

# 50 TOP CARDIOVASCULAR HOSPITALS

STUDY OVERVIEW AND RESEARCH FINDINGS

13TH EDITION

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# INTRODUCTION

Cardiovascular disease is the long-standing, number-one killer in the United States. About every 25 seconds, an American will have a coronary event, and about one American every minute will die from one. It is the most expensive condition hospitals treat: In 2010, the total costs of cardiovascular diseases in the United States were estimated to be \$444 billion.<sup>1</sup> These facts make cardiovascular services among the highest profile of all hospital service lines, with more than 1,000 hospitals performing open-heart surgery and thousands more offering medical cardiovascular programs.

With these volumes, hospitals must do all they can to provide high-quality cardiovascular care as efficiently as possible. To improve performance, cardiovascular hospital leaders need objective information about what is achievable — relevant benchmarks that allow them to compare their performance to peers and the top-performing organizations. By naming the 50 Top Cardiovascular Hospitals in the nation, the Thomson Reuters 100 Top Hospitals® program provides hospital executives, physicians, and cardiovascular service line managers with valuable, practical targets for raising performance. Information in this study abstract, and available in separate facility-specific reports, provides targets to reach for, with detailed analysis of how the winners and their nonwinning peers performed on the study's balanced scorecard of measures.

Now in its 13th year, the 50 Top Cardiovascular Hospitals study identifies hospitals that achieve the best performance on the scorecard of performance measures. This year, based on comparisons between the study winners and a peer group of similar high-volume hospitals that were not winners, we found

that if all cardiovascular providers performed at the level of this year's winners:

- Nearly 7,700 additional lives could be saved
- Approximately 6,500 additional patients could be complication-free
- More than \$1 billion could be saved

We based this analysis on the Medicare patients included in this study. If the same standards were applied to all inpatients, the impact would be even greater. The winning hospitals also:

- Spent approximately \$4,000 less per bypass surgery patient and \$1,500 less per heart attack patient admitted
- Had significantly better 30-day survival
- Maintained lower 30-day readmission rates for heart attack and heart patients
- Released bypass patients nearly a full day sooner, and their heart attack, heart failure, and angioplasty patients about half a day sooner than their peers
- Were more likely to follow recommended care protocol

This year, we also found that gaps in a highly recommended coronary bypass surgery technique (the percentage of bypass surgery patients who received an internal mammary artery) have decreased substantially. Not only are more hospitals using this preferred technique, but the gaps in usage between men and women, the middle-aged and the elderly, and regional variations, are closing.

For more details, including complete hospital reporting data on this year's cardiovascular winning hospitals, please see the Findings section of this document.

#### **CREATING A BETTER STUDY**

Throughout the 18 years of the 100 Top Hospitals® program, we have worked to ensure that the measures and methodology we use are fair, consistent, and telling. We continually test the validity of our performance measures and data sources. To enhance the study this year, we are now reporting data for the measures of hospital efficiency (average length of stay and cost per case) separately for all four patient groups studied (heart attack, heart failure, percutaneous coronary interventions, and bypass surgeries). This means you'll be able to see winner versus nonwinner statistics for all these groups, allowing for better apples-to-apples comparisons.

As a part of our own internal performance-improvement process, we welcome comments from hospitals and physicians. To submit comments, visit [100tophospitals.com](http://100tophospitals.com) and click Contact Us.

#### **ABOUT THOMSON REUTERS**

Thomson Reuters is the world's leading source of intelligent information for businesses and professionals. We combine industry expertise with innovative technology to deliver critical information to leading decision makers in the financial, legal, tax and accounting, healthcare and science, and media markets, powered by the world's most trusted news organization. With headquarters in New York and major operations in London and Eagan, Minnesota, Thomson Reuters employs more than 50,000 people and operates in over 100 countries. Thomson Reuters shares are listed on the Toronto Stock Exchange (TSX: TRI) and New York Stock Exchange (NYSE: TRI). For more information, go to [thomsonreuters.com](http://thomsonreuters.com).

# 2012 AWARD WINNERS

Thomson Reuters is proud to present the 50 Top Cardiovascular Hospitals, 2012. We stratify winners by three separate peer groups: Teaching Hospitals With Cardiovascular Residency Programs, Teaching Hospitals Without Cardiovascular Residency

Programs, and Community Hospitals. For full details on these peer groups and the process we use to select the benchmark hospitals, please see the Methodology section of this document.

## Teaching Hospitals With Cardiovascular Residency Programs\*

MEDICARE ID	HOSPITAL	LOCATION
030103	Mayo Clinic Hospital	Phoenix, AZ
170040	The University of Kansas Hospital	Kansas City, KS
220171	Lahey Clinic	Burlington, MA
220176	Saint Vincent Hospital	Worcester, MA
240053	Park Nicolett Methodist Hospital	St. Louis Park, MN
310001	Hackensack University Medical Center	Hackensack, NJ
310031	Deborah Heart and Lung Center	Browns Mills, NJ
330214	NYU Langone Medical Center	New York, NY
360079	Kettering Medical Center	Kettering, OH
360152	Doctors Hospital	Columbus, OH
390042	The Washington Hospital	Washington, PA
390050	Allegheny General Hospital	Pittsburgh, PA
390079	Robert Packer Hospital	Sayre, PA
390139	Bryn Mawr Hospital	Bryn Mawr, PA
390195	Lankenau Hospital	Wynnewood, PA

\*Order of hospitals does not reflect performance rating. Hospitals are ordered by Medicare ID.

## Teaching Hospitals Without Cardiovascular Residency Programs\*

MEDICARE ID	HOSPITAL	LOCATION
100127	Morton Plant Hospital	Clearwater, FL
130006	St. Luke's Boise Medical Center	Boise, ID
140053	St. John's Hospital	Springfield, IL
140135	Decatur Memorial Hospital	Decatur, IL
230054	Marquette General Hospital	Marquette, MI
230156	St. Joseph Mercy Hospital	Ann Arbor, MI
360070	Mercy Medical Center	Canton, OH
360084	Aultman Hospital	Canton, OH
360179	Bethesda North Hospital	Cincinnati, OH
390049	St. Luke's Hospital	Bethlehem, PA
390063	UPMC Hamot	Erie, PA
390096	St. Joseph Medical Center	Reading, PA
450184	Memorial Hermann Hospital System	Houston, TX
450231	Baptist St. Anthony's Health System	Amarillo, TX
450788	Corpus Christi Medical Center	Corpus Christi, TX
460047	St. Mark's Hospital	Salt Lake City, UT
490059	St. Mary's Hospital	Richmond, VA
520030	Aspirus Wausau Hospital	Wausau, WI
520087	Gundersen Lutheran	La Crosse, WI
520089	Meriter Hospital	Madison, WI

## Community Hospitals\*

MEDICARE ID	HOSPITAL	LOCATION
050104	St. Francis Medical Center	Lynwood, CA
050232	French Hospital Medical Center	San Luis Obispo, CA
100044	Martin Memorial Medical Center	Stuart, FL
140113	Provena Covenant Medical Center	Urbana, IL
150153	St. Vincent Heart Center of Indiana	Indianapolis, IN
190263	Heart Hospital of Lafayette	Lafayette, LA
280128	Nebraska Heart Institute & Heart Hospital	Lincoln, NE
340032	Gaston Memorial Hospital	Gastonia, NC
390179	The Chester County Hospital and Health System	West Chester, PA
390203	Doylestown Hospital	Doylestown, PA
440073	Maury Regional Medical Center	Columbia, TN
450824	Heart Hospital of Austin	Austin, TX
460021	Dixie Regional Medical Center	St. George, UT
490069	Memorial Regional Medical Center	Mechanicsville, VA
520049	Bellin Hospital	Green Bay, WI

\*Order of hospitals does not reflect performance rating. Hospitals are ordered by Medicare ID.

# FINDINGS

The organizations that win 100 Top Hospitals® program awards are setting new standards for the industry. One of our goals, as administrators of the program, is to share what they do differently, highlight what makes them so successful, and offer models for other hospitals to emulate.

This year, we found:

- Gaps in a highly recommended CABG surgery technique (the percentage of bypass surgery patients who received an internal mammary artery) have decreased substantially. Not only are more hospitals using this preferred technique, but the gaps in usage between men and women, the middle-aged and the elderly, and regional variations, are closing.
- This study's winners provide measurably better care and are more efficient than their peers. Based on comparisons between the study winners and a peer group of hospitals treating the same types of patients, we found that if all cardiovascular providers performed at the level of this year's winners, nearly 7,700 additional lives could be saved, approximately 6,500 additional patients could be complication-free, and more than \$1 billion could be saved. We based this analysis on the Medicare patients included in this study. If the same standards were applied to all inpatients, the impact would be even greater.
- Patients that seek treatment at the 50 Top Cardiovascular Hospitals also have better longer-term outcomes: They are released from the hospital sooner and have lower 30-day mortality.
- Winning hospitals may be better prepared for changes dictated by the healthcare reform law: Their readmission rates are lower than their peers, and they do a better job following accepted clinical care process standards.
- Winning hospitals release patients sooner than their peers. The typical winning hospital released their bypass patients nearly a full day sooner,

and their acute myocardial infarction (AMI), heart attack (HF), and percutaneous coronary intervention (PCI) patients about half a day sooner than their peers.

- The 50 Top Cardiovascular Hospitals manage all of these clinical gains while still keeping costs lower. The typical winning hospital spent more than \$4,000 less per bypass surgery patient and \$1,500 less per heart attack patient admitted.

## GAPS IN INTERNAL MAMMARY ARTERY USE DECREASE

Coronary artery bypass graft surgery (CABG) uses patient veins or arteries to bypass narrowed areas of the coronary arteries to increase blood flow to the heart. Surgeons commonly use vessels from the saphenous vein of the leg, the internal mammary artery (IMA) from the chest, or the radial artery from the arm. A number of studies have shown improved outcomes when using the IMA.<sup>1,2</sup> And in the last decade, quality measures and initiatives have recommended IMA use for bypass surgeries for nearly all CABG patients, despite their age or sex. Although support from the medical community has been strong,<sup>3,4,5</sup> IMA use has been inconsistent – higher for men than women and more for younger than older patients. It's also been used less in the South than in other parts of the country.<sup>6,7</sup>

We analyzed the trends of IMA use in CABG surgeries by the hospitals in our cardiovascular study databases from 2002 to the present. We also looked at trends in overall use and by age group, geographic region, and sex using Medicare data

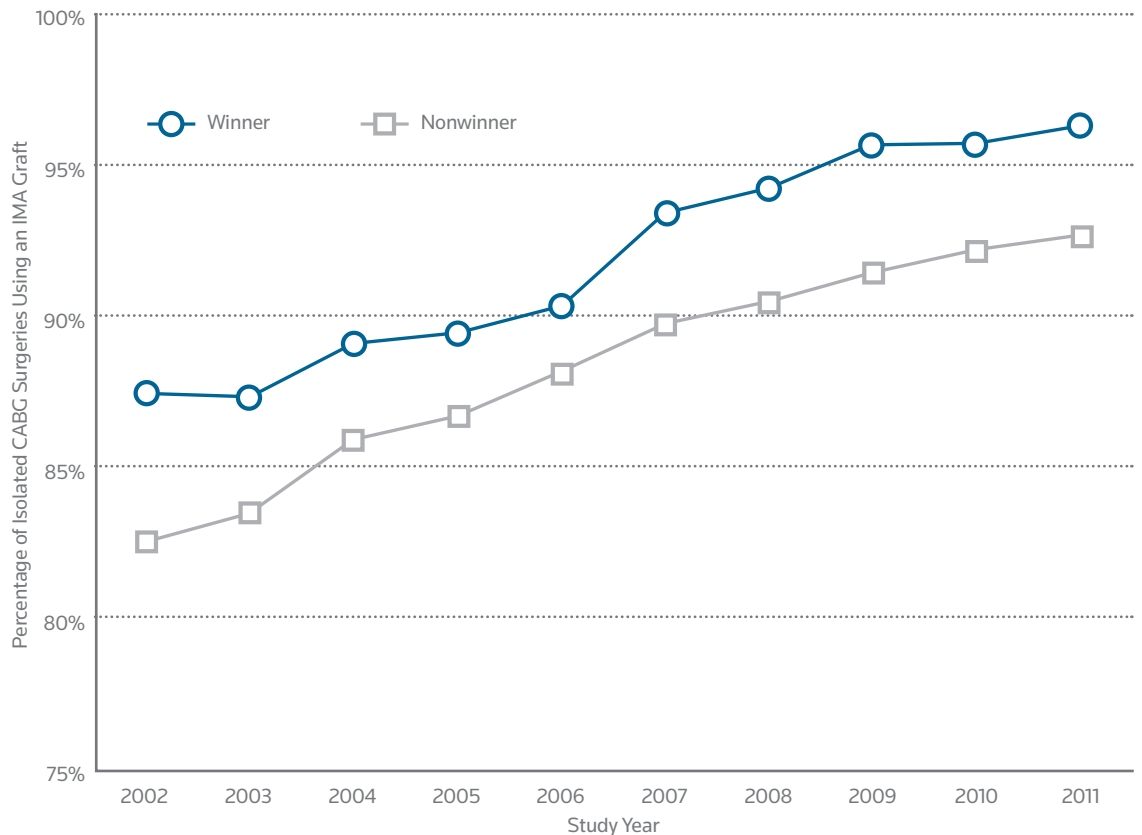
from 2000 to 2010. The population of this study was Medicare patients over age 64. Patients with previous CABG surgeries were excluded.

We found that:

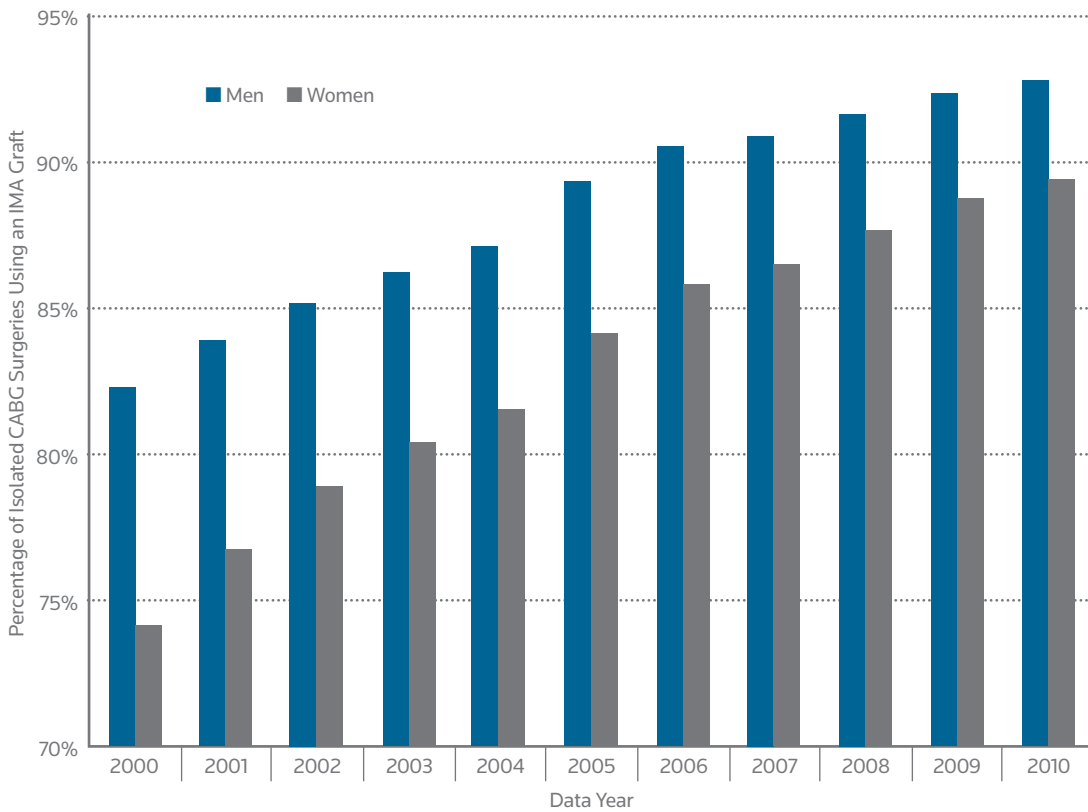
- Between study years 2002 and 2011, both winners and nonwinners of the 100 Top Hospitals program’s cardiovascular award have increased IMA use: from 83 to 93 percent in nonwinner hospitals, and from 88 to 96 percent in winner hospitals (Figure 1). Although it’s not surprising that the study winners would have higher utilization than nonwinners (IMA utilization is a performance measure used in ranking), it’s notable that the bar continues to be raised. That is, to perform at benchmark levels in the current study, hospitals must outperform the benchmark level in the previous study.
- Between 2000 and 2010, the IMA usage gap between men and women decreased, but IMA use in women still lags behind men – 89 versus 93 percent (Figure 2).
- IMA utilization is highest in the Northeast, followed by the Midwest and West, and lowest in the South. Although this order remained constant between 2000 and 2010, the South had the greatest increase, thus narrowing the gap. In 2000, only 75 percent of Medicare patients in the South received an IMA graft, compared with 83 percent in the Northeast. By 2000, the gap decreased to just 3 percentage points – with 90 percent in the South and 93 percent in the Northeast (Figure 4).

For full details, please visit [100tophospitals.com](http://100tophospitals.com) to download a research brief on this study.

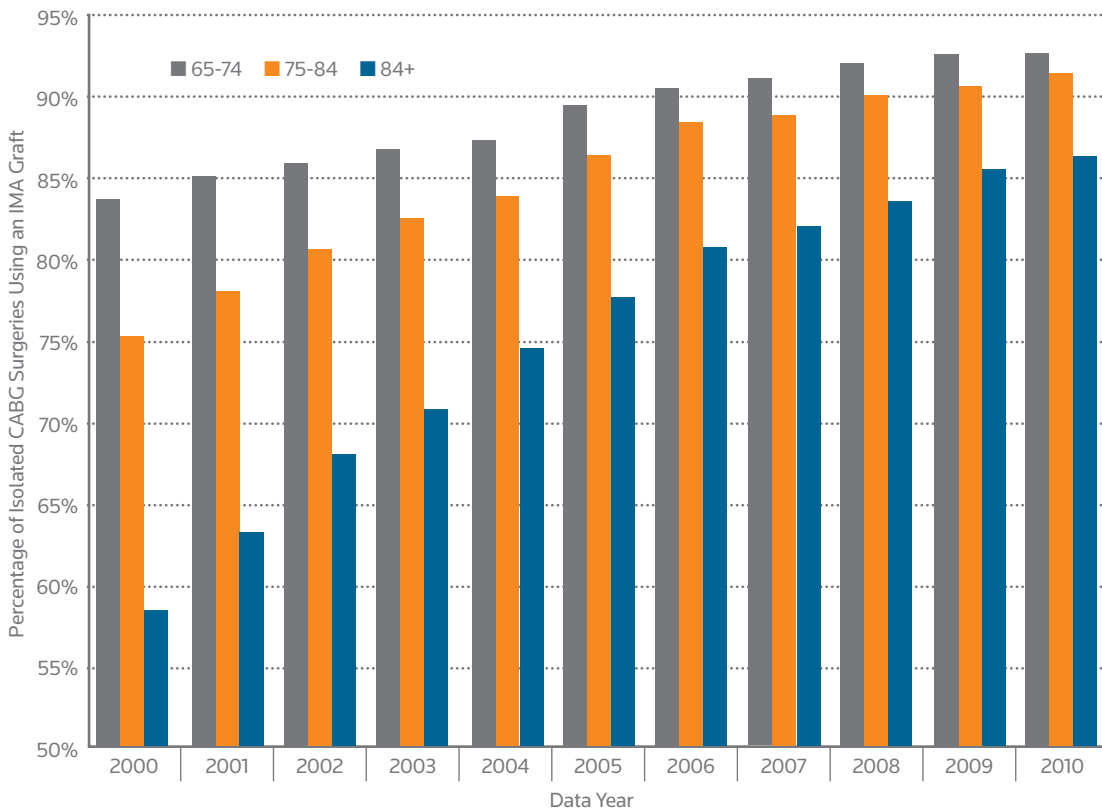
**FIGURE 1: Cardiovascular Hospitals Increase IMA Use**



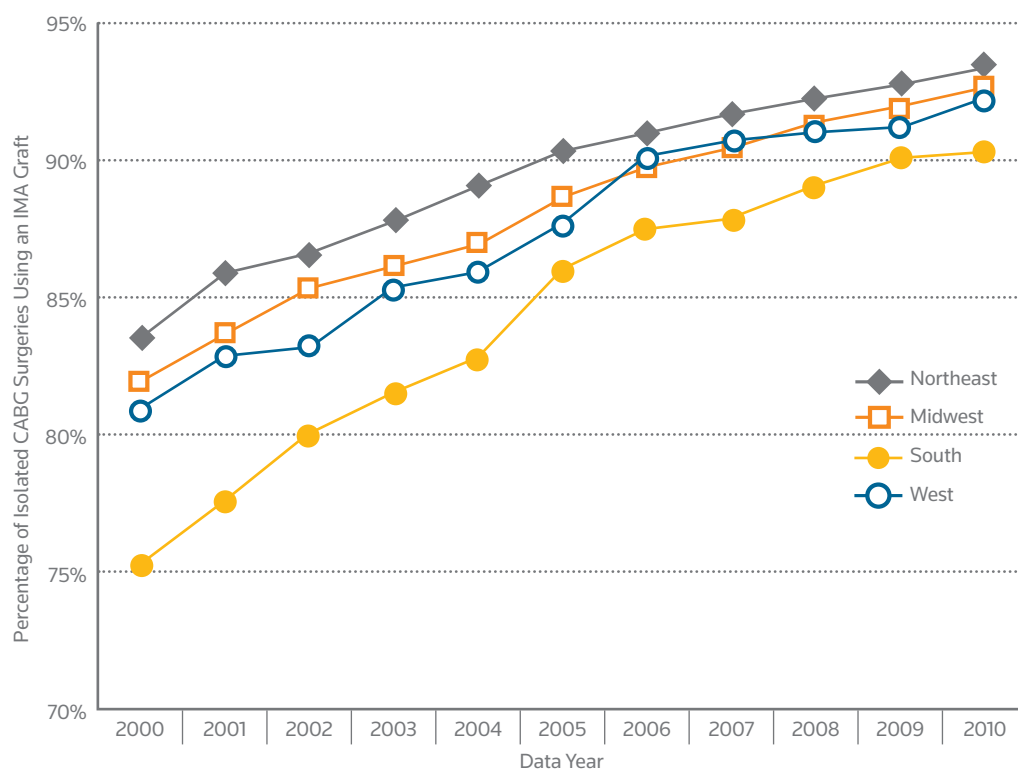
**FIGURE 2: IMA Usage Disparity Between Men and Women Decreases**



**FIGURE 3: IMA Usage Disparity Between Age Groups Narrows**



**FIGURE 4: Northeast Leads IMA Usage, but South Narrows the Gap**



Note: CMS regulations now require all inpatient prospective payment system hospitals to document whether a patient has certain conditions when admitted, and our complications rate methodology now uses this present on admission (POA) data (see the Methodology section for more details). Consequently, the complications rates now exclude “false positive” complications and are more accurate than previous years.

**HOW THE WINNERS ARE OUTPERFORMING THEIR PEERS**

**All Study Hospitals**

Although our research shows that all hospitals have improved cardiovascular patient outcomes in recent years (nearly 97 percent of cardiovascular patients who receive inpatient care are surviving, and approximately 96 percent are complication-free), comparisons between the 50 Top Cardiovascular Hospitals and their peers show that much room for improvement exists.

Survival rates are markedly better at benchmark (winning) hospitals, particularly for patients receiving bypass surgery and angioplasties (CABGs and PCIs). The median benchmark hospital had a risk-adjusted CABG mortality index of 0.71, meaning they experienced 29 percent fewer deaths than would be expected, given patient severity. Peer (nonwinning) hospitals, on the other hand, had only 8 percent fewer CABG mortalities than expected (Table 1 and Figure 5).

Reducing patient complications is an ongoing goal for all hospitals targeting improved performance. The cardiovascular study winners

had a substantially lower complications index than their peers. Most notable was the heart attack (AMI) complications index at winning hospitals, which showed 45 percent fewer complications than expected. Peer hospitals, on the other hand, had only 8 percent fewer AMI patient complications than expected.

These lower complications rates could also be helping the winning hospitals hold down their 30-day readmission and mortality rates. Longer-term outcomes were indeed better at winning hospitals. The winner hospitals’ 30-day heart failure and heart attack mortality rates were lower than their peers, meaning a smaller percentage of patients died, of any cause, 30 days after their admission. The winners also had lower readmission rates, with a lower percentage of patients returning to the hospital, for any cause, within 30 days.

These longer-term outcome measures are part of CMS’ value-based purchasing program and are currently being watched closely in the industry. And starting in federal fiscal year 2013, CMS will be able to penalize hospitals with too-high readmission rates.

Winning hospitals comply with core measures protocols more closely. With a median AMI and HF core measures score of 98.8 and 98.0 percent, respectively, we know that this year's winners are using the recommended core measures protocol for nearly all of their heart failure patients.

The winning hospitals are also more efficient than their peers. This year we displayed the length of stay and cost data comparisons by patient type (AMI, HF, CABG, and PCI). Over all the patient types, the 50 Top Cardiovascular hospitals have ALOS that is about 10 percent shorter than the nonwinning hospitals. Specifically, they release AMI, HF, and PCI patients about half a day sooner and CABG patients

**TABLE 1: All Hospitals In Study, Benchmark versus Peer Comparisons**

	PERFORMANCE MEASURE		BENCHMARK MEDIAN	PEER MEDIAN	DIFFERENCE	PERCENT DIFFERENCE	BENCHMARK HOSPITALS OUTPERFORM PEER HOSPITALS
CLINICAL OUTCOME MEASURES <sup>1,2</sup>	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.89	0.98	-0.09	-9.2	lower mortality
		HF Mortality	0.81	0.98	-0.17	-17.4	lower mortality
		CABG Mortality	0.71	0.92	-0.21	-22.8	lower mortality
		PCI Mortality	0.76	0.94	-0.18	-19.2	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.55	0.92	-0.37	-40.2	fewer complications
		HF Complications	0.79	0.94	-0.15	-16.0	fewer complications
		CABG Complications	0.89	0.99	-0.10	-10.1	fewer complications
		PCI Complications	0.89	0.99	-0.10	-10.1	fewer complications
CLINICAL PROCESS MEASURES <sup>3,5</sup>	AMI Core Measures Mean Percent		98.8	97.8	0.9	n/a	better performance
	HF Core Measures Mean Percent		98.0	96.8	1.3	n/a	better performance
	CABG Patients With Internal Mammary Artery Use (%)		96.3	92.7	3.6	n/a	higher IMA use
EXTENDED OUTCOME MEASURES <sup>4,5</sup>	AMI 30-Day Mortality (%)		14.5	15.4	-1.0	n/a	lower 30-day mortality
	HF 30-Day Mortality (%)		10.6	11.1	-0.5	n/a	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		19.3	19.7	-0.4	n/a	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		23.1	24.5	-1.5	n/a	lower 30-day readmissions
EFFICIENCY MEASURES	AMI Severity-Adjusted Average Length of Stay		4.3	4.9	-0.6	-11.9	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.5	5.0	-0.6	-11.0	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.4	9.3	-0.9	-9.7	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		3.3	3.7	-0.4	-10.1	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		\$8,301	\$9,765	-1,463	-15.0	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		\$7,391	\$8,029	-637	-7.9	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		\$31,204	\$35,440	-4,236	-12.0	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		\$16,118	\$17,396	-1,277	-7.3	lower cost per case

Notes:

1. MedPAR 2009 and 2010 combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare 2009Q4–2010Q1, Q2, Q3.
4. CMS Hospital Compare July 1, 2007–June 30, 2010.
5. We do not calculate percentage difference for measures already expressed as a percent.

nearly a full day sooner. The winners also maintain costs per case that are about \$1,900 lower than their nonwinning peers. The most dramatic difference is in the CABG patient group, where the winners spent about \$4,200, or 12 percent, less per case than their peers (Figure 6).

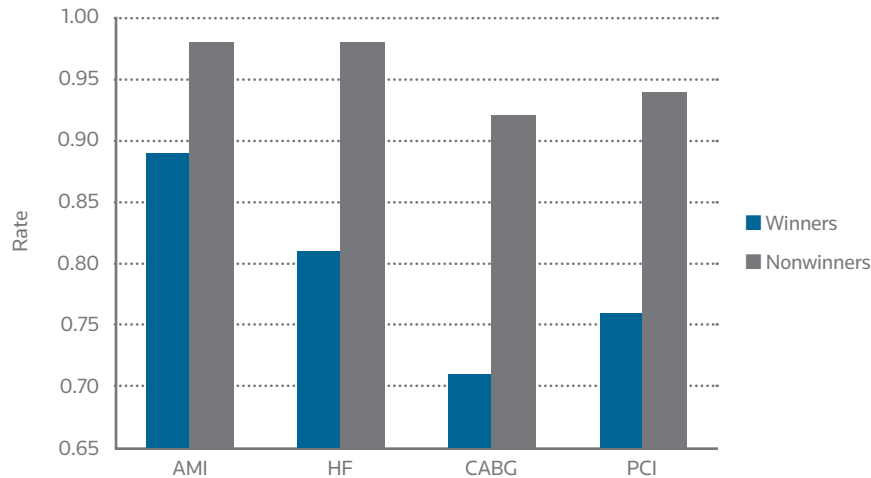
### Teaching Hospitals With Cardiovascular Residency Programs

Teaching hospitals with residency programs generally treat more complex patients and have more sophisticated personnel mixes and higher input costs than community hospitals and those without cardiovascular residency programs. As such, when comparing the three hospital groups, the teaching hospitals with residency programs have lower performance than the teaching hospitals

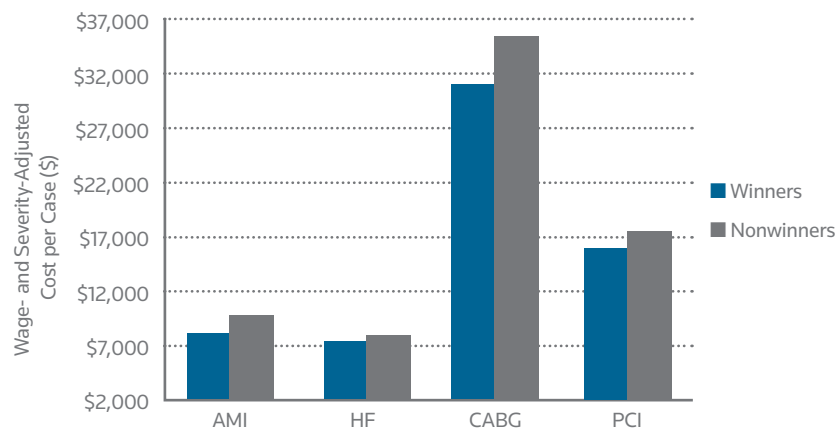
without residency programs and the community hospitals for some of the included measures. One area where they bucked this trend was in mortality rates for CABG and PCI patients. Winners in this group outperformed their peers by a greater margin than the other two hospital groups in this study. The winners' mortality rates were 30 and 21 percent lower than their peers' for CABG (Figure 7) and PCI patients, respectively.

Benchmark hospitals in this group were also much more successful than their peers at avoiding patient complications, especially for AMI patients. Their risk-adjusted rate for this measure showed they had 44 percent fewer AMI patient complications than expected, whereas their peers had only 7 percent fewer than expected (Table 2).

**Figure 5: Risk-Adjusted Mortality Index, All Hospitals**



**Figure 6: Wage- and Severity-Adjusted Average Cost per Case, All Hospitals**



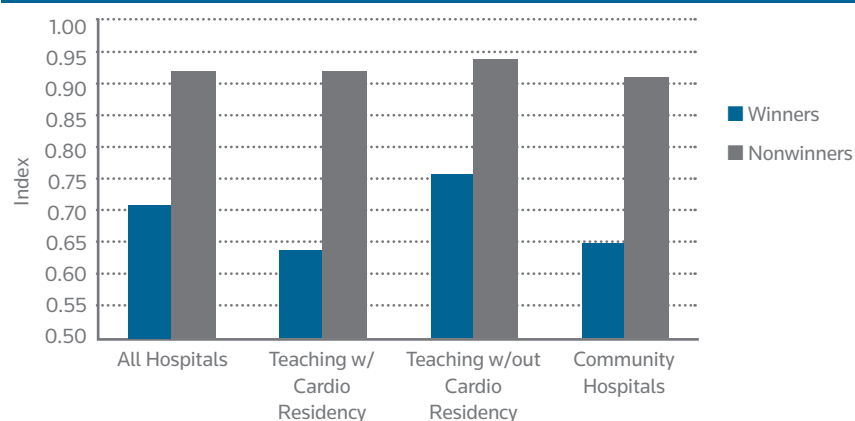
**TABLE 2: Teaching Hospitals With Cardiovascular Residency Programs, Benchmark Versus Peer Performance Comparisons**

	PERFORMANCE MEASURE		BENCHMARK MEDIAN	PEER MEDIAN	DIFFERENCE	PERCENT DIFFERENCE	BENCHMARK HOSPITALS OUTPERFORM PEER HOSPITALS
CLINICAL OUTCOME MEASURES <sup>1,2</sup>	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.89	0.96	-0.07	-7.3	lower mortality
		HF Mortality	0.83	1.01	-0.18	-17.8	lower mortality
		CABG Mortality	0.64	0.92	-0.28	-30.4	lower mortality
		PCI Mortality	0.74	0.94	-0.20	-21.3	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.56	0.93	-0.37	-39.8	fewer complications
		HF Complications	0.71	0.98	-0.27	-27.6	fewer complications
		CABG Complications	0.89	0.98	-0.09	-9.2	fewer complications
		PCI Complications	0.91	1.00	-0.09	-9.0	fewer complications
CLINICAL PROCESS MEASURES <sup>3,5</sup>	AMI Core Measures Mean Percent <sup>3</sup>		98.8	97.7	1.2	n/a	better performance
	HF Core Measures Mean Percent <sup>3</sup>		98.5	96.5	2.0	n/a	better performance
	CABG Patients With Internal Mammary Artery Use (%)		96.0	93.4	2.6	n/a	higher IMA use
EXTENDED OUTCOME MEASURES <sup>4,5</sup>	AMI 30-Day Mortality (%)		14.0	15.0	-1.0	n/a	lower 30-day mortality
	HF 30-Day Mortality (%)		9.9	10.2	-0.3	n/a	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		19.8	20.3	-0.4	n/a	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		24.5	25.0	-0.5	n/a	lower 30-day readmissions
EFFICIENCY MEASURES	AMI Severity-Adjusted Average Length of Stay		4.4	4.8	-0.4	-9.2	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.4	5.0	-0.6	-11.4	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.4	9.3	-0.9	-9.2	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		3.5	3.7	-0.3	-7.0	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		\$9,386	\$9,750	-364	-3.7	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		\$7,890	\$8,171	-281	-3.4	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		\$36,883	\$37,189	-306	-0.8	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		\$18,343	\$18,839	-496	-2.6	lower cost per case

**Notes:**

1. MedPAR 2009 and 2010 combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare 2009Q4–2010Q1, Q2, Q3.
4. CMS Hospital Compare July 1, 2007–June 30, 2010.
5. We do not calculate percentage difference for measures already expressed as a percent.

**Figure 7: CABG Risk-Adjusted Mortality Index, by Hospital Group**



### 50 Top Teaching Hospitals Without Cardiovascular Residency Programs

The winning hospitals in this category displayed some of the lowest costs, especially versus their nonwinning peers. Their wage- and severity-adjusted CABG costs per case were lower than their nonwinning peers by a wide margin – 6,520, or 18 percent lower per case (Table 3) – and also lower than the other two hospital comparison groups (Figure 8).

Benchmark teaching hospitals without cardiovascular residency programs had a risk-adjusted complications index for AMI patients that was 50 percent lower than their peers. The winners' 0.48 AMI mortality index means they had 52 percent fewer deaths than would be expected. This is a markedly better outcome than that experienced by the peer hospitals in this group, who, with an index of 0.96, had only 4 percent fewer CABG mortalities than expected (Table 3).

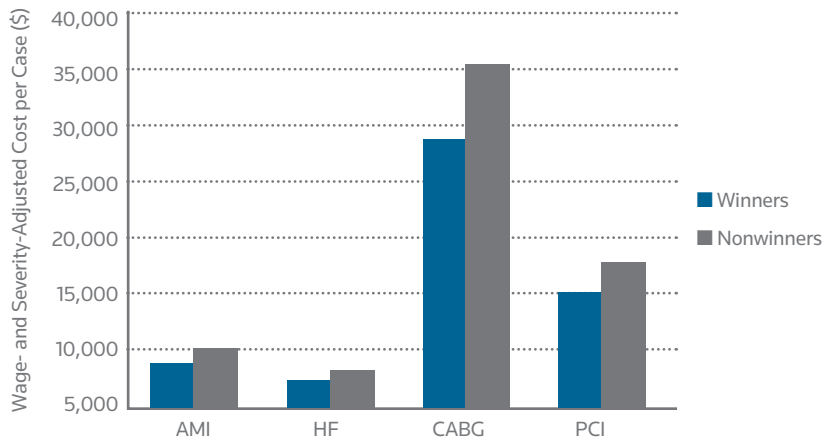
### Benchmark Community Hospitals

The benchmark community hospitals had the shortest hospital stays for PCI patients and outperformed their peers on this measure more than the two teaching hospital groups we studied (Table 4). Winning hospitals released PCI patients an average half-day sooner than their nonwinning peers (Figure 9).

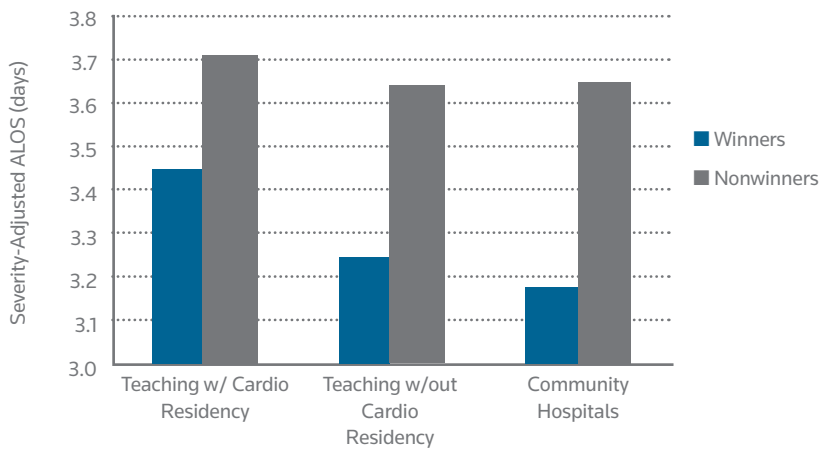
This group also performed particularly well in avoiding deaths for medical (AMI and HF) heart patients. For both patient groups, the winning hospitals had about 30 percent fewer patient deaths than expected, given patient severity (Table 4, risk-adjusted mortality index). Nonwinning hospitals, on the other hand, avoided only 3 percent of the expected deaths for their medical cardiology patients.

The winning community hospitals had AMI readmission rates that were lower than the other two hospital comparison groups and below their nonwinning peers – just under 19 percent of their HF patients were readmitted, for any cause, within 30 days of their original admission date.

**Figure 8: Cost per Case, Teaching Hospitals Without Cardiovascular Residency Programs**



**Figure 9: PCI Patient Length of Stay, by Hospital Group**



**TABLE 3: Teaching Hospitals Without Cardiovascular Residency Programs, Benchmark Versus Peer Performance Comparisons**

	PERFORMANCE MEASURE	BENCHMARK MEDIAN	PEER MEDIAN	DIFFERENCE	PERCENT DIFFERENCE	BENCHMARK HOSPITALS OUTPERFORM PEER HOSPITALS	
CLINICAL OUTCOME MEASURES <sup>1,2</sup>	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.92	0.99	-0.07	-7.1	lower mortality
		HF Mortality	0.90	0.99	-0.09	-9.1	lower mortality
		CABG Mortality	0.76	0.94	-0.18	-19.2	lower mortality
		PCI Mortality	0.76	0.96	-0.20	-20.8	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.48	0.96	-0.48	-50.0	fewer complications
		HF Complications	0.94	0.94	0.00	0.0	no difference
		CABG Complications	0.88	0.99	-0.11	-11.1	fewer complications
		PCI Complications	0.91	0.99	-0.08	-8.1	fewer complications
CLINICAL PROCESS MEASURES <sup>3,5</sup>	Heart Attack Core Measures Mean Percent <sup>3</sup>	98.6	97.5	1.1	n/a	better performance	
	Heart Failure Core Measures Mean Percent <sup>3</sup>	97.0	96.5	0.5	n/a	better performance	
	CABG Patients With Internal Mammary Artery Use (%)	96.7	93.0	3.8	n/a	higher IMA use	
EXTENDED OUTCOME MEASURES <sup>4,5</sup>	AMI 30-Day Mortality (%)	14.7	15.2	-0.5	n/a	lower 30-day mortality	
	HF 30-Day Mortality (%)	10.9	11.3	-0.5	n/a	lower 30-day mortality	
	AMI 30-Day Readmissions Rate (%)	19.3	19.6	-0.3	n/a	lower 30-day readmissions	
	HF 30-Day Readmissions Rate (%)	22.6	24.2	-1.7	n/a	lower 30-day readmissions	
EFFICIENCY MEASURES	AMI Severity-Adjusted Average Length of Stay	4.3	4.9	-0.6	-12.9	shorter ALOS	
	HF Severity-Adjusted Average Length of Stay	4.4	5.0	-0.6	-11.2	shorter ALOS	
	CABG Severity-Adjusted Average Length of Stay	8.2	9.4	-1.2	-13.2	shorter ALOS	
	PCI Severity-Adjusted Average Length of Stay	3.3	3.6	-0.4	-10.7	shorter ALOS	
	AMI Wage- and Severity-Adjusted Average Cost per Case	\$8,955	\$10,239	-1,284	-12.5	lower cost per case	
	HF Wage- and Severity-Adjusted Average Cost per Case	\$7,395	\$8,329	-934	-11.2	lower cost per case	
	CABG Wage- and Severity-Adjusted Average Cost per Case	\$28,856	\$35,376	-6,520	-18.4	lower cost per case	
	PCI Wage- and Severity-Adjusted Average Cost per Case	\$15,276	\$17,982	-2,706	-15.1	lower cost per case	

**Notes:**

1. MedPAR 2009 and 2010 combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare 2009Q4–2010Q1, Q2, Q3.
4. CMS Hospital Compare July 1, 2007–June 30, 2010.
5. We do not calculate percentage difference for measures already expressed as a percent.

**TABLE 4: Community Hospitals, Benchmark Versus Peer Performance Comparisons**

	PERFORMANCE MEASURE		BENCHMARK MEDIAN	PEER MEDIAN	DIFFERENCE	PERCENT DIFFERENCE	BENCHMARK HOSPITALS OUTPERFORM PEER HOSPITALS
CLINICAL OUTCOME MEASURES <sup>1,2</sup>	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.70	0.97	-0.27	-27.8	lower mortality
		HF Mortality	0.72	0.97	-0.25	-25.8	lower mortality
		CABG Mortality	0.65	0.91	-0.26	-28.6	lower mortality
		PCI Mortality	0.78	0.92	-0.14	-15.2	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.56	0.88	-0.32	-36.4	fewer complications
		HF Complications	0.79	0.92	-0.13	-14.1	fewer complications
		CABG Complications	0.92	0.99	-0.07	-7.1	fewer complications
		PCI Complications	0.88	0.99	-0.11	-11.1	fewer complications
CLINICAL PROCESS MEASURES <sup>3,5</sup>	AMI Core Measures Mean Percent		99.0	98.0	1.0	n/a	better performance
	HF Core Measures Mean Percent		98.0	96.8	1.3	n/a	better performance
	CABG Patients With Internal Mammary Artery Use (%)		95.8	92.3	3.5	n/a	higher IMA use
EXTENDED OUTCOME MEASURES <sup>4,5</sup>	AMI 30-Day Mortality (%)		14.5	15.5	-1.0	n/a	lower 30-day mortality
	HF 30-Day Mortality (%)		10.7	11.3	-0.6	n/a	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		18.7	19.5	-0.8	n/a	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		22.9	24.4	-1.5	n/a	lower 30-day readmissions
EFFICIENCY MEASURES	AMI Severity-Adjusted Average Length of Stay		4.4	4.9	-0.5	-9.4	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.7	5.0	-0.3	-6.0	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.6	9.3	-0.7	-7.7	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		3.2	3.7	-0.5	-12.9	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		\$7,958	\$9,610	-1,653	-17.2	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		\$7,114	\$7,835	-721	-9.2	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		\$32,042	\$34,705	-2,663	-7.7	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		\$15,260	\$16,833	-1,573	-9.4	lower cost per case

**Notes:**

1. MedPAR 2009 and 2010 combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare 2009Q4–2010Q1, Q2, Q3.
4. CMS Hospital Compare July 1, 2007–June 30, 2010.
5. We do not calculate percentage difference for measures already expressed as a percent.



# METHODOLOGY

The 50 Top Cardiovascular Hospitals is a quantitative study that uses a balanced scorecard approach, based on publicly available data, to identify the top cardiovascular hospitals in the United States. This study focuses on short-term, acute-care, nonfederal U.S. hospitals that treat a broad spectrum of cardiology patients. It includes patients requiring medical management, as well as those who receive invasive or surgical procedures. Because multiple measures are used, a hospital must provide all forms of cardiovascular care, including open-heart surgery, to be included in the study.

## OVERVIEW

The main steps we take in selecting the 50 cardiovascular study winners are:

- Building the database of hospitals, including special selection and exclusion criteria
- Classifying hospitals into comparison groups
- Scoring hospitals on a set of weighted performance measures
- Determining the 50 hospitals with the best performance by ranking relative to comparison group

The following section is intended to be an overview of these steps. To request more detailed information on any of the study concepts outlined here, please email us at [healthcare.pubs@thomsonreuters.com](mailto:healthcare.pubs@thomsonreuters.com) or call +1 800 568 3282.

Note: The level of cardiovascular care has improved significantly across the industry over the last 10 years, as demonstrated by the improvements we've seen — better survival, fewer patient complications, and shorter hospital stays — since the study's inception. With all cardiovascular service providers showing a higher level of performance, competition

has increased and the top providers have become a more elite group. Therefore, to better highlight those providers that are truly leading the way, we now name only 50 winners. With a group of 50 winners, we are able to raise the bar with much higher achievable targets. If all hospitals performed like the cardiovascular study winners:

- Nearly 7,700 more lives could be saved
- Approximately 6,500 additional patients could be complication-free
- More than \$1 billion could be saved

## BUILDING THE DATABASE OF HOSPITALS

### Primary Data Sources

Like all 100 Top Hospitals® studies, the Cardiovascular Benchmarks study uses only publicly available data. The data primarily come from:

- The Medicare Provider Analysis and Review (MedPAR) data set
- The Medicare Cost Report
- The Centers for Medicare and Medicaid Services (CMS) Hospital Compare data set

We use MedPAR patient-level medical record information to calculate mortality, complications, and length of stay. It is also used for patient-level charge data in estimating cost per adjusted discharge. This data set contains information on the approximately 12 million Medicare patients who are discharged from the nation's acute-care hospitals annually. We used the most recent two years of MedPAR data available, 2009 and 2010, in this study.

To be included in the study, a hospital must have both years of data available.

We use Medicare Cost Reports to create our proprietary database, which contains hospital-specific demographic information and hospital-specific all-payer cost and charges data. The hospital ratio of cost to charges is applied to MedPAR patient-level claims data to estimate cost for the study's cost measures. For this study, we used 2010 cost report data to determine the ratio of cost to charges, whenever available. If 2010 data were not available, we used 2009 data.

The Medicare Cost Report is filed annually by every U.S. hospital that participates in the Medicare program. Hospitals are required to submit cost reports in order to receive reimbursement from Medicare. It should be noted, however, that cost report data include services for all patients, not just Medicare beneficiaries.

We and many others in the healthcare industry have used the MedPAR and Medicare Cost Report databases for many years. We believe they are accurate and reliable sources for the types of analyses performed in this study. Medicare data are highly representative of the cardiovascular patients included in this study. In fact, Medicare inpatients usually represent about two-thirds of all patients undergoing medical treatment for acute myocardial infarction (AMI) or experiencing heart failure (HF), and about half of all patients undergoing percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG). Furthermore, many previous academic and economic studies of healthcare in the United States have been based on the assumption that Medicare data are representative of the all-payer activity at hospitals.

We used the CMS Hospital Compare data set published the second quarter of 2011 for core measures, 30-day mortality rate, and 30-day

readmission rate performance measures. Finally, we use residency program information to classify teaching hospitals. This comes from the American Medical Association (for Accreditation Council for Graduate Medical Education (ACGME)-accredited programs) and the American Osteopathic Association (AOA).

#### Present on Admission Data

Thomson Reuters propriety severity adjustment models for mortality, complications, length of stay (LOS), and cost per case now include present on admission (POA) data that was reported in the 2009 and 2010 MedPAR data sets (2010 only for LOS and cost). In addition, the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicator risk models also take into account POA. Under the Deficit Reduction Act of 2005, as of federal fiscal year 2008, hospitals do not receive payment for cases with certain conditions — like falls, surgical site infections, and pressure ulcers — that were not present on the patient's admission but occur during their hospitalization. As a result, CMS now requires all inpatient prospective payment system hospitals to document whether a patient has these conditions when admitted.<sup>8</sup>

#### Hospitals and Patient Groups Included

The focus of the study is on hospitals that offer both medical and surgical options for patients with two of the most common cardiovascular conditions — coronary atherosclerosis, including AMI, and HF. To build such a database, we included all hospitals that had, in the 2009 and 2010 data years combined, at least 30 unique cases<sup>9</sup> in each of the groups described below.

1. AMI patients in Medicare Severity Diagnosis Related Groups (MS-DRGs) 280–285 with the following ICD-9-CM codes as primary diagnosis only:
  - 410.01 Acute myocardial infarction of anterolateral wall, initial episode of care
  - 410.11 Acute myocardial infarction of other anterior wall, initial episode of care
  - 410.21 Acute myocardial infarction of inferolateral wall, initial episode of care
  - 410.31 Acute myocardial infarction of inferoposterior wall, initial episode of care
  - 410.41 Acute myocardial infarction of other inferior wall, initial episode of care
  - 410.51 Acute myocardial infarction of other lateral wall, initial episode of care
  - 410.61 Acute myocardial infarction, true

#### HOW POA DATA HAVE AFFECTED COMPLICATION RATES:

CMS regulations now require all inpatient prospective payment system hospitals to document whether a patient has certain conditions when admitted, and our complications rate methodology now uses POA data. Consequently, the complications rates now exclude "false positive" complications and are more accurate than previous years.

- posterior wall infarction, initial episode of care
- 410.71 Acute myocardial infarction, subendocardial infarction, initial episode of care
- 410.81 Acute myocardial infarction of other specified sites, initial episode of care
- 410.91 Acute myocardial infarction, unspecified site, initial episode of care

The HF category is restricted to non-surgical patients.

3. PCI patients with any (primary or secondary) of the following ICD-9-CM procedure codes:

- 00.66 PTCA or coronary atherectomy
- 36.06 Insertion of coronary artery stent(s)
- 36.07 Insertion of drug-eluting coronary artery stent(s)

Patients with the 36.06 or 36.07 codes are excluded if they also have the procedure code 36.03 (open chest coronary artery angioplasty).

4. CABG patients in MS-DRGs 231–236 and 293 with any (primary or secondary) of the following ICD-9-CM procedure codes:

- 36.10 Aortocoronary bypass, unspecified number of arteries
- 36.11 Aortocoronary bypass, one coronary artery
- 36.12 Aortocoronary bypass, two coronary arteries
- 36.13 Aortocoronary bypass, three coronary arteries
- 36.14 Aortocoronary bypass, four or more coronary arteries
- 36.15 Single internal mammary-coronary artery bypass
- 36.16 Double internal mammary-coronary artery bypass
- 36.17 Abdominal-coronary artery bypass
- 36.19 Other bypass anastomosis for heart revascularization

When a patient record has both PCI and CABG procedures, we place them into the CABG group for all performance measures.

#### Patient Records Excluded

The AMI and HF groups explicitly exclude patients who also had a PCI and/or CABG procedure (to ensure we have exclusively medical patients in these groups).

Also excluded are:

- Patients who were discharged to another short-term facility (this is done to avoid double-counting)
- Patients who were not at least 65 years old

The AMI group is restricted to non-surgical patients.

2. HF patients in MS-DRGs 291–293 with the following ICD-9-CM code as primary diagnosis only:

- 398.91 Rheumatic heart failure
- 402.01 Malignant hypertensive heart disease
- 402.11 Benign hypertensive heart disease
- 402.91 Unspecified hypertensive heart disease
- 404.01 Malignant hypertensive heart and renal disease
- 404.03 Malignant hypertensive heart and renal disease with renal failure
- 404.11 Benign hypertensive heart and renal disease
- 404.13 Benign hypertensive heart and renal disease with renal failure
- 404.91 Unspecified hypertensive heart and renal disease
- 404.93 Unspecified hypertensive heart and renal disease with renal failure
- 428.0 Unspecified congestive heart failure
- 428.1 Left heart failure
- 428.20 Unspecified systolic heart failure
- 428.21 Acute systolic heart failure
- 428.22 Chronic systolic heart failure
- 428.23 Acute on chronic systolic heart failure
- 428.30 Unspecified diastolic heart failure
- 428.31 Acute diastolic heart failure
- 428.32 Chronic diastolic heart failure
- 428.33 Acute on chronic diastolic heart failure
- 428.40 Unspecified combined systolic and diastolic heart failure
- 428.41 Acute combined systolic and diastolic heart failure
- 428.42 Chronic combined systolic and diastolic heart failure
- 428.43 Acute on chronic combined
- 428.9 Unspecified heart failure

## Hospitals Excluded

After building the database of cardiovascular hospitals, we excluded a number of hospitals that would have skewed the study results. A new exclusion was added last year, for hospitals not reporting POA. Also excluded from the study were:

- Hospitals with fewer than 30 unique patient records in each patient group (AMI, HF, CABG, and PCI) for the two MedPAR years combined
- Specialty hospitals, other than cardiac hospitals (e.g., critical access hospitals, children's, women's, psychiatric, substance abuse, rehabilitation, and long-term acute-care hospitals)
- Hospitals with fewer than 25 acute-care beds
- Federally owned hospitals
- Non-U.S. hospitals (such as those in Puerto Rico, Guam, and the Virgin Islands)
- Hospitals with Medicare average lengths of stay longer than 30 days
- Hospitals with no reported deaths
- Hospitals that do not have both 2009 and 2010 Medicare claims
- Hospitals missing data for calculation of one or more performance measures
- Hospitals for which a Medicare Cost Report was not available for 2009 or 2010
- Hospitals that did not code POA information on their 2009 and 2010 MedPAR data, including Maryland\* hospitals in the Medicare waiver program, because their data are not comparable to other hospitals

## CLASSIFYING HOSPITALS INTO COMPARISON GROUPS

Bed size, teaching status, and residency/fellowship program involvement have a profound effect on the types of patients a hospital treats and the scope of services it provides. When analyzing the performance of an individual hospital, it is crucial to evaluate it against other similar hospitals. To address this, we assigned each hospital to one of three comparison groups according to its teaching and residency program status.

Our formula for defining the cardiovascular hospital comparison groups includes each hospital's bed size, residents-to-beds ratio, and involvement in graduate medical education (GME) programs accredited by either the ACGME<sup>10</sup> or the AOA.<sup>11</sup>

We define the groups as follows:

### Teaching Hospitals With Cardiovascular Residency Programs

Must be involved in a cardiovascular residency program accredited by the ACGME or the AOA

AND

Must meet any two of the following three criteria:

1. 200 or more acute-care beds in service
2. An intern-resident-per-bed ratio of at least 0.03
3. Involvement in at least three accredited GME programs overall. Cardiovascular residency programs include any of the following:

- Cardiology
- Cardiothoracic surgery
- Cardiovascular disease
- Cardiovascular medicine
- Interventional cardiology
- Thoracic surgery
- Thoracic surgery – integrated

Clinical cardiac electrophysiology and cardiovascular radiology residency programs are not included.

### Teaching Hospitals Without Cardiovascular Residency Programs

There is *no* involvement in a cardiovascular residency program.

Must meet any two of the following three criteria:

1. 200 or more acute-care beds in service
2. An intern-resident-per-bed ratio of at least 0.03
3. Involvement in at least three accredited GME programs overall

### Community Hospitals

Must meet both of the following criteria:

1. 25 or more acute-care beds in service
2. Not classified as a teaching hospital per definitions above

Bed size and number of interns/residents (full-time equivalents) are taken from each hospital's Medicare Cost Report for the most current year available.

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\*Maryland's hospitals are not paid under Medicare's inpatient prospective payment system. Instead, they have a Medicare waiver agreement that allows Medicare reimbursement according to rates set by the state's Health Services Cost Review Commission. For more information, see [mhcc.maryland.gov/consumerinfo/hospitalguide/patients/other\\_information/overview\\_of\\_maryland\\_regulatory\\_system\\_for\\_hospital\\_oversight.html](http://mhcc.maryland.gov/consumerinfo/hospitalguide/patients/other_information/overview_of_maryland_regulatory_system_for_hospital_oversight.html).

## 2011 Cardiovascular Study Groups

The final study group, after exclusions, consisted of:

COMPARISON GROUP	TOTAL
Teaching Hospitals With Cardiovascular Residency Programs	215
Teaching Hospitals Without Cardiovascular Residency Programs	283
Community Hospitals	538
<b>Total In-Study Hospitals</b>	<b>1,036</b>

## SCORING HOSPITALS ON WEIGHTED PERFORMANCE MEASURES

### Evolution of Performance Measures

We use a balanced scorecard approach, based on public data, to select the measures most useful for boards and CEOs in the current operating environment. Throughout the life of the study, we have worked hard to meet this vision. We gather feedback from industry leaders, hospital executives, academic leaders, and internal experts; review trends in the healthcare market; and survey

hospitals in demanding marketplaces to learn what measures are valid and reflective of top performance. As the market has changed, our methods have evolved.

This year, the significant change is that we included POA data when developing the expected probabilities for mortality, complications, LOS, and cost per case risk models.

The measures used in this year's study are:

CATEGORY	RANKED PERFORMANCE METRIC
CLINICAL OUTCOME MEASURES	1. Risk-Adjusted Mortality (AMI, HF, CABG, PCI)
	2. Risk-Adjusted Complications (AMI, HF, CABG, PCI)
CLINICAL PROCESS MEASURES	3. Core Measures (AMI, HF each weighted ½)
	4. Percentage of CABG Patients With Internal Mammary Artery Use
EXTENDED OUTCOME MEASURES	5. 30-Day Mortality Rates (AMI, HF)
	6. 30-Day Readmission Rates (AMI, HF)
EFFICIENCY MEASURES	7. Severity-Adjusted Average Length of Stay (AMI, HF, CABG, PCI)
	8. Wage- and Severity-Adjusted Average Cost per Case (AMI, HF, CABG, PCI)

On the following pages, we provide a rationale for the selection of our balanced scorecard domains and the measures used for each.

### Clinical Excellence

Clinical excellence can be measured by looking at several key domains: outcomes, process, and extended outcomes.

Our clinical outcome measures are the risk-adjusted mortality and risk-adjusted complications indexes for all included cardiovascular patient groups (AMI, HF, CABG, and PCI). These mortality and

complications measures show us how the provider is performing on the most basic and essential care standards — survival and error-free care — while treating patients in the facility. To address this, our study incorporates a comprehensive risk-adjusted complications measure that includes 30 possible patient complications with expected probabilities calculated from a large national inpatient database. For more information, see the measures details in the table on the following page and read about our complications rate index model in the Appendix of this document.

Clinical process measures include heart attack and heart failure core measures, along with the percentage of CABG patients with internal mammary artery use. Core measures were developed by the Joint Commission and endorsed by the National Quality Forum as minimum process of care standards. They are a widely accepted method for measuring patient care quality that includes specific guidelines for heart attack or chest pain, heart failure, pneumonia, pregnancy and related conditions, and surgical care improvement project measures. Our core measures performance is based on the heart attack and heart failure areas of this program, using Hospital Compare data reported on the CMS Web site. The clinical advantages of using an internal mammary graft are many and have been spelled out in numerous studies over the last two decades.<sup>2, 12-15</sup>

The study's extended outcomes domain includes 30-day mortality rates and 30-day readmission rates for AMI and HF patients. These measures help us understand how the hospital's patients are faring over a longer period of time and may indicate both discharge appropriateness and effectiveness of

follow-up care coordination. Since these measures are part of CMS' value-based purchasing program, they are being watched closely in the industry. Hospitals with lower values appear to be providing care with better medium-term results for these conditions. And readmission rates are among the measures that have taken on greater significance under healthcare reform; starting in federal fiscal year (FFY) 2013, CMS will be able to penalize hospitals for readmission rates that are deemed too high.

### Service Delivery Efficiency

We use severity-adjusted average length of stay and wage- and severity-adjusted cost per case as our measures of service delivery efficiency. For the life of the study, severity-adjusted average length of stay has served as a proxy for clinical efficiency and cost per case has served as a measure of both clinical and operating efficiency. Cost per case provides insight into how cost-effectively a hospital is caring for its patients. Wage and severity adjustments consider patient illness and cost of living differences, and help ensure that we're making fair comparisons among hospitals.

## Risk-Adjusted Mortality Index

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>While all hospitals have patient deaths, this measure shows where deaths occurred that would not have been expected, considering a patient's medical condition.</p>	<p>The Risk-Adjusted Mortality Index is the number of actual deaths in 2009 and 2010, divided by the number expected.</p> <p>We normalize the index based on the observed and expected deaths for each comparison group and for each patient group (AMI, HF, CABG, and PCI). Expected deaths are based on our statistical model for predicting the likelihood of a patient's death based on their medical record (age, sex, presence of complicating diagnoses, and other characteristics) and factors associated with the hospital (teaching status, geographic location, and size). See the Appendix for details.</p> <p>The reference value for this index is 1.00; a value of 1.15 indicates 15 percent more events than predicted, and a value of 0.85 indicates 15 percent fewer.</p>	<p>We used two years of MedPAR data (2009 and 2010) to reduce the influence of chance fluctuation.</p> <p>We based the scoring for each patient group (AMI, HF, CABG, and PCI) on the difference between observed and expected deaths, expressed in normalized standard deviation units (z-score). Normalization was done by comparison group. Hospitals with the fewest deaths, relative to the number expected, received the highest scores. Hospitals with values that were high statistical outliers, based on a normalized z-score greater than or equal to 1.64 (95 percent confidence), were not eligible to be benchmark hospitals.</p> <p>Each patient group under this measure received ½ weight in the final overall ranking process.</p>	<p>Lower</p>

## Risk-Adjusted Complications Index

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENT	FAVORABLE VALUES ARE
<p>Keeping patients free from potentially avoidable complications is an important goal for all healthcare providers. A lower complications index indicates fewer patients with complications, considering what would be expected based on patient characteristics. Like the mortality index, this measure can show where complications did not occur but were expected, or the reverse, given the patient's condition.</p>	<p>We calculate an index value based on the number of cases with complications in 2009 and 2010 combined, divided by the number expected, given the risk of complications for each patient.</p> <p>We normalize the index based on the observed and expected complications for each comparison group and for each patient group (AMI, HF, CABG, and PCI). This measure uses our proprietary expected complications rate index models. These models account for patient-level characteristics (age, sex, principal diagnosis, comorbid conditions, and other characteristics), as well as differences in hospital characteristics (size, teaching status, geographic location, and community setting). Complication rates are calculated from normative data for two patient risk groups: medical and surgical. For more details on the model, see the Appendix.</p> <p>The reference value for this index is 1.00; a value of 1.15 indicates 15 percent more complications occurred than were predicted, and a value of 0.85 indicates 15 percent fewer complications than predicted.</p>	<p>We used two years of MedPAR data (2009 and 2010) to reduce the influence of chance fluctuation.</p> <p>We based the scoring for each patient group (AMI, HF, CABG, and PCI) on the difference between the observed and expected number of patients with complications, expressed in normalized standard deviation units (z-score). Normalization was done by comparison group and patient group (AMI and HF). Hospitals with the fewest observed complications, relative to the number expected, after accounting for standard binomial variability, received the most favorable scores. Hospitals with values that were high statistical outliers, based on a normalized z-score greater than or equal to 1.64 (95 percent confidence), were not eligible to be benchmark hospitals.</p> <p>Each patient group under this measure received ¼ weight in the final overall ranking process.</p>	Lower

## Core Measures Mean Percent

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>To be truly balanced, a scorecard must include various measures of quality. Core measures, developed by The Joint Commission and CMS, and endorsed by the National Quality Forum, are a widely accepted method for measuring patient care quality that includes specific guidelines for AMI and HF care.</p>	<p>Core measures values are from the CMS Hospital Compare Web site. We included six of the seven reported heart attack measures and all of the reported heart failure measures, for a total of 10. We excluded the heart attack core measure "Heart Attack Patients Given Fibrinolytic Medication Within 30 Minutes of Arrival" because it was not reported by most in-study hospitals. For a list of the measures used, see the Appendix.</p> <p>For each hospital, we calculate the mean of the reported core measures percent values for all available core measures by patient group (AMI, HF). We consider reported core measures percents with patient counts that are less than or equal to 25, or that have relative standard error values greater than or equal to 0.30 to be statistically unreliable. In these cases, we substitute the class median percent value for the affected core measure.</p>	<p>If the hospital did not report a specific core measure, or if the core measure was based on too few patients to be sufficiently precise, we substituted the median percent for the comparison group.</p> <p>Core measures values are from the CMS Hospital Compare Web site, data set published the second quarter of 2011 (with data from the fourth quarter of 2009 through the third quarter of 2010).<sup>16</sup></p> <p>Core measures received a weight of 1 in the final overall ranking process (½ for the heart attack core measure mean percent and ½ for the heart failure core measure mean percent).</p>	Higher

## Percentage of CABG Patients with Internal Mammary Artery Use

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>The clinical advantages of using an internal mammary graft are many. Studies over the last two decades have confirmed the benefits of internal mammary CABGs over saphenous (leg) vein grafts, with a higher patency rate being the most significant clinical benefit.<sup>2, 12-15</sup> On a patient-specific basis, certain factors may promote or prohibit the use of an internal mammary graft. However, it is reasonable to use the overall rate at which these grafts are performed as a measure of hospital quality.</p>	<p>Number of CABG surgeries using internal mammary arteries, divided by the total number of CABG surgeries. Patients with prior CABG surgeries are excluded from the calculation.</p>	<p>We used two years of MedPAR data (2009 and 2010) to reduce the influence of chance fluctuation.</p> <p>This measure received a weight of 1 in the final overall ranking process.</p>	Higher

## 30-Day Mortality Rates for AMI and HF Patients

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>30-day mortality rates are an accepted measure of the effectiveness of overall hospital care. They allow us to look beyond immediate patient outcomes and understand how the care the hospital provided to inpatients with these particular conditions may have contributed to their longer-term survival. Because these measures are part of CMS' value-based purchasing program, they are now being watched closely in the industry. In addition, tracking these measures may help hospitals identify patients at risk for post-discharge problems and target improvements in discharge planning and in aftercare processes. Hospitals that score well may be better prepared for pay-for performance.</p>	<p>CMS calculates a 30-day mortality rate for each patient condition using three years of MedPAR data combined. CMS does not calculate rates for hospitals where the number of cases is too small (less than 25). We build a database of this information for the hospitals in our study then rank the hospitals independently on each of the two conditions (AMI and HF), by hospital comparison group.</p> <p>The rates are presented as percentages. A 15 percent 30-day mortality rate would indicate that 15 percent of patients died, of any cause, within 30 days of their original admission date.</p>	<p>Data are from the CMS Hospital Compare data set for the second quarter of 2011. This contains data from July 1, 2007, through June 30, 2010. For more information about this data, see the Appendix.</p> <p>Each patient condition receives ¼ weight, for a total 30-Day Mortality Rate weight of ½ in overall hospital ranking.</p>	Lower

## 30-Day Readmission Rates for AMI and HF Patients

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>30-day readmission rates are an accepted measure of the effectiveness of overall hospital care. They allow us to understand how the care the hospital provided to inpatients with these particular conditions may have contributed to issues with their post-discharge medical stability and recovery. Because these measures are part of CMS' value-based purchasing program, they are now being watched closely in the industry. In addition, tracking these measures may help hospitals identify patients at risk for post-discharge problems if discharged too soon, as well as target improvements in discharge planning and in aftercare processes. Finally, these rates are among the measures that have taken on greater significance under healthcare reform; starting in FFY 2013, CMS will be able to penalize hospitals based on readmission rates.</p>	<p>CMS calculates a 30-day readmission rate for each patient condition using three years of MedPAR data combined. CMS does not calculate rates for hospitals where the number of cases is too small (less than 25). We build a database of this information for the hospitals in our study then rank the hospitals independently on each of the two conditions (AMI and HF), by hospital comparison group.</p> <p>The rates are presented as percentages. A 15 percent 30-day readmission rate means that 15 percent of patients were readmitted, for any cause, within 30 days of their original admission date.</p>	<p>Data are from the CMS Hospital Compare data set published the second quarter of 2011. This contains data from July 1, 2007, through June 30, 2010. For more information about this data, see the Appendix.</p> <p>Each patient condition receives ¼ weight, for a total 30-Day Readmission Rate weight of ½ in overall hospital ranking.</p>	Lower

## Severity-Adjusted Average Length of Stay (ALOS)

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>A lower severity-adjusted ALOS (average number of days spent by a patient in a hospital) generally indicates a more efficient consumption of hospital resources and, possibly, reduced risk to patients.</p>	<p>We calculate a length of stay (LOS) index value for each patient group (AMI, HF, CABG, and PCI) based on the sum of the patient-level lengths of stay divided by the sum of the normalized expected lengths of stay. Expected length of stay adjusts for differences in severity of illness using a linear regression model. We normalize the expected values based on the observed and expected LOS for each patient group (AMI, HF, CABG, and PCI). See the Appendix for more information.</p>	<p>Data for this measure are from 2010 MedPAR only.</p> <p>We adjust ALOS to factor out differences attributable to the varying severity of illness of patients at each hospital. We used POA-enabled risk models. For more information on this model, see the Appendix.</p> <p>LOS performance for each patient group (AMI, HF, PCI, and CABG) received a weight of ¼ in the final overall ranking process.</p> <p>NOTE: Each patient group LOS index is converted into an average length of stay in days by multiplying it by the grand mean of the in-study patient population, without respect to class.</p>	Lower

## Severity- and Wage-Adjusted Cost per Case

WHY WE INCLUDE THIS ELEMENT	CALCULATION	COMMENTS	FAVORABLE VALUES ARE
<p>This measure helps to determine how cost-effectively a hospital is caring for its patients.</p>	<p>We calculate a cost per case index value for each patient group (AMI, HF, CABG, and PCI) based on the sum of the patient-level estimated cost divided by the sum of the normalized expected cost. Cost data is wage-adjusted. We calculate estimated cost by applying the hospital cost-to-charge ratio from the 2010 (or most recent) cost report to the patient-level charges in MedPAR.</p> <p>Expected cost adjusts for differences in severity of illness using a linear regression model. We normalize the expected values based on the observed and expected cost per case for each patient group (AMI, HF, CABG, and PCI). See the Appendix for more information.</p>	<p>Cost-to-charge ratios are from the hospital's 2010 Medicare Cost Report (or 2009, if 2010 not available). In this study, we used the total cost-to-charge ratio reported by the hospital. For more information on our methodology, see the Appendix.</p> <p>Charge data for this measure are from 2010 MedPAR only.</p> <p>Costs are severity adjusted to factor out differences attributable to the varying severity of illness of patients at each hospital and are wage-adjusted to allow for regional wage variations. We use the 2010 CMS wage index for the profiled hospital. We also use POA-enabled risk models.</p> <p>Each cost per case measure (AMI, HF, PCI, and CABG) received a weight of ¼ in the final overall ranking process.</p> <p>NOTE: Each patient group cost per case index is converted into an average cost per case expressed in dollars by multiplying it by the grand mean of the in-study patient population, without respect to class. For more information on our cost per case methodologies, see the Appendix.</p>	<p>Lower</p>

## DETERMINING THE 50 TOP CARDIOVASCULAR HOSPITALS

### Ranking

Within each of the three hospital comparison groups, we ranked hospitals based on their performance on each of the measures independently, relative to other hospitals in their group. Each performance

measure is assigned a weight for use in overall ranking. The weights for each measure are indicated in the table below. Each hospital's measure ranks were summed to arrive at a total score for the hospital. The hospitals were then ranked based on their total scores, and the hospitals with the best overall rankings in each comparison group were selected as the benchmarks.

RANKED PERFORMANCE METRIC	PATIENT GROUP	WEIGHT
Risk-Adjusted Mortality (Normalized Z-Score)	AMI	1/2
	HF	1/2
	CABG	1/2
	PCI	1/2
Risk-Adjusted Complications (Normalized Z-Score)	AMI	1/4
	HF	1/4
	CABG	1/4
	PCI	1/4
Heart Attack Core Measures Mean Percent		1/2
Heart Failure Core Measures Mean Percent		1/2
Percentage of CABG Patients With Internal Mammary Artery Use		1
30-Day Mortality Rates	AMI	1/4
	HF	1/4
30-Day Readmission Rates	AMI	1/4
	HF	1/4
Severity-Adjusted Average Length of Stay Normalized Index	AMI	1/4
	HF	1/4
	CABG	1/4
	PCI	1/4
Wage- and Severity-Adjusted Average Cost per Case Normalized Index	AMI	1/4
	HF	1/4
	CABG	1/4
	PCI	1/4

Note: Mortality and complications normalized z-scores are converted to indexes for reporting. We convert LOS and cost per case indexes to average length of stay and average cost per case, respectively, for reporting. For more details, see the performance measure table above for each measure.

### Screening for Outliers

To reduce the impact of unsustainable performance anomalies and reporting anomalies or errors, hospitals with one or more mortality or complications index scores that were high statistical outliers (95 percent confidence) were not eligible to be winners. In addition, hospitals with costs per case for any patient group that were

high or low statistical outliers (using interquartile range-trimming methodology) were not eligible to be winners. The number of hospitals selected to receive the Thomson Reuters 50 Top Cardiovascular Hospitals award in each hospital comparison group were as follows:

COMPARISON GROUP	TOTAL
Teaching Hospitals With Cardiovascular Residency Program	15
Teaching Hospitals Without Cardiovascular Residency Program	20
Community Hospitals	15
<b>Total</b>	<b>50</b>

# WINNERS THROUGH THE YEARS

HOSPITAL*	LOCATION	TOTAL YEAR(S) WON	STUDY EDITIONS													
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Morton Plant Hospital	Clearwater, FL	13	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Munroe Regional Medical Center	Ocala, FL	10	•	•	•	•	•	•	•	•	•			•		
Providence Hospital and Medical Center	Southfield, MI	10			•	•	•	•	•	•	•	•	•	•	•	
St. Peter's Hospital	Albany, NY	10	•	•	•	•	•	•	•			•	•	•		
MeritCare Medical Center	Fargo, ND	10	•	•		•	•	•	•	•	•	•	•			
Scott and White Memorial Hospital	Temple, TX	10		•	•	•	•	•	•	•	•	•	•	•		
Mercy Medical Center North Iowa	Mason City, IA	9		•	•			•	•	•	•	•	•	•		
Lahey Clinic	Burlington, MA	9		•	•	•	•			•	•			•	•	•
Spectrum Health Hospital Group	Grand Rapids, MI	9	•		•	•	•	•	•	•	•	•			•	
Rochester General Hospital	Rochester, NY	9	•	•		•	•	•	•	•			•	•		
St. Mark's Hospital	Salt Lake City, UT	9	•	•	•	•	•	•				•	•			•
St. Joseph Medical Center	Towson, MD	8	•	•		•	•	•	•			•	•			
Beth Israel Deaconess Medical Center	Boston, MA	8	•			•	•	•	•	•	•			•		
Oakwood Hospital and Medical Center- Dearborn	Dearborn, MI	8	•	•	•			•	•	•	•	•				
St. Joseph Mercy Oakland	Pontiac, MI	8				•	•	•	•			•	•	•	•	
Abbott Northwestern Hospital	Minneapolis, MN	8	•		•			•	•	•	•	•	•			
Park Nicolett Methodist Hospital	St. Louis Park, MN	8			•					•	•	•	•	•	•	•
St. Cloud Hospital	St. Cloud, MN	8	•	•	•	•	•	•	•				•			
St. Mary's Medical Center	Duluth, MN	8	•	•	•	•	•	•	•	•						
Hackensack University Medical Center	Hackensack, NJ	8	•					•	•		•	•	•	•		•
The Christ Hospital	Cincinnati, OH	8	•	•	•	•	•	•	•	•						
Robert Packer Hospital	Sayre, PA	8			•				•	•	•	•			•	•
UPMC Hamot	Erie, PA	8	•						•	•	•			•	•	•
Parkwest Medical Center	Knoxville, TN	8	•	•	•			•	•	•	•	•				
Providence Regional Medical Center Everett	Everett, WA	8		•		•	•	•		•	•	•	•	•		
Aspirus Wausau Hospital	Wausau, WI	8			•	•	•				•	•	•	•		•
Munson Medical Center	Traverse City, MI	7	•	•	•						•		•	•	•	
Mercy Hospital	Coon Rapids, MN	7						•	•	•	•	•	•	•		
Mission Hospitals	Asheville, NC	7		•		•	•	•	•	•	•	•				
Cleveland Clinic Foundation	Cleveland, OH	7	•		•	•	•	•	•			•				
Riverside Methodist Hospital	Columbus, OH	7	•	•				•			•	•	•	•		
Saint Thomas Hospital	Nashville, TN	7	•		•	•				•	•	•	•			
University of Virginia Medical Center	Charlottesville, VA	7	•					•	•	•		•		•	•	
Gundersen Lutheran	La Crosse, WI	7	•					•		•		•	•	•		•

\*List is ordered by years won, then state, then hospital name.

HOSPITAL*	LOCATION	TOTAL YEAR(S) WON	STUDY EDITIONS												
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Saint Joseph's Hospital	Marshfield, WI	7				•	•	•	•	•		•	•		
Arizona Heart Hospital	Phoenix, AZ	6				•		•	•		•	•	•		
Mayo Clinic Hospital	Phoenix, AZ	6							•	•	•	•		•	
Saint Joseph's Hospital of Atlanta	Atlanta, GA	6	•	•	•		•	•	•						
Saint Alphonsus Regional Medical Center	Boise, ID	6		•	•		•				•	•		•	
St. Luke's Boise Medical Center	Boise, ID	6				•	•					•	•	•	
MetroSouth Medical Center	Blue Island, IL	6	•		•	•	•	•	•						
Massachusetts General Hospital	Boston, MA	6	•	•	•	•	•			•					
Marquette General Hospital	Marquette, MI	6								•	•	•	•	•	
St. John Hospital & Medical Center	Detroit, MI	6	•		•	•		•			•	•			
St. Joseph Mercy Hospital	Ann Arbor, MI	6							•	•	•	•	•	•	
William Beaumont Hospital-Royal Oak	Royal Oak, MI	6	•					•	•	•		•	•		
Billings Clinic	Billings, MT	6							•	•	•	•	•		
Dartmouth-Hitchcock Medical Center	Lebanon, NH	6			•		•			•	•	•	•		
Mount Carmel	Columbus, OH	6		•	•		•					•	•	•	
Geisinger Medical Center	Danville, PA	6	•							•	•	•	•	•	
Penn Presbyterian Medical Center	Philadelphia, PA	6				•	•	•	•	•		•			
The Miriam Hospital	Providence, RI	6	•			•	•	•		•	•				
Baylor University Medical Center	Dallas, TX	6	•	•	•	•	•		•						
Heart Hospital of Austin	Austin, TX	6						•	•		•	•	•	•	
LDS Hospital	Salt Lake City, UT	6	•	•		•	•	•	•						
Centra Health	Lynchburg, VA	6		•			•		•	•			•	•	
University of Wisconsin Hospital and Clinics	Madison, WI	6			•				•	•	•	•	•		
Banner Boswell Medical Center	Sun City, AZ	5			•	•	•	•	•						
Yale-New Haven Hospital	New Haven, CT	5					•	•	•		•	•			
Charlotte Regional Medical Center	Punta Gorda, FL	5	•	•		•	•	•							
Lee Memorial Health System	Fort Myers, FL	5	•		•	•		•	•						
Ocala Regional Medical Center	Ocala, FL	5	•	•	•	•		•							
Regional Medical Center Bayonet Point	Hudson, FL	5	•	•	•	•	•								
Sarasota Memorial Hospital	Sarasota, FL	5				•	•	•	•	•					
Venice Regional Medical Center	Venice, FL	5								•	•	•	•	•	
Loyola University Medical Center	Maywood, IL	5				•	•			•		•	•		
Northwest Community Hospital	Arlington Heights, IL	5		•		•		•				•	•		
St. Vincent Indianapolis Hospital	Indianapolis, IN	5	•								•	•	•	•	
Maine Medical Center	Portland, ME	5	•		•			•				•	•		
Union Memorial Hospital	Baltimore, MD	5			•			•	•	•		•			
St. Luke's Hospital	Chesterfield, MO	5	•		•	•	•	•							
St. Patrick Hospital and Health Sciences Center	Missoula, MT	5	•		•				•	•	•				

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
St. Vincent Healthcare	Billings, MT	5	•		•	•	•			•						
BryanLGH Medical Center	Lincoln, NE	5	•	•	•	•	•									
Bethesda North Hospital	Cincinnati, OH	5				•			•	•				•		•
Good Samaritan Hospital	Dayton, OH	5	•			•	•			•	•					
Mercy Medical Center	Canton, OH	5	•			•	•							•		•
Southwest General Health Center	Middleburg Heights, OH	5									•	•	•	•	•	
University Hospital	Cincinnati, OH	5	•	•		•	•			•						
Rogue Valley Medical Center	Medford, OR	5		•	•	•			•	•						
Lankenau Hospital	Wynnewood, PA	5								•	•	•	•			•
St. Luke's Hospital	Bethlehem, PA	5	•		•	•	•									•
UPMC Presbyterian	Pittsburgh, PA	5	•							•	•	•	•			
York Hospital	York, PA	5	•	•	•			•	•							
Avera Heart Hospital of South Dakota	Sioux Falls, SD	5										•	•	•	•	•
Baptist Hospital of East Tennessee	Knoxville, TN	5	•	•	•	•	•									
Memorial Hermann Hospital System	Houston, TX	5						•	•			•	•			•
Sentara Norfolk General Hospital	Norfolk, VA	5	•	•	•	•	•									
Deaconess Medical Center	Spokane, WA	5	•			•			•	•	•					
Aurora St. Luke's Medical Center	Milwaukee, WI	5	•							•			•	•	•	
Bellin Hospital	Green Bay, WI	5	•					•			•	•				•
Thomas Hospital	Fairhope, AL	4									•	•	•	•		
St. Joseph's Hospital and Medical Center	Phoenix, AZ	4						•	•	•				•		
Loma Linda University Medical Center	Loma Linda, CA	4	•		•	•	•									
Memorial Health System	Colorado Springs, CO	4						•	•		•	•				
Hospital of St. Raphael	New Haven, CT	4	•					•	•	•						
Cleveland Clinic Florida	Weston, FL	4										•	•	•	•	
Holy Cross Hospital	Fort Lauderdale, FL	4		•	•	•	•									
JFK Medical Center	Atlantis, FL	4	•									•		•	•	
Advocate Lutheran General Hospital	Park Ridge, IL	4		•	•					•				•		
St. John's Hospital	Springfield, IL	4	•						•					•		•
St. Vincent Heart Center of Indiana	Indianapolis, IN	4									•	•		•		•
The Indiana Heart Hospital	Indianapolis, IN	4									•	•	•	•		
Mercy Medical Center-Des Moines	Des Moines, IA	4	•						•			•		•		
Baystate Medical Center	Springfield, MA	4								•	•			•	•	
Borgess Medical Center	Kalamazoo, MI	4	•					•			•	•				
Henry Ford Hospital	Detroit, MI	4								•	•	•	•			
Fairview Southdale Hospital	Edina, MN	4			•					•			•	•		
Nebraska Heart Institute & Heart Hospital	Lincoln, NE	4									•	•	•			•
North Shore University Hospital	Manhasset, NY	4	•		•	•								•		

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Altru Hospital	Grand Forks, ND	4								•	•	•	•			
Parma Community General Hospital	Parma, OH	4						•				•	•	•		
University Hospitals Case Medical Center	Cleveland, OH	4						•	•	•	•					
Memorial Medical Center	Johnstown, PA	4	•			•	•	•								
Mercy Hospital Scranton	Scranton, PA	4							•	•	•	•				
The Western Pennsylvania Hospital	Pittsburgh, PA	4	•					•				•	•			
Memorial Health Care System	Chattanooga, TN	4	•		•					•	•					
Dixie Regional Medical Center	St. George, UT	4										•		•	•	•
CJW Medical Center	Richmond, VA	4	•				•	•	•							
East Alabama Medical Center	Opelika, AL	3	•	•	•											
Banner Heart Hospital	Mesa, AZ	3									•	•	•			
University Medical Center	Tucson, AZ	3		•							•	•				
French Hospital Medical Center	San Luis Obispo, CA	3											•	•		•
Scripps Green Hospital	La Jolla, CA	3	•				•		•							
Bridgeport Hospital	Bridgeport, CT	3									•	•	•			
Saint Francis Hospital and Medical Center	Hartford, CT	3	•				•		•							
Delray Medical Center	Delray Beach, FL	3										•	•		•	
Halifax Health Medical Center	Daytona Beach, FL	3				•	•		•							
Holmes Regional Medical Center	Melbourne, FL	3	•	•						•						
Lakeland Regional Medical Center	Lakeland, FL	3	•				•	•								
Orlando Regional Medical Center	Orlando, FL	3	•				•	•								
Memorial Health University Medical Center	Savannah, GA	3					•		•	•						
Decatur Memorial Hospital	Decatur, IL	3										•	•			•
Edward Hospital	Naperville, IL	3									•		•		•	
Provena Covenant Medical Center	Urbana, IL	3									•	•				•
St. Luke's Hospital	Cedar Rapids, IA	3								•		•	•			
Jewish Hospital	Louisville, KY	3	•	•					•							
King's Daughters Medical Center	Ashland, KY	3									•	•	•			
Saint Joseph-London	London, KY	3											•	•	•	
Lafayette General Medical Center	Lafayette, LA	3		•	•			•								
Brigham and Women's Hospital	Boston, MA	3					•	•	•							
UMass Memorial Medical Center	Worcester, MA	3						•					•	•		
Henry Ford Macomb Hospitals	Clinton Township, MI	3										•	•	•		
Mayo Clinic - Saint Marys Hospital	Rochester, MN	3	•			•										•
North Memorial Health Care	Robbinsdale, MN	3					•	•		•						
St. Joseph's Hospital	St. Paul, MN	3								•	•		•			
United Hospital	St. Paul, MN	3								•	•	•				
Morristown Memorial Hospital	Morristown, NJ	3		•	•								•			

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Albany Medical Center	Albany, NY	3	•										•	•	
St. Alexius Medical Center	Bismarck, ND	3			•						•	•			
Akron General Medical Center	Akron, OH	3	•					•			•				
Aultman Hospital	Canton, OH	3	•											•	•
EMH Regional Medical Center	Elyria, OH	3	•		•								•		
Good Samaritan Hospital	Cincinnati, OH	3	•										•	•	
Kettering Medical Center	Kettering, OH	3											•	•	•
St. Elizabeth Health Center	Youngstown, OH	3	•									•	•		
Summa Health System	Akron, OH	3		•							•	•			
The Toledo Hospital	Toledo, OH	3	•	•								•			
St. John Medical Center	Tulsa, OK	3	•	•					•						
Legacy Good Samaritan Hospital and Medical Center	Portland, OR	3		•			•				•				
Providence St. Vincent Medical Center	Portland, OR	3	•	•										•	
Allegheny General Hospital	Pittsburgh, PA	3	•										•		•
Lehigh Valley Hospital	Allentown, PA	3	•				•			•					
PinnacleHealth	Harrisburg, PA	3	•										•	•	
UPMC Presbyterian Shadyside	Pittsburgh, PA	3	•	•			•								
Rhode Island Hospital	Providence, RI	3									•	•	•		
Centennial Medical Center	Nashville, TN	3	•	•				•							
Wellmont Holston Valley Medical Center	Kingsport, TN	3									•		•		•
Memorial Hermann-Texas Medical Center	Houston, TX	3									•	•	•		
Providence Health Center	Waco, TX	3						•	•	•					
Inova Fairfax Hospital	Falls Church, VA	3	•		•	•									
Riverside Regional Medical Center	Newport News, VA	3		•							•		•		
St. Mary's Hospital	Richmond, VA	3											•	•	•
Overlake Hospital Medical Center	Bellevue, WA	3		•				•			•				
Providence St. Peter Hospital	Olympia, WA	3	•				•	•							
Sacred Heart Medical Center	Spokane, WA	3	•								•	•			
DCH Regional Medical Center	Tuscaloosa, AL	2							•	•					
UAB Hospital	Birmingham, AL	2	•	•											
Tucson Heart Hospital	Tucson, AZ	2									•		•		
Tucson Medical Center	Tucson, AZ	2									•			•	
Bakersfield Memorial Hospital	Bakersfield, CA	2	•		•										
El Camino Hospital	Mountain View, CA	2	•								•				
Glendale Memorial Hospital & Health Center	Glendale, CA	2		•			•								
Mercy General Hospital	Sacramento, CA	2	•								•				
Saint Agnes Medical Center	Fresno, CA	2	•		•										
Torrance Memorial Medical Center	Torrance, CA	2	•				•								

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HOSPITAL*	LOCATION	TOTAL YEAR(S) WON	STUDY EDITIONS													
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Penrose-St. Francis Health Services	Colorado Springs, CO	2							•	•						
Hartford Hospital	Hartford, CT	2	•						•							
St. Vincent's Medical Center	Bridgeport, CT	2	•		•											
Washington Hospital Center	Washington, DC	2	•						•							
Florida Hospital Ormond Memorial	Ormond Beach, FL	2	•	•												
Gulf Coast Medical Center	Fort Myers, FL	2	•	•												
Martin Memorial Medical Center	Stuart, FL	2													•	•
Mount Sinai Medical Center & Miami Heart Institute	Miami Beach, FL	2					•	•								
Shands at the University of Florida	Gainesville, FL	2						•	•							
Shands Jacksonville Medical Center	Jacksonville, FL	2					•		•							
St. Joseph's Hospital	Tampa, FL	2					•					•				
St. Vincent's Medical Center	Jacksonville, FL	2	•											•		
Athens Regional Medical Center	Athens, GA	2	•	•												
Medical Center of Central Georgia	Macon, GA	2	•		•											
Advocate Christ Medical Center	Oak Lawn, IL	2	•												•	
Advocate Good Samaritan Hospital	Downers Grove, IL	2										•				•
Carle Foundation Hospital	Urbana, IL	2						•				•				
Memorial Hospital of Carbondale	Carbondale, IL	2											•	•		
Methodist Medical Center of Illinois	Peoria, IL	2	•												•	
NorthShore University HealthSystem	Evanston, IL	2		•	•											
Rush University Medical Center	Chicago, IL	2										•	•			
St. James Hospital and Health Centers	Olympia Fields, IL	2							•	•						
Memorial Hospital & Health System	South Bend, IN	2		•	•											
Allen Hospital	Waterloo, IA	2		•						•						
Iowa Methodist Medical Center	Des Moines, IA	2	•							•						
Trinity Regional Medical Center	Fort Dodge, IA	2											•	•		
The University of Kansas Hospital	Kansas City, KS	2													•	•
Wesley Medical Center	Wichita, KS	2		•	•											
Baptist Hospital East	Louisville, KY	2												•	•	
Central Baptist Hospital	Lexington, KY	2					•	•								
St. Elizabeth Healthcare	Edgewood, KY	2		•	•											
CHRISTUS St Patrick Hospital	Lake Charles, LA	2	•	•												
East Jefferson General Hospital	Metairie, LA	2		•	•											
Heart Hospital of Lafayette	Lafayette, LA	2												•		•
Ochsner Medical Center	New Orleans, LA	2												•		•
Our Lady of Lourdes Regional Medical Center	Lafayette, LA	2	•				•									
Our Lady of the Lake Regional Medical Center	Baton Rouge, LA	2			•			•								
Willis-Knighton Medical Center	Shreveport, LA	2												•	•	

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th		
Sinai Hospital of Baltimore	Baltimore, MD	2	•			•											
University of Maryland Medical Center	Baltimore, MD	2										•	•				
Steward St. Elizabeth's Medical Center	Boston, MA	2			•											•	
Beaumont Hospital, Troy	Troy, MI	2										•				•	
Covenant Medical Center Harrison	Saginaw, MI	2	•		•												
Mercy Health Partners	Muskegon, MI	2										•			•		
Mount Clemens Regional Medical Center	Mount Clemens, MI	2						•			•						
Sparrow Health System	Lansing, MI	2		•	•												
St. John Macomb-Oakland Hospital	Warren, MI	2														•	•
University of Michigan Hospitals & Health Centers	Ann Arbor, MI	2										•	•				
Regions Hospital	St. Paul, MN	2											•	•			
Boone Hospital Center	Columbia, MO	2			•	•											
Heartland Regional Medical Center	Saint Joseph, MO	2		•						•							
St. John's Mercy Medical Center	St. Louis, MO	2			•	•											
St. John's Regional Medical Center	Joplin, MO	2	•									•					
St. Luke's Hospital of Kansas City	Kansas City, MO	2								•	•						
Catholic Medical Center	Manchester, NH	2	•	•													
Robert Wood Johnson University Hospital	New Brunswick, NJ	2			•				•								
Ellis Hospital	Schenectady, NY	2			•												•
Lenox Hill Hospital	New York, NY	2	•				•										
St. Francis Hospital	Roslyn, NY	2	•		•												
United Health Services Hospitals	Binghamton, NY	2										•	•				
Vassar Brothers Medical Center	Poughkeepsie, NY	2										•	•				
FirstHealth Moore Regional Hospital	Pinehurst, NC	2		•	•												
Pitt County Memorial Hospital	Greenville, NC	2					•	•									
Medcenter One	Bismarck, ND	2										•				•	
Fairview Hospital	Cleveland, OH	2	•	•													
Firelands Regional Medical Center	Sandusky, OH	2										•				•	
Grant Medical Center	Columbus, OH	2			•			•									
Lake Hospital System	Painesville, OH	2						•				•					
Mercy Hospital Fairfield	Fairfield, OH	2												•			•
St. John Medical Center	Westlake, OH	2														•	•
The Ohio State University Medical Center	Columbus, OH	2						•								•	
Sacred Heart Medical Center	Eugene, OR	2	•				•										
Butler Memorial Hospital	Butler, PA	2										•	•				
Penn State Milton S. Hershey Medical Center	Hershey, PA	2					•					•					
Medical University of South Carolina	Charleston, SC	2					•	•									
Sanford USD Medical Center	Sioux Falls, SD	2		•	•												

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th		
Jackson-Madison County General Hospital	Jackson, TN	2									•		•				
Vanderbilt University Medical Center	Nashville, TN	2												•		•	
Corpus Christi Medical Center	Corpus Christi, TX	2												•			•
Harlingen Medical Center	Harlingen, TX	2												•		•	
Plaza Medical Center of Fort Worth	Fort Worth, TX	2	•	•													
St. David's South Austin Hospital	Austin, TX	2							•	•							
Memorial Regional Medical Center	Mechanicsville, VA	2														•	•
Winchester Medical Center	Winchester, VA	2	•							•							
St. Mary's Medical Center	Huntington, WV	2		•	•												
Aurora BayCare Medical Center	Green Bay, WI	2													•	•	
Meriter Hospital	Madison, WI	2											•				•
Baptist Medical Center South	Montgomery, AL	1				•											
Mobile Infirmary Medical Center	Mobile, AL	1	•														
Physicians Medical Center Carraway	Birmingham, AL	1	•														
Southeast Alabama Medical Center	Dothan, AL	1										•					
St. Vincent's Hospital	Birmingham, AL	1		•													
Trinity Medical Center	Birmingham, AL	1		•													
Arrowhead Hospital	Glendale, AZ	1														•	
Banner Good Samaritan Medical Center	Phoenix, AZ	1															•
Northwest Medical Center	Tucson, AZ	1															•
Phoenix Memorial Hospital	Phoenix, AZ	1					•										
Phoenix Regional Medical Center	Phoenix, AZ	1	•														
St. Edward Mercy Medical Center	Fort Smith, AR	1	•														
California Pacific Medical Center	San Francisco, CA	1		•													
Eisenhower Medical Center	Rancho Mirage, CA	1	•														
Hoag Memorial Hospital Presbyterian	Newport Beach, CA	1															•
John Muir Medical Center, Concord	Concord, CA	1	•														
Kaiser Permanente Los Angeles Medical Center	Los Angeles, CA	1				•											
Kaiser Permanente San Francisco Medical Center	San Francisco, CA	1	•														
Kaweah Delta Hospital	Visalia, CA	1		•													
Long Beach Memorial Medical Center	Long Beach, CA	1		•													
Mercy Medical Center Redding	Redding, CA	1															•
Methodist Hospital	Arcadia, CA	1					•										
Mills-Peninsula Health Services	Burlingame, CA	1		•													
Pomona Valley Hospital Medical Center	Pomona, CA	1															•
Providence Little Company of Mary Medical Center	Torrance, CA	1															•

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Providence Saint Joseph Medical Center	Burbank, CA	1	•													
Salinas Valley Memorial Healthcare System	Salinas, CA	1	•													
San Joaquin Community Hospital	Bakersfield, CA	1	•													
Scripps Mercy Hospital	San Diego, CA	1							•							
Sequoia Hospital	Redwood City, CA	1	•													
Seton Medical Center	Daly City, CA	1		•												
Shasta Regional Medical Center	Redding, CA	1	•													
St. Francis Medical Center	Lynwood, CA	1														•
St. Helena Hospital	St. Helena, CA	1					•									
St. Joseph's Medical Center	Stockton, CA	1	•													
St. Mary's Medical Center	San Francisco, CA	1		•												
Stanford Hospital & Clinics	Stanford, CA	1	•													
Washington Hospital Healthcare System	Fremont, CA	1	•													
Exempla Saint Joseph Hospital	Denver, CO	1					•									
North Colorado Medical Center	Greeley, CO	1									•					
Presbyterian/St. Luke's Medical Center	Denver, CO	1													•	
St. Anthony Central Hospital	Denver, CO	1									•					
St. Mary's Hospital and Regional Medical Center	Grand Junction, CO	1												•		
Baptist Hospital	Pensacola, FL	1									•					
Blake Medical Center	Bradenton, FL	1										•				
Broward General Medical Center	Fort Lauderdale, FL	1		•												
Central Florida Regional Hospital	Sanford, FL	1						•								
Florida Hospital	Orlando, FL	1					•									
Florida Hospital-Ormond Memorial	Ormond Beach, FL	1							•							
Florida Medical Center	Fort Lauderdale, FL	1			•											
Largo Medical Center	Largo, FL	1					•									
Leesburg Regional Medical Center	Leesburg, FL	1							•							
Memorial Regional Hospital	Hollywood, FL	1											•			
Miami Heart Institute South	Miami Beach, FL	1			•											
NCH Downtown Naples Hospital	Naples, FL	1									•					
North Ridge Medical Center	Fort Lauderdale, FL	1	•													
Palm Beach Gardens Medical Center	Palm Beach Gardens, FL	1	•													
Tallahassee Memorial HealthCare	Tallahassee, FL	1	•													
Emory Crawford Long Hospital	Atlanta, GA	1	•													
Emory University Hospital	Atlanta, GA	1	•													

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Piedmont Hospital	Atlanta, GA	1		•												
Redmond Regional Medical Center	Rome, GA	1	•													
Straub Clinic & Hospital	Honolulu, HI	1		•												
Central DuPage Hospital	Winfield, IL	1									•					
Ingalls Memorial Hospital	Harvey, IL	1		•												
Mercy Hospital & Medical Center	Chicago, IL	1											•			
Northwestern Memorial Hospital	Chicago, IL	1								•						
OSF Saint Francis Medical Center	Peoria, IL	1											•			
OSF St. Joseph Medical Center	Bloomington, IL	1	•													
Riverside Medical Center	Kankakee, IL	1											•			
Rush North Shore Medical Center	Skokie, IL	1											•			
Saint Francis Hospital	Evanston, IL	1				•										
Sherman Hospital	Elgin, IL	1											•			
Ball Memorial Hospital	Muncie, IN	1														•
Bloomington Hospital	Bloomington, IN	1		•												
Community Hospital	Munster, IN	1	•													
Community Hospital East/North	Indianapolis, IN	1							•							
Deaconess Hospital & Health System	Evansville, IN	1		•												
Saint Margaret Mercy Healthcare Centers	Hammond, IN	1				•										
St. Elizabeth Medical Center	Lafayette, IN	1								•						
Union Hospital	Terre Haute, IN	1	•													
Genesis Medical Center East	Davenport, IA	1														•
Mercy Medical Center - Sioux City	Sioux City, IA	1				•										
Stormont-Vail HealthCare	Topeka, KS	1							•							
St. Joseph Hospital	Lexington, KY	1				•										
Trover Health System	Madisonville, KY	1											•			
Western Baptist Hospital	Paducah, KY	1														•
Louisiana Medical Center & Heart Hospital	Lacombe, LA	1											•			
Rapides Regional Medical Center	Alexandria, LA	1														•
St. Francis Medical Center	Monroe, LA	1				•										
Peninsula Regional Medical Center	Salisbury, MD	1	•													
Washington Adventist Hospital	Takoma Park, MD	1	•													
Boston Medical Center	Boston, MA	1						•								
Mount Auburn Hospital	Cambridge, MA	1		•												
North Shore Medical Center	Salem, MA	1														•
Saint Vincent Hospital	Worcester, MA	1														•
Tufts-New England Medical Center	Boston, MA	1						•								
Bronson Methodist Hospital	Kalamazoo, MI	1											•			

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
Northern Michigan Regional Hospital	Petoskey, MI	1				•										
St. Mary's of Michigan	Saginaw, MI	1	•													
Memorial Hospital	Gulfport, MS	1			•											
North Mississippi Medical Center	Tupelo, MS	1			•											
Barnes-Jewish Hospital	Saint Louis, MO	1								•						
Freeman Health System	Joplin, MO	1						•								
SSM St. Mary's Health Center	St. Louis, MO	1							•							
Desert Springs Hospital	Las Vegas, NV	1	•													
Sunrise Hospital & Medical Center	Las Vegas, NV	1	•													
Deborah Heart and Lung Center	Browns Mills, NJ	1														•
Newark Beth Israel Medical Center	Newark, NJ	1								•						
Passaic Beth Israel Regional Medical Center	Passaic, NJ	1				•										
Lovelace Medical Center	Albuquerque, NM	1		•												
Presbyterian Hospital	Albuquerque, NM	1	•													
Erie County Medical Center	Buffalo, NY	1		•												
Kaleida Health	Buffalo, NY	1		•												
Long Island Jewish Medical Center	New Hyde Park, NY	1		•												
Maimonides Medical Center	Brooklyn, NY	1					•									
Millard Fillmore Gates Circle Hospital	Buffalo, NY	1	•													
NYU Langone Medical Center	New York, NY	1														•
St. Joseph's Hospital Health Center	Syracuse, NY	1	•													
St. Luke's-Roosevelt Hospital Center	New York, NY	1		•												
St. Vincent's Manhattan	New York, NY	1		•												
Staten Island University Hospital	Staten Island, NY	1												•		
The Mount Sinai Medical Center	New York, NY	1	•													
Carolinas Medical Center-NorthEast	Concord, NC	1												•		
Duke University Hospital	Durham, NC	1				•										
Gaston Memorial Hospital	Gastonia, NC	1														•
High Point Regional Health System	High Point, NC	1													•	
Presbyterian Hospital	Charlotte, NC	1	•													
Rex Healthcare	Raleigh, NC	1		•												
WakeMed Releigh Campus	Raleigh, NC	1		•												
Deaconess Hospital	Cincinnati, OH	1					•									
Doctors Hospital	Columbus, OH	1														•
Forum Health Northside Medical Center	Youngstown, OH	1										•				
Grandview Medical Center	Dayton, OH	1											•			
Hillcrest Hospital	Mayfield Heights, OH	1								•						

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th		
Jewish Hospital	Cincinnati, OH	1	•														
Miami Valley Hospital	Dayton, OH	1										•					
INTEGRIS Baptist Medical Center	Oklahoma City, OK	1	•														
Mercy Health Center	Oklahoma City, OK	1	•														
Oklahoma Heart Hospital	Oklahoma City, OK	1													•		
OU Medical Center	Oklahoma City, OK	1	•														
Saint Francis Hospital	Tulsa, OK	1															•
Good Samaritan Regional Medical Center	Corvallis, OR	1					•										
Providence Portland Medical Center	Portland, OR	1					•										
Bryn Mawr Hospital	Bryn Mawr, PA	1															•
Doylestown Hospital	Doylestown, PA	1															•
DuBois Regional Medical Center	DuBois, PA	1													•		
Excela Health Westmoreland	Greensburg, PA	1															•
Lancaster General Hospital	Lancaster, PA	1					•										
Saint Vincent Health Center	Erie, PA	1													•		
St. Francis Medical Center	Pittsburgh, PA	1	•														
St. Joseph Medical Center	Reading, PA	1															•
The Chester County Hospital and Health System	West Chester, PA	1															•
The Washington Hospital	Washington, PA	1															•
Thomas Jefferson University Hospital	Philadelphia, PA	1					•										
UPMC Mercy	Pittsburgh, PA	1	•														
UPMC Passavant	Pittsburgh, PA	1															•
Williamsport Regional Medical Center	Williamsport, PA	1															•
Grand Strand Regional Medical Center	Myrtle Beach, SC	1					•										
Spartanburg Regional Healthcare System	Spartanburg, SC	1					•										
Avera McKennan Hospital & University Health Center	Sioux Falls, SD	1					•										
Rapid City Regional Hospital	Rapid City, SD	1	•														
Erlanger Health System	Chattanooga, TN	1															•
Fort Sanders Regional Medical Center	Knoxville, TN	1					•										
Johnson City Medical Center	Johnson City, TN	1															•
Maury Regional Medical Center	Columbia, TN	1															•
St. Mary's Medical Center	Knoxville, TN	1					•										
The University of Tennessee Medical Center	Knoxville, TN	1															•
Baptist St. Anthony's Health System	Amarillo, TX	1															•
CHRISTUS Santa Rosa Health System	San Antonio, TX	1					•										
Christus Spohn Hospital Corpus Christi-Shoreline	Corpus Christi, TX	1	•														

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			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th		
Covenant Health System	Lubbock, TX	1	•														
Denton Regional Medical Center	Denton, TX	1	•														
Doctors Hospital at Renaissance	Edinburg, TX	1															•
Good Shepherd Medical Center	Longview, TX	1						•									
Medical Center Hospital	Odessa, TX	1			•												
Memorial Hermann Memorial City Medical Center	Houston, TX	1															•
Seton Medical Center Austin	Austin, TX	1									•						
The Medical Center of Southeast Texas	Port Arthur, TX	1									•						
The Methodist Hospital	Houston, TX	1	•														
Trinity Mother Frances Hospital	Tyler, TX	1	•														
Valley Baptist Medical Center	Hartlingen, TX	1															•
Woodland Heights Medical Center	Lufkin, TX	1		•													
McKay-Dee Hospital Center	Ogden, UT	1															•
Utah Valley Regional Medical Center	Provo, UT	1	•														
Fletcher Allen Health Care	Burlington, VT	1															•
Carilion Clinic	Roanoke, VA	1	•														
Henrico Doctors' Hospital	Richmond, VA	1			•												
VCU Medical Center	Richmond, VA	1															•
Central Washington Hospital	Wenatchee, WA	1															•
PeaceHealth Southwest Washington Medical Center	Vancouver, WA	1		•													
St. Joseph Hospital	Bellingham, WA	1		•													
Virginia Mason Medical Center	Seattle, WA	1		•													
Yakima Regional Medical and Cardiac Center	Yakima, WA	1															•
Appleton Medical Center	Appleton, WI	1							•								
Froedtert & the Medical College of Wisconsin	Milwaukee, WI	1															•
St. Elizabeth Hospital	Appleton, WI	1							•								
Waukesha Memorial Hospital	Waukesha, WI	1															•

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# APPENDIX: METHODOLOGY DETAILS

## METHODS FOR IDENTIFYING COMPLICATIONS OF CARE

### Risk-Adjusted Mortality Index Models

Without adjusting for differences, comparing outcomes among hospitals is like comparing the proverbial apples to oranges: hard, if not impossible, to do. To make valid normative comparisons of hospital outcomes, we must adjust raw data to accommodate for differences that result from the variety and severity of admitted cases. We must also account for individual facility characteristics that affect quality of care measures, such as the hospital's geographic location, size, teaching status, and community setting (urban versus rural).

Thomson Reuters is able to make valid normative comparisons of mortality and complications rates by using patient-level data to control effectively for case mix and severity differences. We do this by evaluating ICD-9-CM diagnosis and procedure codes to adjust for severity within clinical case mix groupings. Conceptually, we group patients with similar characteristics (i.e., age, sex, principal diagnosis, procedures performed, admission type, and comorbid conditions) to produce expected, or normative, comparisons. In the same way, we group facilities with similar characteristics. Through extensive testing, we have found that this methodology produces valid normative comparisons using readily available administrative data, eliminating the need for additional data collection.

Thomson Reuters constructs a normative database of case-level data from its Projected Inpatient Data Base (PIDB), a national all-payer database containing more than 21 million all-payer discharges annually. These data are obtained from approximately 2,600 hospitals, representing 50 percent of all discharges from short-term, general, nonfederal hospitals in the United States. The

data include age, sex, and length of stay; clinical groupings: MS-DRGs, ICD-9-CM principal and secondary diagnoses, and ICD-9-CM principal and secondary procedures; hospital identification; admission source and type; and discharge status. Hospital characteristics are obtained by linking each hospital's identification number with American Hospital Association and Medicare Cost Report data.

From the model, we exclude long-term care facilities; psychiatric, rehabilitation, or other specialty facilities; and federally owned or controlled facilities. Excluded patient groups are newborns, cases transferred to other short-term hospitals, and cases with stays shorter than one day. A standard logistic regression model is used to estimate the risk of mortality or complications for each patient. This is done by weighting the patient records of the client hospital by the logistic regression coefficients associated with the corresponding terms in the model and the intercept term. This produces the expected probability of an outcome for each eligible patient (numerator) based on the experience of the norm for patients with similar characteristics (age, clinical grouping, severity of illness, and so forth) at similar institutions (hospital bed size, census division, teaching status, urban or rural community setting).<sup>17-21</sup> This methodology also ensures that facilities are compared to other facilities with similar characteristics.

Staff physicians at Thomson Reuters have suggested important clinical patient characteristics that were also incorporated into the proprietary models. After assigning the predicted probability of the outcome for each patient, the patient-level data can then be aggregated across a variety of groupings, including hospital, service, or the MS-DRG classification systems, which were originally developed at Yale University in the 1980s.

### Expected Complications Rate Index Models

Risk-adjusted complications refer to outcomes that may be of concern when they occur at a greater than expected rate among groups of patients, possibly reflecting systemic quality of care issues.

The Thomson Reuters complications model uses clinical qualifiers to identify complications that have probably occurred in the inpatient setting. The complications used in the model are:

COMPLICATION	PATIENT GROUP
Post-operative complications relating to urinary tract	Surgical only
Post-operative complications relating to respiratory system except pneumonia	Surgical only
GI complications following procedure	Surgical only
Infection following injection/infusion	All patients
Decubitus ulcer	All patients
Post-operative septicemia, abscess, and wound infection	Surgical, including cardiac
Aspiration pneumonia	Surgical only
Tracheostomy complications	All patients
Complications of cardiac devices	Surgical, including cardiac
Complications of vascular and hemodialysis devices	Surgical only
Nervous system complications from devices/complications of nervous system devices	Surgical only
Complications of genitourinary devices	Surgical only
Complications of orthopedic devices	Surgical only
Complications of other and unspecified devices, implants, and grafts	Surgical only
Other surgical complications	Surgical only
Miscellaneous complications	All patients
Cardio-respiratory arrest, shock, or failure	Surgical only
Post-operative complications relating to nervous system	Surgical only
Post-operative AMI	Surgical only
Post-operative cardiac abnormalities except AMI	Surgical only
Procedure-related perforation or laceration	All patients
Post-operative physiologic and metabolic derangements	Surgical, including cardiac
Post-operative coma or stupor	Surgical, including cardiac
Post-operative pneumonia	Surgical, including cardiac
Pulmonary embolism	All patients
Venous thrombosis	All patients
Hemorrhage, hematoma, or seroma complicating a procedure	All patients
Post-procedure complications of other body systems	All patients
Complications of transplanted organ (excludes skin and cornea)	Surgical only
Disruption of operative wound	Surgical only

A normative database of case-level data including age, sex, length of stay, clinical grouping (MS-DRGs), comorbid conditions, and hospital identification is constructed using our national all-payer database. Hospital characteristics are obtained by linking each hospital's identification number with American Hospital Association and Medicare Cost Report data. The method includes patients from approximately 2,600 short-term, general, nonfederal hospitals that are generally representative of short-term, general, nonfederal hospitals in the United States. Excluded groups are neonates, cases transferred to other short-term hospitals, and cases with stays shorter than one day. Also, clinical groupings that require special consideration with regard to complications outcomes — such as psychiatry/mental illness, substance abuse, rehabilitation, obstetrics, and pediatrics (less than 17 years of age) — are excluded from the general risk-adjusted complications measure.

Complication rates are calculated from normative data for two patient risk groups: medical and surgical. A standard regression model is used to estimate the risk of experiencing a complication for each patient. This is done by weighting the patient records of the client hospital by the regression coefficients associated with the corresponding terms in the prediction models and intercept term. This method produces the expected probability of a complication for each patient based on the experience of the norm for patients with similar characteristics at similar institutions. After assigning the predicted probability of a complication for each patient in each risk group, it is then possible to aggregate the patient-level data across a variety of groupings.<sup>22-25</sup>

### Index Interpretation

An outcome index is a ratio of an observed number of outcomes to an expected number of outcomes in a particular population. This index is used to make normative comparisons and is standardized in that the expected number of events is based on the occurrence of the event in a normative population. The normative population used to calculate expected numbers of events is selected to be similar to the comparison population with respect to relevant characteristics including age, sex, region, and case mix.

The index is simply the number of observed events divided by the number of expected events and can be calculated for outcomes that involve counts of occurrences (e.g., deaths or complications). Interpretation of the index relates the experience of the comparison population relative to a specified event to the expected experience based on the normative population.

Examples:

10 events observed ÷ 10 events expected = 1.0:  
The observed number of events is equal to the expected number of events based on the normative experience.

10 events observed ÷ 5 events expected = 2.0:  
The observed number of events is twice the expected number of events based on the normative experience.

10 events observed ÷ 25 events expected = 0.4:  
The observed number of events is 60 percent lower than the expected number of events based on the normative experience.

Therefore, an index value of 1.0 indicates no difference between observed and expected outcome occurrence. An index value greater than 1.0 indicates an excess in the observed number of events relative to the expected based on the normative experience. An index value less than 1.0 indicates fewer events observed than would be expected based on the normative experience. An additional interpretation is that the difference between 1.0 and the index is the percentage difference in the number of events relative to the norm. In other words, an index of 1.05 indicates 5 percent more outcomes, and an index of 0.90 indicates 10 percent fewer outcomes than expected based on the experience of the norm. The index can be calculated across a variety of groupings (e.g., hospital, service, and DRG).

### CORE MEASURES

Core measures were developed by The Joint Commission and CMS, and endorsed by the National Quality Forum, as minimum basic care standards. They are a widely accepted method for measuring patient care quality that includes specific guidelines for heart attack, heart failure, pneumonia, pregnancy and related conditions, and

surgical infection prevention. Our core measures metric for this study is based on the heart attack and heart failure areas of this program, using Hospital Compare data reported by CMS. We included six of the seven reported heart attack measures and all of the reported heart failure measures. We excluded the AMI core measure “Heart Attack Patients Given Fibrinolytic Medication Within 30 Minutes of Arrival” because it was not reported by most in-study hospitals.

For each hospital and for each patient group we calculate the mean of the reported core measures percent values for all available core measures. We consider reported core measures percents with patient counts that are less than or equal to 25, or that have relative standard error values greater than or equal to 0.30 to be statistically unreliable. In these cases, we substitute the class median percent value for the affected core measure.

The included core measures are (with the CMS number for each in parentheses):

#### Heart Attack Core Measures

1. Patients given aspirin at arrival (AMI\_1)
2. Patients given aspirin at discharge (AMI\_2)
3. Patients given angiotensin-converting enzyme (ACE) inhibitor or angiotensin II receptor blocker (ARB) for left ventricular systolic (LVS) dysfunction (AMI\_3)
4. Patients given smoking cessation advice/counseling (AMI\_4)
5. Patients given beta blocker at discharge (AMI\_5)
6. Patients given fibrinolytic medication within 30 minutes of arrival (AMI\_7a)

#### Heart Failure Core Measures

1. Patients given discharge instructions (HF\_1)
2. Patients given an evaluation of LVS function (HF\_2)
3. Patients given ACE inhibitor or ARB for LVSD (HF\_3)
4. Patients given smoking cessation advice/counseling (HF\_4)

#### LENGTH OF STAY AND COST PER CASE METHODOLOGIES

The study’s length of stay (LOS) and cost per case performance measures use Thomson Reuters proprietary severity-adjusted resource demand methodologies. This model includes POA data

reported in the 2010 MedPAR data set. Under the Deficit Reduction Act of 2005, as of federal fiscal year 2008, hospitals do not receive payment for cases with certain conditions, like falls, surgical site infections, and pressure ulcers, that were not present on the patient’s admission but occur during their hospitalization. As a result, CMS now requires all inpatient prospective payment system hospitals to document whether a patient has these conditions when admitted.<sup>8</sup>

Our severity-adjusted resource demand model allows us to produce risk-adjusted performance comparisons on LOS and hospital charges between or across virtually any subgroup of inpatients. These patient groupings can be based on MS-DRGs, hospitals, product lines, geographic regions, physicians, etc. The methodology adjusts for differences in diagnosis type and illness severity, based on ICD-9-CM coding. It also adjusts for patient age, gender, and admission status, in addition to selected hospital characteristics such as bed size, census division, teaching status, and urban or rural community setting. Its associated LOS and charge weights allow group comparisons on a national level and in a specific market area. These weights are calculated separately for LOS and charges from the PIDB. PIDB discharges are statistically weighted to represent the universe of all short-term, general, nonfederal hospitals in the United States.

This regression-based model incorporates hospital characteristics and provides accuracy in predicting results. The POA component allows us to determine appropriate adjustments based on previous conditions versus complications. We calculate expected values from model coefficients that are normalized to the clinical group and transformed from log scale. The model further adjusts for hospital factors to ensure accurate comparisons.

We estimate costs using the total cost-to-charge ratio (2010 hospital cost report or 2009, if 2010 is not available), applied to the specific charges reported for the study’s cardiovascular patients (AMI, HF, CABG, and PCI) in the MedPAR file. To account for geographic cost of living differences, expected values are adjusted for each hospital using the CMS wage index for the federal fiscal year that matches the MedPAR file year.

## PERFORMANCE MEASURE NORMALIZATION

The mortality, complications, length of stay, and cost measures are normalized, based on the in-study population, by comparison group, to provide a more easily interpreted comparison among hospitals. To address the impact of bed size, teaching status, and residency program involvement and compare hospitals to other like hospitals, we assign each hospital in the study to one of three comparison groups (Teaching Hospitals With Cardiovascular Residency Programs, Teaching Hospitals Without Cardiovascular Residency Programs, and Community Hospitals). Detailed descriptions of the patient and hospital comparison groups can be found in the Methodology section of this document.

For the mortality and complications measures, we base our scoring on the difference between observed and expected events, expressed in standard deviation units (z-scores) that have been normalized. We normalize the individual hospital z-scores by finding the difference between the hospital z-score and the mean z-score for their comparison group. The difference is then divided by the standard deviation of the comparison group's z-scores to produce the normalized z-score for the hospital.

For LOS and cost measures, we base our scoring on the severity-adjusted LOS index and the wage- and severity-adjusted cost per case index. These indices are the ratio of the observed and the normalized expected values for each hospital, where the expected values are the sum of the weights for the hospital cases included in the measure. We normalize the individual hospital expected values by multiplying them by the ratio of the observed to expected values for the comparison group. The hospital's normalized index is then calculated by dividing the hospital's observed value by its normalized expected value to produce the normalized index for the hospital.

## WHY WE HAVE NOT CALCULATED PERCENT CHANGE IN SPECIFIC INSTANCES

We do not calculate winner (benchmark) versus peer percent differences when the performance measure value is already in units of percent. In this case, we report linear difference only. Percent change is a meaningless statistic when the underlying quantity can be positive, negative, or zero. The actual change may mean something, but dividing it by a number that may be zero or of the opposite sign does not convey any meaningful information because the amount of change is not proportional to its previous value.<sup>26</sup>



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