr>
<tr>
<td>Rubidium Heart (PET)</td>
<td>681</td>
</tr>
<tr>
<td>FDG Heart (PET)</td>
<td>494</td>
</tr>
<tr>
<td>MUGA</td>
<td>105</td>
</tr>
<tr>
<td>N-13 Ammonia Heart</td>
<td>109</td>
</tr>
<tr>
<td>Stress Tests</td>
<td>6636</td>
</tr>
</tbody>
</table>
27%
Reoperations accounted for 27% of all cardiac surgeries performed at Cleveland Clinic's main campus in 2013. Reoperations are more complex and are associated with greater risk than primary (first-time) operations.

Cleveland Clinic surgeons performed 13,714 cardiac and thoracic surgical procedures in 2013. A total of 5960 were performed at the main campus and 7754 were performed at Cleveland Clinic hospitals throughout greater Cleveland. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.

Most of the Heart & Vascular Institute’s surgical procedures performed in 2013 were cardiac surgeries at Cleveland Clinic’s main campus.
National Hospital Comparisons for Cardiac Surgery Volume and In-Hospital Mortality (N = 4405)

Main Campus
2013

Cleveland Clinic is the nation’s leader in cardiac surgery volume while also achieving the lowest mortality rates.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu

In-Hospital Mortality — Isolated Procedures (N = 1549)
2013

The mortality rates for isolated procedures were lower at Cleveland Clinic’s Heart & Vascular Institute than the rates expected by the Society of Thoracic Surgeons. Isolated procedures are those performed without any other surgical procedure.

Source: Society of Thoracic Surgeons (STS)
National Adult Cardiac Surgery Database 2013.

Abbreviations: CABG, coronary artery bypass graft
In 2013, Cleveland Clinic surgeons performed 1555 thoracic surgical procedures.

### In-Hospital Mortality — Combined Procedures (N = 327)

The in-hospital mortality rates for combined procedures were lower at Cleveland Clinic’s Heart & Vascular Institute than the rates expected by the Society of Thoracic Surgeons. Combined procedures are those performed with another surgical treatment and are generally more complex than isolated procedures.


Abbreviations: CABG, coronary artery bypass graft

---

### General Thoracic Surgery Volume

In 2013, Cleveland Clinic surgeons performed 1555 thoracic surgical procedures.

---

Cleveland Clinic

STS expected

Aortic valve replacement + CABG

Mitral valve replacement + CABG

Mitral valve repair + CABG

Percent

0%

6%

8%

10%

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

2009 2010 2011 2012 2013

Volume
Cleveland Clinic surgeons performed 7350 vascular surgeries in 2013. A total of 3291 of these procedures were done at the main campus, and 4059 were done at Cleveland Clinic hospitals throughout greater Cleveland. For a complete list of Cleveland Clinic hospitals, visit clevelandclinic.org.

Of the 1555 thoracic surgeries at Cleveland Clinic in 2013, the majority were pulmonary procedures. Approximately 25% of cardiovascular surgeries performed at Cleveland Clinic in 2013 were reoperations. These are more complex than primary (first-time) operations.

Cardiac Surgery Volume (N = 4023, STS National Registry)

Approximately 25% of cardiovascular surgeries performed at Cleveland Clinic in 2013 were reoperations. These are more complex than primary (first-time) operations.

Vascular Surgery Volume

Main Campus and Other Cleveland Clinic Hospitals

2004 – 2013

Major Thoracic Surgery by Type (N = 1555)
The overall average mortality rate for patients who had vascular surgery at Cleveland Clinic in 2013 was 1.75% compared with the 5.33% average for other teaching hospitals. The mortality rates associated with each age group were also comparatively lower at Cleveland Clinic.

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.

Source: Solucient.
Cardiac Catheterization Laboratory Procedures (N = 11,213)

Cleveland Clinic is a regional and national referral center for percutaneous coronary intervention (PCI). A total of 11,213 cardiac catheterization procedures were done in 2013 to treat patients with simple and complex ischemic heart disease.

The data comparisons 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.

Risk Factors Among Patients Undergoing PCI Procedures (N = 1594)

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Cleveland Clinic</th>
<th>Comparable ACC-NCDR hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (&gt; 75 years)</td>
<td>25%</td>
<td>15%</td>
</tr>
<tr>
<td>Acute care transfer</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>Prior MI</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>Prior heart failure</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Diabetes</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Severe LV dysfunction</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Multivessel disease</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Complex medical backgrounds can affect outcomes for patients who have PCI. Compared with patients at comparable hospitals, patients who had PCI at Cleveland Clinic in 2013 had more complex backgrounds.

Use of Adjunctive Medications Before and After PCI Procedures (N = 1730)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Cleveland Clinic</th>
<th>Comparable ACC-NCDR hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin on admission</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>Aspirin</td>
<td>95%</td>
<td>90%</td>
</tr>
<tr>
<td>Statins</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td>Thienopyridines</td>
<td>85%</td>
<td>80%</td>
</tr>
</tbody>
</table>

One of the ACC-NCDR key performance measures is the use of appropriate adjunctive medications before and after PCI. Cleveland Clinic’s administration rates exceed those of comparable hospitals.

Source: ACC-NCDR database
In 2013, the rate of major vascular complications associated with PCI was lower than at comparable hospitals. The rates of stroke and risk-adjusted bleeding events were slightly higher. Cleveland Clinic is continuously striving to achieve the best possible outcomes for patients.

Source: ACC-NCDR database

In 2013, the American College of Cardiology/American Heart Association (ACC/AHA) changed the guideline for door-to-balloon time for patients who arrive in the emergency department with ST-elevated myocardial infarction (STEMI). The previous recommendation was PCI balloon inflation within 90 minutes of arrival vs the current 60 minutes. Cleveland Clinic continues to work toward this new goal to reduce risks of morbidity and mortality. In 2013, the median door-to-balloon time at Cleveland Clinic was 65 minutes.

Source: ACC-NCDR database

*A total of 40 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, time to reperfusion was 65 minutes.
Surgical Treatment for Ischemic Heart Disease (N = 1296)

CABG Volume

2013

Cleveland Clinic surgeons performed 1296 coronary artery bypass graft (CABG) procedures in 2013. A total of 729 were in combination with another procedure and 567 were isolated procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated</td>
<td>567</td>
</tr>
<tr>
<td>CABG + Other</td>
<td>729</td>
</tr>
</tbody>
</table>

CABG Volume, Primary and Reoperations

2013

The majority of CABG procedures at Cleveland Clinic in 2013 were primary operations. A primary operation is the first time a patient has a particular procedure. Reoperations are repeat procedures.

CABG + Other, Inpatient Hospital Mortality

2013

Inpatient hospital mortality rates among patients who had CABG surgery plus another procedure at Cleveland Clinic in 2013 (primary and reoperations) were lower than those at comparable hospitals.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Isolated CABG Procedures, Inpatient Hospital Mortality (N = 567)

Cleveland Clinic surgeons performed 567 isolated CABG procedures in 2013. The inpatient hospital mortality rate was 0.5% (N = 3), which was lower than the expected rate of 2.0%.


Isolated CABG Procedures, Inpatient Hospital Mortality — Primary and Reoperation 2013

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 inpatient hospital mortality rates at Cleveland Clinic were 0% for reoperations and 0.6% (N = 3) for primary operations. Both rates were lower than expected.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu

STS CABG Quality Ratings

Overall

Use of Internal Mammary Artery

Medications

Cleveland Clinic is among the 15% of hospitals that achieved an overall three-star rating from The Society of Thoracic Surgeons (STS) for CABG surgery. The rating reflects the highest quality of cardiac surgery.

*Based on data comparisons from July 2012 through June 2013.
Primary Isolated CABG: Age-Related Risk of Inpatient Hospital Mortality

The complexity of CABG procedures increases with age. The majority of patients who had primary isolated CABG surgery at Cleveland Clinic in 2013 were age 60 and older. Mortality rates were lower than expected for all age groups, except among patients age 80 or older. Cleveland Clinic continuously strives to achieve the best possible outcome for every patient.

<table>
<thead>
<tr>
<th>Age</th>
<th>Observed mortality (%)</th>
<th>Expected mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50 years (N = 46)</td>
<td>0.0</td>
<td>0.7</td>
</tr>
<tr>
<td>50–59 years (N = 113)</td>
<td>0.0</td>
<td>1.1</td>
</tr>
<tr>
<td>60–69 years (N = 204)</td>
<td>0.0</td>
<td>1.7</td>
</tr>
<tr>
<td>70–79 years (N = 119)</td>
<td>0.8</td>
<td>2.7</td>
</tr>
<tr>
<td>≥ 80 years (N = 30)</td>
<td>6.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Total (N = 512)</td>
<td>7.5</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Isolated CABG: Additional Outcomes

Deep Sternal Wound Infection

The expected rate of a deep sternal wound after isolated CABG surgery was 0.5% in 2013. The rate was lower at Cleveland Clinic (0.4%).

**Ventilator Time > 24 Hours**

2013
A total of 6.9% of patients who had isolated CABG surgery at Cleveland Clinic in 2013 spent more than 24 hours on a ventilator. This is lower than the expected rate of 10.6%.


**In-Hospital Reoperation**

2013
The expected rate of in-hospital reoperation after isolated CABG surgery was 5.2% in 2013. The rate at Cleveland Clinic was 2.8%.


**Postoperative Stroke**

2013
A total of 1.2% of patients who had isolated CABG surgery at Cleveland Clinic in 2013 had a postoperative stroke. This is the same as the expected rate for this complication.

**Postoperative Renal Failure**

**2013**
Postoperative renal failure occurred in 1.4% of patients who had isolated CABG surgery at Cleveland Clinic in 2013. This was lower than the expected rate of 4.3%.


**Process Measures**

**2013**
Cleveland Clinic was 100% compliant in 2013 with all Society of Thoracic Surgeons process measures. The process measures include the use of a perioperative beta blocker; beta blocker, statin, and aspirin at discharge; and use of an internal mammary artery during isolated CABG surgery.

The Centers for Medicare & Medicaid Services (CMS) calculates the two AMI outcomes measures above based on Medicare claims and enrollment information. The most recent risk-adjusted data available from CMS are shown. Although Cleveland Clinic’s AMI mortality rate is lower than the US national rate, and Cleveland Clinic’s AMI readmissions rate is slightly higher than the US national rate, CMS ranks Cleveland Clinic’s performance on both as “no different than” the US national rate. To further reduce avoidable readmissions, Cleveland Clinic is focused on improving transitions from hospital to home or postacute facility. Specific initiatives have been implemented in each of these areas: communication, education, and follow-up.
Patients Undergoing Electrophysiology Laboratory Procedures (N = 4990)

2013

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. The total number of procedures includes some that are not detailed in the graph below.\(^a\)

Volume

\[\begin{array}{|c|c|}
\hline
\text{Volume} & 1600 \\
\hline
1200 & 800 \\
600 & 400 \\
200 & 0 \\
\hline
\end{array}\]

- Non-CRT (N = 572)
- CRT (N = 62)
- CRT (N = 458)
- CRT (N = 353)
- PVAI (N = 811)
- Other arrhythmias (N = 393)
- Ventricular arrhythmias (N = 223)

\(^a\)Other procedures include electrophysiology study, ICD testing, temporary pacer, loop recorders, and electrophysiology specials (endomyocardial biopsy, esophageal pacing, right heart catheterization, venography, and other).

Abbreviations: CRT, cardiac resynchronization therapy; ICD, implantable cardioverter defibrillator; PVAI, pulmonary vein antrum isolation

Pulmonary Vein Antrum Isolation Procedures

2009 – 2013

Volume

\[\begin{array}{|c|c|}
\hline
\text{Year} & \text{Volume} \\
\hline
2009 & 696 \\
2010 & 693 \\
2011 & 776 \\
2012 & 819 \\
2013 & 811 \\
\hline
\end{array}\]

Pulmonary vein antrum isolation (PVAI) essentially disconnects the pathway of the abnormal heart rhythm and prevents atrial fibrillation.
Success Rates of PVAI
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 study 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 this 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 post-second ablation.


PVAI Complications\(^a\)

2013

The overall risk associated with PVAI in 2013 was 3.21%.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pericardial tamponade/pericardiocentesis</td>
<td>6</td>
<td>0.74</td>
</tr>
<tr>
<td>Stroke (cerebellar punctate stroke)(^b)</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td>Embolic cilioretinal artery occlusion</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td>Gastroparesis</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td>Pulmonary vein stenosis</td>
<td>11</td>
<td>1.36</td>
</tr>
<tr>
<td>Pseudoaneurysm</td>
<td>4</td>
<td>0.49</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td>Hematoma</td>
<td>1</td>
<td>0.12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>26</strong></td>
<td><strong>3.21</strong></td>
</tr>
</tbody>
</table>

\(^a\)The total percentage was calculated by dividing the total number of complications (N = 26) by the total number of PVAI procedures (N = 811).

\(^b\)No acute intracranial abnormalities identified on follow-up MRI, all symptoms resolved.
PVAI Complications

2009 – 2013

It can take months or years for patients to develop pulmonary vein (PV) stenosis after a PVAI. In an effort to provide data that are as accurate and transparent as possible, the table to the right details the incidence of pulmonary vein stenosis after PVAI from 2009 through 2013, and is consistent with data previously published by Cleveland Clinic.\(^a\)

<table>
<thead>
<tr>
<th>Year</th>
<th>PV stenosis (N)</th>
<th>PVAI volume (N)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>8</td>
<td>696</td>
<td>1.15</td>
</tr>
<tr>
<td>2010</td>
<td>8</td>
<td>693</td>
<td>1.15</td>
</tr>
<tr>
<td>2011</td>
<td>4</td>
<td>776</td>
<td>0.52</td>
</tr>
<tr>
<td>2012</td>
<td>7</td>
<td>819</td>
<td>0.85</td>
</tr>
<tr>
<td>2013</td>
<td>11</td>
<td>811</td>
<td>1.36</td>
</tr>
<tr>
<td>5-year total</td>
<td>38</td>
<td>3795</td>
<td>1.00</td>
</tr>
</tbody>
</table>


Ablation of Ventricular Arrhythmia (N = 223)

2013

Cleveland Clinic is a national referral center for patients with ventricular arrhythmias. In 2013, a total of 223 ablations were done. The procedure was completely successful in 81% of cases, partially successful in 14% of cases, and 5% of ablations were unsuccessful to correct ventricular arrhythmias. Partial success means that among patients with multiple arrhythmias, at least one arrhythmia was ablated.

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 (Aliot et al., 2009, EHRA/HRS Expert Consensus on Catheter Ablation of Ventricular Arrhythmias).

Complications Among Patients With Ejection Fraction < 50% (N = 136)

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death within 7 days</td>
<td>1</td>
<td>0.74</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Complications Among Patients With Ejection Fraction ≥ 50% (N = 87)

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudoaneurysm</td>
<td>1</td>
<td>1.15</td>
</tr>
<tr>
<td>Vascular thrombosis</td>
<td>1</td>
<td>1.15</td>
</tr>
<tr>
<td>Pericardial tamponade/pericardiocentesis</td>
<td>1</td>
<td>1.15</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>3.45</td>
</tr>
</tbody>
</table>
Atrial Fibrillation Surgical Procedure Volume (N = 534)

2013
In 2013, Cleveland Clinic surgeons performed 534 procedures, including minimally invasive approaches, to treat patients with atrial fibrillation. The majority of procedures were done at the same time as valve surgery. The overall in-hospital mortality rate was 0.9% (N = 5).

Device Implants (N = 1445)

<table>
<thead>
<tr>
<th>Volume</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICDs</td>
<td>811</td>
</tr>
<tr>
<td>Pacemakers</td>
<td>634</td>
</tr>
</tbody>
</table>

Cleveland Clinic physicians in the electrophysiology laboratory implanted 1445 devices in 2013.

2009 – 2013

1.7
average number of leads extracted per procedure

94 months
average lead age at removal

71 months
median lead age at removal
## Initial Pacemaker or ICD Implantation Complications

2013

<table>
<thead>
<tr>
<th>Complications within 30 days</th>
<th>Pacemaker (N = 429) N (%)</th>
<th>ICD (N = 380) N (%)</th>
<th>Overall (N = 809) N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>1 (0.23)</td>
<td>0</td>
<td>1 (0.12)</td>
</tr>
<tr>
<td>Pneumothorax or hemothorax plus a chest tube</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hematoma plus a blood transfusion or evacuation</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cardiac tamponade or pericardiocentesis</td>
<td>1 (0.23)</td>
<td>1 (0.26)</td>
<td>2 (0.25)</td>
</tr>
</tbody>
</table>

### Complications within 90 days

- Mechanical complications requiring a system revision
  - Pacemaker: 7 (1.63)
  - ICD: 4 (1.05)
  - Overall: 11 (1.36)
- Device-related infection
  - Pacemaker: 0
  - ICD: 3 (0.79)
  - Overall: 3 (0.37)

**Total**: 9 (2.09) 8 (2.11) 17 (2.10)

---

## Secondary Pacemaker or ICD Implantation Complications

2013

<table>
<thead>
<tr>
<th>Complications within 30 days</th>
<th>Pacemaker (N = 205) N (%)</th>
<th>ICD (N = 431) N (%)</th>
<th>Overall (N = 636) N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0</td>
<td>1 (0.23)</td>
<td>1 (0.16)</td>
</tr>
<tr>
<td>Pneumothorax or hemothorax plus a chest tube</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hematoma plus a blood transfusion or evacuation</td>
<td>0</td>
<td>2 (0.46)</td>
<td>2 (0.31)</td>
</tr>
<tr>
<td>Cardiac tamponade or pericardiocentesis</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Complications within 90 days

- Mechanical complications requiring a system revision
  - Pacemaker: 2 (0.98)
  - ICD: 3 (0.70)
  - Overall: 5 (0.79)
- Device-related infection
  - Pacemaker: 1 (0.49)
  - ICD: 8 (1.86)
  - Overall: 9 (1.42)

**Total**: 3 (1.46) 14 (3.25) 17 (2.67)

---

*Initial implant refers to patients who have not had a prior device implant, including devices for bradycardia and tachycardia. Special devices, such as laptop and loop recorders, and replacement and device upgrades to implantable cardiac defibrillator (ICD) or cardiac resynchronization therapy (CRT) devices are excluded.

*Secondary implant refers to patients who have had a prior implant, excluding adapters, loop recorders, and monitoring devices.

Abbreviation: ICD, implantable cardiac defibrillator
Device Lead Extractions (Leads in Place > 1 Year or Requiring Extraction Technology)
Extraction Procedures (N = 1174)

2009 – 2013

Electrophysiologists at Cleveland Clinic perform the greatest number of lead extractions in the world. 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.

<table>
<thead>
<tr>
<th>Clinical success rate</th>
<th>98.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major complications</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

\(^a\) Success rate is defined as removal of all the required leads without causing bleeding from the veins or heart.

Device Clinic Evaluations Volume (N = 38,743)

2013

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\textsuperscript{®} function in Epic, Cleveland Clinic’s electronic medical record system, to quickly notify patients of their device status.
Remote Device Evaluations Volume (N = 16,751)

2013

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote pacemaker transmissions</td>
<td>6119</td>
</tr>
<tr>
<td>Remote ICD transmissions</td>
<td>10,632</td>
</tr>
</tbody>
</table>

Abbreviation: ICD, implantable cardiac defibrillator

2009 – 2013

Volume

2010 2011 2012 2013

Evaluation of Patients With Syncope

2013

Cleveland Clinic electrophysiologists and neurologists work collaboratively to evaluate patients with unexplained loss of consciousness (syncope). Evaluation includes blood volume studies, tilt table testing, and hemodynamic testing. Heart rate variability and autonomic reflex testing are available through Cleveland Clinic’s Neurological Institute and may be included as part of a syncope evaluation.
In 2013, Cleveland Clinic surgeons performed 2852 valve surgeries. A total of 2059 were primary operations and 793 were reoperations.

Cleveland Clinic is the nation’s leader for valve surgery volume.

Abbreviations: AVR, aortic valve replacement; CABG, coronary artery bypass grafting; MV, mitral valve; MVR, mitral valve replacement

Cleveland Clinic recently received The Society of Thoracic Surgeons’ (STS) prestigious three-star rating for aortic valve replacement and AVR+CABG. The rating is awarded to hospitals across the country that demonstrate the highest quality of cardiac surgery. Cleveland Clinic was awarded the rating based on data comparisons from January – December 2013.

The 2013 mortality rates for all types of valve surgery were lower than expected at Cleveland Clinic.


Abbreviations: AVR, aortic valve replacement; CABG, coronary artery bypass grafting; MV, mitral valve; MVR, mitral valve replacement

Distribution of Isolated and Combined Valve Operations (N = 2852)
2013

The majority of valve procedures performed at Cleveland Clinic in 2013 were combined primary procedures. Reoperations made up 28% of all valve procedures.
The volume of aortic valve (AV) procedures performed at Cleveland Clinic continues to increase. In 2013, a total of 1757 procedures were done. The majority (N = 1549) were valve replacements. Surgeons performed a total of 101 valve-sparing and 107 valve repair procedures.

Aortic valve replacement, in combination with other surgical procedures, is a complex operation. Despite this complexity and the associated increase in risks, mortality rates for both primary and reoperations were low.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Mitral Valve Surgery
Volume (N = 1282)

2013

Cleveland Clinic surgeons performed 1282 mitral valve surgeries in 2013. The majority (70%) were valve repair procedures and 30% were valve replacements.

Mitral Valve Surgery Volume — Repair vs Replacement
2009 – 2013

Cleveland Clinic performs mitral valve repair procedures rather than replacement whenever possible. Mitral valve repair 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 Hospital Mortality
2013

In 2013, the mortality rates for patients who had isolated mitral valve surgery were lower at Cleveland Clinic than the expected rates for both repair and replacement procedures.

Surgical Treatment of Infective Endocarditis

Bacterial (infective) endocarditis is a life-threatening infection of the heart valves or the heart’s inner lining (endocardium). The condition causes growths on or holes in the valves or scarring of the valve tissue, most often resulting in a leaky heart valve. Cleveland Clinic surgeons treat patients with infective endocarditis, including those with advanced disease and prosthetic valve endocarditis.

Volume and Hospital Mortality

2009 – 2013

In 2013, Cleveland Clinic surgeons performed 130 valve procedures to treat patients with infective endocarditis. A total of 70 were primary operations (in-hospital mortality rate, 0%) and 60 were reoperations (in-hospital mortality rate, 8.3%).

Infective Endocarditis Primary Hospital Mortality (N = 70)

2009 – 2013

Infective Endocarditis Reoperation Hospital Mortality (N = 60)

2009 – 2013

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Percutaneous Mitral Valvuloplasty Volume and Hospital Mortality
2009 – 2013

Seven patients had percutaneous mitral valvuloplasty at Cleveland Clinic in 2013. Cleveland Clinic surgeons consistently maintain a 0% mortality rate for this procedure.

Robotic Assisted Mitral Valve Repair Volume
2009 – 2013

Of the 133 robotically assisted mitral valve repair procedures in 2013, a total of 130 were mitral valve repairs. The in-hospital mortality rate for these procedures was 0.8% compared to an expected mortality rate of 1.2%.
**Transcatheter Aortic Valve Replacement**
Cleveland Clinic is a national leader in the use of percutaneous treatment options for patients with valve disease.

**Transcatheter Aortic Valve Replacement Volume and Hospital Mortality**
2009 – 2013

A total of 187 patients had transcatheter aortic valve replacement (TAVR) procedures at Cleveland Clinic in 2013. The in-hospital mortality rate was 2.1% compared with an expected rate of 4.0%.

Cleveland Clinic is one of the nation’s leading hospitals for this procedure. The technique is currently approved for use in certain patients, and further research is being conducted to assess use in other patient populations.


**PARTNER II Trial**
Cleveland Clinic is currently recruiting patients for the second arm of the Placement of Aortic Transcatheter Valves (PARTNER II) trial. This phase involves a randomized study of patients who have a moderately high risk associated with traditional surgery to treat severe aortic stenosis. Researchers are studying the use of percutaneous aortic valve replacement in this patient population. The procedure is done through the transfemoral or left subclavian artery or via a transapical approach. Research also includes an approach through the ascending aorta via a mini-J incision.
The TAVR procedure can be performed via a transfemoral or transapical approach. In 2013, Cleveland Clinic doctors used the transfemoral approach in 113 procedures (in-hospital mortality, 2.7%). The transapical approach was used in 54 procedures (in-hospital mortality, 0%). Other approaches are being researched.

Cleveland Clinic was one of the first hospitals to perform the TAVR procedure. The femoral approach has been consistently associated with low mortality. TAVR is used to treat some of the most critically ill patients with aortic valve disease.
Cleveland Clinic surgeons performed 2852 valve procedures in 2013. The majority were first operations.

Valve surgery reoperations are associated with a somewhat increased risk of death due to patients' decreased overall health over time. Despite the increased risk, Cleveland Clinic had lower than expected inpatient mortality rates in 2013.

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Cleveland Clinic uses a comprehensive, multidisciplinary approach to treat patients with aortic disease. Using conventional, minimally invasive, and endovascular techniques, surgeons treat all sections of the aorta, from the aortic valve to the blood supply to the pelvic vasculature.

### Aortic Surgery Volume and Type

**2004 – 2013**

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume</th>
<th>2013 Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Open ascending/ arch repair (N = 676)</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>Open descending/ thoracoabdominal repair (N = 113)</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>Endovascular descending/ thoracoabdominal repair (N = 250)</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Open abdominal repair (N = 101)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>Endovascular abdominal repair (N = 79)</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A total of 1219 aortic surgeries were performed at Cleveland Clinic in 2013. The majority of procedures were open repairs of the ascending aorta/arch.
In 2013, Cleveland Clinic surgeons performed 676 open procedures to repair the ascending aorta and aortic arch.

Reoperations

30%-50%
of patients who survive an acute dissection will require an aortic reoperation.

Cleveland Clinic surgeons are among the most experienced in the world for reoperations on patients who have developed late problems after surviving an emergency ascending aortic dissection. In a recent analysis of more than 429 reoperations performed at Cleveland Clinic, the in-hospital mortality rate was 6.1%. Rigorous follow-up with early intervention has been shown to be important to improving short- and long-term outcomes.

Aortic Arch Aneurysm Repairs (N = 121)

At Cleveland Clinic in 2013, a total of 121 patients had elective surgery to repair the aortic arch. The in-hospital mortality rate was 0.8%, less than one-third the expected rate based on comparison to other national academic centers.

Emergency and Urgent Arch Aneurysm Operations Volume and Mortality (N = 70)

2009 – 2013

A total of 70 Cleveland Clinic patients had emergency open procedures to repair the aortic arch in 2013. The mortality rate for this very high-risk population remained low at 10%.

Rescue After Thoracic Stent grafting

Thoracic endovascular aortic repair (TEVAR) has been applied to increasingly complex aortic pathology, resulting in an increase in late complications. Cleveland Clinic surgeons recently published their experience performing open repair after prior TEVAR in 50 patients for type 1 endoleaks, retrograde dissections, persistent growth of chronic dissections, and graft infections with a mortality of only 6% in a very complex population.

An increasing number of patients with connective tissue disorders like Marfan syndrome and Loeys Dietz syndrome are being diagnosed with aortic aneurysms. Up to 2% of the population is born with a bicuspid aortic valve that is commonly associated with thoracic aortic aneurysm.

**Valve-Sparing Operations**

Cleveland Clinic surgeons are among the most experienced in the world for valve-sparing aortic root aneurysm repairs ("modified David’s valve reimplantation procedure"). In a recently published analysis of 178 patients with connective tissue disorder who underwent the procedure, there were no deaths, and freedom from reoperation at 6 years was 92%.

**Modified David’s Valve Reimplantation Procedure**

2009 – 2013


**Aneurysm Repair in Patients with Bicuspid Aortic Valves**

2011 – 2013

Up to 2% of the population is born with a bicuspid aortic valve. It is estimated that 30%-50% of those patients are prone to develop an aneurysm of the proximal aorta including the root, ascending, and arch to varying degrees. Cleveland Clinic surgeons have consistently performed more than 200 aortic repairs per year for patients with bicuspid valves and achieved an inhospital mortality rate of 0.6%. One-third of those operations are performed using a minimally invasive technique.


New Indication for TEVAR — Descending Dissection

In 2013, the FDA approved the use of stent grafts for treating both acute and chronic aortic dissections involving the descending thoracic aorta. This decision was based in part on data from the Cleveland Clinic experience with treating these complex patients.


Aortic Disease (continued)

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 both open and endovascular repair techniques with excellent outcomes, and tailor the choice to each patient's needs.

DTA Repair Volume and Type (N = 810)

2009 – 2013

<table>
<thead>
<tr>
<th>Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open elective</td>
<td>17% (N = 142)</td>
</tr>
<tr>
<td>Open emergency</td>
<td>6% (N = 52)</td>
</tr>
<tr>
<td>Endovascular elective</td>
<td>53% (N = 422)</td>
</tr>
<tr>
<td>Endovascular emergency</td>
<td>24% (N = 194)</td>
</tr>
</tbody>
</table>

The majority of the 810 DTA repairs performed at Cleveland Clinic from 2009 through 2013 were done using an endovascular approach.

DTA Repair Hospital Mortality

2009 – 2013

<table>
<thead>
<tr>
<th>Type</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective</td>
<td>6%</td>
</tr>
<tr>
<td>Emergency</td>
<td>17%</td>
</tr>
<tr>
<td>Open elective</td>
<td>2%</td>
</tr>
<tr>
<td>Open emergency</td>
<td>6%</td>
</tr>
<tr>
<td>Endovascular elective</td>
<td>53%</td>
</tr>
<tr>
<td>Endovascular emergency</td>
<td>24%</td>
</tr>
</tbody>
</table>

Cleveland Clinic surgeons have extensive experience in treating patients with disease involving the descending aorta, including patients who have the most complex cases. In 2013, the mortality rate for all repairs remained lower than the expected rates. For open elective repairs mortality was 2% (3.2% expected). The rate for emergency open repairs was 5.6% (7% expected). The rates for endovascular repairs were 1.9% for elective procedures (3.4% expected), and 11.1% for emergency repairs (15.1% expected).

Abbreviation: TAAA, thoracoabdominal aortic aneurysm
Staging Procedures Improve Spinal Cord Outcomes
Neurologic dysfunction, especially spinal cord injury, remains a devastating complication of thoracoabdominal aneurysm repair. To reduce this risk, Cleveland Clinic surgeons routinely repair the aorta in stages, if possible. This approach helps minimize the shock to the spinal cord by giving it time to recover.

In a review of cases involving type II repair between January 2008 and July 2013, patients whose surgery was intentionally staged had a lower rate of spinal cord injury than those whose repairs were not staged (1.11% vs 37.5%). In addition, this approach decreased the risk of 30-day mortality (0% vs 8.8%) among the same groups. This evidence will change the approach to complex aortic repair in the future.


Late Rescue of Stent Graft Failure Using Branched and Fenestrated Devices
The use of infrarenal stent grafting has grown over the years, and vascular surgeons are starting to see patients treated with early devices that are now failing. Corrective treatment with conventional surgery can involve a major incision and a high risk of complications. In 2013, Cleveland Clinic surgeons demonstrated the efficacy of using a branched/fenestrated stent to reline the failed device and prevent aortic expansion or rupture.

Cleveland Clinic surgeons used this approach in 52 rescue procedures, and successful target vessel stenting was achieved in 92% of vessels. These complex procedures were performed without an increase in the radiation dose compared with routine fenestrated procedures. The 30-day mortality rate in this group was 3.8% (N = 2).

TAAA Surgeries
The most challenging aortic procedures involve patients with TAAA. Cleveland Clinic surgeons have extensive experience using both open and endovascular techniques to treat these patients.

TAAA Surgeries by Type
2009 – 2013

Crawford Classification of Aortic Aneurysms

Type I
Aneurysms involve most or all of the descending thoracic aorta to the level of the renal arteries.

Type II
Aneurysms involve most or all of the descending thoracic aorta, with abdominal extension to below the renal arteries.

Type III
Aneurysms involve the lower portion of the descending thoracic aorta, extending to the abdominal aorta below the level of the renal arteries.

Type IV
Aneurysms involve the upper half or all of the abdominal aorta.
The complex nature of TAAA procedures is associated with a greater risk of mortality. Cleveland Clinic continuously strives to maintain the lowest mortality rates possible. In 2013, the mortality rate for endovascular branch vessel procedures was 3.27%. The rate for open elective repairs was 0%. Emergency repairs require open surgery. The mortality rate for these procedures was 9.09%.

“Challenging the Dogma”: Chemotherapy in Patients With Aneurysm
For years, many surgeons held the belief that administering chemotherapy to a patient with an aneurysm might increase the risk of rupture — a belief that is based on minimal evidence. Cleveland Clinic researchers conducted a review to determine if there was any basis for this belief. A total of 91 Cleveland Clinic patients with aneurysms needed chemotherapy between 2000 and 2010. The most common type of cancer among these patients was lung cancer (N = 34, 38%), followed by lymphoma (N = 21, 23%) and colorectal cancer (N = 10, 11%). The baseline aneurysm diameter at the time of the initial chemotherapy was 41.4 mm (IQR 34.9, 51.3). The annual rate of growth among these patients was found to be similar to patients not receiving chemotherapy: 2.3 mm/year.

Aortic Disease (continued)

Gaining More Experience With Stents in the Aortic Arch
Arch aneurysm repair in patients who have had previous surgery or who are advanced in age can be high risk. Cleveland Clinic surgeons have had very good experience using a novel stent graft in the arch to treat patients who do not have other surgical options. Cleveland Clinic recently collaborated with an international consortium to publish the results of global use of this device, which included 38 patients from eight different centers in Europe and North America. Technical success was observed in 32 patients (84.2%, 95% CI, 72.4–95.9) with a 30-day mortality rate of 13.2% (95% CI, 2.2–24.2). Of utmost importance, however, is evidence that there is an critical learning curve associated with this device, suggesting that only centers with experience should champion its use.


Abdominal Aortic Aneurysms
The abdominal aorta is second to the ascending aorta for aneurysm formation. Cleveland Clinic treats patients with abdominal aortic aneurysms (AAAs) both below and adjacent to the renal arteries. Surgeons use both open and endovascular repair procedures.

AAA Procedure Volume and Type
2009 – 2013

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open (N = 386)</td>
<td>43%</td>
</tr>
<tr>
<td>Endovascular (N = 503)</td>
<td>57%</td>
</tr>
</tbody>
</table>

The majority of the 889 AAA repair procedures performed at Cleveland Clinic from 2009 to 2013 were endovascular.

Open AAA Repair Volume and Type (N = 386)
2009 – 2013

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective (N = 314)</td>
<td>81%</td>
</tr>
<tr>
<td>Emergency (N = 72)</td>
<td>19%</td>
</tr>
</tbody>
</table>

Cleveland Clinic surgeons performed 386 open AAA repairs from 2009 through 2013. Although open repairs are associated with greater risk, the institute maintains high volumes and excellent outcomes.
Cleveland Clinic surgeons performed 508 endovascular AAA repair procedures from 2009 to 2013. A total of 40 fenestrated grafts were used to repair juxtarenal aneurysms.

In 2013, Cleveland Clinic surgeons achieved a 1.3% mortality rate for elective open AAA repairs. The mortality rate for emergency open AAA repairs was 16.67%.

The mortality rate for elective endovascular AAA repair was 0% in 2013. The rate for emergency repairs was 15.9%.

0% mortality rate for patients with juxtarenal aneurysms treated with fenestrated graft procedures (N = 40) from 2009 to 2013.
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, 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.

Cleveland Clinic continues to be one of the nation’s leaders for volume and outcomes among patients with HOCM. In 2013, a total of 205 had surgical treatment. The inpatient mortality rate was 0.5%.
The majority of patients with HOCM who had surgical repair at Cleveland Clinic in 2013 had a septal myectomy in addition to a valve surgery.

**Septal Myectomy Mortality**

The expected in-hospital mortality rate for patients who had a septal myectomy in 2013 was 1.6%. The rate at Cleveland Clinic was lower (0.5%).
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 United States 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 Center for Pediatric and Adult Congenital Heart Disease’s services are further enhanced by the Special Delivery Unit. The unit provides in utero diagnosis of complex heart conditions and immediate treatment after birth.

Percutaneous Interventional Procedures for Adult Congenital Heart Disease

Volume and Outcomes (N = 53) 2013

A total of 53 patients had percutaneous closure procedures at Cleveland Clinic in 2013. The success rate was 100%. The mortality rates for both ASD and PFO closures were 0%.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percutaneous ASD closures</td>
<td>14</td>
</tr>
<tr>
<td>Percutaneous PFO closures</td>
<td>39</td>
</tr>
</tbody>
</table>

Abbreviations: ASD, atrial septal defect; PFO, patent foramen ovale
Adult Congenital Heart Surgery Volume and Type (N = 213)

2013
The majority of the 213 adult congenital surgeries performed at Cleveland Clinic in 2013 were within the “other” category, which includes complex valve and complex great vessel surgery.

Volume

Abbreviations: AAOCA, anomalous aortic origin of a coronary artery; ASD, atrial septal defect; CABG, coronary artery bypass grafting; PAPVR, partial anomalous pulmonary venous return; VAD, ventricular assist device

Adult Congenital Heart Surgery Mortality

2013
The in-hospital mortality rate for adult congenital surgery at Cleveland Clinic in 2013 was 2%, compared with the expected rate of 3%.

Percent

These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Pediatric Congenital Heart Surgery Volume and Type \( (N = 138) \)

2013

Cleveland Clinic surgeons performed 138 pediatric congenital surgeries in 2013. The majority of procedures, represented by the “other” category included truncus arteriosus repair and various procedures of varying complexity.

![Bar chart showing pediatric congenital heart surgery volume and type](chart.png)

Abbreviations: ASD, atrial septal defect; ASO, arterial switch operation; AV, atrioventricular; ECMO, extracorporeal membrane oxygenation; PA, pulmonary arterioplasty; PDA, patent ductus arteriosus ligation; TXP, transplant; RV, right ventricle; TOF, tetralogy of Fallot; VAD, ventricular assist device; VSD, ventricular septal defect

Pediatric Congenital Heart Surgery Mortality

2012 – 2013

The in-hospital mortality rate for pediatric congenital surgery in 2013 was 1.4%.

![Bar chart showing pediatric congenital heart surgery mortality](chart2.png)
Pericardial Disease: Patient Volume

2009 – 2013

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 includes cardiologists, surgeons, and imaging specialists, which enhances collaboration in the management of these diseases. There were 1444 visits to the center in 2013.

Pericardial Disease Syndromes in Outpatient Clinic Volume, New and Consult (N = 534)

2013

The most common diagnosis among patients seen at the pericardial disease center in 2013 was pericardial effusion (with or without tamponade). The “other” category includes pericardial cysts, neoplasms, pericardial fistula, pericardial thickening, pericardial calcification, and visits for a history of pericardial disease. They collectively account for a small number of visits and are therefore combined in the “other” category.
Pericardial Disease (continued)

Echocardiography

Detection of pericardial effusion and cardiac tamponade
Detection of myocardial involvement

Computed Tomography

Detection of loculated pericardial effusion
Pericardial effusion in traumatic cases

Cardiac MRI

Detection of pericardial inflammation
Detection of myocardial involvement

Pericardial Disease Etiology (N = 534)

2013
Pericarditis can be caused by a number of conditions; however, it is common for the cause to be unknown. In 2013, a total of 397 patients seen at Cleveland Clinic had pericarditis of unknown origin.

100%

74% Idiopathic (N = 397)
8% Autoimmune (N = 40)
7% Postpericardiotomy syndrome (N = 38)
4% Viral (N = 23)
4% Other (N = 22)
3% Radiation (N = 14)

Pericardial Procedures (N = 152)

2013
Pericardiocentesis accounted for the majority of pericardial procedures performed at Cleveland Clinic in 2013. This percutaneous treatment is used to drain large pericardial effusions in patients, and the use of echocardiography during the procedure helps improve outcomes.

100%

54% Pericardiocentesis (N = 83)
32% Pericardietomy (N = 48)
14% Window (N = 21)

Pericardietomy: 2.19% mortality (4.4% expected)
Window: 0.0% mortality (8.2% expected)
Cleveland Clinic’s cardiac transplant program is one of the largest in the United States and is the leading center in Ohio.

**Heart Transplant Volume**

**July 2007 – June 2013**

Cleveland Clinic surgeons performed 44 heart transplant procedures in 2013.

**Heart Transplant Patient Survival**

**Survival (%)**

<table>
<thead>
<tr>
<th>Time Since Transplant</th>
<th>1 year N = 116</th>
<th>3 years N = 135</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/1/10 to 12/31/12</td>
<td>92.04%</td>
<td>90.85%</td>
</tr>
<tr>
<td>January 2008 to June 2010</td>
<td>90%</td>
<td>83.39%</td>
</tr>
</tbody>
</table>

Survival rates among patients who had a heart transplant at Cleveland Clinic were statistically as expected for both 1-year and 3-year rates.

*Expected based on risk adjustment
Source: Scientific Registry of Transplant Recipients. Center and OPO-Specific Reports, March 2014. Ohio, Heart Centers, Cleveland Clinic. Table 11. srtr.org
Mechanical Circulatory Support Device Volume

2009 – 2013
Mechanical circulatory support (MCS) devices can be used to help preserve heart function while patients are waiting for a heart transplant (bridge-to-transplant) or as a final treatment option (destination therapy). Cleveland Clinic has more than 25 years of experience with MCS. In 2013, a total of 34 patients received MCS devices as a bridge-to-transplant, and 32 began destination therapy.

Left Ventricular Assist Device In-Hospital Mortality

2009 – 2013
A total of 66 Cleveland Clinic patients received left ventricular assist devices in 2013. The in-hospital mortality rate was 7.5%. Cleveland Clinic continuously works to reduce these rates.

Ventricular Assist Device Mortality

2013
The expected in-hospital mortality rate for patients with ventricular assist devices was 18% in 2013. The rate at Cleveland Clinic was much lower (7.5%).

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Heart Failure

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

July 2009 – June 2012

The Centers for Medicare & Medicaid Services (CMS) calculates the two heart failure outcomes measures above based on Medicare claims and enrollment information. The most recent risk-adjusted data available from CMS are shown. Although Cleveland Clinic’s heart failure mortality rate is lower than the US national rate, and Cleveland Clinic’s heart failure readmissions rate is slightly higher than the national rate, CMS ranks Cleveland Clinic’s performance on both as “no different than” the US national rate. To further reduce avoidable readmissions, Cleveland Clinic is focused on improving transitions from hospital to home or postacute facility. Specific initiatives have been implemented in each of these areas: communication, education, and follow-up.

*Source: medicare.gov/hospitalcompare
*N = eligible discharges
The Lung and Heart-Lung Transplant Program at Cleveland Clinic is among the highest volume programs in the United States and is the leading center in Ohio. It is the only major lung transplant center in Ohio with a 7/1/2012-6/30/2013 volume of 98 transplanted patients. The next highest volume center in Ohio performed only 2 transplants.

**Lung Transplant Procedures Volume and Type**

**2009 – 2013**

<table>
<thead>
<tr>
<th>Year</th>
<th>Liver-lung</th>
<th>Heart-lung</th>
<th>Double lung</th>
<th>Single lung</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>160</td>
<td>40</td>
<td>57</td>
<td>110</td>
</tr>
<tr>
<td>2010</td>
<td>160</td>
<td>80</td>
<td>41</td>
<td>79</td>
</tr>
<tr>
<td>2011</td>
<td>120</td>
<td>80</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>2012</td>
<td>80</td>
<td>80</td>
<td>33</td>
<td>67</td>
</tr>
<tr>
<td>2013</td>
<td>80</td>
<td>80</td>
<td>33</td>
<td>67</td>
</tr>
</tbody>
</table>

In 2013, Cleveland Clinic surgeons performed 98 lung transplant procedures. The majority were single lung (50%) and double lung (47%) procedures.

**Primary Disease of Lung Transplant Recipients (N = 98)**

**July 2012 – June 2013**

- **57%** Interstitial lung disease/fibrosis (N = 56)
- **18%** Other (N = 17)
- **14%** Emphysema/chronic obstructive pulmonary disease (N = 14)
- **11%** Cystic fibrosis (N = 11)

The majority of patients who had lung transplant procedures at Cleveland Clinic in 2013 had interstitial lung disease/fibrosis.

Source: Scientific Registry of Transplant Recipients. Center and OPO-Specific Reports, March 2014. Ohio, Lung Centers, Cleveland Clinic. Table 11. srtr.org
Patients who undergo lung transplantation at Cleveland Clinic have survival rates as expected and not statistically different from national rates.

* Expected survival rate based on risk adjustment. Source: Scientific Registry of Transplant Recipients. March 2013, Ohio, Lung Centers, Cleveland Clinic. Table 10. srtr.org.

Waiting Time for Lung Transplant
7/1/2007 – 12/31/2012

The median wait time for lung transplantation at Cleveland Clinic is shorter than in the region as well as throughout the United States.

Source: Scientific Registry of Transplant Recipients. March 2013, Ohio, Lung Centers, Cleveland Clinic. Table 6. srtr.org.

Wait List Mortality
July 2012 – June 2013

Patients on the waiting list have a mortality rate not statistically different from the national rate.

*Expected survival rate based on risk adjustment. Source: Scientific Registry of Transplant Recipients. March 2012, Ohio, Lung Centers, Cleveland Clinic. Table 3. srtr.org.
In 2013, 99% of venous duplex ultrasound studies were read in 24 hours; 100% of all other vascular studies were finalized within 48 hours.

**Lower Extremity Interventional Procedures**

Cleveland Clinic’s team of vascular surgeons and interventional cardiologists performs a variety of procedures to treat patients with peripheral artery conditions. They are skilled at angioplasty, atherectomy, stenting, thrombectomy, and thrombolysis.

**Lower Extremity Surgery Volume and Mortality (N = 260)**

A total of 260 lower extremity surgical procedures were performed at Cleveland Clinic in 2013. Of these, 228 were bypass procedures and 32 were thrombectomies. The 30-day mortality rate for bypass surgery was 2.7%.

**2013 Volume**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bypass</td>
<td>228</td>
</tr>
<tr>
<td>Thrombectomy</td>
<td>32</td>
</tr>
</tbody>
</table>

**2013 30-Day Mortality (%)**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bypass</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

**Lower Extremity Interventional Procedure Volume**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angioplasty</td>
<td>186</td>
</tr>
<tr>
<td>Atherectomy</td>
<td>9</td>
</tr>
<tr>
<td>Stenting</td>
<td>253</td>
</tr>
<tr>
<td>Thrombolysis</td>
<td>118</td>
</tr>
</tbody>
</table>
**Executive Health Screening Program**

2011 – 2013

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 arterial disease, which can indicate an increased risk of heart attack and stroke and can impair function and quality of life; and abdominal aortic aneurysm (AAA). Ruptured AAAs are almost entirely preventable if an AAA is identified and monitored; however, about 15,000 people die each year in the United States due to ruptured AAAs.

---

**Noninvasive Vascular Lab Ultrasound Study Distribution (N = 36,379)**

2013

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 2013, 36,379 vascular lab studies were performed.

- **44%** Venous Duplex (N = 15,822)
- **38%** Arterial Duplex (N = 13,832)
- **18%** Physiologic Testing (N = 6725)

All Cleveland Clinic vascular lab technologists are certified registered vascular technologists, which exemplifies Cleveland Clinic’s commitment to quality patient care. A total of 36,379 vascular lab studies were performed in 2013.
Fibromuscular Dysplasia

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. In 2013, a total of 199 patients seen in the program had a primary diagnosis of FMD, and 218 patients had FMD as a secondary diagnosis.

Fibromuscular Dysplasia — Patient Volume

Lower Extremity Wound Clinic Volume

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. In 2013, a total of 2070 patients with a primary thrombosis diagnosis were seen in the center at Cleveland Clinic’s main campus.
**Iliac Stenting**

**2010 – 2013**

![Volume Chart]

A total of 179 iliac stent procedures were performed at Cleveland Clinic in 2013. The use of stents to treat patients with iliac occlusive disease has increased in recent years. The treatment is associated with excellent outcomes (restoring blood flow and minimal complications).

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**Hybrid Procedures Trends (Endarterectomy With Stent)**

**2011 – 2013**

![Volume Chart]

In 2013, Cleveland Clinic performed 34 iliac endarterectomy procedures with stent. This hybrid procedure is used in place of an aortic femoral bypass for patients with complex aorto-iliac occlusive disease.
Visceral Stenting Trends

Volume 2010 – 2013

Chronic mesenteric ischemia is a condition caused by blockages to the intestinal (visceral) blood vessels. Cleveland Clinic has led the change in clinical practice from primarily surgical bypass to endovascular stenting. There has been steady growth year over year in procedure volumes. In 2013, stenting was used to treat 26 patients with chronic mesenteric ischemia and 13 patients with acute mesenteric ischemia.

---

Visceral Stenting Trends

Volume and Mortality 2010 – 2013

The use of brachial artery, rather than femoral artery, access to treat critically ill patients with acute mesenteric ischemia has led to improved outcomes at Cleveland Clinic. In 2013, 39 patients had mesenteric stenting. The in-hospital mortality rate was 0%, and 30-day mortality was 7.7%.
The use of a patient's own vein (autologous) in bypass surgery results in better outcomes than the use of prosthetic conduits (70% vs 20% 5-year patency; 93% limb salvage rate, 73/78). In 2013, Cleveland Clinic used autologous veins in 82% of bypass procedures and used all sources possible (saphenous, arm, and femoral veins).
Carotid artery stenosis is the cause of more than half of all temporary and permanent strokes. Patients with hypertension, coronary artery disease, and peripheral artery disease are at increased risk of developing carotid artery stenosis. This risk can be reduced through early diagnosis with vascular ultrasound and through disease management with medications such as antiplatelet and antihypertensive agents. Cleveland Clinic incorporates the most current technology and methods to care for patients with cerebrovascular disease. These include specialized ultrasound laboratories and advanced medical treatments, such as open carotid surgery and minimally invasive carotid artery stenting procedures.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>N</th>
<th>MI (%)</th>
<th>Stroke (%)</th>
<th>In-Hospital Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid Stenting</td>
<td>377</td>
<td>0.5</td>
<td>2.1</td>
<td>0</td>
</tr>
<tr>
<td>Carotid Endarterectomy</td>
<td>689</td>
<td>1.4</td>
<td>1.7</td>
<td>0.7</td>
</tr>
</tbody>
</table>

*For all procedures performed at Cleveland Clinic’s main campus

The mortality rate for patients treated for cerebrovascular disease at Cleveland Clinic’s main campus was below the expected rate.

The Heart & Vascular Institute is currently enrolling patients in medical, surgical, and endovascular trials involving cerebrovascular disease. These national trials represent the most up-to-date therapies available to patients with atherosclerotic carotid diseases. Ongoing registries are also available for patients who are eligible. In addition, both minimally invasive and open surgeries are performed for cerebrovascular debranching to expand the application of thoracic stent grafting technology in patients with thoracic aneurysms.
Cleveland Clinic thoracic surgeons treat patients with a wide variety of diseases of the lung and esophagus. The staff is composed of 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 Mortality**

2009 – 2013

In 2013, Cleveland Clinic surgeons performed 1555 thoracic procedures. The in-hospital mortality rate was 1.2%.
The majority of major thoracic surgical procedures at Cleveland Clinic in 2013 were pulmonary procedures.

*Other such as thymectomies, wedge resections, tumor surgeries, paraesophageal hiatal hernia repairs, thyroidectomies.

Cleveland Clinic surgeons performed 319 pulmonary resections in 2013. The in-hospital mortality rate was 0.6%.
Distribution of Pulmonary Resections by Type (N = 319)

2013

- 28% Open lobectomy (N = 88)
- 25% Video-assisted lobectomy (N = 81)
- 22% Video-assisted wedge (N = 71)
- 7% Other open (N = 22)
- 6% Other VATS (N = 19)
- 5% Pneumonectomy (N = 17)
- 4% Open wedge (N = 12)
- 3% Segmentectomy (N = 9)

The majority of pulmonary resections performed at Cleveland Clinic in 2013 were open and video-assisted lobectomies. Video-assisted surgeries (VATS) and minimally invasive techniques are used when appropriate to yield the best possible outcomes for each patient.

Pulmonary Resection Postoperative Length of Stay (N = 319)

2013

Cleveland Clinic surgeons perform a variety of open and VATS. The postoperative length of stay is generally shorter with VATS compared with open procedures.
Lobectomy for Stage I Lung Cancers
2010 – 2013

Video-assisted/robotic techniques are less invasive than open procedures and can help improve outcomes. Cleveland Clinic surgeons use these techniques whenever appropriate.

Major Pulmonary Resections Operative Mortality
2009 – 2013

The expected in-hospital mortality rate for patients who had major pulmonary resections in 2013 was 1.5%. The rate at Cleveland Clinic was lower than expected (0.6%).

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu
Combined Morbidity and Mortality for Pulmonary Resections for Lung Cancer, July 2010 – June 2013

Cleveland Clinic surgeons performed 489 pulmonary resections from 2010 to 2013. The risk-adjusted rates for morbidity and mortality were among the best in the country.

<table>
<thead>
<tr>
<th>Eligible procedures</th>
<th>Unadjusted rate</th>
<th>Risk-adjusted rate (95% CI)</th>
<th>Standardized incidence ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>489</td>
<td>6.3%</td>
<td>6.4% (4.7%-8.4%)</td>
<td>0.79 (0.58-1.05)</td>
</tr>
</tbody>
</table>


Lobectomy Length of Stay

2013

<table>
<thead>
<tr>
<th>Median (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open lobectomy (N = 88)</td>
</tr>
</tbody>
</table>

The median length of stay was lower among patients who had video-assisted lobectomies compared with those who had open procedures.
Esophageal Surgery Volume and Mortality
2009 – 2013

Cleveland Clinic thoracic surgeons performed 206 esophageal procedures in 2013. The in-hospital mortality rate was 0.9%.

![Graph showing esophageal surgery volume and mortality from 2009 to 2013]

Source: These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. uhc.edu

Esophagectomy Mortality 1 Year After Surgery
2013

The one-year mortality rate following esophagectomy was 1.2% among patients who had surgery at Cleveland Clinic. The expected rate was higher (3.5%).

![Graph showing esophagectomy mortality 1 year after surgery]

Cleveland Clinic surgeons performed 149 esophageal surgeries from 2010 to 2013 with a risk-adjusted rate of morbidity and mortality better than the national median.

<table>
<thead>
<tr>
<th>Eligible procedures</th>
<th>Unadjusted rate</th>
<th>Risk-adjusted rate (95% CI)</th>
<th>Standardized incidence ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>149</td>
<td>25.5%</td>
<td>26.6% (20.5%-33.1%)</td>
<td>0.94 (0.73-1.17)</td>
</tr>
</tbody>
</table>


Cleveland Clinic surgeons performed 149 esophageal surgeries from 2010 to 2013 with a risk-adjusted rate of morbidity and mortality better than the national median.

Distribution of Esophageal Surgeries by Indication (N = 206)

2013

- 34% Paraesophageal hernia repair (N = 71)
- 33% Cancer (N = 68)
- 20% Achalasia (N = 41)
- 7% Other (N = 14)
- 3% Esophageal reconstruction (N = 6)
- 3% Reflux (N = 6)

The majority of esophageal surgeries at Cleveland Clinic in 2013 were to treat patients with paraesophageal hernias and esophageal cancer.
Lung Volume Reduction Program

Lung volume reduction (LVR) aims to reduce hyperinflation in patients with emphysema, thereby improving dyspnea and quality of life. The National Emphysema Treatment Trial (NETT) has shown that, in appropriately selected patients, the procedure leads to a significant improvement in quality of life and in survival. Cleveland Clinic has had an active Lung Volume Reduction Surgery Program even prior to NETT, in which it was a leading site. This is a multidisciplinary program of teams from the Respiratory Institute and the section of Thoracic Surgery in the Heart & Vascular Institute. Due to the extensive preoperative and longitudinal management of these complex patients, Cleveland Clinic has built a program that facilitates screening and evaluation of potential candidates for the procedure by partnering with referring physicians. Whenever possible, Cleveland Clinic works with local pulmonary rehabilitation programs to prepare patients for the procedure. When patients are brought to Cleveland, testing and clinical assessment are carried out through coordinated appointments that allow rapid patient evaluation.

In 2013, Cleveland Clinic screened 150 patients and performed four lung volume reduction surgeries. Since the inception of the program in 2004, 38 patients have undergone lung volume reduction surgery at Cleveland Clinic. Beginning in 2011, the procedure has been performed with video-assisted thoracoscopic surgery, a less morbid procedure than the classic approach involving median sternotomy. The lung volume reduction program also offers several bronchoscopic lung volume reduction research protocols that have been enrolling patients in clinical trials since 2004.
Patients who underwent lung volume reduction surgery at Cleveland Clinic showed improvement in lung function, as measured by forced exhaled volume in 1 second, and in exertional capacity, as measured by 6-minute walk distance. In the graphs, N = number of patients with complete data at interval shown.

**Improvement in Lung Function**

2004 – 2013

FEV<sub>1</sub> (L)<sup>a</sup>

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>6 Months</th>
<th>1 Year</th>
<th>2 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>29</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

<sup>a</sup>FEV<sub>1</sub> (L) = forced exhaled volume in 1 second (in liters).

**Improvement in Exertional Capacity**

2004 – 2013

**Change From Baseline for 6-Minute Walk (Feet)**

<table>
<thead>
<tr>
<th></th>
<th>6 Months</th>
<th>1 Year</th>
<th>2 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>12</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>
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 and had at least two follow-up visits within one year. The time between visits varied from patient to patient.

**Primary Prevention, Statin-Tolerant Adults (N = 877 in 2013)**

2008 – 2013

**Secondary Prevention, Statin-Tolerant Adults (N = 659 in 2013)**

2008 – 2013
**LDL Levels Among Statin-Intolerant Adults**

Patients referred to the prevention clinic who could not tolerate statins still experienced reductions in LDL levels. Patients had at least two follow-up visits within a year.

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**Primary Prevention, Statin-Intolerant Adults (N = 199 in 2013)**

2008 – 2013

**LDL Value**

- **Baseline:** 126 mg/dL
- **2nd follow-up:** 96.5 mg/dL

---

**Secondary Prevention, Statin-Intolerant Adults (N = 236 in 2013)**

2008 – 2013

**LDL Value**

- **Baseline:** 136.5 mg/dL
- **2nd follow-up:** 79 mg/dL
Blood Pressure Among Primary and Secondary Prevention Patients (N = 948)

2013

Patients who were seen in the prevention clinic for both primary and secondary prevention experienced reductions in blood pressure. All patients had at least two follow-up visits within a year.

Value (mmHg)

<table>
<thead>
<tr>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>76</td>
</tr>
<tr>
<td>122</td>
<td>70</td>
</tr>
</tbody>
</table>

Pediatric Preventive Cardiology and Metabolic Clinic Lipid Levels (N = 135)

2013

Value (mg/dL)

<table>
<thead>
<tr>
<th>LDL</th>
<th>HDL</th>
<th>Triglycerides</th>
<th>Total cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>193</td>
<td>131</td>
<td>97</td>
<td>263</td>
</tr>
<tr>
<td>122</td>
<td>70</td>
<td>87</td>
<td>192</td>
</tr>
</tbody>
</table>

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 one follow-up visit in 2013.
**Exercise Prescriptions**

**2010 – 2013**

Cleveland Clinic's exercise prescriptions are designed to help patients start an exercise program. The prescription is written after the patient's fitness level is determined. It provides the information about the recommended frequency, intensity, type, and length of exercise sessions. In 2013, 464 patients received exercise prescriptions.

---

**HbA\textsubscript{1c} Levels Among Patients With Diabetes (N = 285)**

2013

Patients seen in the prevention clinic who had diabetes reduced HbA\textsubscript{1c} levels during the course of their treatment. All patients were seen at baseline and had at least two follow-up visits within a year.

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**Exercise Prescriptions**

**2010 – 2013**

Cleveland Clinic's exercise prescriptions are designed to help patients start an exercise program. The prescription is written after the patient's fitness level is determined. It provides the information about the recommended frequency, intensity, type, and length of exercise sessions. In 2013, 464 patients received exercise prescriptions.
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 = 246)

2013

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 average predicted reduction in mortality for patients in the program based on improvement in functional capacity (METs) was approximately 18%.

Data represent all cardiac rehab patients with both entry and exit visits in 2013.

Cardiac Rehabilitation

Improvement in Systolic Blood Pressure (N = 246)

2013

Among patients who completed the Cardiac Rehabilitation Program, 89% achieved normal blood pressure (< 140/90 mmHg). The average improvement was 12 mmHg.

Data represent all cardiac rehab patients with both entry and exit visits in 2013.
Cardiac Rehabilitation

Improvement in Weight (N = 246)

2013

Weight (lbs.)

The average weight loss for patients who completed the Cardiac Rehabilitation Program was 4.9 pounds.

Data represent all cardiac rehab patients with both entry and exit visits in 2013.

Cardiac Rehabilitation Program Volume

2009 - 2013

In 2013, there were 16,118 patient visits for cardiac rehab (Phase 1, 8233; Phase II, 4174; Phase III, 3711).
### Improvement in Quality of Life Assessment (N = 246)

#### 2013

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. Patients who completed the program experienced improved physical and emotional quality of life.

#### SF-36 Score

![Bar chart showing SF-36 score improvement](chart.png)

- Physical summary score
- Mental summary score

#### The Weigh to a Healthy Heart

**2012 - 2013**

The Weigh to a Healthy Heart is a comprehensive 10-week weight loss program designed to help prevent cardiovascular disease. The program is guided by a team of dietitians, physicians, exercise physiologists, and behavioral counselors. Patients receive an exercise prescription and participate in private nutrition sessions, group exercise classes, lipid and fasting sugar testing, and weekly group support sessions. They also get help creating a grocery list.

In 2012, patients who attended more than 75% of the classes lost an average of 8 pounds. Patients who attended more than 75% of classes in 2013 lost an average of 7 pounds.

#### Mean Weight Loss Over 10 Weeks

<table>
<thead>
<tr>
<th>Year</th>
<th>Weight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>8 pounds</td>
</tr>
<tr>
<td>2013</td>
<td>7 pounds</td>
</tr>
</tbody>
</table>
Cleveland Clinic has partnered with the *NFL Player Care Foundation* to help retired NFL players improve their quality of life and stay healthy. Players receive free comprehensive cardiovascular screenings in addition to urologic health evaluations and prostate exams. More than 500 former players are expected to participate by the end of 2014.
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 ACS NSQIP performance benchmarked against more than 400 participating hospitals.

Cleveland Clinic Overall Multispecialty 30-Day Mortality and 30-Day Morbidity (N = 4682)

July 2012 – June 2013

Overall mortality was lower than expected; overall morbidity was higher than expected and identified as a statistical outlier by the ACS NSQIP hierarchical model.

Surgical Care Improvement Program (SCIP) — Appropriateness of Care

This composite metric, based on a group of hospital surgical quality process measures developed by the Centers for Medicare & Medicaid Services, shows the percentage of patients who received all the recommended care for which they were eligible.

Cleveland Clinic’s goal is for all patients to receive all the recommended care that is appropriate. An aggregated “all or nothing” measurement approach to monitoring multiple publicly reported surgical measures trended positively in 2013.

Source: medicare.gov/hospitalcompare
In addition to overall surgical performance, ACS NSQIP data specific to vascular surgery are provided. Surgical site infection was higher than expected and identified as a statistical outlier by the ACS NSQIP hierarchical model.

In addition to overall surgical performance, ACS NSQIP data specific to thoracic surgery are provided. Thirty-day mortality, ventilator > 48 hrs, urinary tract infection, and return to operating room were lower than expected; deep vein thrombosis was higher than expected; all were identified as statistical outliers by the ACS NSQIP hierarchical model.
Cleveland Clinic is dedicated to delivering excellent clinical outcomes surrounded by the best possible experience for patients and their families. Reported patient experiences are shared with caregivers and used to identify opportunities to improve care. Cleveland Clinic’s Office of Patient Experience supports caregivers through educational opportunities and training programs designed to help them provide the best possible experience in every patient encounter.

### Outpatient Office Visit Survey — Heart & Vascular Institute

**CG-CAHPS Assessmenta (N = 5539)**  
2013

<table>
<thead>
<tr>
<th>Percent Best Response</th>
<th>CAHPS Database Average (All Practicesb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appointment Access</td>
<td>[Graph showing results]</td>
</tr>
<tr>
<td>Doctor Communication</td>
<td>[Graph showing results]</td>
</tr>
<tr>
<td>Doctor Rating</td>
<td>[Graph showing results]</td>
</tr>
<tr>
<td>Clerical Staff</td>
<td>[Graph showing results]</td>
</tr>
<tr>
<td>Test Results</td>
<td>[Graph showing results]</td>
</tr>
</tbody>
</table>

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 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 CAHPS database from 2399 medical practices in 2012.

Source: Press Ganey, a national hospital survey vendor
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.

Inpatient Survey — Heart & Vascular Institute

HCAHPS Overall Assessment
2012 – 2013

Percent Best Response

<table>
<thead>
<tr>
<th></th>
<th>2012 (N = 4351)</th>
<th>2013 (N = 4068)</th>
<th>National Average All Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Rating (% 9 or 10)</td>
<td>87%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Recommend Hospital (% Definitely Yes)</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Source: Press Ganey, a national hospital survey vendor

HCAHPS Domains of Care
2012 – 2013

Percent Best Response

<table>
<thead>
<tr>
<th></th>
<th>2012 (N = 4351)</th>
<th>2013 (N = 4068)</th>
<th>National Average All Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge Information % Yes</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Doctor Communication</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Nurse Communication</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Pain Management</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Room Clean % Always</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>New Medications Communication</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Responsiveness to Needs</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>Quiet at Night</td>
<td>88%</td>
<td>88%</td>
<td>90%</td>
</tr>
</tbody>
</table>

(Options: Always, Usually, Sometimes, Never)

Source: Press Ganey, a national hospital survey vendor

Excerpt for “Room Clean” and “Quiet at Night,” each bar represents a composite score based on responses to multiple survey questions.

Based on national survey results of discharged patients, April 2012 – March 2013, from 3938 US hospitals. medicare.gov/hospitalcompare
**Overview**

Cleveland Clinic health system uses a systematic approach to performance improvement while simultaneously pursuing three 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 2013 focus areas in pursuit of this three-part aim. Throughout this section, “Cleveland Clinic” refers to the academic medical center or “main campus,” and those results are shown.

Real-time dashboard 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**

**Observed/Expected Ratio**

2012 – 2013

- **O/E Ratio**
  - 1.0
  - 0.8
  - 0.6
  - 0.4
  - 0.2
  - 0.0
  - Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4

- Cleveland Clinic
- UHC Academic Medical Center 50th Percentile (2013)

*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 for every CLABSI occurrence support reductions in CLABSI rates in the high-risk critical care population.*

Cleveland Clinic Central Line-Associated Bloodstream Infection — ICU Rate per 1000 Line Days

2012 – 2013

- **Rate per 1000 Line Days**
  - 2.5
  - 2.0
  - 1.5
  - 1.0
  - 0.5
  - 0.0
  - Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4

- Cleveland Clinic Performance
- Cleveland Clinic Target

*These data are prepared using the University HealthSystem Consortium (UHC) Clinical Database. [uhc.edu](http://uhc.edu)*
Improved screening and prevention strategies have supported Cleveland Clinic’s continued improvement with respect to postoperative pulmonary embolism and deep vein thrombosis (AHRQ Patient Safety Indicator 12). Embolism/thrombosis prevention remains a safety priority for Cleveland Clinic in 2014.
Cleveland Clinic is dedicated to delivering excellent clinical outcomes surrounded by the best possible experience for patients and their families. Reported patient experiences are shared with caregivers and used to identify opportunities to improve care. Cleveland Clinic’s Office of Patient Experience supports caregivers through educational opportunities and training programs designed to help them provide the best possible experience in every patient encounter.

Outpatient Office Visit Survey — Cleveland Clinic

CG-CAHPS Assessment\(a\) (N = 64,463)  
2013

Percent Best Response

\[\begin{array}{cccccc}
\text{CAHPS Database Average} \\
\text{(All Practices\(b\))}
\end{array}\]

\(a\)In 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 and supported by the Centers for Medicare & Medicaid Services for use in the physician office setting to measure patients’ perspectives of outpatient care.

\(b\)Based on results submitted to the CAHPS database from 2399 medical practices in 2012.

Source: Press Ganey, a national hospital survey vendor
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
2012 – 2013

Percent Best Response

- Discharge Information: % Yes
- Doctor Communication: % Yes
- Nurse Communication: % Yes
- Pain Management: % Yes
- Room Clean: % Always
- New Medications Communication: % Always
- Responsiveness to Needs: % Always
- Quiet at Night: % Always

Except for “Room Clean” and “Quiet at Night,” each bar represents a composite score based on responses to multiple survey questions.

Source: Press Ganey, a national hospital survey vendor

Based on national survey results of discharged patients, April 2012 – March 2013, from 3938 US hospitals. medicare.gov/hospitalcompare
Focus on Value

Cleveland Clinic is developing and implementing new models of care that focus on “Patients First” and aim to deliver on the Institute of Medicine goal of Safe, Timely, Effective, Efficient, Equitable, Patient-centered care. Creating new models of Value-Based Care is a top strategic priority for Cleveland Clinic as healthcare reform moves care delivery from fee-for-service to a population health and bundled payment delivery system, while concurrently improving patient safety, outcomes, and experience.

What will our new model of care look like?

- The Cleveland Clinic Integrated Care Model is a value-based model of care, designed to improve outcomes while reducing cost.
- The patient remains at the heart of the Cleveland Clinic Integrated Care Model.
- The blue band represents the care system, which is a seamless pathway that patients move along as they receive care in the different settings listed. The care system represents integration of care across the continuum.
- To build this new care system, critical competencies are care paths and care coordination. We have therefore begun to build disease and condition-specific care paths, and are implementing comprehensive care coordination.
- Care paths guide patient care both within a venue (e.g., a hospital) as well as along the care system (blue band) to appropriate care venues. Care paths will improve value by employing evidence and/or experience-based practice to reduce unnecessary variation in care, with the goal of achieving optimal outcomes at the lowest possible cost. Measurement of use and outcomes is integral to care paths.
- Care coordination identifies high-risk patients and risk points in transitions of care, and enhances communication and handoffs between providers and locations.
Improve Population Health

In the future, value will be increasingly focused on measures such as the patient’s functional status, rather than on traditional outcomes measures. The stroke care path measure below is an example.

Improved Health-Related Quality of Life with Implementation of Stroke Care Path (N = 480) 2009 – 2012

The Ischemic Stroke Care Path, spanning the in-hospital and ambulatory settings, was implemented in 2010. Health-related quality of life, defined by the EQ-5D and measured in the ambulatory setting, has shown greater improvements since implementation of the care path.

Reduce the Cost of Care

Cleveland Clinic All-Cause 30-Day Readmission Rate to Any Cleveland Clinic Hospital 2012 – 2013

<table>
<thead>
<tr>
<th>Percent of Discharges</th>
<th>Case Mix Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 2012 - 2013</td>
<td>0.03 0.03</td>
</tr>
<tr>
<td>Q2 2012 - 2013</td>
<td>0.07 0.07</td>
</tr>
<tr>
<td>Q3 2012 - 2013</td>
<td>0.04 0.04</td>
</tr>
<tr>
<td>Q4 2012 - 2013</td>
<td>0.08 0.08</td>
</tr>
</tbody>
</table>

Cleveland Clinic monitors 30-day readmission rates for any reason to any of its system hospitals. Unplanned readmissions are actively reviewed for improvement opportunities. Strategies associated with communication, education, and follow-up have been implemented for several high-risk conditions, including heart failure and pneumonia. These practices are being expanded and enhanced to reduce overall avoidable readmissions. Sicker, more complex patients are more susceptible to readmission. Case mix index (CMI) reflects patient severity. Cleveland Clinic’s CMI remains one the highest among American Academic Medical Centers.
The Global Cardiovascular Innovation Center (GCIC) is an incubator facility that is part of the Cleveland Clinic Innovation Center. The GCIC has awarded 56 commercialization grants totaling $17.9 million to 35 companies and eight projects within the Heart & Vascular Institute. The funds have helped create 46 novel advances in cardiovascular technology. The GCIC has helped attract 20 new businesses to Ohio and has helped create 668 Ohio jobs. In addition, the GCIC has secured $556 million in follow-on investments.
**Nanostim™ Pacemaker**

Cleveland Clinic was one of only three hospitals in the United States to implant the first leadless pacemaker. The Nanostim is more than 90% smaller than a traditional pacemaker. The device is battery-powered. A sensor electrode receives information about the heart rate, which is processed with miniature software, and a generator sends stimulation to the heart as needed. The Nanostim is implanted directly in the heart using a catheter that is guided through the femoral vein. Traditional pacemakers require a chest incision and creation of a pocket to implant the pacemaker and leads (wires) that carry electrical impulses to the device. Eliminating the incision and leads reduces the risk of complications, such as infection and broken and dislodged leads. The Nanostim is awaiting approval in the United States and is currently being studied only in patients who require single-chamber pacing.

Image provided courtesy of St. Jude Medical Inc.

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**iTransmit Study**

Cleveland Clinic researchers are studying the use of smartphones to monitor the heart rhythms of patients who have an ablation for atrial fibrillation (AF). AliveCor™ is a smartphone-based heart monitor that allows patients to use an electrode-embedded phone case to transmit a 30-second ECG for evaluation. At least one finger from each hand is placed on the electrodes, and the information is recorded, sent, and available for wireless download and viewing on any browser. Standard follow-up for Cleveland Clinic patients who have ablation for AF includes 3 months of transtelephonic cardiac monitoring and an in-person visit at 3 months postprocedure. Follow-up treatment needs are determined, in large part, on the data collected in this time frame. The iTransmit study allows physicians to compare traditional transmissions with the smartphone transmissions and determine how this novel approach to monitoring can improve treatment plans for patients who have ablation for AF.
Serelaxin

Heart failure is responsible for 55,000 deaths each year in the United States. Despite the available medications and devices to treat patients with heart failure, half of all who are hospitalized with acute heart failure die within 5 years, and 25% die within 1 year of admission. Cleveland Clinic researchers helped develop a drug that, once approved by the FDA, will be the first novel treatment for patients with heart failure in 20 years.

Serelaxin is a synthetic version of the naturally occurring hormone human relaxin-2. It increases blood flow throughout the body and acts as an anti-inflammatory, which helps prevent heart failure-related damage to the kidneys, liver, and heart. Serelaxin is infused over a 48-hour period after a heart failure episode or heart attack. In clinical trials, this treatment has been associated with a 38% reduction in death rates after 6 months among patients with acute heart failure compared with standard therapy.

Exercise Echocardiography to Identify Mitral Regurgitation

Exercise echocardiography can help identify high-risk individuals with significant mitral regurgitation. Cleveland Clinic researchers discovered that about 30% of patients with significant myxomatous mitral regurgitation who consider themselves asymptomatic do not achieve 100% of their expected age-gender-predicted metabolic equivalents during testing. Patients who did not achieve 85% of what was expected during testing were three times more likely to develop events in the long-term compared with patients who achieved more than 100%. Further research is ongoing to determine whether stress echocardiography can be used to safely determine the best time to have mitral valve surgery.
Identifying Dysfunctional HDL

High-density lipoprotein (HDL) is associated with heart-protective properties. However, recent studies at Cleveland Clinic identified buildup and oxidation of the primary protein in HDL, apolipoprotein A1 (apoA1), in the artery wall during development of coronary artery disease (CAD). The buildup of the oxidized apoA1 in the arteries was shown to be linked to development of inflammation in the artery wall and an increased risk of CAD. Cleveland Clinic researchers have developed an antibody that detects trace levels of the oxidized and “dysfunctional” apoA1 and HDL present in the artery wall, based on the small amount that leaches back out into the bloodstream. This new test may help identify patients at greatest risk of developing atherosclerosis. It may also help identify the need for early and more aggressive preventive treatment efforts in patients who have not been identified by traditional risk factors as being at risk for cardiovascular disease and disease progression.
ValveXchange® Heart Valve System

In 2011, Cleveland Clinic was first to implant the ValveXchange heart valve system. This novel approach to valve replacement may eliminate the need for invasive surgery when the need arises for leaflet replacement. The technology may also simplify open procedures. Because the system uses bioprosthetic materials, patients do not need lifelong anticoagulant therapy. Since the initial implant in 2011, the system has been approved for use in Europe and is awaiting FDA trials for approval for use in the United States.

Patient-Centered Rounding

Efforts within the Miller Family Heart & Vascular Institute to improve patient care and communication between doctors and nurses include patient-centered rounding. The program started in 2011 and has demonstrated positive changes in not only the aforementioned goals, but also in HCAHPS scores. The program features regular communication between the nurse assigned to each patient and the cardiology team prior to meeting with the patient and available family members. The nurse-physician team maintains a patient-centered focus while talking to the patient and family about overnight events, testing plans, and the patient care management strategy.

HCAHPS Domain J71/J73 Nurse Communication

<table>
<thead>
<tr>
<th>Percent</th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse communication % always</td>
<td>blue line</td>
<td>90th percentile</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HCAHPS Domain Cardiovascular Medicine Doctor Communication

<table>
<thead>
<tr>
<th>Percent</th>
<th>100</th>
<th>90</th>
<th>80</th>
<th>70</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor communication % always</td>
<td>blue line</td>
<td>90th percentile</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mini-Cog™ Test to Help Predict Heart Failure Readmissions and Outcomes

Cognitive impairment in patients with heart failure is known to be related to reduced rates of treatment adherence, ability to perform activities of daily living, and adequate self-care. Published heart failure guidelines recommend screening for cognitive impairment but do not suggest which test to use. Cleveland Clinic researchers were the first to use Mini-Cog, a cognitive impairment screening test previously developed for use in geriatric populations, to assess patients hospitalized for heart failure. In this three-step test, patients were asked to memorize three unrelated words, draw a clock, and then recall the words. Researchers found that nearly a quarter of this population had cognitive impairment, which subsequently correlated with high rates of poor post-discharge outcomes. Patients with cognitive impairment were twice as likely to be readmitted or die within 30 days of hospital discharge. The risk was higher among patients discharged to home rather than a postacute facility.

Sutureless Transcatheter Mitral Stent Valve

Researchers at Cleveland Clinic have developed a sutureless transcatheter mitral stent valve delivery system. Although catheter-based devices do exist for aortic valve replacement, this is the first system designed for catheter-based mitral valve replacement. The device may be an appropriate treatment option for patients with severe mitral regurgitation who are not candidates for surgery, which is currently required for mitral valve replacement. The design includes two sets of stent wings that surround the valve and incorporate leaflets against the valve annulus. The wings open with stent self-expansion, so that the stent valve attaches securely to the valve annulus through radial force. The prosthetic valve is positioned over the native valve.
Sydell and Arnold Miller Family Heart & Vascular Institute

General Information and Appointments 800.659.7822

Thoracic and Cardiovascular Surgery Evaluation
Nurse practice managers will expedite patient record review with a Cleveland Clinic surgeon and address questions. 216.444.3500 or 877.8HEART1 (877.843.2781)

Cardiovascular Medicine Appointments/Referrals 216.444.6697 or 800.223.2273, ext. 46697

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 or to schedule a second opinion. 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
Heart & Vascular Institute staff authored 861 publications in 2013.

For a complete list, go to clevelandclinic.org/outcomes.

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
702.483.6000

For address corrections or changes, please call
800.890.2467
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 3,200 Cleveland Clinic staff physicians and scientists in 130 medical specialties and subspecialties care for more than 5.5 million patients across the system, performing more than 202,000 surgeries and conducting more than 476,000 emergency department visits. Patients come to Cleveland Clinic from all 50 states and more than 130 nations around the world.

Cleveland Clinic is an integrated healthcare delivery system with local, national, and international reach. The main campus in midtown Cleveland, Ohio, has a 1,440-bed hospital, outpatient clinic, specialty institutes, labs, classrooms, and research facilities in 44 buildings on 167 acres. Cleveland Clinic patients represent the highest CMS case-mix index in the nation. Cleveland Clinic encompasses 75 northern Ohio outpatient locations, including 16 full-service family health centers, eight community hospitals, an affiliate hospital, and a rehabilitation hospital for children. Cleveland Clinic also includes Cleveland Clinic Florida; Cleveland Clinic Nevada, which includes the Lou Ruvo Center for Brain Health in Las Vegas, and urology and nephrology services; Cleveland Clinic Canada; and Sheikh Khalifa Medical City (management contract). Cleveland Clinic Abu Dhabi is a full-service hospital and outpatient center in the United Arab Emirates (UAE) scheduled to begin offering services in the spring of 2015. Cleveland Clinic is the second-largest employer in Ohio, with more than 43,400 employees. It generates $10.95 billion of economic activity a year.

Cleveland Clinic Global Solutions supports physician education, training and consulting, and patient services around the world through offices in Riyadh, Saudi Arabia; London, England; Istanbul, Turkey; and Dubai, UAE, as well as El Salvador, Panama, Guatemala, Honduras, the Dominican Republic, and other Caribbean nations.

The Cleveland Clinic Model

Cleveland Clinic was founded in 1921 by four 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 model set forth by the founders. 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.

The Cleveland Clinic system began to grow in 1987 with the founding of Cleveland Clinic Florida and expanded in the 1990s with the development of 16 family health centers across Northeast Ohio. Fairview Hospital, Hillcrest Hospital, and six other community hospitals joined Cleveland Clinic over the past decade and a half, offering Cleveland Clinic institute services in heart and neurological care, physical rehabilitation, and more. Clinical and support services were reorganized into 27 patient-centered institutes beginning in 2007. Institutes combine medical and surgical specialists around specific diseases or body systems under single leadership and in a shared location to provide optimal team care for every patient. Institutes work with the Office of Patient Experience to give every patient the best outcome and experience.
Cleveland Clinic Lerner Research Institute

At the Lerner Research Institute, hundreds of principal investigators, project scientists, research associates, and postdoctoral fellows are involved in laboratory-based translational and clinical research. Total research expenditures from external and internal sources exceeded $248 million in 2013. Research programs include cardiovascular, oncology, neurology, musculoskeletal, allergy and immunology, ophthalmology, metabolism, and infectious diseases.

Cleveland Clinic Lerner College of Medicine

Lerner College of Medicine of Case Western Reserve University is known for its small class size, unique curriculum, and full-tuition scholarships for all students. The program is open to 32 students who are preparing to be physician investigators. Cleveland Clinic is building a new Health Education Campus as the new home for the college and for its partner Case Western Reserve University’s schools of medicine, dental medicine, and nursing.

Graduate Medical Education

In 2013, nearly 1,800 residents and fellows trained at Cleveland Clinic and Cleveland Clinic Florida, which is part of a continuing upward trend.

U.S. News & World Report Ranking

Cleveland Clinic is consistently ranked among the top hospitals in America by U.S. News & World Report, and its heart and heart surgery program has been ranked No. 1 in the nation since 1995. In 2013, five programs were ranked No. 2 in the nation—diabetes and endocrinology, gastroenterology and GI surgery, nephrology, rheumatology, and urology.

For more information about Cleveland Clinic, please visit clevelandclinic.org.
Resources

Referring Physician Center and Hotline
For the 24/7 hotline to streamline access to an array of medical services and schedule patient appointments, call 855.REFER.123 (855.733.3712), email refdr@ccf.org, or visit clevelandclinic.org/refer123. A free Physician Referral App is now available so you can get in touch immediately with one click of your iPhone®, iPad®, or Android™ phone or tablet.

Remote Consults
Online medical second opinions from Cleveland Clinic’s MyConsult® are particularly valuable for patients who wish to avoid the time and expense of travel. Cleveland Clinic offers online medical second opinions for more than 1,200 life-threatening and life-altering diagnoses. For more information, visit clevelandclinic.org/myconsult, email eclevelandclinic@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
DrConnect® offers referring physicians secure access to their patients’ treatment progress while at Cleveland Clinic. To establish a DrConnect account, visit clevelandclinic.org/drconnect or email drconnect@ccf.org. MyPractice Community gives referring physicians online access to their patients’ test results, medications, and treatment plans during Cleveland Clinic care. Cleveland Clinic’s eRadiology system offers teleradiology consultation for physicians nationwide.

Medical Records Online
Cleveland Clinic continues to expand and improve electronic medical records (EMRs) to provide faster, more efficient, and more accurate care by sharing patient data through a highly secure network. Patients using MyChart® can renew prescriptions and review test results and medications from their personal computers. MyChart provides a link to Microsoft HealthVault, a free online service that helps patients securely gather and store health information. It connects to Cleveland Clinic’s social media and Internet site, currently the most visited hospital website in America. For more information, visit clevelandclinic.org/mychart.

Critical Care Transport Worldwide
Cleveland Clinic’s critical care transport team and fleet of mobile ICU vehicles, helicopters, and fixed-wing aircraft serve critically ill and highly complex patients across the globe. 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 one of the largest and most successful CME programs in the country. The center’s website (ccfcmee.org) is an educational resource for healthcare providers and the public. Available 24/7, it houses programs that cover topics in 30 areas. Among other resources, the website contains a virtual textbook of medicine (Disease Management Project) and myCME, a system for physicians to manage their CME portfolios. Live courses, however, remain the backbone of the center’s CME operation. Most live courses are held in Cleveland, but outreach plans are underway.
Clinical Trials

Cleveland Clinic has promoted research from its earliest days, and has since participated in historic, large, multicenter clinical trials. Today, Cleveland Clinic is running more than 2,200 clinical trials of various types. Researchers are focused on an array of 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. To learn more, go to clevelandclinic.org/research.

Cancer Clinical Trials is a new mobile app that provides up-to-date information on the more than 100 active clinical trials available for cancer patients. Download the free Cancer Clinical Trials App at clevelandclinic.org/cancertrialapp.

Healthcare Executive Education

Cleveland Clinic's executive education program offers its programs to caregivers worldwide seeking insights into the business, operations, and logistics of a major medical center. The Executive Visitors' Program is an intensive three-day behind-the-scenes view of Cleveland Clinic's organization for the busy executive. The Samson Global Leadership Academy is a two-week immersion into the challenges of leadership, management, and innovation. The curriculum includes coaching and a personalized three-year leadership development plan. Learn more at clevelandclinic.org/execed.
Treating the Whole Patient

The Heart & Vascular Institute works with the Office of Patient Experience, Spiritual Care Department, Healing Services, and the Arts & Medicine Institute to provide a full range of complimentary services to patients and visitors.

Services include light massage therapy, reiki and Healing Touch™ therapies, art and music therapy, and a guided imagery program to help patients relax and prepare for surgery or other procedures.

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

Patients and visitors can enjoy a variety of live musical performances and art programs, including art therapy and guided tours of Cleveland Clinic’s extensive collection of contemporary art.

Each day, there are scheduled activities on the rooftop plaza. The space provides a spectacular view of the city. Guests can enjoy yoga, chair massages, labyrinth walk meditation, reiki, live cooking demonstrations, and tea.

In addition, the Sydell and Arnold Miller Family Pavilion hosts many musical and other performances and events throughout the year.

Patient and Family Health and Education Center

800.223.2273, ext. 43771
healthl@ccf.org

The Patient and Family Health and Education Center has provided resources to patients and visitors since October 2008. The center serves as a library of health and education materials. In addition, patients and guests have complimentary access to computers with Internet access, audio and video education programs, and health education classes and screenings. There were 13,564 visitors to the center in 2013.

Heart & Vascular Institute Resource Nurses

866.289.6911
heartcenter@ccf.org

A team of dedicated, experienced nurses staffs the Resource Center. They answer thoracic- and cardiovascular-related questions by phone, email and online chat. This service is open to everyone and is especially helpful to those who do not have immediate access to a Cleveland Clinic cardiologist or surgeon. In 2013, there were 19,346 total contacts. This includes 5,986 phone calls; 6,391 online chats; 5,079 webmails; and 1,890 email, mail, in-person and other contacts.

The nurses also staff a 24/7 toll-free inbound call line for all patients discharged from the institute who have questions or concerns after they leave the hospital. In 2013, they answered 5,894 calls. The effort to improve the patient experience also includes a follow-up phone call from a registered nurse to every patient. Patients are asked about symptoms, complications, or concerns they may have once they are home.

Staying in Touch

The Heart & Vascular Institute has a variety of ways for patients and others to contact the institute and learn more about topics related to heart and vascular health. The institute’s Twitter account (twitter.com/ClevClinicHeart) has more than 1,600 followers and was recently named one of Good Housekeeping’s 14 Most Trusted Health Sites. In 2013, more than 3,100 participants took part in the institute’s 40 live webchats and 3 video Spreakcasts with experts who answered questions about specific thoracic and cardiovascular topics. Transcripts are posted at clevelandclinic.org/heart/webchat. In 2013, the institute’s website (clevelandclinic.org/heart) and blog (health.clevelandclinic.org/heart) received more than 9.7 million visits combined. The YouTube channel (youtube.com/clevelandclinic) had more than 164,000 views.
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