



100 TOP HOSPITALS

50 Top Cardiovascular Hospitals: Study Overview

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TRUVEN HEALTH ANALYTICS 

**100 TOP
HOSPITALS**

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HEALTH ANALYTICS™

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Truven Health 50 Top Cardiovascular Hospitals: 2013 Study Overview
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Introduction

Cardiovascular diseases account for more than one-third of all deaths in the U.S., and the costs to treat it are staggering: \$1 of every \$6 spent on healthcare in the U.S. is attributed to heart disease.¹ It's no wonder, then, that cardiovascular services are among the highest profile of all hospital service lines; in fact, more than 1,000 hospitals perform open-heart surgery and thousands more offer medical cardiovascular programs. With the stakes so high, it's vital that hospitals provide the highest quality, most efficient heart care possible, and that they look closely for ways to improve.

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 Truven Health 50 Top Cardiovascular Hospitals in the nation, the Truven Health 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 14th 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 8,600 additional lives could be saved
- 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 \$3,500 less per bypass surgery patient and nearly \$1,000 less per heart attack patient admitted
- Had significantly better 30-day survival
- Maintained lower 30-day readmission rates for heart attack and heart failure patients
- Released bypass patients a full day sooner, and their heart attack and heart failure patients about three-quarters of a day sooner than their peers
- Were more likely to follow recommended care protocol

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

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

About Truven Health Analytics

Truven Health AnalyticsSM delivers unbiased information, analytic tools, benchmarks, and services to the healthcare industry. Hospitals, government agencies, employers, health plans, clinicians, pharmaceutical, and medical device companies have relied on us for more than 30 years. We combine our deep clinical, financial, and healthcare management expertise with innovative technology platforms and information assets to make healthcare better by collaborating with our customers to uncover and realize opportunities for improving quality, efficiency, and outcomes. With more than 2,000 employees globally, we have major offices in Ann Arbor, Mich.; Chicago; and Denver. Advantage Suite, Micromedex, ActionOI, MarketScan, and 100 Top Hospitals are registered trademarks or trademarks of Truven Health Analytics.

2013 Award Winners

Truven Health AnalyticsSM is proud to present the Truven Health 50 Top Cardiovascular Hospitals, 2013. 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
050025	UC San Diego Medical Center	San Diego, CA
050424	Scripps Green Hospital	La Jolla, CA
220036	Steward St. Elizabeth's Medical Center	Boston, MA
220077	Baystate Medical Center	Springfield, MA
220176	Saint Vincent Hospital	Worcester, MA
230019	Providence Hospital and Medical Center	Southfield, MI
230029	St. Joseph Mercy Oakland	Pontiac, MI
240010	Mayo Clinic — Saint Marys Hospital	Rochester, MN
360048	The University of Toledo Medical Center	Toledo, OH
360079	Kettering Medical Center	Kettering, OH
360152	Doctors Hospital	Columbus, OH
360163	The Christ Hospital	Cincinnati, OH
390195	Lankenau Medical Center	Wynnewood, PA
390223	Penn Presbyterian Medical Center	Philadelphia, 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
050108	Sutter General Hospital	Sacramento, CA
130006	St. Luke's Boise Medical Center	Boise, ID
140053	St. John's Hospital	Springfield, IL
140135	Decatur Memorial Hospital	Decatur, IL
140187	St. Elizabeth's Hospital	Belleville, IL
160045	St. Luke's Hospital	Cedar Rapids, IA
160083	Mercy Medical Center-Des Moines	Des Moines, IA
160110	Allen Hospital	Waterloo, IA
230156	St. Joseph Mercy Hospital	Ann Arbor, MI
240001	North Memorial Medical Center	Robbinsdale, MN
240063	St. Joseph's Hospital	St. Paul, MN
280003	Bryan Medical Center	Lincoln, NE
360016	The Jewish Hospital	Cincinnati, OH
360070	Mercy Medical Center	Canton, OH
360123	St. John Medical Center	Westlake, OH
360179	Bethesda North Hospital	Cincinnati, OH
390063	UPMC Hamot	Erie, PA
390096	St. Joseph Medical Center	Reading, PA
490052	Riverside Regional Medical Center	Newport News, VA
490059	Bon Secours St. Mary's Hospital	Richmond, VA

Community Hospitals*

Medicare ID	Hospital	Location
030105	Banner Heart Hospital	Mesa, AZ
050017	Mercy General Hospital	Sacramento, CA
050232	French Hospital Medical Center	San Luis Obispo, CA
050764	Shasta Regional Medical Center	Redding, CA
140291	Advocate Good Shepherd Hospital	Barrington, IL
270014	Providence St. Patrick Hospital	Missoula, MT
280128	Nebraska Heart Institute & Heart Hospital	Lincoln, NE
350006	Trinity Hospital	Minot, ND
360011	Marion General Hospital	Marion, OH
360095	Blanchard Valley Hospital	Findlay, OH
430095	Avera Heart Hospital	Sioux Falls, SD
450431	St. David's Medical Center	Austin, TX
460021	Dixie Regional Medical Center	St. George, UT
520049	Bellin Hospital	Green Bay, WI
520193	Aurora BayCare Medical Center	Green Bay, WI

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

Findings

Why are the 50 Top Cardiovascular Winners the best in the industry? One of the goals of the Truven Health 100 Top Hospitals® program is to highlight what makes the winners so successful and offer benchmarks for other hospitals to emulate.

This year's Truven Health 50 Top Cardiovascular Hospitals 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, more than 8,600 additional lives 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.

Although our research shows that all hospitals have improved cardiovascular patient outcomes in recent years (approximately 96 percent of cardiovascular patients who receive inpatient care are surviving and are complication-free), comparisons between the 50 Top Cardiovascular Hospitals and their peers show that much room for improvement exists (Table 1):

- 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 0.59, meaning they experienced 41 percent fewer deaths than would be expected, given patient severity. Peer (nonwinning) hospitals, on the other hand, had only 9 percent fewer CABG mortalities than expected. Winner versus nonwinner differences were similar for PCI survival rates.
- The cardiovascular study winners had a substantially lower complications index than their peers. Most notable was the heart failure complications index at winning hospitals, which showed 37 percent fewer complications than expected. Peer hospitals, on the other hand, had only 3 percent fewer heart failure patient complications than expected.
- Longer-term outcomes were better at winning hospitals. The winning hospitals' 30-day heart failure and heart attack mortality rates were substantially 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. 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. A median core measures score of 96.6 percent shows that this year's winners are following recommended core measures protocol for nearly all of their heart patients.
- Winning hospitals release patients sooner than their peers. The typical winning hospital released their bypass patients a full day sooner, and their acute myocardial infarction (AMI) and heart failure (HF) patients about three-quarters of 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 \$3,500 less per bypass surgery patient and about \$1,000 less per percutaneous coronary intervention (PCI) patient admitted.

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 ^{1,2}	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.86	0.98	-0.12	-12.2	lower mortality
		HF Mortality	0.80	0.98	-0.18	-18.4	lower mortality
		CABG Mortality	0.59	0.91	-0.32	-35.2	lower mortality
		PCI Mortality	0.72	0.95	-0.23	-24.2	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.76	0.93	-0.17	-18.3	fewer complications
		HF Complications	0.63	0.97	-0.34	-35.1	fewer complications
		CABG Complications	0.98	1.03	-0.05	-4.9	fewer complications
		PCI Complications	0.89	1.00	-0.11	-11.0	fewer complications
Clinical Process Measures	Core Measures Mean Percent ^{3,5}		96.6	95.2	1.4	n/a ⁵	better performance
	CABG Patients With Internal Mammary Artery Use (%) ¹		96.9	93.4	3.5	n/a ⁵	higher IMA use
Extended Outcome Measures ^{4,5}	AMI 30-Day Mortality (%)		14.2	15.1	-0.9	n/a ⁵	lower 30-day mortality
	HF 30-Day Mortality (%)		10.8	11.3	-0.5	n/a ⁵	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		18.7	19.6	-1.0	n/a ⁵	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		23.5	24.5	-1.1	n/a ⁵	lower 30-day readmissions
Efficiency Measures	AMI Severity-Adjusted Average Length of Stay		4.1	4.8	-0.7	-15.3	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.3	5.0	-0.6	-12.5	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.3	9.2	-1.0	-10.7	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		2.7	3.2	-0.4	-13.8	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		9,115	10,090	-975	-9.7	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		7,906	8,354	-448	-5.4	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		33,096	36,629	-3,533	-9.6	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		14,815	15,888	-1,074	-6.8	lower cost per case

Notes:

1. MedPAR 2010 and 2011, combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare October 1, 2010 - September 30, 2011.
4. CMS Hospital Compare July 1, 2008 - June 30, 2011.
5. We do not calculate percentage difference for measures already expressed as a percent.

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 measures. Still, these winners are outperforming their peers by wide margins in a number of measures. One example is in their markedly higher survival rates: the winners' mortality rates were 39 and 32 percent lower than their peers' for CABG (Table 2) 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 2 percent fewer than expected.

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 ^{1,2}	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.93	0.96	-0.03	-3.1	lower mortality
		HF Mortality	0.81	0.98	-0.17	-17.3	lower mortality
		CABG Mortality	0.54	0.88	-0.34	-38.6	lower mortality
		PCI Mortality	0.65	0.96	-0.31	-32.3	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.56	0.98	-0.42	-42.9	fewer complications
		HF Complications	0.64	0.96	-0.32	-33.3	fewer complications
		CABG Complications	1.03	1.01	0.02	2.0	more complications*
		PCI Complications	0.92	1.01	-0.09	-8.9	fewer complications
Clinical Process Measures	Core Measures Mean Percent ^{3,5}		97.4	95.0	2.4	n/a ⁵	better performance
	CABG Patients With Internal Mammary Artery Use (%) ¹		97.3	93.8	3.5	n/a ⁵	higher IMA use
Extended Outcome Measures ^{4,5}	AMI 30-Day Mortality (%)		13.6	14.5	-0.9	n/a ⁵	lower 30-day mortality
	HF 30-Day Mortality (%)		9.9	10.6	-0.7	n/a ⁵	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		18.2	20.3	-2.1	n/a ⁵	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		24.2	25.2	-1.0	n/a ⁵	lower 30-day readmissions
Efficiency Measures	AMI Severity-Adjusted Average Length of Stay		4.0	4.7	-0.6	-13.7	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.3	4.9	-0.7	-13.4	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.4	9.2	-0.8	-8.5	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		2.7	3.2	-0.5	-16.3	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		9,659	9,950	-291	-2.9	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		7,940	8,295	-355	-4.3	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		36,759	37,088	-329	-0.9	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		16,392	15,984	408	2.6	higher cost per case*

Notes:

1. MedPAR 2010 and 2011, combined.
 2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
 3. CMS Hospital Compare October 1, 2010 - September 30, 2011.
 4. CMS Hospital Compare July 1, 2008 - June 30, 2011.
 5. We do not calculate percentage difference for measures already expressed as a percent.
- * Peer outperforms Bench

50 Top Teaching Hospitals Without Cardiovascular Residency Programs

The winning hospitals in this category displayed low costs compared with their nonwinning peers. Their wage- and severity-adjusted CABG costs per case were lower than their nonwinning peers by a wide margin — \$4,074, or 11 percent, lower per case (Table 3).

Benchmark teaching hospitals without cardiovascular residency programs had a risk-adjusted complications index for heart failure patients that was 40 percent lower than their peers. The winners' 0.61 HF complications index means they had 39 percent fewer patient complications than would be expected, given patient severity. This is a markedly better outcome than that experienced by the peer hospitals in this group, that, with an index of 1.02, had 2 percent more HF complications than expected.

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 ^{1,2}	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.83	1.01	-0.18	-17.8	lower mortality
		HF Mortality	0.78	1.01	-0.23	-22.8	lower mortality
		CABG Mortality	0.67	0.92	-0.25	-27.2	lower mortality
		PCI Mortality	0.77	0.98	-0.21	-21.4	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.81	0.94	-0.13	-13.8	fewer complications
		HF Complications	0.61	1.02	-0.41	-40.2	fewer complications
		CABG Complications	0.96	1.01	-0.05	-5.0	fewer complications
		PCI Complications	0.91	0.99	-0.08	-8.1	fewer complications
Clinical Process Measures	Core Measures Mean Percent ^{3,5}		96.5	94.8	1.7	n/a ⁵	better performance
	CABG Patients With Internal Mammary Artery Use (%) ¹		97.1	93.5	3.6	n/a ⁵	higher IMA use
Extended Outcome Measures ^{4,5}	AMI 30-Day Mortality (%)		14.5	15.1	-0.7	n/a ⁵	lower 30-day mortality
	HF 30-Day Mortality (%)		11.5	11.5	-0.1	n/a ⁵	no difference in 30-day mortality
	AMI 30-Day Readmissions Rate (%)		18.7	19.3	-0.7	n/a ⁵	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		23.7	24.2	-0.6	n/a ⁵	lower 30-day readmissions
Efficiency Measures	AMI Severity-Adjusted Average Length of Stay		4.2	4.8	-0.7	-13.5	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.5	4.9	-0.4	-8.3	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.4	9.2	-0.8	-9.1	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		2.8	3.2	-0.4	-11.9	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		9,464	10,223	-759	-7.4	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		8,093	8,455	-361	-4.3	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		32,132	36,206	-4,074	-11.3	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		13,855	15,753	-1,898	-12.0	lower cost per case

Notes:

1. MedPAR 2010 and 2011, combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare October 1, 2010 - September 30, 2011.
4. CMS Hospital Compare July 1, 2008 - June 30, 2011.
5. We do not calculate percentage difference for measures already expressed as a percent.

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 other hospital groups we studied (Table 4). Winning hospitals released PCI patients nearly three-quarters of a day sooner than their nonwinning peers.

This group also performed particularly well in avoiding deaths for heart surgery patients. For the CABG and PCI patient groups, the winning hospitals had 41 and 42 percent fewer patient deaths than expected, given patient severity. Nonwinning hospitals, on the other hand, avoided only 9 and 6 percent of the expected deaths for their medical cardiology patients.

The winning community hospitals had heart failure patient readmission rates that were lower than the other two hospital comparison groups and well below their nonwinning peers — just 23 percent of their HF patients were readmitted, for any cause, within 30 days of their original admission date.

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 ^{1,2}	Risk-Adjusted Medical Mortality Index	AMI Mortality	0.87	0.97	-0.10	-10.3	lower mortality
		HF Mortality	0.78	0.97	-0.19	-19.6	lower mortality
		CABG Mortality	0.59	0.91	-0.32	-35.2	lower mortality
		PCI Mortality	0.58	0.94	-0.36	-38.3	lower mortality
	Risk-Adjusted Complications Index	AMI Complications	0.84	0.84	0.00	0.0	no difference in complications
		HF Complications	0.65	0.93	-0.28	-30.1	fewer complications
		CABG Complications	0.89	1.05	-0.16	-15.2	fewer complications
		PCI Complications	0.80	1.00	-0.20	-20.0	fewer complications
Clinical Process Measures	Core Measures Mean Percent ^{3,5}		96.2	95.2	1.0	n/a ⁵	better performance
	CABG Patients With Internal Mammary Artery Use (%) ¹		96.5	93.1	3.4	n/a ⁵	higher IMA use
Extended Outcome Measures ^{4,5}	AMI 30-Day Mortality (%)		14.2	15.4	-1.2	n/a ⁵	lower 30-day mortality
	HF 30-Day Mortality (%)		11.4	11.5	-0.1	n/a ⁵	lower 30-day mortality
	AMI 30-Day Readmissions Rate (%)		18.8	19.4	-0.6	n/a ⁵	lower 30-day readmissions
	HF 30-Day Readmissions Rate (%)		22.6	24.5	-1.9	n/a ⁵	lower 30-day readmissions
Efficiency Measures	AMI Severity-Adjusted Average Length of Stay		3.9	4.8	-0.9	-18.4	shorter ALOS
	HF Severity-Adjusted Average Length of Stay		4.2	5.0	-0.7	-14.5	shorter ALOS
	CABG Severity-Adjusted Average Length of Stay		8.2	9.3	-1.1	-11.9	shorter ALOS
	PCI Severity-Adjusted Average Length of Stay		2.5	3.2	-0.7	-20.8	shorter ALOS
	AMI Wage- and Severity-Adjusted Average Cost per Case		8,301	10,107	-1,806	-17.9	lower cost per case
	HF Wage- and Severity-Adjusted Average Cost per Case		7,873	8,346	-474	-5.7	lower cost per case
	CABG Wage- and Severity-Adjusted Average Cost per Case		30,755	36,666	-5,911	-16.1	lower cost per case
	PCI Wage- and Severity-Adjusted Average Cost per Case		13,319	15,971	-2,652	-16.6	lower cost per case

Notes:

1. MedPAR 2010 and 2011, combined.
2. Ratings greater than 1.0 exceed national norms; ratings less than 1.0 fall below national norms.
3. CMS Hospital Compare October 1, 2010 - September 30, 2011.
4. CMS Hospital Compare July 1, 2008 - June 30, 2011.
5. We do not calculate percentage difference for measures already expressed as a percent.

Methodology

The Truven Health 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 100tophospitals@truvenhealth.com or call +1.800.366.7526.

Building the Database of Hospitals

Primary Data Sources

Like all Truven Health 100 Top Hospitals® studies, the Cardiovascular Benchmarks study uses only publicly available data. The data 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 record information to calculate mortality, complications, and length of stay. MedPAR 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, 2010 and 2011, 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 charge data. The hospital cost-to-charge ratios are applied to MedPAR patient-level claims data to estimate cost for the study's cost measures. This is done at the cost center and charge code level for each patient record. For this study, we used 2010 cost report data to determine the ratio of cost to charges. This year, 2011 cost reports were not yet available in the CMS Hospital Cost Report Information System (HCRIS) data file at time of study production, apparently due to slow implementation of new Cost Report Form 2552-10.

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 in the first and second quarters of 2012 for core measures, 30-day mortality and 30-day readmission rate performance measures, respectively. 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

Truven Health 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 2010 and 2011 MedPAR data sets (2011 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 receive a reduced 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.¹²

Hospitals and Patient Groups Included

The focus of the study is on hospitals that offer both medical and surgical treatment 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 2010 and 2011 data years combined, at least 30 unique cases¹³ 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 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 AMI group is restricted to non-surgical patients.

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.

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

The HF category is restricted to non-surgical patients.

3. PCI patients¹ in MS-DRGs 246-251 with any 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).

¹ Definition of PCI has been changed. We have confined PCI patients to those patients in a PCI-related MS-DRG for this study. See Appendix for details.

4. CABG patients in MS-DRGs 231–236 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

Hospitals Excluded

After building the database of cardiovascular hospitals, we excluded a number of hospitals that would have skewed the study results. 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 2010 and 2011 Medicare claims
- Hospitals missing data for calculation of one or more performance measures
- Hospitals for which a Medicare Cost Report was not available for 2010 or 2011
- Hospitals that did not code POA information on their 2010 and 2011 MedPAR data, including Maryland* hospitals in the Medicare waiver program who are not required to report POA, because their data are not comparable to other hospitals

*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.

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 ACGME¹⁴ or the AOA.¹⁵ 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. Cardiovascular residency programs include any of the following:

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

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

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.

Cardiovascular Study Groups

The final study group, after exclusions, consisted of:

Comparison Group	Total
Teaching Hospitals With Cardiovascular Residency Programs	218
Teaching Hospitals Without Cardiovascular Residency Programs	274
Community Hospitals	512
Total In-Study Hospitals	1,004

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 we dropped a number of core measures that CMS is retiring in 2012. Five core measures related to cardiovascular care were retained, including two added SCIP core measures. See appendix for details.

The measures used in this year's study, along with their data sources, are:

Category	Ranked Performance Metric	Data Source
Clinical Outcome	1. Risk-Adjusted Mortality (AMI, HF, CABG, PCI)	MedPAR federal fiscal year (FFY) 2010 and 2011
	2. Risk-Adjusted Complications (AMI, HF, CABG, PCI)	MedPAR FFY 2010 and 2011
Clinical Process	3. Core Measures (AMI, HF each weighted ½)	CMS Hospital Compare, 1st quarter 2012 release (October 1, 2010–September 30, 2011 dataset)
	4. Percentage of CABG Patients With Internal Mammary Artery Use	MedPAR FFY 2010 and 2011
Extended Outcome	5. 30-Day Mortality Rates (AMI, HF)	CMS Hospital Compare, 2nd quarter 2012 release (July 1, 2008–June 30, 2011 dataset)
	6. 30-Day Readmission Rates (AMI, HF)	CMS Hospital Compare, 2nd quarter 2012 release (July 1, 2008–June 30, 2011 dataset)
Efficiency	7. Severity-Adjusted Average Length of Stay (AMI, HF, CABG, PCI)	MedPAR FFY 2011
	8. Wage- and Severity-Adjusted Average Cost per Case (AMI, HF, CABG, PCI)	MedPAR FFY 2011

Below, 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 47 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 selected heart attack, heart failure, and surgical care improvement project 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 five core measures selected as relevant to the cardiovascular patient groups included in the study, using Hospital Compare data reported on the CMS website. The clinical advantages of using an internal mammary graft are many and have been spelled out in numerous studies over the last two decades.²⁻¹¹

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 2010 and 2011, 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 age, sex, presence of complicating diagnoses, and other characteristics. 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 (2010 and 2011) 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 statistically worse than expected (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	Comments	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 2010 and 2011 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). 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 (2010 and 2011) 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. 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 statistically worse than expected (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>	<p>Lower</p>

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 cardiovascular patient care (selected AMI, HF, and SCIP).</p>	<p>Core measures values are from the CMS Hospital Compare public data set. We included five of the available core measures that are currently sanctioned by CMS as appropriate for use: two heart attack, one heart failure and two surgical care improvement project (SCIP) measures. 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 included 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.</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 first quarter of 2012 (with data from October 1, 2010 through September 30, 2011).¹⁶</p> <p>The core measures mean received a weight of 1 in the final overall ranking process.</p>	<p>Higher</p>

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.²⁻¹¹</p> <p>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 (2010 and 2011) to reduce the influence of chance fluctuation.</p> <p>This measure received a weight of 1 in the final overall ranking process.</p>	<p>Higher</p>

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 2012. This contains data from July 1, 2008, through June 30, 2011.¹⁶ For more information about this data, see the Appendix.</p> <p>Each patient condition receives ¼ weight in the final overall ranking process.</p>	<p>Lower</p>

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 hospital discharge date.</p>	<p>Data are from the CMS Hospital Compare data set published the second quarter of 2012. This contains data from July 1, 2008, through June 30, 2011.¹⁶ For more information about this data, see the Appendix.</p> <p>Each patient condition receives ¼ weight in the overall ranking process.</p>	<p>Lower</p>

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), by hospital comparison group.</p> <p>Each patient group LOS index is converted into an average length of stay in days by multiplying it by the grand mean length of stay of the in-study patient population overall.</p> <p>See the Appendix for more information.</p>	<p>Data for this measure are from 2011 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>Lower</p>

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 ratios for each cost center 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), by hospital comparison group.</p> <p>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 cost per case of the in-study patient population overall.</p> <p>See the Appendix for more information.</p>	<p>Cost-to-charge ratios are from the hospital's 2010 Medicare Cost Report (most 2011 Cost Reports were not available at production time). 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 2011 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 2011 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>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
Core Measures Mean Percent		1
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 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
Total	50

Appendix: Methodology Details

Methods for Identifying Complications of Care

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.

Truven Health AnalyticsSM 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. 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.¹⁷

Normative Database Development

For the cardiovascular study, Truven Health constructed a normative database of case-level data from the most recent three years of available MedPAR data (2009, 2010, and 2011). The data include both fee for service Medicare claims and HMO encounters. Demographic and clinical data are also included: 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†; present on admission coding; admission source and type; and discharge status.

Present on Admission Data

Under the Deficit Reduction Act of 2005, as of federal fiscal year (FFY) 2008, hospitals receive reduced payments for cases with certain conditions — such as falls, surgical site infections, and pressure ulcers — that were not present on the patient's admission, but occur during hospitalization. As a result, CMS now requires all inpatient prospective payment system hospitals to document whether a patient has these conditions when admitted. Truven Health proprietary risk-adjustment models for mortality, complications, and length of stay (LOS) include present on admission (POA) data that was reported in the 2009, 2010, and 2011 MedPAR datasets.

* We used 25 diagnostic codes in 2011 MedPAR; 9 diagnostic codes in 2009 and 2010 MedPAR data sets.

† We used 25 procedure codes in 2011 MedPAR; 6 procedure codes in 2009 and 2010 MedPAR data sets.

Risk-Adjusted Mortality Index Models

An overall mortality risk model is developed, which is used for heart failure (HF) patients, in the cardiovascular study. In addition, because cardiovascular disease is the most prevalent inpatient diagnostic group, separate risk models are developed for heart attack (AMI), percutaneous cardiac intervention (PCI) and coronary artery bypass graft (CABG) patients.

Long-term care, psychiatric, substance abuse, rehabilitation and federally owned or controlled facilities were not included. In addition, we excluded certain patient records from the data set: psychiatric, substance abuse, rehabilitation, and unclassified cases (MS-DRGs 945, 946, and 999); cases where patient age was less than 65 years and where patient transferred to other short-term acute care hospital. It should be noted that palliative care patients (v66.7) are included in the mortality risk model, which is calibrated to determine probability of death for these patients.

A standard logistic regression model is used to estimate the risk of mortality 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).¹⁸⁻²²

Staff physicians at Truven Health 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 Truven Health 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

Complication	Patient Group
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 acute myocardial infarction	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
Complications relating to anesthetic agents and CNS depressants	Surgical, including cardiac
Complications relating to antibiotics	All patients
Complications relating to other anti-infective drugs	All patients
Complications relating to anti-neoplastic and immunosuppressive drugs	All patients
Complications relating to anticoagulants and drugs affecting clotting factors	All patients
Complications relating to blood products	All patients
Complications relating to narcotics and related analgesics	All patients
Complications relating to non-narcotic analgesics	All patients
Complications relating to anti-convulsants and anti-Parkinsonism drugs	All patients
Complications relating to sedatives and hypnotics	All patients
Complications relating to psychotropic agents	All patients
Complications relating to CNS stimulants and drugs affecting the autonomic nervous system	All patients
Complications relating to drugs affecting cardiac rhythm regulation	All patients
Complications relating to cardiotonic glycosides (digoxin) and drugs of similar action	All patients
Complications relating to other drugs affecting the cardiovascular system	All patients
Complications relating to anti-asthmatic drugs	All patients
Complications relating to other medications (includes hormones, insulin, iron, and oxytocic agents)	All patients

A normative database of case-level data including age, sex, length of stay, clinical grouping (MS-DRGs), and comorbid conditions was constructed using the most recent three years of available MedPAR data (2009, 2010, and 2011). Long-term care, psychiatric, substance abuse, rehabilitation and federally owned or controlled facilities were not included. In addition, we excluded certain patient records from the data set: psychiatric, substance abuse, rehabilitation and unclassified cases (MS-DRGs 945, 946, and 999); cases where patient age was less than 65 years and where patient transferred to other short-term acute care hospital.

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. 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.^{23–26}

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).

PCI Group Definition Change

While most patients undergoing an inpatient percutaneous coronary intervention (PCI) are grouped into one of the PCI related MS-DRGs, a few are grouped into other MS-DRGs. Patients may be grouped into another MS-DRG if they have a cardiac procedure considered to be higher in the DRG surgical hierarchy than PCI, or if they have a principal diagnosis that is not cardiac in nature. The approximately 9 percent of Medicare 2010 PCI patients grouped to other MS-DRGs tend to have longer lengths of stay, higher costs, and more complications than those in PCI MS-DRGs, probably because many of them have more complex surgery during the same hospitalization. Because we have confined PCI patients to those patients in a PCI related MS-DRG for this study, whereas in previous studies we included all PCI patients except those who also had a CABG, it is likely that observed and expected values for various metrics have declined.

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 five core measures related to heart attack (AMI), heart failure (HF), and surgical care improvement project (SCIP). Only core measures related to the care of patients with cardiovascular disease were included. We also dropped AMI and HF core measures that have been retired by CMS in 2012. The two SCIP measures were included for the first time this year.

For each hospital we calculate the mean of the reported core measures percent values for all included 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):

1. Heart attack or chest pain patients given PCI within 90 minutes of arrival (AMI-8a)
2. Heart attack patients given a prescription for a statin at discharge (AMI-10)
3. Heart failure patients given discharge instructions (HF-1)
4. Heart surgery patients whose blood sugar (blood glucose) is kept under good control in the days right after surgery (SCIP-INF-4)
5. Surgery patients who were taking heart drugs called beta blockers before coming to the hospital, who were kept on the beta blockers during the period just before and after their surgery (SCIP-CARD-2)

Length of Stay and Cost per Case Methodologies

The study's length of stay (LOS) and cost per case performance measures use Truven Health proprietary severity-adjusted resource demand methodologies.

Our severity-adjusted resource demand model allows us to produce risk-adjusted performance comparisons on LOS and hospital costs 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. Its associated LOS and cost weights allow group comparisons on a national level and in a specific market area. These weights are calculated separately for LOS and costs from the MedPAR normative database described in the first section of this Appendix.

This regression-based model has been demonstrated to provide accuracy in predicting results. The POA component allows us to determine appropriate adjustments based on previous conditions versus complications of hospitalization. We calculate expected values from model coefficients that are normalized to the clinical group and transformed from log scale.

We estimate costs using the cost center cost-to-charge ratios[†] applied to the specific charges reported for the study's cardiovascular patients (AMI, HF, CABG, and PCI) in the most recent MedPAR file. To account for geographic cost of living differences, expected values are adjusted for each hospital using the CMS area wage index for the federal fiscal year that matches the MedPAR file year.

[†]In this study, primarily the hospital 2010 cost reports were used because the HCRIS 2012 first quarter data file contained almost no 2011 cost reports, due to a mandated change in cost report format that caused delayed submissions (new Cost Report Form 2552-10).

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 indexes 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.²⁷

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