Truven Health Analytics | IBM Watson Health

100 TOP HOSPITALS

100 Top Hospitals Study, 2017

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Truven Health 100 Top Hospitals® Study 2017, 24th edition

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Introduction

100 Top Hospitals: Setting national standards of excellence and delivering insights to help leaders achieve consistent top performance

The Truven Health 100 Top Hospitals® program from Truven Health Analytics®, IBM Watson Health™, is dedicated to the development of evidence-based management in healthcare. For 24 years, the 100 Top Hospitals national balanced scorecard and benchmarks have set the standard for hospital-wide performance goals. In addition, the program's studies have also been the basis for academic research on leadership best practices.

The annual 100 Top Hospitals study uses independent, quantitative research to identify US hospitals with the best overall performance across multiple organizational metrics. To maintain the study's high level of integrity and eliminate bias, only objective, public data sources are used for calculating outcome metrics. This supports inclusion of hospitals across the country, and facilitates consistency of definitions and data. Hospitals do not apply for consideration, and winners do not pay for use of the 100 Top Hospitals title.

The 100 Top Hospitals national balanced scorecard, based on Norton and Kaplan's concept[1], is the foundation of our research. It is comprised of key measures of hospital organizational performance: quality inpatient and outpatient care, operational efficiency, financial health, and customer perception of care. The overall performance score derived from these measures reflects excellence in hospital care, management, and leadership.

Unbiased information to help solve modern healthcare leadership dilemmas

The healthcare industry is changing quickly, and winners of the 100 Top Hospitals designation demonstrate how effective leaders can manage change and continue to achieve excellence in a dynamic environment. Winners consistently set industry benchmarks for critical performance measures like 30-day readmissions, mortality rates, customer perception of care, and profit margins. And they do so even as markets, payment models, and reforms shift and bars are raised.

Since 1993, the 100 Top Hospitals program has collaborated with top academics to uncover the impact organizational leadership has on the performance and best practices within the nation's top healthcare organizations. Those studies have found that leadership excellence is essential for superior performance and delivery of high value to community stakeholders. The 100 Top Hospitals methodology creates an integrated program that identifies long-term rates of improvement, providing a picture of how innovative leaders can transform the performance of the entire organization over time by identifying and seizing improvement opportunities and adjusting organizational goals for key performance domains.

Higher composite scores on the 100 Top Hospitals national balanced scorecard indicate more effective leadership and consistent delivery of value to communities. This approach is what makes the 100 Top Hospitals program one of the most respected standards for measuring the performance of healthcare organizations in the United States.

New trended metrics shed additional light on longer-term improvements

For this 2017 100 Top Hospitals study, we have added two new measures to our trend analysis: mean emergency department (ED) throughput and the Medicare spend per beneficiary (MSPB) index. Both measures are recent additions to the study, and we now have sufficient years of data available which, for the first time, can provide leaders with insight into their rates of improvement in these areas, relative to industry peers.

Equal consideration for hospitals in each category

Health systems, accountable care organizations, and insurance networks in today's healthcare environment continue to expect consistent outcomes and expanded transparency, regardless of hospital type. However, because different types of hospitals perform at varying levels for each metric, the 100 Top Hospitals study divides the nation's hospitals into five categories (major teaching, teaching, small community, medium community, and large community hospitals). This helps ensure the benchmarks are comparable and action-driving across each organizational type. Each kind of hospital has its own inherent set of specific challenges and opportunities, and each category may require a different level of risk tolerance.

While hospital types differ, our studies demonstrate that the nation's high-performing hospitals work to adapt to meet the challenges of their respective industry categories. Our interviews with 100 Top Hospitals award-winning leaders have often shown they use evidence-based management, driven by objective data and analytics, to help prevent the acceptance of performance patterns that, while traditional, may prove to be unnecessary or detrimental to progress. They also appear to understand the need to evaluate resources to drive new practice patterns and set targets for performance improvement initiatives, regardless of hospital category.

How our 2017 winners compare to their industry peers

Using the measures presented in our national balanced scorecard, this year's 100 Top Hospitals study revealed significant differences between award winners and their nonwinning peers.

Our study's highest-performing hospitals:

- Had lower inpatient mortality considering patient severity
- Had fewer patient complications
- Followed accepted care protocols for stroke care and blood clot prevention
- Had lower 30-day mortality and 30-day readmission rates
- Sent patients home sooner
- Provided more timely emergency care
- Kept expenses low, both in-hospital and through the aftercare process
- Scored 10 points higher on patient ratings of their overall hospital experience

For more detailed information on these achievements, see the Findings section of this document.

The standards of excellence

Our study projections indicate that if the new national benchmarks of high performance established by our 2017 winners were achieved by all hospitals in the US, the following would be true:

- Nearly 89,000 additional lives could be saved in-hospital
- Over 61,000 additional patients could be complication-free
- Over $5.6 billion in inpatient costs could be saved
- The typical patient could be released from the hospital a half day sooner and would have 2% fewer expenses related to the complete episode of care than the median patient in the US
- Over 300,000 fewer discharged patients would be readmitted within 30 days
- Patients could spend 9 minutes less in hospital emergency rooms per visit

Truven Health 100 Top Hospitals award winners demonstrate that quality care and operational efficiency can often be achieved simultaneously, even during periods of industry change.

This analysis is based on applying the difference between study winners and nonwinners to Medicare patient counts. If the same standards were applied to all inpatients, the impact would be even greater.

The versatility of the 100 Top Hospitals program

To increase understanding of trends in specific areas of the industry, the 100 Top Hospitals program includes a range of studies and reports:

- **100 Top Hospitals and Everest Award studies**: Research that annually recognizes the 100 top-rated hospitals in the nation based on a proprietary, balanced scorecard of overall organizational performance, and also identifies those hospitals that excel at long-term rates of improvement in addition to performance
- **50 Top Cardiovascular Hospitals study**: A yearly study identifying hospitals that demonstrate the highest performance in hospital cardiovascular services
- **15 Top Health Systems study**: An annual study introduced in 2009 that provides an objective measure of health system performance and improvement based on our national health systems scorecard
- **100 Top Hospitals Performance Matrix**: A two-dimensional analysis, available for nearly all US hospitals, that provides a view of how long-term improvement and resultant current performance compare with national peers
- **Custom benchmark reports**: A variety of reports designed to help healthcare executives understand how their organizational performance compares with peers within health systems, states and markets

You can read more about these studies and reports, and view lists of all winners, by visiting **100tophospitals.com**.

About Truven Health Analytics, a part of the IBM Watson Health business

Truven Health Analytics, IBM Watson Health, provides market-leading performance

improvement solutions built on data integrity, advanced analytics, and domain expertise. For more than 40 years, our insights and solutions have been providing hospitals and clinicians, employers and health plans, state and federal government agencies, life sciences companies, and policymakers the facts they need to make confident decisions that directly affect the health and well-being of people and organizations in the US and around the world. The company was acquired by IBM in 2016 to help form a new business, Watson Health. Watson Health aspires to improve lives and give hope by delivering innovation to address the world's most pressing health challenges through data and cognitive insights.

In addition to the 100 Top Hospitals program, Truven Health owns some of the most trusted brands in healthcare, such as MarketScan®, Advantage Suite®, Micromedex®, Simpler®, and ActionOI®. Truven Health has its principal offices in Ann Arbor, Mich.; Chicago; and Denver. For more information, visit **truvenhealth.com**.

2017 Award winners

Truven Health Analytics®, IBM Watson Health™ is pleased to present the 2017 Truven Health 100 Top Hospitals® award winners. We stratify winners by five separate peer comparison groups: major teaching, teaching, large community, medium community, and small community hospitals.

To see a full list of *Winners Through the Years,* please visit **100tophospitals.com/studies-winners/100-top-hospitals/year**.

Major teaching hospitals*			
Hospital	**Location**	**Medicare ID**	**Total year(s) won**
Advocate Lutheran General Hospital	Park Ridge, IL	140223	18
Baptist Medical Center Jacksonville	Jacksonville, FL	100088	3
Beaumont Hospital - Royal Oak	Royal Oak, MI	230130	7
Emory University Hospital	Atlanta, GA	110010	3
Houston Methodist Hospital	Houston, TX	450358	5
NorthShore University HealthSystem	Evanston, IL	140010	18
Northwestern Memorial Hospital	Chicago, IL	140281	8
Ochsner Medical Center	New Orleans, LA	190036	5
OhioHealth Doctors Hospital	Columbus, OH	360152	7
Providence–Providence Park Hospital	Southfield, MI	230019	9
SSM Health St. Mary's Hospital	St. Louis, MO	260091	2
St. Joseph Mercy Hospital	Ann Arbor, MI	230156	9
St. Luke's University Hospital – Bethlehem	Bethlehem, PA	390049	5
University of Colorado Hospital	Aurora, CO	060024	4
University of Utah Health Care	Salt Lake City, UT	460009	1

* Everest Award winners are in bold type above.

Teaching hospitals*			
Hospital	**Location**	**Medicare ID**	**Total year(s) won**
Adventist Medical Center Hinsdale	Hinsdale, IL	140122	1
Aspirus Wausau Hospital	Wausau, WI	520030	5
Beaumont Hospital - Grosse Pointe	Grosse Pointe, MI	230089	1
Bethesda North Hospital	Cincinnati, OH	360179	7
Billings Clinic Hospital	Billings, MT	270004	5
BSA Health System	Amarillo, TX	450231	4
Franciscan Health Indianapolis	Indianapolis, IN	150162	4
IU Health Ball Memorial Hospital	Muncie, IN	150089	2
Kendall Regional Medical Center	Miami, FL	100209	10
Lancaster General Hospital	Lancaster, PA	390100	11
LDS Hospital	Salt Lake City, UT	460006	4
Mercy Health Saint Mary's	Grand Rapids, MI	230059	2
Mercy Hospital St. Louis	St. Louis, MO	260020	5
Newton-Wellesley Hospital	Newton, MA	220101	7
Park Nicollet Methodist Hospital	St. Louis Park, MN	240053	4
Parkview Regional Medical Center	Fort Wayne, IN	150021	3
Poudre Valley Hospital	Fort Collins, CO	060010	11
Riverside Medical Center	Kankakee, IL	140186	8
Rose Medical Center	Denver, CO	060032	10
Sentara Leigh Hospital	Norfolk, VA	490046	3
St. Cloud Hospital	St. Cloud, MN	240036	11
St. Luke's Boise Medical Center	Boise, ID	130006	9
St. Mary's Hospital	Madison, WI	520083	4
St. Vincent Healthcare	Billings, MT	270049	2
The Christ Hospital Health Network	Cincinnati, OH	360163	7

* Everest Award winners are in bold type above.

Large community hospitals*

Hospital	Location	Medicare ID	Total year(s) won
Advocate Condell Medical Center	Libertyville, IL	140202	3
Asante Rogue Regional Medical Center	Medford, OR	380018	5
Chandler Regional Medical Center	Chandler, AZ	030036	1
Chester County Hospital	West Chester, PA	390179	1
CHRISTUS Mother Frances Hospital Tyler	Tyler, TX	450102	7
EvergreenHealth Kirkland	Kirkland, WA	500124	2
FirstHealth Moore Regional Hospital	Pinehurst, NC	340115	5
Florida Hospital Memorial Medical Center	Daytona Beach, FL	100068	3
Henrico Doctors' Hospital	Richmond, VA	490118	2
Logan Regional Hospital	Logan, UT	460015	7
Memorial Hermann Memorial City Medical Center	Houston, TX	450610	6
Mercy Hospital	Coon Rapids, MN	240115	6
Mosaic Life Care	Saint Joseph, MO	260006	3
North Florida Regional Medical Center	Gainesville, FL	100204	9
Roper Hospital	Charleston, SC	420087	3
Scripps Memorial Hospital La Jolla	La Jolla, CA	050324	2
St. David's Medical Center	Austin, TX	450431	8
St. Francis Downtown	Greenville, SC	420023	3
WellStar West Georgia Medical Center	LaGrange, GA	110016	2
West Florida Hospital	Pensacola, FL	100231	4

* Everest Award winners are in bold type above.

Medium community hospitals*

Hospital	Location	Medicare ID	Total year(s) won
American Fork Hospital	American Fork, UT	460023	7
Baptist Medical Center Beaches	Jacksonville Beach, FL	100117	1
Baylor Scott & White Healthcare - Round Rock	Round Rock, TX	670034	2
Blanchard Valley Hospital	Findlay, OH	360095	5
Bon Secours St. Francis Hospital	Charleston, SC	420065	4
Chino Valley Medical Center	Chino, CA	050586	6
Clermont Hospital	Batavia, OH	360236	8
Dupont Hospital	Fort Wayne, IN	150150	4
Fairview Park Hospital	Dublin, GA	110125	4
Holland Hospital	Holland, MI	230072	12
Inova Fair Oaks Hospital	Fairfax, VA	490101	4
Medical Center of the Rockies	Loveland, CO	060119	1
Mercy Medical Center	Cedar Rapids, IA	160079	5
Ochsner Medical Center – Baton Rouge	Baton Rouge, LA	190202	2
Saint Alphonsus Medical Center – Nampa	Nampa, ID	130013	1
Sherman Oaks Hospital	Sherman Oaks, CA	050755	2
St. Vincent Carmel Hospital	Carmel, IN	150157	4
Sycamore Medical Center	Miamisburg, OH	360239	8
Texas Health Harris Methodist Hospital Southwest Fort Worth	Fort Worth, TX	450779	2
West Valley Medical Center	Caldwell, ID	130014	4

* Everest Award winners are in bold type above.

Small community hospitals*			
Hospital	**Location**	**Medicare ID**	**Total year(s) won**
Alta View Hospital	Sandy, UT	460044	5
Aurora Medical Center	Two Rivers, WI	520034	2
Aurora Medical Center	Oshkosh, WI	520198	2
Fairview Northland Medical Center	Princeton, MN	240141	2
Franklin Woods Community Hospital	Johnson City, TN	440184	2
Hawkins County Memorial Hospital	Rogersville, TN	440032	2
Henry Community Health	New Castle, IN	150030	1
Lakeview Hospital	Bountiful, UT	460042	7
Lakeview Hospital	Stillwater, MN	240066	6
Lakeview Medical Center	Rice Lake, WI	520011	2
Oaklawn Hospital	Marshall, MI	230217	2
OSF Saint James – John W. Albrecht Medical Center	Pontiac, IL	140161	1
Parkview Huntington Hospital	Huntington, IN	150091	5
Spectrum Health United Hospital	Greenville, MI	230035	7
Spectrum Health Zeeland Community Hospital	Zeeland, MI	230003	3
St. John Owasso Hospital	Owasso, OK	370227	1
St. Joseph Mercy Livingston Hospital	Howell, MI	230069	3
Texas Health Harris Methodist Hospital Alliance	Fort Worth, TX	670085	1
Waynesboro Hospital	Waynesboro, PA	390138	2
Yampa Valley Medical Center	Steamboat Springs, CO	060049	1

* Everest Award winners are in bold type above.

The Everest Award

The Truven Health 100 Top Hospitals® Everest Award honors hospitals that have both the highest current performance and the fastest long-term improvement in the years of data analyzed.

This award recognizes the boards, executives, and medical staff leaders who developed and executed the strategies that drove the highest rates of improvement, resulting in the highest performance in the US at the end of five years.

The Everest Award winners are a special group of the 100 Top Hospitals award winners that, in addition to achieving benchmark status for one year, have simultaneously set national benchmarks for the fastest long-term improvement on our national balanced scorecard. In 2017, only 10 organizations achieved this level of performance.

The 2017 Everest Award winners

Truven Health Analytics®, IBM Watson Health™, is pleased to present the winners of the 100 Top Hospitals Everest Award.

2017 Everest Award winners			
Hospital	**Location**	**Medicare ID**	**Total year(s) won**
Baptist Medical Center Beaches	Jacksonville Beach, FL	100117	1
Baptist Medical Center Jacksonville	Jacksonville, FL	100088	1
Beaumont Hospital - Grosse Pointe	Grosse Pointe, MI	230089	1
Beaumont Hospital - Royal Oak	Royal Oak, MI	230130	1
Hawkins County Memorial Hospital	Rogersville, TN	440032	2
Mosaic Life Care	Saint Joseph, MO	260006	3
Ochsner Medical Center – Baton Rouge	Baton Rouge, LA	190202	1
Park Nicollet Methodist Hospital	St. Louis Park, MN	240053	2
St. Joseph Mercy Hospital	Ann Arbor, MI	230156	2
St. Joseph Mercy Livingston Hospital	Howell, MI	230069	1

Value to the healthcare industry

Leaders making critical decisions can benefit from sophisticated intelligence that provides objective insights into the complexity of changing organizational performance. Those insights can also help leaders balance short- and long-term goals to drive continuous gains in performance and value.

Transparency presents hospital boards and CEOs with a public challenge to increase the value of core services to their communities. Providing value is characteristically not a one-time event; it is a continuous process of increasing worth over time. The 100 Top Hospitals program provides information that helps inform the leadership decisions that guide hospitals to achieve these objectives.

Integrating national benchmarks for highest achievement with those for fastest long-term improvement can increase the value of the objective business information available for strategy development and decision making. Comparing hospital or health system performance to these integrated benchmarks allows leaders to review the effectiveness of the long-term strategies that led to current performance. This integrated information also helps boards and CEOs to better answer multidimensional questions, such as:

- Did our long-term strategies result in a stronger hospital across all performance areas?
- Did our strategies drive improvement in some areas but inadvertently cause deteriorating performance in others?
- What strategies will help us increase the rate of improvement in the right areas to come closer to national performance levels?
- What incentives do we need to implement for management to achieve the desired improvement more quickly?
- Will the investments we are considering help us achieve improvement goals?
- Can we quantify the long- and short-term increases in value our hospital has provided to our community?

How we select the Everest Award winners

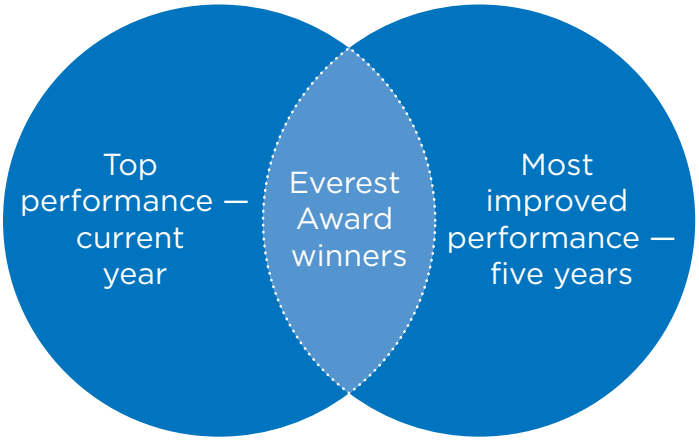
Winners of the 100 Top Hospitals Everest Award are setting national benchmarks for both long-term (five-year) improvement and highest current year performance on the study's balanced scorecard. Everest Award winners are selected from among the new 100 Top Hospitals award winners. The national award and the Everest Award are based on a set of measures that reflect highly effective performance across the whole organization.

Our methodology for selecting the Everest Award winners can be summarized in three main steps:

1. Selecting the annual 100 Top Hospitals award winners using our objective methodology* based on publicly available data and a balanced scorecard of performance measures using the most current data available (2015 at the time of this study)
2. Using our five-year (2011 - 2015) trending methodology to select the 100 hospitals that have shown the fastest, most consistent improvement rates on the same balanced scorecard of performance measures
3. Identifying those hospitals that ranked in the top 100 on both lists; these hospitals are the Everest Award winners

* For full details on how the 100 Top Hospitals winners are selected, see the Methodology section of this document.

Combining these two methodologies yields a select group of Everest Award winners. The number of winners will vary every year, based solely on performance in the two dimensions.



Data sources

As with all 100 Top Hospitals awards, our methodology is objective, and all data comes from trusted public sources. We build a database of short-term, acute care, nonfederal US hospitals that treat a broad spectrum of patients. The primary data sources are the Medicare Provider Analysis and Review (MEDPAR) patient claims data set, the Centers for Medicare & Medicaid Services (CMS) Hospital Compare hospital performance data set, and the Hospital Cost Report Information System (HCRIS) Medicare Cost Report file. We use the most recent five years of data available for trending and the most current year for selection of winners*.

Residency program information, used in classifying teaching hospitals, is from the American Medical Association (Accreditation Council for Graduate Medical Education [ACGME]-accredited programs) and the American Osteopathic Association (AOA).

For this year's study, after excluding hospitals with insufficient, missing, or invalid data, along with hospitals that would skew study results (for example, specialty hospitals), we had a database study group of 2,740 hospitals.

Comparison groups

Because bed size and teaching status have a profound effect on the types of patients a hospital treats and the scope of services it provides, we assigned each hospital in our study database to one of five comparison groups according to its size and teaching status (for definitions of each group, see the Methodology section of this document):

- Major teaching hospitals
- Teaching hospitals
- Large community hospitals
- Medium community hospitals
- Small community hospitals

* Hospital inpatient mortality and complications are based on two years of data combined for each study year data point. See the Performance Measures section of this document for details.

To judge hospitals fairly and compare them to like hospitals, we use these comparison groups for all scoring and ranking to determine winners. For more information on how we build the database, see the Methodology section.

Performance measures

Both the 100 Top Hospitals and the Everest awards are based on a set of measures that assess balanced performance across the organization, reflecting the leadership effectiveness of board members, medical staff, management, and nursing. These measures fall into seven domains of performance: inpatient outcomes, process of care, extended outcomes, operational efficiency, cost efficiency, financial health, and patient experience.

The 11 measures used to select the 2017 winners are:

1. Risk-adjusted inpatient mortality index
2. Risk-adjusted complications index
3. Core measures mean percent
4. Mean 30-day risk-adjusted mortality rate (includes acute myocardial infarction [AMI]), heart failure [HF], pneumonia, chronic obstructive pulmonary disease [COPD], and stroke)
5. Mean 30-day risk-adjusted readmission rate (includes AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke)
6. Severity-adjusted average length of stay (ALOS)
7. Mean emergency department (ED) throughput (minutes)
8. Case mix- and wage-adjusted inpatient expense per discharge
9. Medicare spend per beneficiary (MSPB) index
10. Adjusted operating profit margin
11. Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) score (patient rating of overall hospital performance)

For full details, including calculation and scoring methods, see the Methodology section. We use present-on-admission (POA) data in our proprietary risk models. POA coding became available in the 2009 MEDPAR data set.

For the inpatient mortality and complications (clinical measures with low frequency of occurrence), we combine two years of data for each study year to stabilize results. This year, we combined as follows:

- Study year 2015 = 2015 and 2014 MEDPAR data sets
- Study year 2014 = 2014 and 2013 MEDPAR data sets
- Study year 2013 = 2013 and 2012 MEDPAR data sets
- Study year 2012 = 2012 and 2011 MEDPAR data sets
- Study year 2011 = 2011 and 2010 MEDPAR data sets

For specific data years used for all of the measures, see page 28 of the Methodology section.

Ranking and five-year trend summary

To select the 100 Top Hospitals award winners, we rank hospitals on the basis of current year performance on each of the study measures relative to other hospitals in their comparison group. We then sum each hospital's performance-measure rankings and re-rank them, overall, to arrive at a final rank for the hospital. The hospitals with the best final ranks in each comparison group are selected as the 100 Top Hospitals award winners. See the Methodology section for details on the ranking methodology, including measures, weighting, and selection of 100 Top Hospitals winners.

Separately, for every hospital in the study, we calculate a t-statistic that measures five-year performance improvement for each of the included performance measures. This statistic measures the direction and magnitude of change in performance, and the statistical significance of that change. We rank hospitals on the basis of their performance improvement t-statistic on each of the study measures relative to other hospitals in their comparison group. We then sum each hospital's performance-measure rankings and re-rank them overall, to arrive at a final rank for the hospital. The hospitals with the best final rank in each comparison group are selected as the performance improvement benchmark hospitals. See the Methodology section for details on trending, including measure weighting.

As our final step, we find those hospitals that are identified as benchmarks on both lists. These hospitals are the Everest Award winners.

Findings

The Truven Health 100 Top Hospitals® study shines an important light on how high-performing hospitals in the country operate. According to independent data and our proven methodologies, these industry leaders appear to have successfully negotiated the fine line between running highly effective operations, and being innovative and forward-thinking in ways that grow their organizations over the short and long term.

Year after year, the public data we have gathered for the 100 Top Hospitals studies has provided numerous examples of the benchmark hospitals' financial and operational excellence and affirmed the validity and stability of this approach to performance measurement[2–28].

The study is more than a list of accomplishments; it is a method US hospital and health system leaders can use to guide their own performance improvement initiatives. By highlighting what the highest-performing leaders around the country are doing well, we create aspirational benchmarks for the rest of the industry.

Based on comparisons between the 100 Top Hospitals study winners and a peer group of similar hospitals that were not winners, we found that if all hospitals performed at the level of this year's winners:

- Nearly 89,000 additional lives could be saved in-hospital
- Over 61,000 additional patients could be complication-free
- Over $5.6 billion in inpatient costs could be saved
- The typical patient could be released from the hospital a half day sooner and would have 2% fewer expenses related to the complete episode of care than the median patient in the US
- Over 300,000 fewer discharged patients would be readmitted within 30 days
- Patients could spend 9 minutes less in hospital emergency rooms per visit

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.

Note: All currency amounts listed in this 100 Top Hospitals study are in US dollars.

How the winning hospitals compare to their peers

In this section, we show how the 100 Top Hospitals performed within their comparison groups (teaching, major teaching, small community, medium community, and large community hospitals), compared with nonwinning peers. For performance measure details and definitions of each comparison group, see the Methodology section of this document.

Note: In Tables 1 - 6, data for the 100 Top Hospitals award winners is labeled "Benchmark," and data for all hospitals, excluding award winners, is labeled "Peer group." In columns labeled "Benchmark compared with peer group," we calculate the actual and percentage difference between the benchmark hospital scores and the peer group scores.

100 Top Hospitals had better survival rates*

- Overall, the winners had 21.0% fewer deaths than expected (0.79 index), considering patient severity, while their nonwinning peers had 3% more deaths than would be expected (1.03 index) (Table 1)
- Small community hospitals had the most dramatic difference between winners and nonwinners; the winning small hospital median mortality rate was 49.9% lower than nonwinning peers (Table 6)
- Medium-sized community hospitals also had a significantly lower median mortality index than nonwinning peer hospitals, with a 26.2% lower index (Table 5)

100 Top Hospitals had fewer patient complications*

- Overall, patients at the winning hospitals had 22.0% fewer complications than expected (0.78 index), considering patient severity, while their nonwinning peers had only 6% fewer complications than expected (0.94 index) (Table 1)
- For complications, as with inpatient mortality, small community hospitals had the most dramatic difference between winners and nonwinners; the winning small hospital median mortality rate was 35.1% lower than nonwinning peers (Table 6)
- Medium community hospitals also had a significantly lower median complications index than nonwinning peer hospitals, with a 26.3% lower index (Table 5)

100 Top Hospitals followed accepted care protocols

The core measures composite metric is made up of individual core measures from the Centers for Medicare & Medicaid Services (CMS) Hospital Compare data set. Stroke care and blood clot prevention process-of-care measures have replaced the recently retired acute myocardial infarction (AMI), heart failure (HF), pneumonia, and Surgical Care Improvement Project (SCIP) measures that historically made up the core measures mean composite measure. These measures offer hospitals a new challenge to address basic standards of care with two new patient groups (Tables 1 - 6).

- Overall, winning hospitals' higher median value for the core measures composite (98.5%) tells us that they have better adherence to recommended standards of care than their peers, who had a median of 96.7% (Table 1)
- Medium and small community hospitals had the highest rates of compliance with core measures standards for both winners (98.9% and 99.7%, respectively) and nonwinners (96.6% and 97.7%, respectively) (Tables 5 and 6)

* Risk-adjusted measures are normalized by comparison group, so results cannot be compared across comparison groups.

100 Top Hospitals had lower 30-day mortality and readmission rates

A number of patient groups are included in the 30-day mortality and readmission extended care composite metrics. The mean 30-day mortality rate now includes AMI, HF, pneumonia, chronic obstructive pulmonary disease (COPD), and stroke patient groups. The mean 30-day readmission rate includes AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke patient groups.

- Mean 30-day mortality and readmission rates were lower at the winning hospitals than nonwinning hospitals, across all comparison groups (by 0.4 to 1.3 percentage points) (Table 1)
- Major teaching hospital winners demonstrated the best 30-day mortality performance among all hospital comparison groups with an 11.4% rate (1.3 percentage points lower than nonwinners) (Table 2)
- Small community hospital winners had the best 30-day readmission performance among all comparison groups (14.8%) and, along with teaching hospital winners, outperformed nonwinners by the greatest margin (0.9 percentage points) (Tables 3 and 6)

Patients treated at 100 Top Hospitals returned home sooner*

- Overall, winning hospitals had a median severity-adjusted average length of stay (ALOS) that was a 0.5 day shorter than peers (Table 1)
- The winning medium-sized and small community hospitals had the greatest difference in ALOS relative to nonwinning peers of all the groups, with median ALOS 0.8 and 0.7 days shorter, respectively (Tables 5 and 6)

Patients spent less time in 100 Top Hospitals emergency departments

- Overall, winning hospitals had shorter median wait times for emergency services** than their peers by 5.5% (Table 1)
- The most dramatic difference in service delivery times between winning hospitals and their peers was in the teaching and major teaching categories, where there was an average of 28.2 minutes and 27.7 minutes less time-to-service, respectively. However, major teaching hospitals had the longest throughput times of all comparison groups at an average of 197 minutes for winners and 224.7 minutes for nonwinners (Tables 2 and 3)
- As might be expected, small community hospitals had the shortest throughput times of all comparison groups for both winning and nonwinning hospitals (123.8 and 135 minutes, respectively) (Table 6)

100 Top Hospitals had lower inpatient expenses and Medicare spend per beneficiary episode costs

- The findings show that overall, and in all comparison groups, the winning hospital median for case mix- and wage-adjusted inpatient expense per discharge was lower than the median for nonwinner peers this year (Tables 1 - 6)
- For Medicare spend per beneficiary (MSPB), which is a measure of the expenses associated with an admission episode, including three days prior through 30 days post-admission, winning hospitals had a lower median index than nonwinning hospitals by 2%, overall (Table 1)

* Risk-adjusted measures are normalized by comparison group, so results cannot be compared across comparison groups.

** Includes median minutes for discharge from the emergency department (ED), admission to the hospital, and receipt of pain medications for long bone fracture.

- Large and medium community hospital winners had the lowest case mix- and wage-adjusted inpatient expense per discharge, at $5,972 and $5,991, respectively (Tables 4 and 5)
- The best MSPB episode cost performance was in the small community hospital group, where both winners and nonwinners outperformed all other groups with MSPB indexes of 0.90 and 0.95, respectively (Table 6)
- Small community hospitals also had the greatest difference between winning and nonwinning hospitals in both the inpatient expense and MSPB measures, at 13.0% and 5.8%, respectively (Table 6)

As the MSPB measure is fairly new to our study, we continue to evaluate the relationship between this episode-of-care measure and the inpatient expense per discharge metric. Further investigation of the interrelationship between inpatient care and episode care is needed. Given that some winners had higher inpatient expense but lower Medicare spend, one possibility is that winning organizations are moving patients to lower-cost settings more quickly. Another possibility is that the inpatient expense factor in our overall scorecard now has less impact on the selection of winners.

In addition, the relationship between the use of acute and non-acute care in achieving best patient outcomes, and the cost-benefit tradeoffs of each, should be explored. It would be important to know whether or not hospitals that manage the inpatient stay and the selection of appropriate sites of care cost more on the acute side but achieve more economical care overall, with equal or better outcomes.

100 Top Hospitals were more profitable

- Overall, winning hospitals had a median operating profit margin that was 9.4 percentage points higher than nonwinning hospitals (13.8% versus 4.4%) (Table 1)
- Profitability difference was the most dramatic in the medium and small community hospital groups, where winners had operating profit margins that were 14.0 and 13.4 percentage points higher than nonwinners, respectively (Tables 5 and 6)
- Medium hospital winners also had the largest median operating profit margin of any winning group at 18.7% (Table 5)
- In contrast, major teaching hospital winners had the lowest median operating profit margin of any winning group at 9.4% (Table 2)

Patients rated 100 Top Hospitals higher than peer hospitals

- Patients treated at the 100 Top Hospitals reported a better overall hospital experience than those treated in peer hospitals, with a 3.8% higher median Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) score (Table 1)
- The winning small community hospitals had the highest median HCAHPS score of all comparison groups at 274 versus 264 for nonwinners (maximum score is 300) (Table 6)
- Medium community hospital winners had the biggest performance difference over peers (4.2%), among all the comparison groups (Table 5)

Table 1. National performance comparisons (all hospitals in study)

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.79	1.03	-0.24	-23.3%	Lower mortality
	Complications index[1]	0.78	0.94	-0.16	-17.1%	Fewer complications
Process of care	Core measures mean percent[2]	98.5	96.7	1.8	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	12.3	13.0	-0.7	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	14.9	15.4	-0.6	n/a[6]	Fewer 30-day readmissions
Process efficiency	Average length of stay (ALOS)[1]	4.4	4.9	-0.5	-9.4%	Shorter stays
	Emergency department (ED) measure mean minutes[4]	149.0	157.7	-8.7	-5.5%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$6,148	$6,755	-$608	-9.0%	Lower inpatient cost
	Medicare spend per beneficiary (MSPB) index[4]	0.97	0.99	-0.02	-2.0%	Lower episode cost
Financial health	Operating profit margin[5]	13.8	4.4	9.4	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	272.0	262.0	10.0	3.8%	Better patient experience

1. Mortality, complications, and ALOS based on present-on-admission (POA)-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS Hospital Cost Report Information System (HCRIS) data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

Table 2. Major teaching hospital performance comparisons

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.89	1.02	-0.13	-12.4%	Lower mortality
	Complications index[1]	0.89	1.03	-0.14	-13.6%	Fewer complications
Process of care	Core measures mean percent[2]	97.1	95.9	1.2	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	11.4	12.6	-1.3	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	15.4	16.1	-0.8	n/a[6]	Fewer 30-day readmissions
Process efficiency	ALOS[1]	4.7	5.0	-0.3	-6.5%	Shorter stays
	ED measure mean minutes[4]	197.0	224.7	-27.7	-12.3%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$7,123	$7,713	-$591	-7.7%	Lower inpatient cost
	MSPB index[4]	0.98	1.01	-0.03	-3.0%	Lower episode cost
Financial health	Operating profit margin[5]	9.4	4.0	5.4	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	270.0	261.0	9.0	3.4%	Better patient experience

1. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS HCRIS data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

Table 3. Teaching hospital performance comparisons

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.85	1.01	-0.16	-15.9%	Lower mortality
	Complications index[1]	0.81	0.99	-0.19	-18.9%	Fewer complications
Process of care	Core measures mean percent[2]	97.9	96.2	1.7	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	12.3	13.1	-0.8	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	14.8	15.6	-0.9	n/a[6]	Fewer 30-day readmissions
Process efficiency	ALOS[1]	4.4	5.0	-0.6	-11.7%	Shorter stays
	ED measure mean minutes[4]	152.7	180.8	-28.2	-15.6%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$6,024	$6,506	-$482	-7.4%	Lower inpatient cost
	MSPB index[4]	0.96	1.01	-0.05	-5.0%	Lower episode cost
Financial health	Operating profit margin[5]	13.4	5.5	7.9	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	272.0	262.0	10.0	3.8%	Better patient experience

1. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS HCRIS data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

Table 4. Large community hospital performance comparisons

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.82	1.02	-0.20	-19.8%	Lower mortality
	Complications index[1]	0.81	1.00	-0.19	-19.4%	Fewer complications
Process of care	Core measures mean percent[2]	98.4	96.2	2.2	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	12.2	13.0	-0.8	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	14.7	15.5	-0.8	n/a[6]	Fewer 30-day readmissions
Process efficiency	ALOS[1]	4.8	5.0	-0.2	-4.6%	Shorter stays
	ED measure mean minutes[4]	156.2	177.5	-21.3	-12.0%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$5,972	$6,394	-$421	-6.6%	Lower inpatient cost
	MSPB index[4]	1.00	1.01	-0.02	-1.5%	Lower episode cost
Financial health	Operating profit margin[5]	12.8	7.9	4.9	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	272.0	262.0	10.0	3.8%	Better patient experience

1. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS HCRIS data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

Table 5. Medium community hospital performance comparisons

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.73	0.98	-0.26	-26.2%	Lower mortality
	Complications index[1]	0.72	0.97	-0.26	-26.3%	Fewer complications
Process of care	Core measures mean percent[2]	98.9	96.6	2.3	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	12.5	13.1	-0.7	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	15.1	15.6	-0.4	n/a[6]	Fewer 30-day readmissions
Process efficiency	ALOS[1]	4.2	5.0	-0.8	-16.4%	Shorter stays
	ED measure mean minutes[4]	135.2	157.7	-22.5	-14.3%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$5,991	$6,506	-$516	-7.9%	Lower inpatient cost
	MSPB index[4]	0.97	1.00	-0.03	-3.0%	Lower episode cost
Financial health	Operating profit margin[5]	18.7	4.7	14.0	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	272.0	261.0	11.0	4.2%	Better patient experience

1. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS HCRIS data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

Table 6. Small community hospital performance comparisons

Domain	Performance measures	Medians		Benchmark compared with peer group		
		Benchmark hospitals (winners)	Peer hospitals (nonwinners)	Difference	Percent difference	Comments
Inpatient outcomes	Inpatient mortality index[1]	0.51	1.02	-0.51	-49.9%	Lower mortality
	Complications index[1]	0.58	0.89	-0.31	-35.1%	Fewer complications
Process of care	Core measures mean percent[2]	99.7	97.7	2.0	n/a[6]	Greater care compliance
Extended outcomes	30-day mortality rate[3]	12.3	13.0	-0.7	n/a[6]	Lower 30-day mortality
	30-day readmission rate[3]	14.6	15.1	-0.4	n/a[6]	Fewer 30-day readmissions
Process efficiency	ALOS[1]	4.3	5.0	-0.7	-14.4%	Shorter stays
	ED measure mean minutes[4]	123.8	135.0	-11.2	-8.3%	Less time-to-service
Cost efficiency	Inpatient expense per discharge[5]	$6,234	$7,163	-$929	-13.0%	Lower inpatient cost
	MSPB index[4]	0.90	0.95	-0.05	-5.8%	Lower episode cost
Financial health	Operating profit margin[5]	16.0	2.6	13.4	n/a[6]	Higher profitability
Patient experience	HCAHPS score[4]	274.0	264.0	10.0	3.8%	Better patient experience

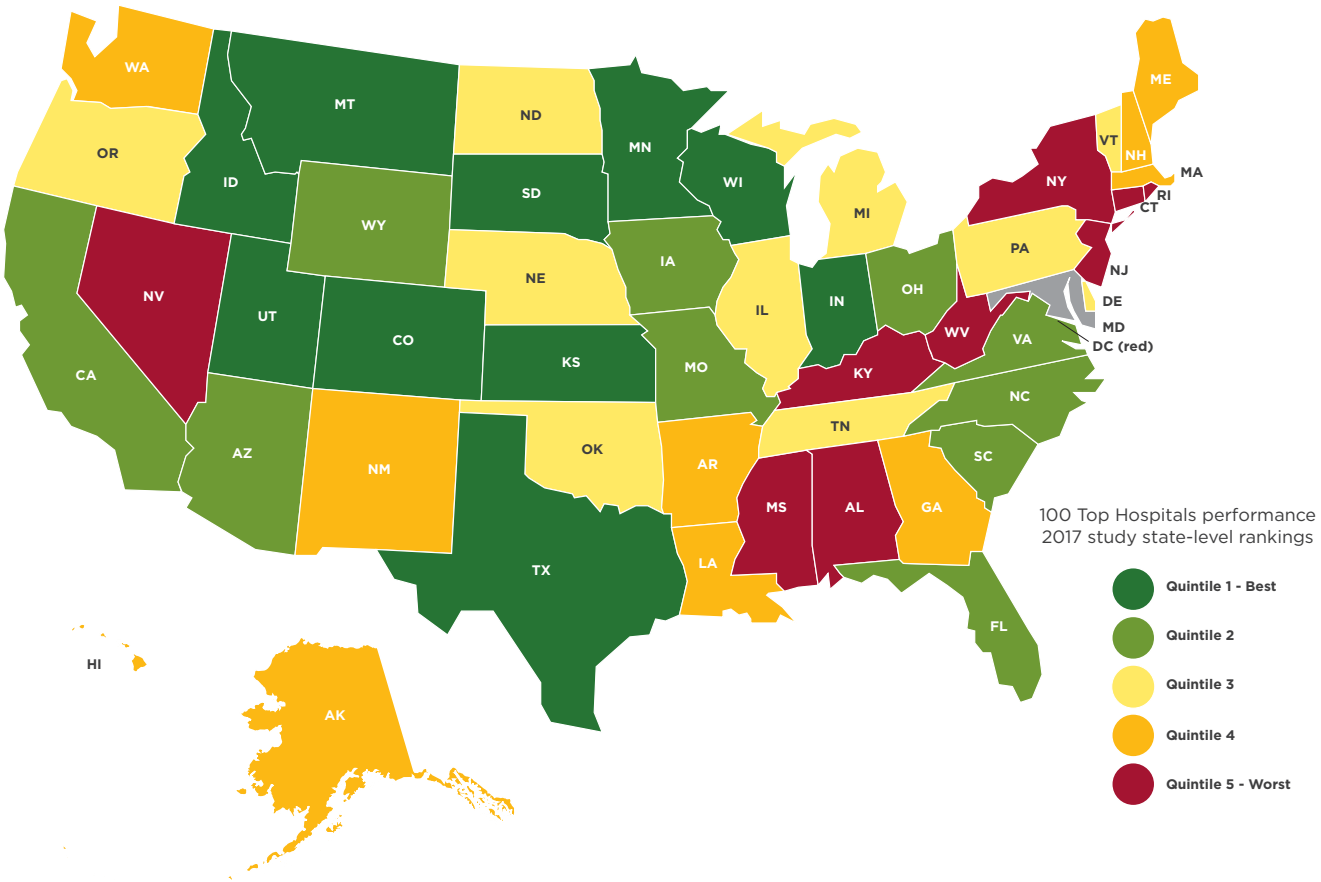
1. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).
2. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
3. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
4. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
5. Inpatient expense and operating profit margin data from CMS HCRIS data file, 2015.
6. We do not calculate percent difference for this measure because it is already a percent value.

US map and states by region

The US maps, (Figures 1 and 2), provide a visual representation of the variability in performance across the country for the current and previous studies (2017 and 2016). Additionally, Table 7 shows each state's rank quintile performance, grouped by geographic region, for the current and previous studies. To produce this data, we calculated the 100 Top Hospitals measures at the state level*, ranked each measure, then weighted and summed the ranks to produce an overall state performance score. States were ranked from best to worst on the overall score, and the results were reported as rank quintiles. This analysis allows us to observe geographic patterns in performance. Among our observations:

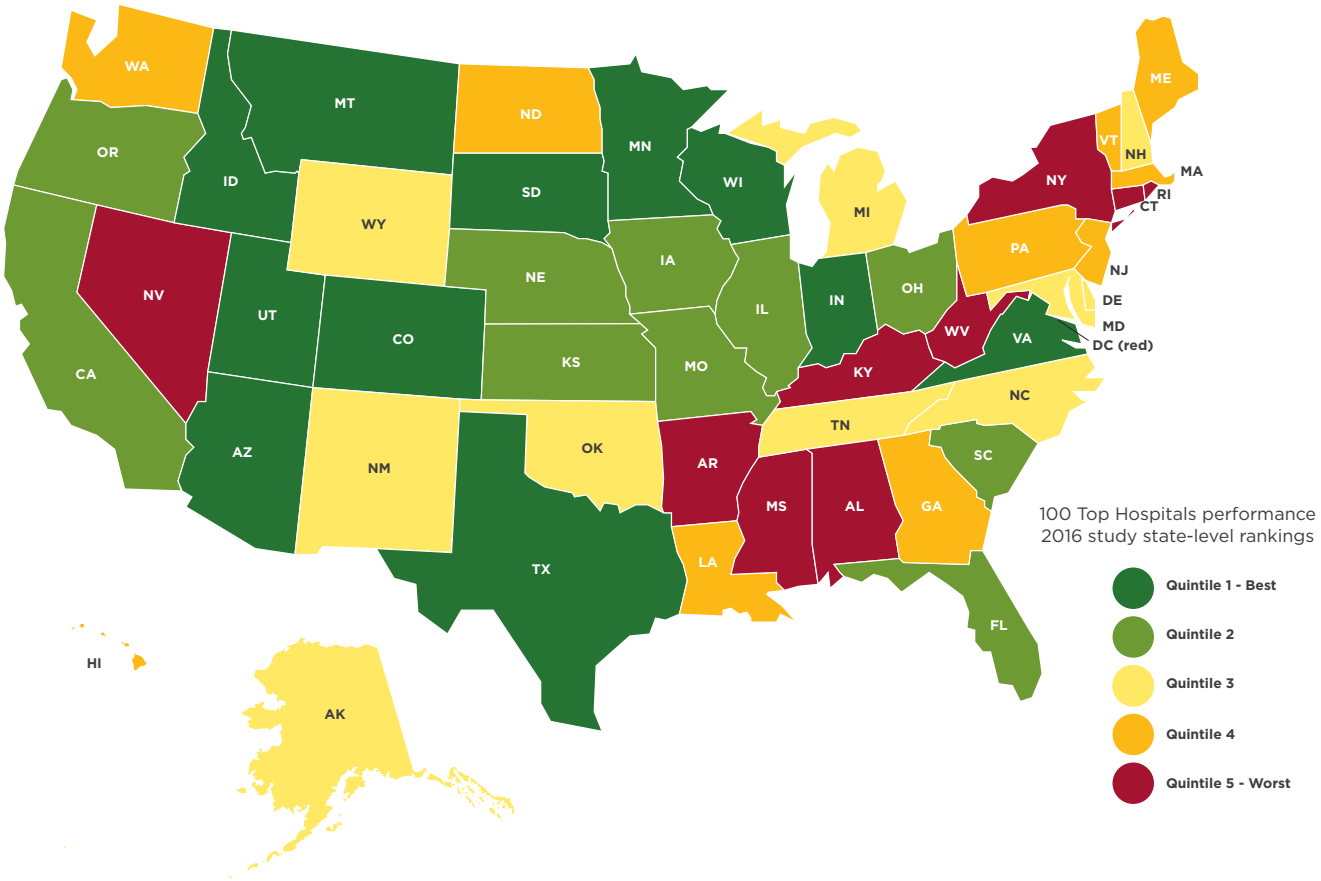
- The Midwest was the front-runner in percentage of states in the top two performance quintiles versus other regions, although this lead has declined (66.7% of states in the 2017 study versus 83.3% in 2016)
- The Midwest was also the only region with no hospitals in the bottom performance quintile in both years
- The Northeast showed the poorest performance overall, by a large margin in both years, with 77.8% of its states in the bottom two quintiles in 2017 and 88.9% in 2016
- In addition, the Northeast was the only region with no hospitals in the top two quintiles for both years

Figure 1. State-level performance comparisons, 2017 study



State data note: The 2017 state findings were based on the 100 Top Hospitals measure methodologies, using 2014 and 2015 MEDPAR data (combined) for inpatient mortality and complications; July 1, 2012 - June 30, 2015, for 30-day rates and 2015 data for all other measures.

Figure 2. State-level performance comparisons, 2016 study



State data note: The 2016 state findings were based on the 100 Top Hospitals measure methodologies, using 2013 and 2014 MEDPAR data (combined) for inpatient mortality and complications; July 1, 2011 - June 30, 2014 for 30-day rates, and 2014 data for all other measures.

* Each state measure is calculated from the acute care hospital data for that state. Mortality, complications, and ALOS are aggregated from MEDPAR patient record data. Core measures, 30-day mortality, and 30-day readmission rates are aggregated from the numerator and denominator data for each hospital. Inpatient expense per discharge, operating profit margin, MSPB index, and HCAHPS scores are hospital values weighted by the number of acute discharges at each hospital; mean ED throughput is weighted by the ED visits at each hospital. For expense, profit, MSPB, HCAHPS, and ED throughput, a mean weighted value is calculated for each state by summing the weighted hospital values and dividing by the sum of the weights. To calculate the state overall score, individual measure ranks are weighted, using the same measure rank weights as in the 100 Top Hospitals study, then summed.

Table 7. 100 Top Hospitals two-year state-level performance comparisons

Northeast		Midwest		South		West	
Current study	**Previous study**	**Current study**	**Previous study**	**Current study**	**Previous study**	**Current study**	**Previous study**
Connecticut	Connecticut	Illinois	Illinois	Alabama	Alabama	Alaska	Alaska
Maine	Maine	Indiana	Indiana	Arkansas	Arkansas	Arizona	Arizona
Massachusetts	Massachusetts	Iowa	Iowa	Delaware	Delaware	California	California
New Hampshire	New Hampshire	Kansas	Kansas	District of Columbia	District of Columbia	Colorado	Colorado
New Jersey	New Jersey	Michigan	Michigan	Florida	Florida	Hawaii	Hawaii
New York	New York	Minnesota	Minnesota	Georgia	Georgia	Idaho	Idaho
Pennsylvania	Pennsylvania	Missouri	Missouri	Kentucky	Kentucky	Montana	Montana
Rhode Island	Rhode Island	Nebraska	Nebraska	Louisiana	Louisiana	Nevada	Nevada
Vermont	Vermont	North Dakota	North Dakota	*	Maryland	New Mexico	New Mexico
		Ohio	Ohio	Mississippi	Mississippi	Oregon	Oregon
		South Dakota	South Dakota	North Carolina	North Carolina	Utah	Utah
		Wisconsin	Wisconsin	Oklahoma	Oklahoma	Washington	Washington
				South Carolina	South Carolina	Wyoming	Wyoming
				Tennessee	Tennessee		
				Texas	Texas		
				Virginia	Virginia		
				West Virginia	West Virginia		

Quintile 1 - Best
Quintile 2
Quintile 3
Quintile 4
Quintile 5 - Worst

* Maryland is not displayed in the table under the South region for current study due to missing 30-day outcome measures statewide.

Performance improvement over time: All hospitals

By studying the direction of performance change of all hospitals in our study (winners and nonwinners), we can see that US hospitals have not been able to significantly improve performance across the entire balanced scorecard of performance measures (Table 8). However, over the years we studied (2011 through 2015), many hospitals have been able to raise the performance bar for a number of clinical and operational measures (see green column in Table 8):

- Nearly 52% of hospitals significantly improved their 30-day readmission rates, likely a result of the attention these measures are getting in payment systems.
- 21% of hospitals significantly improved their inpatient mortality, and the great majority of hospitals (91%) had no change in their 30-day mortality rates over the same time period, which is a promising sign of improvement in mortality.
- Even for complications, which has been a volatile measure over the years, 12.3% of hospitals significantly improved while only 1.3% declined in their performance.
- Nearly 18% of hospitals made significant strides in improving ALOS.
- While 19.2% of the hospitals studied had a significant increase in inpatient expense per discharge (declining performance), it is worth noting that 78.6% of hospitals held their costs steady, which was a significant achievement as this measure was not adjusted for inflation.

For the remainder of the measures, the majority of hospitals in the study had no statistically significant change in performance (yellow column in Table 8).

Table 8. Direction of performance change for all hospitals in study, 2011–2015

Performance measure	Significantly improving performance		No statistically significant change in performance		Significantly declining performance	
	Count of hospitals[1]	Percent of hospitals[2]	Count of hospitals[1]	Percent of hospitals[2]	Count of hospitals[1]	Percent of hospitals[2]
Risk-adjusted inpatient mortality index	564	20.9%	2,134	79.0%	4	0.1%
Risk-adjusted complication index	333	12.3%	2,334	86.4%	35	1.3%
30-day mortality rate	6	0.2%	2,453	90.8%	243	9.0%
30-day readmission rate	1394	51.6%	1,304	48.3%	4	0.1%
Severity-adjusted ALOS	484	17.9%	2,058	76.2%	160	5.9%
ED throughput (minutes)	159	5.9%	2,315	85.7%	228	8.4%
Adjusted inpatient expense per discharge	60	2.2%	2,110	78.6%	515	19.2%
MSPB index	86	3.2%	2,502	93.4%	90	3.4%
Operating profit margin	229	8.5%	2,315	86.0%	148	5.5%
HCAHPS score	363	13.4%	2,240	82.9%	99	3.7%

1. Count refers to the number of in-study hospitals whose performance fell into the highlighted category on the measure.
Note: Total number of hospitals included in the analysis will vary by measure due to exclusion of interquartile range outlier data points. Inpatient expense and profit are affected. Some in-study hospitals had too few data points remaining to calculate trend.
2. Percent is of total in-study hospitals across all peer groups.

Test metrics: Reported for information only

Every year, we evaluate the 100 Top Hospitals study and explore whether new measures would enhance the value of the analysis we provide. For this 2017 study, we are testing new performance measures that update basic standards of inpatient care and expand the balanced scorecard across the continuum of care. If you would like to provide feedback on these proposed measures, email **100tophospitals@truvenhealth.com**.

Healthcare-associated infection (HAI) measures — The HAIs reported by CMS in the public Hospital Compare data set capture important new information about the quality of inpatient care. Tracking and intervening to reduce infection rates for methicillin-resistant staphylococcus aureus (MRSA), central line-associated blood stream infections (CLABSI), catheter-associated urinary tract infection (CAUTI), Clostridium difficile colitis (C.diff), and other problem infections are becoming an important focus in hospitals. New public data will allow the development of national benchmarks for use by hospital leadership to affect change. The reported data period is calendar year 2015.

30-day mortality and readmission measures — We are publishing the following 30-day measures that CMS is publicly reporting in the Hospital Compare data set: coronary artery bypass graft (CABG) 30-day mortality and 30-day readmission measures, and the hospital-wide 30-day readmission measure. The data period for CABG is the same as for the other 30-day metrics: July 1, 2012 - June 30, 2015. The data period for the hospital-wide readmission measure is July 1, 2014 - June 30, 2015.

30-day episode-of-care payment measures — Risk-standardized payments associated with 30-day episode-of-care measures for three patient groups are now being published by CMS in the Hospital Compare data set. These new measures capture differences in services and supplies provided to patients who have been diagnosed with AMI, HF, or pneumonia. According to the CMS definition of these new measures, they are the sum of payments made for care and supplies starting the day the patient enters the hospital and for the next 30 days. The data period for these measures is the same as for the other 30-day metrics for specific patient conditions: three years, combined (July 1, 2012 - June 30, 2015).

Table 9 shows the national performance of benchmark and peer hospitals on the test metrics. Key findings include the following:

- Consistent with the findings for the 30-day rates included in the 2017 study, we see that 100 Top Hospitals had lower rates than peers on the CABG and hospital-wide test measures
- However, the benchmark hospitals did not outperform peers on several HAIs (surgical site infection [SSI]-hysterectomy, MRSA, and C.diff); the exception was SSI-colon
- For 30-day episode cost, winners had lower costs than nonwinners in all three patient groups (AMI, HF, and pneumonia)

Table 9. National performance comparisons (all hospitals)

Performance measure	Medians		Benchmark compared with peer group		
	Winning benchmark hospitals	Nonwinning peer group of US hospitals	Difference	Percent difference	Comments
30-Day CABG mortality rate[1]	3.1	3.2	-0.1	n/a[4]	Lower 30-day mortality
30-Day CABG readmission rate[1]	14.0	14.4	-0.4	n/a[4]	Fewer 30-day readmissions
30-Day hospital-wide readmission rate[2]	14.8	15.6	-0.8	n/a[4]	Fewer 30-day readmissions
Central line-associated blood stream infections (CLABSI)[3]	0.5	0.5	0.0	n/a[4]	No difference
Catheter-associated urinary tract infections (CAUTI)[3]	0.5	0.5	0.0	n/a[4]	No difference
Surgical site infection from colon surgery[3]	0.8	0.9	0.0	n/a[4]	Fewer infections
Surgical site infection from abdominal hysterectomy[3]	1.0	0.7	0.3	n/a[4]	More infections
Methicillin-resistant staphylococcus aureus (MRSA-bloodstream)[3]	0.9	0.8	0.1	n/a[4]	More infections
Clostridium difficile (C.diff.-intestinal)[3]	0.9	0.8	0.1	n/a[4]	More infections
AMI 30-day episode payment[1]	$22,704	$22,959	-255.0	-1.1%	Lower episode cost
HF 30-Day episode payment[1]	$15,991	$15,998	-7.5	0.0%	Lower episode cost
Pneumonia 30-day episode payment[1]	$14,689	$14,747	-58.0	-0.4%	Lower episode cost

1. 30-day mortality, 30-day readmissions, and 30-day episode payment metrics from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.
2. 30-day hospital-wide readmission rate from CMS Hospital Compare July 1, 2014 - June 30, 2015, data set.
3. HAIs from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.
4. We do not calculate percent difference for this measure because it is already a percent value.

Methodology

Truven Health 100 Top Hospitals® is a quantitative study that annually identifies 100 US hospitals with the highest achievement on a balanced scorecard. The 100 Top Hospitals scorecard, based on Norton and Kaplan's[1] concept, consists of 11 measures distributed across seven domains (inpatient outcomes, process of care, extended outcomes, process efficiency, cost efficiency, financial health, and patient experience) and uses only publicly available data. The hospitals with the highest ranking on a composite score of the 11 measures are the highest-achieving hospitals in the study. This 100 Top Hospitals study includes only short-term, nonfederal, acute care US hospitals that treat a broad spectrum of patients.

The main steps we take in selecting the 100 Top Hospitals are:

- Building the database of hospitals, including special selection and exclusion criteria
- Classifying hospitals into comparison groups by size and teaching status
- Scoring hospitals on a balanced scorecard of 11 performance measures across seven domains
- Determining 100 Top Hospitals by ranking hospitals relative to their comparison groups

The following section is intended to be an overview of these steps. To request more detailed information on any of the study methodologies outlined here, email **100tophospitals@truvenhealth.com** or call 1-800-366-7526.

Note: This section details the methods used to determine the 100 Top Hospitals award winners. For details on the methods used to select the Everest Award winners, see the Everest Awards section of this document.

Building the database of hospitals

The publicly available data used for this study primarily come from:

- Medicare Provider Analysis and Review (MEDPAR) data set
- Medicare Hospital Cost Reports (all-payer)
- Centers for Medicare & Medicaid Services (CMS) Hospital Compare data sets

We use MEDPAR patient-level demographic, diagnosis, and procedure information to calculate inpatient mortality, complications, and length of stay (LOS). The MEDPAR data set contains information on the approximately 15 million Medicare patients discharged annually from US acute care hospitals. In this study, we used the most recent two federal fiscal years of MEDPAR data available (2014 and 2015), which include Medicare Advantage (HMO) encounters*. Hospitals that file Medicare claims jointly with other hospitals under one provider number are analyzed as one organization. Six years of MEDPAR data is used to develop the study trend database (2010 - 2015). In this 2017 study, we used the two most recent years of MEDPAR data available (2014 and 2015) to identify current performance and to select the winning hospitals. To be included in the study, a hospital must have both years of data available, with valid present-on-admission (POA) coding.

We, like a multitude of highly respected academic researchers, have used the MEDPAR database for many years. We believe it to be an accurate and reliable source for the types of high-level analyses performed in this study. Performance based on Medicare data has been found to be highly representative of both the inpatient all-payer and the inpatient medical-surgical populations.

Note: To choose the Everest Award winners, we also reviewed the most recent five years of data, 2011 through 2015, to study the rate of change in performance through the years. To read more about the Everest Award methodology, see the special Everest Award section of this document. For specific data sources for each performance measure, see the table on page 38.

We use Medicare Cost Reports to create our 100 Top Hospitals database, which contains hospital-specific demographic information and hospital-specific, all-payer revenue and expense data. The Medicare Cost Report is filed annually by every US hospital that participates in the Medicare program. Hospitals are required to submit cost reports to receive reimbursement from Medicare. It should be noted that the Medicare Cost Report includes all hospital costs, not just costs associated with Medicare beneficiaries.

The Medicare Cost Report promotes comparability of costs and efficiency among hospitals in reporting. We used hospital 2015 cost reports published in the federal Healthcare Cost Report Information System (HCRIS) third-quarter 2016 data set for this study. If we did not have a complete 2015 cost report for a hospital, we excluded the hospital from the study.

* The MEDPAR data years quoted in 100 Top Hospitals are federal fiscal years, a year that begins on October 1 of each calendar year and ends on September 30 of the following calendar year. Federal fiscal years (FFY) are identified by the year in which they end (for example, FFY 2015 begins October 1, 2014, and ends September 30, 2015). Data for all CMS Hospital Compare measures is provided in calendar years, with the exception of the 30-day rates. CMS publishes the 30-day rates as three-year combined data values. We label these data points based on the end date of each data set. For example, July 1, 2012 - June 30, 2015, is named "2015."

In this study, we used CMS Hospital Compare data sets published in the third quarter of 2016 for core measures, 30-day mortality rates, 30-day readmission rates, emergency department (ED) throughput measures, Medicare spend per beneficiary index, and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient experience-of-care data. We used the 2015 data point to identify current performance and to select the winning hospitals. Five data points, 2011 through 2015, were used to develop the study trend database.

We also used residency program information to classify hospitals. This comes from the American Medical Association (Accreditation Council for Graduate Medical Education (ACGME)-accredited programs) and the American Osteopathic Association (AOA)*.

Risk- and severity-adjustment models

The Truven Health Analytics®, IBM Watson Health™ proprietary risk- and severity-adjustment models for inpatient mortality, complications, and LOS have been recalibrated this release using FFY 2014 data available in the all-payer Truven Health Projected Inpatient Data Base (PIDB). The PIDB is one of the largest US inpatient, all-payer databases of its kind, containing approximately 23 million inpatient discharges annually, obtained from approximately 3,700 hospitals, which comprise more than 65% of the nonfederal US market. Truven Health risk- and severity-adjustment models take advantage of available POA coding that is reported in all-payer data. Only patient conditions that are present on admission are used to determine the probability of death, complications, or the expected LOS.

The recalibrated models were used in producing the risk-adjusted inpatient mortality and complications indexes, based on two years of MEDPAR data (2014 and 2015). The severity-adjusted LOS was produced based on MEDPAR 2015 data.

Present-on-admission coding adjustments

From 2010 through 2015, we have observed a significant rise in the number of principal diagnosis (PDX) and secondary diagnosis (SDX) codes that do not have a valid POA indicator code in the MEDPAR data files. Since 2011, an invalid code of "0" has been appearing. This phenomenon has led to an artificial rise in the number of complications that appear to be occurring during the hospital stay. See Appendix C for details.

To correct for this bias, we adjusted MEDPAR record processing through our mortality and complications risk models, and LOS severity-adjustment model, as follows:

1. We treated all diagnosis codes on the CMS exempt list as "exempt," regardless of POA coding
2. We treated all principal diagnoses as present on admission
3. We treated secondary diagnoses where POA indicator codes "Y" or "W" appeared more than 50% of the time in the Truven Health all-payer database as present on admission when a POA indicator code of "0" was found

* We obtain ACGME program data from the American Medical Association (AMA). This year's study is based on the ACGME file received from the AMA in May 2013. AOA residency information is collected from the AOA website (http://opportunities.osteopathic.org/). This file was last updated in May 2013. ACGME updates are no longer available and alternative classification data sourcing is being explored.

Hospital exclusions

After building the database, a total of 3,251 short-term, general, acute care US hospitals were available in the MEDPAR 2015 data file. This was our starting population, prior to applying hospital exclusions to avoid skewing study results. Excluded from the study were:

- Specialty hospitals (that is, critical access, children's, women's, psychiatric, substance abuse, rehabilitation, cardiac, orthopedic, heart, cancer, and long-term acute care)
- Federally owned hospitals
- Non-US hospitals (such as those in Puerto Rico, Guam, and the US Virgin Islands)
- Hospitals with fewer than 25 acute care beds
- Hospitals with fewer than 100 Medicare patient discharges in FFY 2015
- Hospitals with Medicare average LOS longer than 25 days in FFY 2015
- Hospitals with no reported Medicare patient deaths in FFY 2015
- Hospitals for which a 2015 Medicare Cost Report was not available
- Hospitals with a 2015 Medicare Cost Report that was not for a 12-month reporting period
- Hospitals that had fewer than 60% of patient records with valid POA codes
- Hospitals missing data required to calculate performance measures

In addition, specific patient records were also excluded:

- 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
- Rehabilitation, psychiatric, and substance-abuse patients
- Patients with stays shorter than one day

After all exclusions were applied, 2,740 hospitals were included in the study.

Classifying hospitals into comparison groups

Bed size, teaching status, and extent of residency/fellowship program involvement can 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 important to evaluate it against other similar hospitals. To address this, we assigned each hospital to one of five comparison groups, according to its size and teaching status.

Our classification methodology draws a significant distinction between major teaching hospitals and teaching hospitals by reviewing the number and type of teaching programs, and by accounting for level of involvement in physician education and research through evidence of program sponsorship versus simple participation. This methodology de-emphasizes the role of bed size and focuses more on teaching program involvement. Using this approach, we seek to measure both the depth and breadth of teaching involvement and recognize teaching hospitals' tendencies to reduce beds and concentrate on true tertiary care.

Our formula for defining the teaching comparison groups includes each hospital's bed size, residents*-to-acute-care-beds ratio, and involvement in graduate medical education programs accredited by either the ACGME or the AOA. The definition includes both the number of programs and type (sponsorship or participation) of graduate

* We include interns, residents, and fellows reported in FTEs on the hospital cost report.

medical education (GME) program involvement. In this study, AOA residency program involvement is treated as being equivalent to ACGME program sponsorship.

The five comparison groups and their parameters are as follows:

Major teaching hospitals

There are three ways to qualify:

1. 400 or more acute care beds in service, plus a resident*-per-bed ratio of at least 0.25, plus
   - Sponsorship of at least 10 GME programs, or
   - Involvement in at least 20 programs overall
2. Involvement in at least 30 GME programs overall (regardless of bed size or resident*-per-bed ratio)
3. A resident*-per-bed ratio of at least 0.60 (regardless of bed size or GME program involvement)

Teaching hospitals

- 200 or more acute care beds in service, and
- Either a resident*-per-bed ratio of at least 0.03 or involvement in at least three GME programs overall

Large community hospitals

- 250 or more acute care beds in service, and
- Not classified as a teaching hospital per definitions above

Medium community hospitals

- 100 to 249 acute care beds in service, and
- Not classified as a teaching hospital per definitions above

Small community hospitals

- 25 to 99 acute care beds in service, and
- Not classified as a teaching hospital per definitions above

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 hospital operating environment. Throughout the life of the study, we have worked diligently 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 healthcare industry has changed, our methods have evolved. Our current measures are centered on seven main components of hospital performance: inpatient outcomes, process of care, extended outcomes, process efficiency, cost efficiency, financial health, and patient experience.

* We include interns, residents, and fellows reported in FTEs on the hospital cost report.

The 11 measures included in the 2017 study, by performance domain, are:

Inpatient outcomes

1. Risk-adjusted inpatient mortality index
2. Risk-adjusted complications index

Process of care

3. Core measures mean percent (stroke care and blood clot prevention)

Extended outcomes

4. Mean 30-day risk-adjusted mortality rate (includes acute myocardial infarction [AMI], heart failure [HF], pneumonia, chronic obstructive pulmonary disease [COPD], and stroke)
5. Mean 30-day risk-adjusted readmission rate (includes AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke)

Process efficiency

6. Severity-adjusted average length of stay (ALOS)
7. Mean ED throughput (minutes)

Cost efficiency

8. Case mix- and wage-adjusted inpatient expense per discharge
9. Medicare spend per beneficiary (MSPB) index

Financial health

10. Adjusted operating profit margin

Patient experience

11. HCAHPS score (patient rating of overall hospital performance)

Following is the rationale for the selection of our balanced scorecard domains and the measures used for each.

Inpatient outcomes

Our measures of inpatient outcomes include two measures: risk-adjusted mortality index and risk-adjusted complications index. These measures show us how the hospital is performing on the most basic and essential care standards (survival and error-free care) while treating patients in the hospital.

Process of care

We include two groups of core measures: stroke care and blood clot prevention. These measures were developed by The Joint Commission (TJC) and CMS, and endorsed by the National Quality Forum (NQF), as minimum basic process-of-care standards. These measures have included specific guidelines for a wide variety of patient conditions and, as compliance has grown, CMS has retired many and replaced them with new ones. Our core measures score is based on the stroke care and blood clot prevention measures, using Hospital Compare data reported on the CMS website[29]. In this study, we included core measures that CMS mandated for reporting in 2015. See Appendix C for a list.

Extended outcomes

The extended outcomes measures (30-day mortality rates for AMI, HF, pneumonia, COPD, and stroke patients, and 30-day readmission rates for AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke patients) help us understand how the hospital's patients are faring over a longer period[29]. These measures are part of the CMS Hospital Value-Based Purchasing Program and are watched closely in the industry. Hospitals with lower values appear to be providing or coordinating the care continuum with better medium-term results for these conditions.

As hospitals become more interested in contracting for population health management, understanding outcomes beyond the walls of the acute care setting is imperative. We are committed to adding new metrics that assess performance along the continuum of care as they become publicly available.

Process efficiency

The process efficiency domain includes severity-adjusted ALOS and ED throughput measures. ALOS serves as a proxy for clinical efficiency in an inpatient setting, while the ED throughput measures focus on process efficiency in one of the most important access points to hospital care. For ED throughput, we use the mean of the reported median minutes for three critical processes: time from door to admission, time from door to discharge for non-admitted patients, and time to receipt of pain medications for long bone fracture.

ALOS requires adjustment to increase the validity of comparisons across the hospital industry. We use a Truven Health proprietary severity-adjustment model to determine expected LOS at the patient level. Patient-level observed and expected LOS values are used to calculate the hospital-level, severity-adjusted, average LOS.

Cost efficiency

The cost efficiency domain includes inpatient expense per discharge and the MSPB index. We adjust inpatient expense, as reported on the hospital cost report, for patient severity (Medicare case mix index) and area wage levels (CMS area wage index applied to labor cost). These adjustments allow us to more accurately compare hospitals with different levels of patient severity operating in varying cost-of-living environments. See Appendix C for details on the calculation of this measure.

The MSPB index is a new proxy for continuum-of-care performance, recently added to the study. This measure, as defined and calculated by CMS, is the ratio of MSPB treated in a specific hospital and the median MSPB, nationally. It includes Medicare Part A and Part B payments three days prior to the hospital stay, during the stay, and 30 days post-discharge. We believe this indicator can be a beginning point for understanding hospital and local area cost performance relative to hospital peer markets.

Financial health

Currently, we have one measure of hospital financial health: adjusted operating profit margin. The operating profit margin is a measure of management's ability to operate within its current financial constraints and provides an indicator of the hospital's financial health. We adjust operating profit margin for net related organization expense, as reported on the hospital cost report, to provide a more accurate measure of a hospital's profitability. See Appendix C for details on the calculation of this measure.

Previous studies included measures of hospital liquidity and asset management. We retired these measures as more and more hospitals became a part of health systems. Health system accounting practices often recognize hospitals as units of the system, with no cash or investment assets of their own; a typical practice is to transfer revenue up to the health system accounts daily. Moreover, hospitals in health systems are now often reported as having no debt in their own name. Using public data, there is no effective way to accurately measure liquidity or other balance sheet-related measures of financial health.

Patient experience

We believe that a measure of patient perception of care (the patient "experience") is crucial to the balanced scorecard concept. Understanding how patients perceive the care a hospital provides, and how that perception compares and contrasts with perceptions of patients in peer hospitals, is an important step a hospital can take in pursuing performance excellence. For this reason, we calculate an HCAHPS score, based on patient perception-of-care data from the HCAHPS patient survey. In this study, the HCAHPS score is based on the HCAHPS overall hospital rating question only.

A comprehensive, balanced view

Through the combined measures described above, we hope to provide a balanced picture of overall hospital performance, which can be a reflection of leadership's ability to consistently improve performance over time and sustain high performance, once achieved. Full details about each of these performance measures are included on the following pages.

Performance measures

Risk-adjusted inpatient mortality index			
Why we include this element	**Calculation**	**Comment**	**Favorable values are**
Patient survival is a universally accepted measure of hospital quality. The lower the mortality index, the greater the survival of the patients in the hospital, considering what would be expected based on patient characteristics. While all hospitals have patient deaths, this measure can show where deaths did not occur but were expected, or the reverse, given the patient's condition.	We calculate an index value based on the number of actual in-hospital deaths in 2014 and 2015, divided by the number expected, given the risk of death for each patient. We use our proprietary risk-adjusted mortality index model to determine expected deaths. This model is designed to predict the likelihood of a patient's death based on patient-level characteristics (age, sex, presence of complicating diagnoses, and other characteristics). We normalize the expected value based on the observed and expected deaths for each comparison group. We calculate a normalized index based on the observed and normalized expected deaths, and patient count. Palliative care patients (v66.7) are included in the risk model. POA coding is considered in the risk model. Post-discharge deaths are not included. Do not resuscitate (DNR) patients (v49.86) are excluded. For more information, see Appendix C. The reference value for this index is 1.00; a value of 1.15 indicates 15% more deaths occurred than were predicted, and a value of 0.85 indicates 15% fewer deaths than predicted.	We rank hospitals on the difference between observed and expected deaths, expressed in normalized standard deviation units (z-score)[30,31]. Hospitals with the fewest deaths, relative to the number expected, after accounting for standard binomial variability, receive the most favorable scores. We use two years of MEDPAR data (for this study, 2014 and 2015) to reduce the influence of chance fluctuation. The MEDPAR data set includes both Medicare fee-for-service claims and Medicare Advantage (HMO) encounter records. Hospitals with observed values statistically worse than expected (99% confidence), and whose values are above the high trim point, are not eligible to be named benchmark hospitals. For more details, see Appendix C.	Lower

Risk-adjusted complications index

Why we include this element	Calculation	Comment	Favorable values are
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.	We calculate an index value based on the number of cases with complications (for this study) in 2014 and 2015, divided by the number expected, given the risk of complications for each patient. We use our proprietary expected complications risk index models to determine expected complications. 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. We normalize the expected value based on the observed and expected complications for each comparison group. POA coding is considered in the risk model. For more details, see Appendix C. The reference value for this index is 1.00; a value of 1.15 indicates 15% more complications occurred than were predicted, and a value of 0.85 indicates 15% fewer complications than predicted.	We rank hospitals on the difference between the observed and expected number of patients with complications, expressed in normalized standard deviation units (z-score). We use two years of MEDPAR data (for this study, 2014 and 2015) to reduce the influence of chance fluctuation. The MEDPAR data set includes both Medicare fee-for-service claims and Medicare Advantage (HMO) encounter records. Hospitals with observed values statistically worse than expected (99% confidence), and whose values are above the high trim point, are not eligible to be named benchmark hospitals.	Lower

Core measures mean percent

Why we include this element	Calculation	Comment	Favorable values are
To be truly balanced, a scorecard must include various measures of quality. Core measures were developed by TJC and endorsed by the NQF as minimum basic standards. They are a widely accepted method for measuring patient care quality. The reported core measure percent values reflect the percentage of eligible patients who received the expected standard of patient care.	Core measure values are from the CMS Hospital Compare data set. For this study, we included data for Jan. 1, 2015, through Dec. 31, 2015, for stroke care and for blood clot prevention measures. For each hospital, we calculate the arithmetic mean of the included core measure percent values. We consider reported core measure percents with patient counts less than or equal to 25, or with relative standard error values greater than or equal to 0.30, statistically unreliable. In these cases, we substitute the comparison group-specific median percent value for the affected core measure.	We rank hospitals by comparison group, based on the mean core measure percent value for included core measures (stroke care, blood clot prevention). Because of low reporting, we exclude a number of core measures for small community hospitals and medium community hospitals. For a list of the measures used and those excluded, please see Appendix C.	Higher

Mean 30-day risk-adjusted mortality rate (AMI, HF, pneumonia, COPD, and stroke patients)

Why we include this element	Calculation	Comment	Favorable values are
30-day mortality rates are a widely accepted measure of the effectiveness of hospital care. They allow us to look beyond immediate inpatient 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 the CMS Hospital Value-Based Purchasing Program, they are 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 aftercare processes. Hospitals that score well may be better prepared for a pay-for-performance structure.	Data is from the CMS Hospital Compare data set. CMS calculates a 30-day mortality rate (all-cause deaths within 30 days of admission, per 100 patients) for each patient condition using three years of MEDPAR data, combined. For this study, we included data for the July 1, 2012, through June 30, 2015, data set. CMS does not calculate rates for hospitals where the number of cases is too small (less than 25). In these cases, we substitute the comparison group-specific median rate for the affected 30-day mortality measure. For more information about this data, see Appendix C. We calculate the arithmetic mean of the included 30-day mortality rates (AMI, HF, pneumonia, COPD, and stroke).	We rank hospitals by comparison group, based on the mean rate for included 30-day mortality measures (AMI, HF, pneumonia, COPD, and stroke). The CMS Hospital Compare data for 30-day mortality is based on Medicare fee-for-service claims only. For more information, see Appendix C.	Lower

Mean 30-day risk-adjusted readmission rate (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke patients)			
Why we include this element	**Calculation**	**Comment**	**Favorable values are**
30-day readmission rates are a widely accepted measure of the effectiveness of 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. These measures are being watched closely in the industry. 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 aftercare processes. Hospitals that score well may be better prepared for a pay-for-performance structure.	Data is from the CMS Hospital Compare data set. CMS calculates a 30-day readmission rate (all-cause readmissions within 30 days of discharge, per 100 patients) for each patient condition using three years of MEDPAR data, combined. For this study, we included data for the July 1, 2012, through June 30, 2015, data set. CMS does not calculate rates for hospitals where the number of cases is too small (less than 25). In these cases, we substitute the comparison group-specific median rate for the affected 30-day readmission measure. For more information about this data, see Appendix C. We calculate the arithmetic mean of the included 30-day readmission rates (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke).	We rank hospitals by comparison group, based on the mean rate for included 30-day readmission measures (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke).	Lower

Severity-adjusted average length of stay			
Why we include this element	**Calculation**	**Comment**	**Favorable values are**
A lower severity-adjusted average length of stay (LOS) generally indicates more efficient consumption of hospital resources and reduced risk to patients.	For this study, we used 2015 MEDPAR data for this measure. We calculate an LOS index value by dividing the actual LOS by the normalized expected LOS. Expected LOS adjusts for difference in severity of illness using a linear regression model. We normalize the expected values based on the observed and expected LOS of the hospitals in each comparison group. Each hospital LOS index is converted to an average LOS in days by multiplying by the in-study population grand mean LOS. See Appendix C for more information. POA coding is considered in the severity-adjustment model. For more details, see Appendix C.	We rank hospitals on their severity-adjusted ALOS. We severity-adjust ALOS to factor out differences attributable to the varying severity of illness of patients at each hospital.	Lower

Mean emergency department throughput measure			
Why we include this element	**Calculation**	**Comment**	**Favorable values are**
The hospital emergency department (ED) is an important access point to healthcare for many people. A key factor in evaluating ED performance is process "throughput," measures of the timeliness with which patients receive treatment, and either are admitted or discharged. Timely ED processes impact both care quality and the quality of the patient experience.	Data is from the CMS Hospital Compare data set. CMS publishes the median minutes for each throughput measure, by calendar year (for this study, 2015). We include three of the published measures in our calculation of the mean ED throughput measure.	We include three measures that define three important ED processes: time from door to admission, time from door to discharge for non-admitted patients, and time to receipt of pain medications for long bone fracture. For more details, see Appendix C.	Lower

Case mix- and wage-adjusted inpatient expense per discharge

Why we include this element	Calculation	Comment	Favorable values are
This measure helps to determine how efficiently a hospital cares for its patients. Low values indicate lower costs and thus better efficiency.	This measure uses Medicare Cost Report data for hospital cost reports (for this study, reports ending in calendar year 2015). We calculate the inpatient expense per discharge measure by aggregating the cost center-level inpatient expense from the hospital cost report and dividing by the total acute inpatient discharges, adjusted for case mix and area wage indexes. Inpatient expense for each department is calculated from fully allocated cost using the ratio of inpatient charges to total charges. For inpatient nursing units, this will always be 100% of the fully allocated cost. For departments with inpatient and outpatient services, the ratio will vary. Non-reimbursable and special purpose cost centers are omitted as these have no charges for patient care. See Appendix C for detailed calculations and the Medicare Cost Report locations (worksheet, line, and column) for each calculation element.	Adjusted inpatient expense per discharge measures the hospital's average cost of delivering inpatient care on a per-unit basis. The hospital's CMS-assigned case mix index adjusts inpatient expense to account for differences in patient complexity. The CMS area wage index is applied to labor cost only and accounts for geographic differences in cost of living. We rank hospitals on their adjusted inpatient expense per discharge. Hospitals with extreme outlier values for this measure are not eligible to be named benchmark hospitals.	Lower

Medicare spend per beneficiary index

Why we include this element	Calculation	Comment	Favorable values are
Medicare spend per beneficiary (MSPB) helps to determine how efficiently a hospital coordinates the care for its patients across continuum-of-care sites. Lower values indicate lower costs relative to national medians and thus greater efficiency.	We report the hospital index published in the CMS Hospital Compare public data set (for this study, calendar year 2015). CMS aggregates costs associated with the index admission from three days preadmission, through inpatient stay, and 30 days post-discharge. This cost is divided by the median national cost. CMS applies both numerator and denominator adjustments. An index value above 1.0 means higher-than-national median cost per beneficiary. An index value below 1.0 means lower-than-national median cost per beneficiary.	We rank hospitals on the MSPB index. CMS calculates the cost of care for each admitted patient, including both Medicare Part A and Part B costs.	Lower

Adjusted operating profit margin

Why we include this element	Calculation	Comment	Favorable values are
Operating profit margin is one of the most straightforward measures of a hospital's financial health. It is a measure of the amount of income a hospital is taking in versus its expenses.	This measure uses Medicare Cost Report data for hospital cost reports (for this study, reports ending in calendar year 2015). We calculate the adjusted operating profit margin by determining the difference between a hospital's total operating revenue and total operating expense, expressed as a percentage of its total operating revenue, adjusted for net related organization expense. Total operating revenue is the sum of net patient revenue plus other operating revenue. Operating expense is adjusted for net related organization expense. See Appendix C for detailed calculations and the Medicare Cost Report locations (worksheet, line, and column) for each calculation element.	We adjust hospital operating expense for net related organization expense to obtain a true picture of the operating costs. Net related organization expense includes the net of costs covered by the hospital on behalf of another organization and costs covered by another organization on behalf of the hospital. We rank hospitals on their adjusted operating profit margin. Hospitals with extreme outlier values for this measure are not eligible to be named benchmark hospitals.	Higher

Hospital Consumer Assessment of Healthcare Providers and Systems score (overall hospital rating)			
Why we include this element	**Calculation**	**Comment**	**Favorable values are**
We believe that including a measure of patient assessment/perception of care is crucial to the balanced scorecard concept. How patients perceive the care a hospital provides has a direct effect on its ability to remain competitive in the marketplace.	Data is from the CMS Hospital Compare data set. For this study, we included the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) results for calendar year 2015. We use the HCAHPS survey instrument question, "How do patients rate the hospital, overall?" to score hospitals. Patient responses fall into three categories, and the number of patients in each category is reported as a percent: ▪ Patients who gave a rating of 6 or lower (low) ▪ Patients who gave a rating of 7 or 8 (medium) ▪ Patients who gave a rating of 9 or 10 (high) For each answer category, we assign a weight as follows: 3 equals high or good performance, 2 equals medium or average performance, and 1 equals low or poor performance. We then calculate a weighted score for each hospital by multiplying the HCAHPS answer percent by the category weight. For each hospital, we sum the weighted percent values for the three answer categories. The result is the HCAHPS score.	We rank hospitals based on the weighted percent sum or HCAHPS score. The highest possible HCAHPS score is 300 (100% of patients rate the hospital high). The lowest HCAHPS score is 100 (100% of patients rate the hospital low). See Appendix C for full details. HCAHPS data is survey data, based on either a sample of hospital inpatients or all inpatients. The data set contains the question scoring of survey respondents.	Higher

Data sources and periods		
Performance measure	**Current performance (100 Top Hospitals award selection)**	**Five-year trend performance**
Risk-adjusted inpatient mortality index	MEDPAR federal fiscal year (FFY) 2014 and 2015*	MEDPAR Federal Fiscal Year (FFY) 2010 - 2015*
Risk-adjusted complications index	MEDPAR FFY 2014 and 2015*	MEDPAR FFY 2010 - 2015*
Core measures mean percent (stroke care, blood clot prevention)	CMS Hospital Compare calendar year (CY) 2015	Trend not available
Mean 30-day mortality rate** (AMI, HF, pneumonia, COPD, stroke)	CMS Hospital Compare July 1, 2012 - June 30, 2015	CMS Hospital Compare: Three-year data sets ending June 30 in 2011, 2012, 2013, 2014, 2015
Mean 30-day readmission rate*** (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, stroke)	CMS Hospital Compare July 1, 2012 - June 30, 2015	CMS Hospital Compare: Three-year data sets ending June 30 in 2011, 2012, 2013, 2014, 2015
Severity-adjusted ALOS	MEDPAR FFY 2015	MEDPAR FFY 2011–2015
Mean ED throughput measure	CMS Hospital Compare CY 2015	CMS Hospital Compare CY 2012, FFY 2013, CY 2014, CY 2015 (CY 2013 not published)
Inpatient expense per discharge (case mix- and wage-adjusted)	HCRIS Medicare Cost reports ending in 2015	HCRIS Medicare Cost Reports ending in 2011 - 2015
MSPB index	CMS Hospital Compare CY 2015	CMS Hospital Compare CY 2012 - 2015
Adjusted operating profit margin	HCRIS Medicare Cost reports ending in 2015	HCRIS Medicare Cost Reports ending in 2011 - 2015
HCAHPS score (overall hospital rating)	CMS Hospital Compare CY 2015	CMS Hospital Compare CY 2011 - 2015

* Two years of data is combined for each study year data point.
** Trend data for 30-day mortality does not include COPD or stroke.
*** Trend data for 30-day mortality does not include hip/knee arthroplasty, COPD, or stroke.

Determining the 100 Top Hospitals

Eliminating outliers

Within each of the five hospital comparison groups, we rank hospitals based on their performance on each of the measures relative to other hospitals in their group. Prior to ranking, we use three methods of identifying hospitals that were performance outliers. These hospitals are not eligible to be named winners.

Interquartile range methodology

We use the interquartile range methodology to identify hospitals with extreme outlier values for the following measures:

- Case mix- and wage-adjusted inpatient expense per discharge (high or low outliers)
- Adjusted operating profit margin (high and low outliers)

This is done to avoid the possibility of hospitals with a high probability of having erroneous cost report data being declared winners.

For more information on the interquartile range methodology, see Appendix C.

Mortality and complications outliers

For mortality and complications, which have observed and expected values, we identify hospitals with performance that is statistically worse than expected. Hospitals that are worse than expected are excluded from consideration when we select the study winners. This is done because we do not want hospitals that have poor clinical outcomes to be declared winners.

A hospital is winner-excluded if both of the following conditions apply:

1. Observed value is higher than expected and the difference is statistically significant with 99% confidence. When a hospital's observed value is 30 or greater, we use the approximate binomial confidence interval methodology. When a hospital's observed value is less than 30, we use the exact mid-p binomial confidence interval methodology. If the hospital's low confidence interval index value is greater than or equal to 1.0, the hospital is statistically worse than expected with 99% confidence.
2. We calculate the 75th percentile index value for mortality and complications, including data only for hospitals that meet condition 1. These values are used as the high trim points for those hospitals. Hospitals with mortality or complications index values above the respective trim points are winner-excluded.

Hospitals with a negative operating profit margin

We identify hospitals with a negative adjusted operating profit margin as outliers. This is done because we do not want hospitals that fail to meet this basic financial responsibility to be declared winners.

Ranking

Within the five hospital comparison groups, we rank hospitals on the basis of their performance on each of the performance measures independently, relative to other hospitals in their comparison group. Each performance measure is assigned a weight for use in overall ranking (see table below). Each hospital's weighted performance measure ranks are summed to arrive at a total score for the hospital. The hospitals are then ranked based on their total scores, and the hospitals with the best overall rankings in each comparison group are selected as the winners.

Measure	Weight
Risk-adjusted inpatient mortality index	1
Risk-adjusted complications index	1
Core measures mean percent (stroke care, blood clot prevention)	1
Mean 30-day mortality rate (AMI, HF, pneumonia, COPD, stroke)	1
Mean 30-day readmission rate (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, stroke)	1
Severity-adjusted ALOS	1
Mean ED throughput measure	1
Inpatient expense per discharge (case mix- and wage-adjusted)	½
MSPB index	½
Adjusted operating profit margin	1
HCAHPS score (overall hospital rating)	1

This study hospital population includes:

Comparison group	Number of winners	Number of nonwinners	Total hospitals in study
Major teaching hospitals	15	189	204
Teaching hospitals	25	420	445
Large community hospitals	20	292	312
Medium community hospitals	20	913	933
Small community hospitals	20	826	846
All hospitals	**100**	**2,640**	**2,740**

Appendix A

Distribution of winners by state and region

State	Number of winners	
	Current study	Previous study
Alabama	0	0
Alaska	0	0
Arizona	1	1
Arkansas	0	0
California	3	8
Colorado	5	3
Connecticut	0	0
Delaware	0	1
District of Columbia	0	0
Florida	6	4
Georgia	3	1
Hawaii	0	0
Idaho	3	2
Illinois	7	8
Indiana	7	4
Iowa	1	3
Kansas	0	2
Kentucky	0	0
Louisiana	2	1
Maine	0	0
Maryland*	0	0
Massachusetts	1	0
Michigan	10	7
Minnesota	5	4
Mississippi	0	0
Missouri	3	2
Montana	2	2
Nebraska	0	0
Nevada	0	1
New Hampshire	0	0
New Jersey	0	0

State	Number of winners	
	Current study	Previous study
New Mexico	0	0
New York	0	1
North Carolina	1	2
North Dakota	0	0
Ohio	6	11
Oklahoma	1	0
Oregon	1	1
Pennsylvania	4	3
Rhode Island	0	0
South Carolina	3	3
South Dakota	0	0
Tennessee	2	2
Texas	8	8
Utah	6	6
Vermont	0	0
Virginia	3	1
Washington	1	1
West Virginia	0	0
Wisconsin	5	7
Wyoming	0	0

Census region	Number of winners	
	Current study	Previous study
Northeast	5	4
Midwest	44	48
South	29	23
West	22	25

* Maryland hospitals were excluded from the study for missing Medicare spend per beneficiary (MSPB) and 30-day mortality and readmission measures.

Appendix B

States included in each US Census region

Northeast	Midwest	South	West
Connecticut	Illinois	Alabama	Alaska
Maine	Indiana	Arkansas	Arizona
Massachusetts	Iowa	Delaware	California
New Hampshire	Kansas	District of Columbia	Colorado
New Jersey	Michigan	Florida	Hawaii
New York	Minnesota	Georgia	Idaho
Pennsylvania	Missouri	Kentucky	Montana
Rhode Island	Nebraska	Louisiana	Nevada
Vermont	North Dakota	Maryland	New Mexico
	Ohio	Mississippi	Oregon
	South Dakota	North Carolina	Utah
	Wisconsin	Oklahoma	Washington
		South Carolina	Wyoming
		Tennessee	
		Texas	
		Virginia	
		West Virginia	

Appendix C: Methodology details

Methods for identifying patient severity

Without adjusting for differences in patient severity, comparing outcomes among hospitals does not present an accurate picture of performance. To make valid normative comparisons of hospital outcomes, we must adjust raw data to accommodate differences that result from the variety and severity of admitted cases.

Truven Health Analytics®, IBM Watson Health™, 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 (that is, 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[32–36].

To support the transition from ICD-9-CM to ICD-10-CM, our risk- and severity-adjustment models have been modified to use the Agency for Healthcare Research and Quality (AHRQ) Clinical Classifications System (CCS)[37] categories for risk assignment. CCS categories are defined in both coding languages with the intent of being able to accurately compare ICD-9 categories with ICD-10 categories. Calibrating our models using CCS categories provides the flexibility to accept and process patient record data in either ICD-9 or ICD-10 coding formats and produces consistent results in risk and severity adjustment.

The CCS-based approach applies to all Truven Health proprietary models that use code-based rate tables, which include the Risk-Adjustment Mortality Index, Expected Complication Risk Index, and Expected Resource Demand (PFD/ERD) Length of Stay (LOS) models used in this study.

Normative database development

Truven Health constructed a normative database of case-level data from its Projected Inpatient Data Base (PIDB), a national all-payer database containing more than 23 million all-payer discharges annually. This data is obtained from approximately 3,700 hospitals, representing over 65% of all discharges from short-term, general, nonfederal hospitals in the US. PIDB discharges are statistically weighted to represent the universe of all short-term, general, nonfederal hospitals in the US demographic, and clinical data is also included: age, sex, and LOS; clinical groupings (Medicare Severity Diagnosis Related Groups, or MS-DRGs), ICD-9-CM principal and secondary diagnoses and procedures; present-on-admission (POA) coding; admission source and type; and discharge status. For this study, risk models were recalibrated using federal fiscal year (FFY) 2014 all-payer data.

Use of present-on-admission data

Under the Deficit Reduction Act of 2005, as of FFY 2008, hospitals receive reduced payments for cases with certain conditions, such as falls, surgical site infections, and pressure ulcers, which were not present at the time of the patient's admission but occurred during hospitalization. As a result, the Centers for Medicare & Medicaid Services (CMS) now requires all Inpatient Prospective Payment System (IPPS) hospitals to document whether a patient has these and other conditions when admitted. The Truven Health proprietary risk-adjustment models for mortality, complications, and LOS take into account POA data reported in the all-payer data. Our risk models develop expected values based only on conditions that were present on admission.

In addition to considering the POA indicator codes in calibration of our risk- and severity-adjustment models, we also have adjusted for missing/invalid POA coding found in the Medicare Provider Analysis and Review (MEDPAR) data files. From 2010 through 2015, we have observed a significant rise in the number of principal diagnosis (PDX) and secondary diagnosis (SDX) codes that do not have a valid POA indicator code in the MEDPAR data files. Since 2011, an invalid code of "0" has been appearing. This phenomenon has led to an artificial rise in the number of conditions that appear to be occurring during the hospital stay, as invalid POA codes are treated as "not present" by POA-enabled risk models.

Percentage of diagnosis codes with POA indicator code of "0" by MEDPAR year						
	2010	2011	2012	2013	2014	2015
Principal diagnosis	0.00%	4.26%	4.68%	4.37%	3.40%	4.99%
Secondary diagnosis	0.00%	15.05%	19.74%	22.10%	21.58%	23.36%

To correct for this bias, we adjusted MEDPAR record processing through our mortality, complications, and LOS risk models as follows:

1. We treated all diagnosis codes on the CMS exempt list as "exempt," regardless of POA coding
2. We treated all principal diagnoses as present on admission
3. We treated secondary diagnoses where POA code "Y" or "W" appeared more than 50% of the time in the Truven Health all-payer database as present on admission when a POA indicator code of "0" was found

Risk-adjusted inpatient mortality index models

Truven Health has developed an overall inpatient mortality risk model. We exclude long-term care, psychiatric, substance abuse, rehabilitation, and federally owned or controlled facilities. In addition, we exclude certain patient records from the data set: psychiatric, substance abuse, rehabilitation, and unclassified cases (MS-DRGs 945, 946, and 999); cases in which patient age was less than 65 years; and cases in which a patient transferred to another short-term, acute care hospital. Palliative care patients (v66.7) are included in the mortality risk model, which is calibrated to determine probability of death for these patients. The Truven Health mortality risk model now excludes records with "do not resuscitate" (DNR) (v49.86) orders that are coded as present on admission.

Excluding records that are DNR status at admission is supported by the literature. A recent peer-reviewed publication stated: "Inclusion of DNR patients within mortality studies likely skews those analyses, falsely indicating failed resuscitative efforts rather than humane decisions to limit care after injury"[38]. We solicited input from both internal and external clinical and coding experts before implementing the POA DNR exclusion. The basic rationale is straightforward: If a patient is admitted DNR (POA), then typically no heroic efforts would be made to save that patient if they began to fail. Without the POA DNR exclusion, if a given hospital has a higher proportion of POA DNR patients that it is not attempting to save from death compared to an otherwise similar hospital that is not admitting as high a proportion of such patients, the first hospital would look lower-performing compared to the second through no fault of its own. The difference would be driven by the proportion of POA DNR 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 (for example, age, clinical grouping, and severity of illness)[32-36]. This model takes into account only patient conditions that are present on admission when calculating risk. Additionally, in response to the upcoming transition to ICD-10-CM, diagnosis and procedure codes, and the interactions among them, have been mapped to AHRQ CCS categories for assignment of risk instead of using the individual diagnosis, procedure, and interaction effects. See discussion under the methods for identifying patient severity above.

Staff physicians at Truven Health have suggested important clinical patient characteristics that have also been 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 health system, hospital, service line, or MS-DRG classification.

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 occurred in the inpatient setting. The complications used in the model are:

Complication	Patient group
Postoperative complications relating to urinary tract	Surgical only
Postoperative complications relating to respiratory system, except pneumonia	Surgical only
Gastrointestinal complications following procedure	Surgical only
Infection following injection/infusion	All patients
Decubitus ulcer	All patients
Postoperative 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, including cardiac
Miscellaneous complications	All patients
Cardio-respiratory arrest, shock, or failure	Surgical only
Postoperative complications relating to nervous system	Surgical only
Postoperative AMI	Surgical only
Postoperative cardiac abnormalities, except AMI	Surgical only
Procedure-related perforation or laceration	All patients
Postoperative physiologic and metabolic derangements	Surgical, including cardiac
Postoperative coma or stupor	Surgical, including cardiac
Postoperative pneumonia	Surgical, including cardiac
Pulmonary embolism	All patients
Venous thrombosis	All patients
Hemorrhage, hematoma, or seroma complicating a procedure	All patients
Postprocedure 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 central nervous system depressants	Surgical, including cardiac
Complications relating to antibiotics	All patients
Complications relating to other anti-infective drugs	All patients
Complications relating to antineoplastic 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 anticonvulsants and antiparkinsonism 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 antiasthmatic drugs	All patients
Complications relating to other medications (includes hormones, insulin, iron, and oxytocic agents)	All patients

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[39-42], including health system, hospital, service line, or MS-DRG classification. This model takes into account only patient conditions that are present on admission when calculating risk. Additionally, in response to the upcoming transition to ICD-10-CM, diagnosis and procedure codes, and the interactions among them, have been mapped to AHRQ CCS categories for assignment of risk instead of using the individual diagnosis, procedure, and interaction effects.

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 (for example, 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% 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 of 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% more outcomes, and an index of 0.90 indicates 10% fewer outcomes than expected based on the experience of the norm. The index can be calculated across a variety of groupings (for example, hospital or service line).

Core measures

Core measures were developed by The Joint Commission (TJC) and endorsed by the National Quality Forum (NQF), the nonprofit public-private partnership organization that endorses national healthcare performance measures, as minimum basic care standards. Core measures have been a widely accepted method for measuring quality of patient care that includes specific guidelines for a wide variety of patient conditions. CMS no longer requires reporting of the core measures formerly used in the study (acute myocardial infarction [AMI], heart failure [HF], pneumonia, and surgical care improvement project [SCIP] measures), so these have been dropped. In their place, we are now including the stroke care and blood clot prevention core measures in our composite core measures mean percent metric.

In calculating each hospital's core measures mean percent, the comparison group median core measure value was substituted for a missing core measure. In addition, the comparison group median core measure value was substituted when the hospital reported core measures with patient counts less than or equal to 25 or with relative standard error greater than or equal to 0.30. This was done because the original reported values were considered statistically unreliable.

Stroke care core measures	
STK-1	Ischemic or hemorrhagic stroke patients who received treatment to keep blood clots from forming anywhere in the body within 2 days of arriving at the hospital
STK-4**	Ischemic stroke patients who got medicine to break up a blood clot within 3 hours after symptoms started
STK-6*	Ischemic stroke patients needing medicine to lower cholesterol, who were given a prescription for this medicine before discharge
STK-8*	Ischemic or hemorrhagic stroke patients or caregivers who received written educational materials about stroke care and prevention during the hospital stay

Blood clot prevention and treatment core measures	
VTE-1	Patients who got treatment to prevent blood clots on the day of or day after hospital admission or surgery
VTE-2	Patients who got treatment to prevent blood clots on the day of or day after being admitted to the intensive care unit (ICU)
VTE-3*	Patients with blood clots who got the recommended treatment, which includes using two different blood thinner medicines at the same time
VTE-5*	Patients with blood clots who were discharged on a blood thinner medicine and received written instructions about that medicine
VTE-6**	Patients who developed a blood clot while in the hospital who did not get treatment that could have prevented it

30-day risk-adjusted mortality rates and 30-day risk-adjusted readmission rates

This study currently includes two extended outcome measures (30-day mortality and 30-day readmissions), as developed by CMS and published in the Hospital Compare data set. CMS is reporting three-year rolling data periods, with the most current data set being July 1, 2012 - June 30, 2015. The Hospital Compare website and database were created by CMS, the US Department of Health and Human Services, and other members of the Hospital Quality Alliance. The data on the website comes from hospitals that have agreed to submit quality information that will be made public. Both of the measures used in this study have been endorsed by the NQF.

* We did not include this measure for small community hospitals due to very low reporting.
** We did not include this measure for small and medium community hospitals due to very low reporting.

CMS calculates the 30-day mortality and 30-day readmission rates from Medicare enrollment and claims records using sophisticated statistical modeling techniques that adjust for patient-level risk factors and account for the clustering of patients within hospitals. Only Medicare fee-for-service records are included. We are including 30-day mortality rates for AMI, HF, pneumonia, chronic obstructive pulmonary disease (COPD), and stroke patients, and 30-day readmission rates for AMI, HF, pneumonia, elective total hip or knee arthroplasty, COPD, and stroke patients.

The individual CMS mortality models estimate hospital-specific, risk-standardized, all-cause 30-day mortality rates for patients hospitalized with a principal diagnosis of AMI, HF, pneumonia, COPD, or stroke. All-cause mortality is defined as death from any cause within 30 days after the admission date, regardless of whether the patient dies while still in the hospital or after discharge.

The individual CMS readmission models estimate hospital-specific, risk-standardized, all-cause 30-day readmission rates for patients discharged alive to a non-acute care setting with a principal diagnosis of AMI, HF, pneumonia, elective total hip or knee arthroplasty, COPD, or stroke. Patients may have been readmitted back to the same hospital, to a different hospital, or to another acute care facility. They may have been readmitted for the same condition as their recent hospital stay or for a different reason (CMS has indicated this is to discourage hospitals from coding similar readmissions as different readmissions)[29]. All readmissions that occur 30 days after discharge to a non-acute care setting are included, with a few exceptions. CMS does not count planned admissions (obstetrical delivery, transplant surgery, maintenance chemotherapy, rehabilitation, and non-acute admissions for a procedure) as readmissions.

Data note relating to the July 2016 Hospital Compare performance period (July 1, 2012 - June 30, 2015):

The pneumonia measure cohort was expanded to include principal discharge codes for sepsis and aspiration pneumonia. This resulted in a significant increase in pneumonia 30-day mortality rates nationally.

Length-of-stay methodologies

We use the Truven Health proprietary severity-adjusted resource demand methodology for the LOS performance measure[43]. The LOS severity-adjustment model is calibrated using our normative PIDB, a national all-payer database containing more than 23 million all-payer discharges annually, described in more detail at the beginning of this appendix.

Our severity-adjusted resource demand model allows us to produce risk-adjusted performance comparisons on LOS between or across virtually any subgroup of inpatients. These patient groupings can be based on factors such as clinical groupings, hospitals, product lines, geographic regions, and physicians. This regression model 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 weights allow group comparisons on a national level and in a specific market area. In response to the upcoming transition to ICD-10-CM, diagnosis, procedure, and interaction codes have been mapped to AHRQ CCS categories for severity assignment instead of using the individual diagnosis, procedure, and interaction effects.

POA coding allows us to determine appropriate adjustments to LOS weights based on pre-existing conditions versus complications that occurred during hospital care. We calculate expected values from model coefficients that are normalized to the clinical group and transformed from log scale.

Emergency department throughput measure

We have included three emergency department (ED) throughput measures from the CMS Hospital Compare data set. The hospital ED is an important access point to healthcare for many people. A key factor in evaluating ED performance is process "throughput," measures of timeliness with which patients are seen by a provider, receive treatment, and either are admitted or discharged. Timely ED processes impact both care quality and the quality of the patient experience. We chose to include measures that define three important ED processes: time from door to admission, time from door to discharge for non-admitted patients, and time to receipt of pain medications for long bone fracture.

The measure data from CMS Hospital Compare is published in median minutes and is based on calendar year (2015) data. Our ranked metric is the calculated mean of the three included measures. The hospital's comparison group median ED measure value was substituted for a missing measure for the purpose of calculating the composite measure. Hospitals missing all three included measures were excluded from the study.

ED throughput measures
Average time patients spent in the emergency department, before they were admitted to the hospital as an inpatient
Average time patients spent in the emergency department before being sent home
Average time patients who came to the emergency department with broken bones had to wait before receiving pain medication

Medicare spend per beneficiary index

The Medicare spend per beneficiary (MSPB) index is included as a proxy for episode-of-care cost efficiency for hospitalized patients. CMS develops and publishes this risk-adjusted index in the public Hospital Compare data sets, and in FFY 2015, it began to be included in the Hospital Value-Based Purchasing program. The CMS-stated reason for including this measure is "...to reward hospitals that can provide efficient care at a lower cost to Medicare"[44].

The MSPB index evaluates hospitals' efficiency relative to the efficiency of the median hospital, nationally. Specifically, the MSPB index assesses the cost to Medicare of services performed by hospitals and other healthcare providers during an MSPB episode, which comprises the period three days prior to, during, and 30 days following a patient's hospital stay. Payments made by Medicare and the beneficiary (that is, allowed charges) are counted in the MSPB episode as long as the start of the claim falls within the episode window. IPPS outlier payments (and outlier payments in other provider settings) are also included in the calculation of the MSPB index. The index is available for Medicare beneficiaries enrolled in Medicare Parts A and B who were discharged from short-term acute care hospitals during the period of performance. Medicare Advantage enrollees are not included. This measure excludes patients who died during the episode.

The MSPB index is calculated by dividing the profiled hospital's risk-adjusted average episode cost by the national hospital median. The profiled hospital's MSPB amount is the sum of standardized, risk-adjusted spending across all of a hospital's eligible episodes divided by the number of episodes for that hospital. This is divided by the median MSPB amount across all episodes nationally. CMS adjusts spending amounts for area price variation and also for various risk factors including case mix, age, and hierarchical condition category (HCC) indicators.

Inpatient expense per discharge and operating profit margin measure calculations

A number of our calculations include data from the Medicare Cost Report. Below you will find our calculations and the cost report locations (worksheet, line, and column) for all of these items. The following apply to the 100 Top Hospitals study and the hospital Medicare Cost Report for the hospital fiscal year ending in 2015. The line and column references are the standard based on CMS Form 2552-10. Any deviations from this standard are checked by system and manual data analysis to ensure that coding has been done properly.

Case mix- and wage-adjusted inpatient expense per discharge

[((0.62 × acute inpatient expense ÷ CMS wage index) + 0.38 × acute inpatient expense) ÷ acute inpatient discharges] ÷ Medicare case mix index

acute inpatient expense = inpatient expense − subprovider expense − nursery expense − skilled nursing facility expense − intermediate-care facility expense − other long-term care facility expense − cost centers without revenue (for example, organ procurement, outpatient therapy, and other capital-related costs)

inpatient expense = sum over all departments [(inpatient department charges ÷ department charges) × department cost]

Individual element locations in the Medicare Cost Report:

- Acute inpatient discharges — worksheet S-3, line 14, column 15
- Inpatient department (cost center) elements
  - Fully allocated cost — worksheet C, part 1, column 1; if missing, use worksheet B, part 1, column 26
  - Total charges — worksheet C, part 1, column 8
  - Inpatient charges — worksheet C, part 1, column 6
- Medicare case mix index — Federal Register: CMS IPPS FFY 2015 Final Rule table 2 (cost report end dates in 2015 Q1, Q2, Q3) or IPPS FFY 2016, table 2 (cost report end dates in 2015 Q4)
- CMS wage index — CMS Federal Register: CMS IPPS FFY 2015 (cost report end dates in 2015 Q1, Q2, Q3) or IPPS FFY 2016, table 2 (cost report end dates in 2015 Q4)

Adjusted operating profit margin

[(net patient revenue + other operating revenue − (total operating expense + net related organization expense)) ÷ (net patient revenue + other operating revenue)] × 100

other operating revenue = [total other income − other income: (for example, contributions and donations) − other income from investments]

Individual element locations in the Medicare Cost Report:

- Net patient revenue — worksheet G-3, line 3, column 1
- Total other income — worksheet G-3, line 25, column 1
- Other income: contributions, donations, etc. — worksheet G-3, line 6, column 1
- Other income from investments — worksheet G-3, line 7, column 1
- Total operating expense — worksheet G-3, line 4, column 1
- Related organization expense — worksheet A-8, line 12, column 2

Note: Where a hospital has already reported the net related organization expense in its total operating expense, we subtract any values reported on worksheet G-2 lines 30 through 35 (including sublines) where titles contain either "HOME OFFICE" or "RELATED ORG" from total operating expense to avoid double-counting the adjustment.

Hospital Consumer Assessment of Healthcare Providers and Systems overall hospital rating

To measure patient perception of care, this study uses the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient survey. HCAHPS is a standardized survey instrument and data collection methodology for measuring patients' perspectives on their hospital care. HCAHPS is a core set of questions that can be combined with customized, hospital-specific items to produce information that complements the data hospitals currently collect to support internal customer service and quality-related activities.

HCAHPS was developed through a partnership between CMS and AHRQ that had three broad goals:

- Produce comparable data on patients' perspectives of care that allow objective and meaningful comparisons among hospitals on topics that are important to consumers
- Encourage public reporting of the survey results to create incentives for hospitals to improve quality of care
- Enhance public accountability in healthcare by increasing the transparency of the quality of hospital care provided in return for the public investment

The HCAHPS survey has been endorsed by the NQF and the Hospital Quality Alliance. The federal government's Office of Management and Budget has approved the national implementation of HCAHPS for public reporting purposes.

Voluntary collection of HCAHPS data for public reporting began in October 2006. The first public reporting of HCAHPS results, which encompassed eligible discharges from October 2006 through June 2007, occurred in March 2008. HCAHPS results are posted on the Hospital Compare website, found at **hospitalcompare.hhs.gov** or through a link on **medicare.gov**. A downloadable version of HCAHPS results is available.

Although we are reporting hospital performance on all HCAHPS questions, only performance on the overall hospital rating question, "How do patients rate the hospital, overall?" is used to rank hospital performance. Patient responses fall into three categories, and the number of patients in each category is reported as a percent:

- Patients who gave a rating of 6 or lower (low)
- Patients who gave a rating of 7 or 8 (medium)
- Patients who gave a rating of 9 or 10 (high)

For each answer category, we assign a weight as follows: 3 equals high or good performance, 2 equals medium or average performance, and 1 equals low or poor performance. We then calculate a weighted score for each hospital by multiplying the HCAHPS answer percent by the category weight. For each hospital, we sum the weighted percent values for the three answer categories. Hospitals are then ranked by this weighted percent sum. The highest possible HCAHPS score is 300 (100% of patients rate the hospital high). The lowest possible HCAHPS score is 100 (100% of patients rate the hospital low).

Performance measure normalization

The inpatient mortality, complications, and LOS measures are normalized based on the in-study population and by comparison group to provide a more easily interpreted comparison among hospitals. To address the impact of bed size and teaching status, including extent of residency program involvement, and compare hospitals to other like hospitals, we assign each hospital in the study to one of five comparison groups (major teaching, teaching, large community, medium community, and small community hospitals). Detailed descriptions of the hospital comparison groups can be found in the Methodology section of the 100 Top Hospitals study.

For the mortality and complications measures, we base our ranking on the difference between observed and expected events, expressed in standard deviation units (z-scores) that have been normalized. We normalize the individual hospital expected values by multiplying them by the ratio of the observed to expected values for their comparison group. We then calculate the normalized z-score based on the observed and normalized expected values and the patient count.

For the LOS measure, we base our ranking on the normalized, severity-adjusted LOS index expressed in days. This index is the ratio of the observed and the normalized expected values for each hospital. We normalize the individual hospital's expected values by multiplying them by the ratio of the observed to expected values for its comparison group. The hospital's normalized index is then calculated by dividing the hospital's observed value by its normalized expected value. We convert this normalized index into days by multiplying by the average LOS of all in-study hospitals (grand mean LOS).

Differences between current and trend profiles

Normalization

The 2015 values on the current and trend graphs will not match for inpatient mortality, complications, or average length of stay. This is because we use different norm factors to normalize the expected values.

- Current profile: We combine in-study hospitals' data for only the most current study year to calculate each comparison group norm factor (observed/expected). Note: The current study year was comprised of 2014 and 2015 MEDPAR data for inpatient morality and complications, and 2015 data only for average length of stay (ALOS).
- Trend profile: We combine in-study hospitals' data for all five study years to calculate each comparison group norm factor.

In-study hospital counts

There are fewer in-study hospitals in the trend profile than the current profile because some hospitals do not have enough data points for one or more measures to calculate trend, so they are excluded.

- Additional impact on ALOS calculation: The observed/normalized expected LOS index for each hospital is converted into an ALOS in days by multiplying it by the mean ALOS for all in-study hospitals (sum observed LOS/in-study hospital count). The grand mean ALOS will be different in current and trend profiles when there are different numbers of in-study hospitals.

Both the current and trend profiles are internally consistent. They each provide relevant comparisons of a profiled hospital's performance versus peers and national benchmarks.

Interquartile range methodology

For each measure, we calculate an interquartile range (IQR) based on data for all in-study hospitals. Two outlier points (trim points) are set for each measure: one upper limit and one lower limit.

A value (X) is considered an outlier if either of the following is true:

X > = upper-limit outlier point

X < = lower-limit outlier point

The procedure for calculating the IQR and outlier points is as follows:

- Determine the first quartile (Q1). This is the 25th percentile value of all records in the population.
- Determine the third quartile (Q3). This is the 75th percentile value of all records in the population.
- Calculate the IQR by subtracting Q1 from Q3 (IQR = Q3 – Q1).
- Calculate the upper- and lower-limit trim points for inpatient expense per discharge:
  - Upper limit = Q3 + (3.0 × IQR)
  - Lower limit = Q1 – (3.0 × IQR)
- Calculate the upper- and lower-limit trim points for operating profit margin:
  - Upper limit = Q3 + (2.0 × IQR)
  - Lower limit = Q1 – (2.0 × IQR)

Data points that are outside the IQR limits are considered to be extreme outliers and are excluded.

Why we have not calculated percent change in specific instances

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[45].

We also do not report percent change when the metrics are already percentages. In these cases, we report the simple difference between the two percentage values.

Protecting patient privacy

In accordance with patient privacy laws, we do not report any individual hospital data that is based on 11 or fewer patients. This affects the following measures:

- Risk-adjusted inpatient mortality index
- Risk-adjusted complications index
- 30-day mortality rates for AMI, HF, pneumonia, COPD, and stroke (CMS does not report a rate when count is less than 25)
- 30-day readmission rates for AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke (CMS does not report a rate when count is less than 25)
- Average LOS

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