

Truven Health Analytics | IBM Watson Health

**100 TOP
HOSPITALS**

15 Top Health Systems Study, 2017

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Introduction

Truven Health 15 Top Health Systems study: Setting standards of excellence and delivering insights to help leaders achieve consistent top performance

The Truven Health 15 Top Health Systems study, in its ninth year, is the newest analysis added to the robust, two-decades-old 100 Top Hospitals® program from Truven Health Analytics®, part of the IBM Watson Health™ business.

The 15 Top Health Systems study is focused on objectively measuring the impact of health system managerial excellence, and the results correlate with the Malcolm Baldrige National Quality Award winner improvement rates and performance levels¹.

The goal of this study is to inform US health system leaders of relative long-term improvement rates, resultant performance, and the achievement of cross-system alignment of the top-performing organizations versus national peers. This analysis can provide evidence-based guidance to health system boards and executives who use the study's quantitative performance insights to help them put plans in place to achieve consistent top performance. The insights can be used to adjust continuous improvement targets, enrich the collaboration of member hospitals, and track system-wide alignment toward common performance goals.

We believe the 15 Top Health Systems study can assist healthcare leaders in viewing system performance in multiple dimensions: Where they stand versus peers and high performers, and where they stand in the evolution of their own cultures of performance improvement. This can help them determine not only the direction but also the rate of improvement across a health system.

The Truven Health 15 Top Health Systems study is an ongoing research project that is adjusted as changes occur in the healthcare environment, newly public data and metrics become available, and managerial practices evolve. The current study measures relative balanced performance across a range of organizational key performance indicators reflecting care quality, use of evidence-based medicine, post-discharge outcomes, operational efficiency, and customer perception of care.

To maintain the study's level of integrity, only impartial, public data sources are used for calculating study metrics. This helps eliminate bias, supports inclusion of a maximum number of health systems, and facilitates consistency of definitions and data. And like all Truven Health 100 Top Hospitals studies, our 15 Top Health Systems research is performed by a seasoned research team that includes epidemiologists, statisticians, physicians, and former hospital executives.

The Truven Health 15 Top Health Systems scorecard results are divided into two separate sections that graphically illustrate:

- A health system's performance and improvement versus peer health systems
- Alignment of improvement and performance of member hospitals

The 15 Top Health Systems study is not designed as a marketing tool. Because we use only public data, there is no application or fee for inclusion in the study. Winners do not pay to receive their results and do not pay promotional fees. Additionally, neither Truven Health nor award winners release specific 15 Top Health Systems balanced scorecard results to consumers.

A balanced scorecard and a view of system-wide alignment

At the heart of the 15 Top Health Systems research is the methodology used for the Truven Health 100 Top Hospitals national balanced scorecard². This scorecard and its peer-reviewed, risk-adjusted methodologies are the foundation for the comparison of health system-to-peer rate of improvement and performance.

The 15 Top Health Systems scorecard also goes beyond these insights by adding a third measurement: alignment. The alignment factor may be particularly useful to health system leaders as they work to empirically assess the degree of consistency achieved across system facilities and develop action plans to strengthen it.

The result: A comprehensive analysis of the improvement, resultant performance, and alignment of America's health systems.

Unbiased information to help solve modern healthcare leadership dilemmas

The healthcare industry is changing quickly, and winners of the 15 Top Health Systems 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 more. And they do so even as markets, payment models, and reforms shift, and bars are raised.

Key differences between 2017 award winners and their peers

Our analysis found that the 2017 winners of the 15 Top Health Systems award outperformed their peers in the following ways:

- Saved 66,000 more lives and caused 43,000 fewer patient complications
- Followed industry-recommended standards of care more closely (97.3% versus 95.8%)
- Released patients from the hospital a half day sooner
- Readmitted patients less frequently and experienced fewer deaths within 30 days of admission
- Had nearly 18% shorter wait times in their emergency departments
- Had over 5% lower Medicare beneficiary cost per 30-day episode of care
- Scored nearly 7 points higher on patient overall rating of care

In addition, we found that hospitals that are health system members are more likely to be Truven Health 100 Top Hospitals award winners than hospitals that are not a part of a system. In fact, 79% of our winners belonged to systems; whereas 67.4% of nonwinning hospitals belonged to systems.

Understanding the similarities and differences between high and low system performers provides benchmarks for the entire industry. Each year, the relevant benchmarks and findings we assemble for this study provide many examples of excellence, as evidenced in several additional published studies³⁻²⁵.

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

New performance measures

Our studies continue to adapt as the healthcare market changes. We are currently analyzing several new performance measures for information only; they are not yet being used to rank health system performance on our balanced scorecard. These measures include important information about healthcare-associated infections and continue to move outside the inpatient acute care setting.

In these new areas of performance, 2017 winners of the 15 Top Health Systems award outperformed their peers in several ways, as well, even though these measures were not included in the selection of winners. Our winning benchmark health systems had:

- 28% fewer patients with methicillin-resistant staphylococcus aureus (MRSA) infections and 23% fewer patients with catheter-associated urinary tract infections (CAUTI), a notable difference in patient care
- Coronary artery bypass graft (CABG) 30-day mortality and readmission rates that were 0.5 and 0.7 percentage points lower
- 30-day episode payments that were 2% to 5% lower
- Operating margins that were nearly 1% higher

The multifaceted 100 Top Hospitals program

The 15 Top Health Systems research is just one of the studies of the Truven Health 100 Top Hospitals program. To increase understanding of trends in specific areas of the healthcare industry, the 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 overall and offers insight into the ability of a system's member hospitals to deliver consistent top performance across the communities it serves, all based on our national health system 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 to 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.

The 2017 study analyzed 337 health systems and 2,415 hospitals that are members of health systems.

Just as evidence-based medicine can be important for exceptional patient care, evidence-based management can be important to the health and success of health systems.

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

Truven Health Analytics, part of the IBM Watson Health business, 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®, Simplifier®, and ActionOI®. Truven Health has its principal offices in Ann Arbor, Mich.; Chicago; and Denver. For more information, visit truvenhealth.com.

2017 15 Top Health Systems award winners

To thrive in today's and tomorrow's industry, health systems will likely need to deliver higher quality and become more efficient, with potentially lower reimbursements. Our 2017 award winners appear to be rising to that challenge and finding ways to succeed, helping to define standards, and continuing to demonstrate what can be accomplished when passionate professionals work toward continuous improvement and progress in healthcare today.

This year's 15 Top Health Systems, identified by Truven Health Analytics®, part of the IBM Watson Health™ business, placed into size categories by total operating expense, are:

Large health systems (> \$1.75 billion)

	Location
Mayo Foundation	Rochester, MN
Mercy	Chesterfield, MO
Scripps Health	San Diego, CA
Spectrum Health	Grand Rapids, MI
St. Luke's Health System	Boise, ID

Medium health systems (\$750 million - \$1.75 billion)

	Location
HealthPartners	Bloomington, MN
Kettering Health Network	Dayton, OH
Mercy Health Southwest Ohio Region	Cincinnati, OH
Mission Health	Asheville, NC
Parkview Health	Fort Wayne, IN

Small health systems (< \$750 million)

	Location
Asante	Medford, OR
Lakeland Health	St. Joseph, MI
Lovelace Health System	Albuquerque, NM
Maury Regional Health	Columbia, TN
Roper St. Francis Healthcare	Charleston, SC

To see a full list of *Winners Through the Years*, visit 100tophospitals.com/studies-winners/15-top-health-systems/year.

Findings

Health system leaders focused on strategic improvement in today's healthcare environment must determine how the process fits into their mission and then create a plan to drive consistent high performance across the entire system.

According to independent data and our proprietary methodologies, the 2017 Truven Health 15 Top Health Systems are helping to lead the way in accomplishing that objective and outperforming their peers. Aggregating the winner-versus-nonwinner data from our 2017 study can offer insights into how the nation's health and the industry's bottom lines could be improved.

Winner-versus-peer results

By providing detailed performance measurement data, we show what the top health systems have accomplished and offer standards of excellence for the industry. To develop more action-driving benchmarks for like systems, we divided health systems into three comparison groups based on the total operating expense of their member hospitals. For more details on the comparison groups, see the Methodology section.

In this section, Tables 1 through 4 detail how the winning health systems in these groups scored on the study's performance measures and how their performance compared with nonwinning peers.

Next, we highlight several important differences between the winners and their peers, and between the different health system comparison groups.

The top health systems had better survival rates*

- The winners had 13.4% fewer in-hospital deaths than their nonwinning peers, considering patient severity (Table 1)
- Mortality results for medium health systems showed the greatest difference between winners and nonwinners with 18.3% fewer deaths among benchmark health systems (Tables 2 - 4)

The top health systems had fewer patient complications*

- Patients treated at the winning systems' member hospitals had significantly fewer complications, with rates 8.5% lower than at nonwinning system hospitals, considering patient severity (Table 1)
- Small health systems had the greatest difference between winners and nonwinners with 21.9% fewer complications (Tables 2 - 4)

The top health systems followed accepted care protocols somewhat more consistently*

- Overall, the winning systems' higher core measures mean percentage of 97.3 is 1.5 percentage points better than nonwinning peers (Table 1)
- Small winning health systems showed both best overall core measures performance (97.5%) and the greatest difference between winners and nonwinners (2.3 percentage points) (Tables 2 - 4)
- There was no difference between large health system winners and nonwinners, with both having 96.3% compliance (Table 2)

Top health systems had mixed results on longer-term outcomes

We use the mean 30-day mortality and mean 30-day readmission rates to rank and report the results of the extended outcome performance measures. The mean 30-day mortality rate includes acute myocardial infarction (AMI), heart failure (HF), pneumonia, chronic obstructive pulmonary disease (COPD), and stroke. The mean 30-day readmission rate includes AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke.

- The mean 30-day mortality rate for winning systems, overall, was only slightly higher than for nonwinners (0.1 percentage point difference); this was influenced by small health system winner performance, which was worse than nonwinning peers (13.4% compared to 13.2%) and by medium system winners whose performance was the same as nonwinning peers (13.1%) (Tables 1, 3, and 4)
- Large system winners and nonwinners had the best 30-day mortality rate performance among all comparison groups, with 12.8% and 13.0%, respectively (Table 2)
- Small winning systems had the best mean 30-day readmission rate (14.5%) across all comparison groups and outperformed their nonwinning peers by the greatest margin, 1.1 percentage points (Tables 2 - 4)

* Mortality and complications index values cannot be compared between the three different comparison groups because they are normalized by comparison group.

Patients treated at hospitals in the winning health systems returned home sooner*

- Winning systems had a median average length of stay (ALOS) of 4.5 days, half a day shorter than their peers' median of 5.0 days (Table 1)
- The ALOS difference between winners and nonwinners was consistent across all comparison groups, with benchmark systems discharging patients a half day sooner (Tables 2 - 4)
- Large system winners had the best ALOS among all comparison groups: 4.4 days (Table 2)

Patients spent less time in the emergency department at winning health systems

The mean emergency department (ED) throughput composite metric measures the amount of time spent in the ED. The mean of three reported wait time measures was used: median minutes to admission, to discharge from the ED, and to receipt of pain medication for long bone fracture.

- Overall, winning systems had a significantly shorter ED wait time than nonwinners with a 17.5% difference (Table 1)
- The most dramatic difference between winning systems and their peers was in the medium health systems comparison group. Medium system winners averaged 37.1 minutes less wait time per patient visit than nonwinners, nearly a 22% difference; the range of time saved was between 27 and 37.1 minutes (Tables 2 - 4)

Medicare beneficiary episode-of-care costs were lower for patients discharged from winning health systems

- Overall, winning systems had a 5.2% lower Medicare spending per beneficiary (MSPB) index than nonwinners (Table 1)
- Large health systems showed the greatest difference between winners and nonwinners with a 9.7% lower MSPB index (Table 2)
- Large winning systems also had the lowest average MSPB index (0.90) among the comparison groups (Table 2)

Patients treated by members of the top health systems reported a better overall hospital experience than those treated in nonwinning peer hospitals

- Winning systems had a 2.5% higher overall score on the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS), which tells us that patients treated by members of the top health systems reported a better overall hospital experience than those treated in nonwinning peer hospitals (Table 1)
- Large health system winners had the best HCAHPS score (271.4) among the comparison groups (Tables 2 - 4)
- The large winning systems had the biggest lead over nonwinning peers with an HCAHPS score that was 2.8% higher (Tables 2 - 4)

* ALOS cannot be compared between the three different comparison groups because values are normalized by comparison group.

Table 1. National health system performance comparisons (all systems)

Performance measure	Medians		Benchmark compared with peer group		
	Benchmark health systems	Peer group of US health systems	Difference	Percent difference	Comments
Mortality index ¹	0.88	1.02	-0.14	-13.4%	Lower mortality
Complications index ¹	0.92	1.00	-0.09	-8.5%	Lower complications
Core measures mean percent ²	97.3	95.8	1.6	n/a ⁵	Greater care compliance
30-day mortality rate (%) ³	13.0	13.1	-0.1	n/a ⁵	Lower 30-day mortality
30-day readmission rate (%) ³	14.8	15.6	-0.7	n/a ⁵	Fewer 30-day readmissions
Average length of stay (ALOS) (days) ¹	4.5	5.0	-0.5	-10.2%	Shorter stays
Emergency department (ED) measure mean minutes ⁴	136.8	165.7	-28.9	-17.5%	Less time to service
Medicare spending per beneficiary (MSPB) index ⁴	0.94	0.99	-0.05	-5.2%	Lower episode cost
Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) score ⁴	270.1	263.4	6.7	2.5%	Better patient experience

1. Mortality, complications, and ALOS based on present-on-admission (POA)-enabled risk models applied to Medicare Provider Analysis and Review (MEDPAR) 2014 and 2015 data (ALOS 2015 only).

2. Core measures data from Centers for Medicare & Medicaid Services (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. We do not calculate percent difference for this measure because it is already a percent value.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Table 2. Large health system performance comparisons

Performance measure	Medians		Benchmark compared with peer group		
	Benchmark health systems	Peer group of US health systems	Difference	Percent difference	Comments
Mortality index ¹	0.85	1.00	-0.15	-14.8%	Lower mortality
Complications index ¹	0.94	1.02	-0.08	-8.0%	Lower complications
Core measures mean percent ²	96.3	96.3	0.0	n/a ⁵	No difference in care compliance
30-day mortality rate (%) ³	12.8	13.0	-0.2	n/a ⁵	Lower 30-day mortality
30-day readmission rate (%) ³	14.8	15.6	-0.7	n/a ⁵	Fewer 30-day readmissions
ALOS (days) ¹	4.4	4.9	-0.5	-9.8%	Shorter stays
ED measure mean minutes ⁴	139.8	166.9	-27.0	-16.2%	Less time to service
MSPB index ⁴	0.90	0.99	-0.10	-9.7%	Lower episode cost
HCAHPS score ⁴	271.4	263.9	7.5	2.8%	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. We do not calculate percent difference for this measure because it is already a percent value.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Table 3. Medium health system performance comparisons

Performance measure	Medians		Benchmark compared with peer group		
	Benchmark health systems	Peer group of US health systems	Difference	Percent difference	Comments
Mortality index ¹	0.83	1.01	-0.19	-18.3%	Lower mortality
Complications index ¹	0.95	1.00	-0.05	-4.9%	Lower complications
Core measures mean percent ²	97.2	95.4	1.8	n/a ⁵	Greater care compliance
30-day mortality rate (%) ³	13.1	13.1	0.0	n/a ⁵	No difference in 30-day mortality
30-day readmission rate (%) ³	15.1	15.5	-0.4	n/a ⁵	Fewer 30-day readmissions
ALOS (days) ¹	4.5	5.0	-0.5	-10.6%	Shorter stays
ED measure mean minutes ⁴	135.0	172.1	-37.1	-21.6%	Less time to service
MSPB index ⁴	0.96	0.99	-0.03	-2.9%	Lower episode cost
HCAHPS score ⁴	270.4	263.9	6.5	2.5%	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. We do not calculate percent difference for this measure because it is already a percent value.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Table 4. Small health system performance comparisons

Performance measure	Medians		Benchmark compared with peer group		
	Benchmark health systems	Peer group of US health systems	Difference	Percent difference	Comments
Mortality index ¹	0.99	1.02	-0.03	-2.8%	Lower mortality
Complications index ¹	0.78	1.00	-0.22	-21.9%	Lower complications
Core measures mean percent ²	97.5	95.3	2.3	n/a ⁵	Greater care compliance
30-day mortality rate (%) ³	13.4	13.2	0.2	n/a ⁵	Higher 30-day mortality
30-day readmission rate (%) ³	14.5	15.6	-1.1	n/a ⁵	Fewer 30-day readmissions
ALOS (days) ¹	4.5	5.0	-0.5	-10.8%	Shorter stays
ED measure mean minutes ⁴	133.1	160.7	-27.6	-17.1%	Less time to service
MSPB index ⁴	0.95	0.99	-0.04	-4.2%	Lower episode cost
HCAHPS score ⁴	267.9	262.4	5.5	2.1%	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. We do not calculate percent difference for this measure because it is already a percent value.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Winning health system results

In Table 5, we provide the 15 top health systems' scores for each of the study's performance measures. For a list of all hospitals included in each winning health system, see Appendix A.

Table 5. Winning health system performance measure results

Winning system name	Mortality index ¹	Complications index ¹	Core measures mean percent ²	30-day mortality rate ³	30-day readmission rate ³	ALOS ¹	ED measure mean minutes ⁴	MSPB index ⁴	HCAHPS score ⁴
Large health systems									
Mayo Foundation	0.85	1.04	96.3	12.3	14.7	4.4	136.8	0.88	278.5
Mercy	0.83	0.72	95.8	13.4	15.5	4.4	139.8	0.94	265.8
Scripps Health	0.67	0.95	98.3	12.1	15.1	4.4	197.2	1.00	263.7
Spectrum Health	0.97	0.94	94.4	12.8	14.8	4.7	131.8	0.90	271.4
St. Luke's Health System	1.03	0.68	98.0	12.9	14.0	4.1	156.3	0.89	272.3
Medium health systems									
HealthPartners	0.92	1.17	96.7	13.1	15.1	4.3	132.8	0.87	270.4
Kettering Health Network	0.80	0.91	99.3	13.0	15.5	4.5	135.0	1.03	272.7
Mercy Health Southwest Ohio Region	0.67	0.82	95.8	12.3	15.9	4.5	156.5	0.99	270.1
Mission Health	0.89	0.95	97.2	13.6	13.7	4.5	170.6	0.87	269.3
Parkview Health	0.83	0.95	99.6	13.7	14.4	4.5	129.4	0.96	276.8
Small health systems									
Asante	0.99	0.52	97.5	13.9	14.1	4.5	150.9	0.91	265.3
Lakeland Health	0.82	0.94	98.0	14.3	15.0	4.4	129.1	0.95	267.9
Lovelace Health System	0.76	0.85	98.9	12.7	14.5	4.9	157.5	0.96	258.4
Maury Regional Health	1.00	0.48	97.3	13.4	16.1	4.1	133.1	0.94	269.9
Roper St. Francis Healthcare	0.99	0.78	94.6	12.2	13.9	4.7	112.3	0.98	275.2

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.

Note: Mortality, complications, and ALOS measures cannot be compared across comparison groups because they are normalized by comparison group.

Top and bottom quintile results

To provide more significant comparisons, we divided all the health systems in this study into performance quintiles, by comparison group, based on their performance on the study's measures. In Table 6, we have highlighted differences between the highest- and lowest-performing quintiles by providing their median scores on study performance measures. (See Appendix B for a list of the health systems included in the top-performance quintile and Appendix D for all systems included in the study.)

The top quintile systems outperformed their lowest quintile peers in the following ways:

- They had much better patient outcomes: 20.6% lower mortality and 13.1% lower complications
- They followed accepted care protocols for core measures more closely, with 97.2% compliance versus 94.4%
- They had somewhat lower mean 30-day mortality rates (0.2 percentage points lower; includes AMI, HF, pneumonia, COPD, and stroke patients)
- They had lower mean 30-day readmission rates (15% versus 16%; includes AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke patients)
- They had much lower mean ED wait times, with an average difference of 47 minutes per ED patient
- They were more efficient, releasing patients nearly one day sooner than the lowest performers and at a 5.1% lower episode cost (MSPB)
- They scored 11.3 points higher on the HCAHPS overall patient rating of care

Table 6. Comparison of health systems in the top and bottom quintiles of performance¹

Performance measure	Top quintile median	Bottom quintile median	Difference	Percent difference	Top versus bottom quintile
Mortality index ²	0.86	1.08	-0.22	-20.6%	Lower mortality
Complications index ²	0.95	1.09	-0.14	-13.1%	Lower complications
Core measures mean percent ³	97.2	94.4	2.9	n/a ⁵	Greater care compliance
30-day mortality rate (%) ⁴	13.0	13.2	-0.2	n/a ⁵	Lower 30-day mortality
30-day readmission rate (%) ⁴	15.0	16.0	-1.0	n/a ⁵	Fewer 30-day readmissions
ALOS ²	4.5	5.4	-0.9	-17.0%	Shorter stays
ED measure mean minutes ⁵	147.5	194.5	-47.0	-24.2%	Less time to service
MSPB index ⁵	0.96	1.01	-0.05	-5.1%	Lower episode cost
HCAHPS score ⁵	268.5	257.2	11.3	4.4%	Better patient experience

1. Top and bottom performance quintiles were determined by comparison group and aggregated to calculate medians.

2. Mortality, complications, and ALOS based on POA-enabled risk models applied to MEDPAR 2014 and 2015 data (ALOS 2015 only).

3. Core measures data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.

4. 30-day rates from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.

5. ED measure, MSPB, and HCAHPS data from CMS Hospital Compare Jan. 1, 2015 - Dec. 31, 2015, data set.

6. We do not calculate percent difference for this measure because it is already a percent value.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Performance measures under consideration

As the healthcare industry changes, our study methods continue to evolve. Currently, we are analyzing several performance measures for information only; they are not yet being used to rank health system performance on our Truven Health 15 Top Health Systems balanced scorecard.

We are now profiling performance on the new healthcare-associated infection (HAI) measures, as well as on additional measures that move outside the inpatient acute care setting to look at new extended outcomes metrics, 30-day episode payment metrics, and the financial health of the system.

The new performance measures under consideration are:

- Six HAI measures: central line-associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI), surgical site infection (SSI) for colon surgery and abdominal hysterectomy, methicillin-resistant staphylococcus aureus (MRSA-bloodstream), and clostridium difficile (C.diff-intestinal)
- Coronary artery bypass graft (CABG) 30-day mortality and 30-day readmission rates
- Hospital-wide, all-cause 30-day readmission rate
- AMI, HF, and pneumonia 30-day episode payment measures
- Two measures of system financial performance: operating margin and long-term debt-to-capitalization ratio (LTD/cap)

Healthcare-associated infection measures

The HAIs reported by CMS in the public Hospital Compare data set capture important information about the quality of inpatient care. Tracking and intervening to reduce these infection rates are becoming an important focus in hospitals. New public data will allow the development of national benchmarks for use by healthcare leadership to affect change (Table 7).

30-day mortality and readmission measures

We are also profiling health systems on the 30-day mortality and readmission rates for CABG surgical patients that CMS is publicly reporting in the Hospital Compare data set, as well as the hospital-wide, all-cause 30-day readmission rate. Although CABG rates are relevant only to hospitals with open heart surgery programs, we are reporting them here for the convenience of systems with those hospitals (over 1,000 hospitals in our 50 Top Cardiovascular Hospitals study) (Table 7).

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 measures capture differences in service and supply costs provided to patients who have been diagnosed with AMI, HF, or pneumonia. CMS defines these measures as the sum of payments made for care and supplies beginning the day the patient enters the hospital and for the next 30 days (Table 7).

Table 7. Information-only measures—health system performance comparisons (all classes)

Performance measure	Medians		Benchmark compared with peer group		
	Benchmark health systems	Peer group of US health systems	Difference	Percent difference	Comments
30-day CABG mortality rate ¹	3.1	3.1	-0.1	n/a ⁴	Lower 30-day mortality
30-Day CABG readmission rate ¹	14.5	14.3	0.2	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 infection (CLABSI) ³	0.5	0.5	-0.1	-13.3%	Fewer infections
Catheter-associated urinary tract infection (CAUTI) ³	0.5	0.6	-0.1	-8.4%	Fewer infections
Surgical site infection (SSI) from colon surgery ³	0.8	0.9	-0.1	-10.0%	Fewer infections
SSI from abdominal hysterectomy ³	0.7	0.8	-0.1	-13.7%	Fewer infections
Methicillin-resistant staphylococcus aureus (MRSA-bloodstream) ³	0.8	0.9	-0.1	-13.6%	Fewer infections
Clostridium difficile (C.diff.-intestinal) ³	0.9	0.9	-0.0	-2.5%	Fewer infections
AMI 30-day episode payment ¹	\$22,283	\$22,997	-\$714	-3.1%	Lower episode cost
HF 30-day episode payment ¹	\$15,622	\$16,196	-\$574	-3.5%	Lower episode cost
Pneumonia 30-day episode payment ¹	\$14,640	\$14,913	-\$273	-1.8%	Lower episode cost

1. 30-day CABG mortality, 30-day CABG readmission, and 30-day episode payment metrics from CMS Hospital Compare July 1, 2012 - June 30, 2015, data set.

2. 30-day hospital-wide readmissions 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.

Note: Measure values are rounded for reporting, which may cause calculated differences to appear off.

Financial metrics

We continue to publish the financial measures each year for information only, as audited financial statements are not available for all systems included in the study*. These measures are not included in the ranking and selection of benchmark health systems. Results for included systems are found in Table 8 below.

- Overall, benchmark health system performance is better than nonwinning peers, both on operating margin and LTD/cap
- However, medium health system winners have a lower profit margin than nonwinners (3.6% versus 3.8%) and show no difference on LTD/cap ratio (0.3)

Table 8. Information-only financial performance

Performance measure	Health system comparison group	Medians		Difference
		Benchmark health systems	Peer group of US health systems	Benchmark compared with peer group
Operating margin (percentage)	All systems	4.7	3.8	0.9
	Large	5.0	4.2	0.8
	Medium	3.6	3.8	-0.2
	Small	6.8	3.4	3.4
Long-term debt-to-capitalization ratio (LTD/cap)	All systems	0.3	0.4	-0.1
	Large	0.3	0.4	-0.1
	Medium	0.3	0.3	0.0
	Small	0.3	0.4	-0.1

Note: Data sourced from audited 2015 financial reports via dacbond.com, emma.msrb.org, yahoo.brand.edgar-online.com, and sec.gov.

* 81.3% of parent and independent systems published audited financial statements for 2015. Subsystems that are members of a larger "parent" health system do not have separate audited financial statements. This translated into a total of 63.2% of all in-study health systems with available financial reports.

Methodology

The Truven Health 15 Top Health Systems study is the most recent addition to the 100 Top Hospitals® program initiatives from Truven Health Analytics®, part of the IBM Watson Health™ business. It is a quantitative study that identifies 15 US health systems with the highest overall achievement on a balanced scorecard. The scorecard is based on the 100 Top Hospitals national balanced scorecard methodologies and focuses on five performance domains: inpatient outcomes, process of care, extended outcomes, efficiency, and patient experience.

This 2017 health systems study includes nine measures that provide an objective comparison of health system performance using publicly available data. The health systems with the highest achievement are those with the highest ranking on a composite score based on these nine measures. To analyze health system performance, we include data for short-term, acute care, nonfederal US hospitals, as well as cardiac, orthopedic, women's, and critical access hospitals (CAHs) that are members of the health systems.

The main steps we take in selecting the top 15 health systems are:

- Building the database of health systems, including special selection and exclusion criteria
- Identifying which hospitals are members of health systems
- Aggregating the patient-level data from member hospitals and calculating a set of performance measures at the system level
- Classifying health systems into comparison groups based on total operating expense
- Ranking systems on each of the performance measures by comparison group
- Determining the 15 top performers (five in each comparison group) from the health systems' overall rankings based on their aggregate performance (sum of individual weighted measure ranks)

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 us at 100tophospitals@truvenhealth.com or call 1-800-525-9083.

Building the database of health systems

Like all the 100 Top Hospitals studies, the 15 Top Health Systems study uses only publicly available data. The data for this study primarily came from:

- Medicare Provider Analysis and Review (MEDPAR) data set*
- Centers for Medicare & Medicaid Services (CMS) Hospital Compare data set

We use MEDPAR patient-level demographic, diagnosis, and procedure information to calculate mortality, complications, and length of stay (LOS) by aggregating member hospital data to the health system level. The MEDPAR data set contains information on the approximately 15 million Medicare patients discharged annually from US acute care hospitals. In this year's study, we used the most recent two federal fiscal years (FFYs) of MEDPAR data available (2014 and 2015), which included Medicare Advantage health maintenance organization (HMO) encounters*.

We used the CMS Hospital Compare data set published in the third quarter of 2016 for core measures, 30-day mortality rates, 30-day readmission rates, Medicare spending per beneficiary (MSPB) index, and Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) patient perception of care data²⁶.

We also used the 2015 Medicare cost reports, published in the federal Hospital Cost Report Information System (HCRIS) third quarter 2016 data set, to create our proprietary database for determining system membership based on "home office" or "related organization" relationships reported by hospitals. The cost reports were also used to aggregate member hospital total operating expense to the system level. This data was used to classify health systems into three comparison groups.

We, and many others in the healthcare industry, have used these public data sources for many years. We believe them to be accurate and reliable sources for the types of analyses performed in this study. Performance based on Medicare data also has been found to be highly representative of all-payer data.

Risk-adjustment models and present-on-admission data

The Truven Health proprietary risk- and severity-adjustment models for inpatient mortality, complications, and LOS have been calibrated using FFY 2013 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 present-on-admission (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 risk- and severity-adjustment models were used to produce 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.

* The MEDPAR data years quoted in 100 Top Hospitals program studies are FFYs, a year that begins on October 1 of each calendar year and ends on September 30 of the following calendar year. FFYs are identified by the year in which they end (for example, the FFY 2015 begins Oct. 1, 2014, and ends Sept. 30, 2015). Data for all CMS Hospital Compare measures is provided in calendar years, except for 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."

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 adjust MEDPAR record processing through our mortality and complications risk models, and LOS severity-adjustment model, as follows:

1. We treat all diagnosis codes on the CMS exempt list as “exempt,” regardless of POA coding
2. We treat all principal diagnoses as present on admission
3. We treat 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

Hospital exclusions

After building the database, we exclude hospitals that would have skewed the study results. Excluded from the study were:

- Certain specialty hospitals (that is, children’s, psychiatric, substance abuse, rehabilitation, 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 Medicare average LOS longer than 30 days in FFY 2015
- Hospitals with no reported Medicare patient deaths in FFY 2015
- Hospitals that had fewer than 60% of patient records with valid POA codes

Cardiac, orthopedic, women’s hospitals, and CAHs are included in the study, if they are not excluded for any other criteria listed above.

In addition, specific patient records are 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, 2,415 individual hospitals were included in the 2017 study.

Health system exclusions

Health systems are excluded if:

- One or more measures are missing (all 30-day mortality rates, all 30-day readmission rates, or all core measures must be missing*)
- Less than 50% of member hospitals have valid POA coding

* In systems where one or more individual 30-day rates or core measures were missing, we calculated a median value for each, by comparison group, and substituted the median in any case where a health system had no data for that measure.

New this year, all Maryland health systems were excluded because their Maryland-based hospitals were missing all 30-day mortality and readmission rates, as well as the MSPB index. CMS does not publish MSPB index values for hospitals in Maryland, due to a separate payment agreement, and did not publish 30-day mortality rates and 30-day readmission rates in the 2016 Hospital Compare data files. Because of this change, we implemented an additional exclusion rule: Health systems are excluded if fewer than 50% of member acute care hospitals were missing these metrics.

Identifying health systems

To be included in the study, a health system must contain at least two short-term, general, acute care hospitals, as identified using the 100 Top Hospitals specialty algorithm, after hospital exclusions have been applied. In addition, we also include any cardiac, orthopedic, women’s hospitals, and CAHs that passed the hospital exclusion rules cited above. For the 2017 study, we identified the “parent” system by finding the “home office” or “related organization”, as reported on the hospitals’ 2015 (or 2014) Medicare cost report.

We identify health systems that have subsystems with their own reported home offices or related organization relationships. Both the parent system and any identified subsystems are treated as “health systems” for purposes of this study and are independently profiled. Hospitals that belong to a parent health system and a subsystem are included in both for analysis.

To analyze health system performance, we aggregate data from all of a system’s included hospitals. Below, we provide specific details about the calculations used for each performance measure and how these measures are aggregated to determine system performance.

After all exclusions were applied and parent systems identified, the final 2017 study group included 337 health systems with the profile outlined in Table 9.

Table 9. 2017 health systems study group					
System category	Systems	Member hospitals	Medicare patient discharges, federal fiscal year (FFY) 2015	Average hospitals per system	Average discharges per system
Winning systems	15	122	312,892	8.1	20,859
Nonwinning systems	322	2,802	9,172,343	8.7	28,486
Total systems	337	2,924	9,485,235	8.7	28,146

Note: A hospital can be a member of both a parent system and a subsystem of that parent. They will be included in both parent and subsystem member hospital counts. The total unduplicated hospital count in this study was 2,415 hospitals.

Note: Truven Health asked the Agency for Healthcare Research and Quality (AHRQ) to clarify how the the Patient Safety Indicator (PSI) models models treated POA coding. The response included the following statement: “A condition is considered to be POA only if the diagnosis is listed with a POA code of Y or W. A code of N, U, E, I, X or Missing is considered not POA.”

Classifying health systems into comparison groups

Health system comparison groups

We refine the analysis of health systems by dividing them into three comparison groups based on total operating expense of the member hospitals. This is done to develop more action-driving benchmarks for like systems. For the 2017 study, the three comparison groups we used are listed in Table 10.

Table 10. Health system comparison groups, defined

Health system comparison group	Total operating expense	Number of systems in study	Number of winners
Large	> \$1.75 billion	109	5
Medium	\$750 million - \$1.75 billion	115	5
Small	< \$750 million	113	5
Total systems		337	15

Scoring health systems on weighted performance measures

Evolution of performance measures

We use a balanced scorecard approach, based on public data, to select measures useful for boards and CEOs in the current healthcare operating environment. We gather feedback from industry leaders, hospital and health system executives, academic leaders, and internal experts; review trends in the healthcare industry; and survey hospitals in demanding marketplaces to learn what measures are valid and reflective of high performance.

As the industry has changed, our methods have evolved. Our current measures are centered on five main components of hospital performance: inpatient outcomes, process of care, extended outcomes, efficiency, and patient experience.

The 2017 study performance measures

The measures ranked in the 2017 study were:

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)

Efficiency

6. Severity-adjusted average LOS
7. Mean emergency department (ED) throughput (wait time minutes)
8. MSPB index

Patient experience

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

The data sources for these measures are listed in Table 11.

Table 11. Summary of measure data sources and data periods		
Performance measure	Current performance (15 Top Health Systems award selection)	Five-year trend performance
Risk-adjusted inpatient mortality index	MEDPAR FFY 2014 and 2015*	MEDPAR 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 average LOS	MEDPAR FFY 2015	MEDPAR FFY 2011 - 2015
Mean ED throughput measure	CMS Hospital Compare CY 2015	CMS Hospital Compare 2012 - 2015
MSPB index	CMS Hospital Compare CY 2015	CMS Hospital Compare 2012 - 2015
HCAHPS score (consumer overall hospital rating)	CMS Hospital Compare CY 2015	CMS Hospital Compare 2011 - 2015

* Two years of data are combined for each study year data point.

** Trend data for 30-day mortality does not include COPD or stroke.

*** Trend data for 30-day readmissions does not include hip/knee arthroplasty, COPD, or stroke.

Below, we provide a rationale for the selection of our balanced scorecard categories and the measures used for each.

Inpatient outcomes

We include two measures of inpatient outcomes: risk-adjusted mortality index and risk-adjusted complications index. These measures show us how the member hospitals are 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 website²⁶. 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 health system member hospitals' patients are faring over a longer period. These measures are part of the CMS Hospital Value- Based Purchasing Program and are watched in the industry. Hospitals with lower values appear to be providing or coordinating the care continuum with better medium-term results for these conditions.

Efficiency

The efficiency domain includes severity-adjusted average LOS, the mean ED throughput measure, and the MSPB index. Average LOS 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.

Average LOS 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 system-level, severity-adjusted, average LOS.

The MSPB index is a proxy for continuum-of-care performance recently added to the study. This measure, as defined and calculated by CMS, is the ratio of Medicare spending per beneficiary treated in a specific hospital and the median Medicare spending per beneficiary, 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.

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 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 was based on the HCAHPS overall hospital rating question only.

Using the combined measures described above, we provide a balanced picture of health system performance. Details about each of these performance measures are included on the following pages.

Performance measure details

Risk-adjusted inpatient mortality index			
Why we include this element	Calculation	Comment	Favorable values are
<p>Patient survival is a universally accepted measure of hospital quality. The lower the mortality index, the greater the survival of the patients in the system's hospitals, 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.</p>	<p>We calculate a mortality index value based on the aggregate number of actual in-hospital deaths for all member hospitals in each system, divided by the number of normalized expected deaths, given the risk of death for each patient. Expected deaths are derived by processing MEDPAR patient record data through our proprietary mortality risk model, which 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 values using the observed-to-expected ratio for in-study health systems, by comparison group.</p> <p>The mortality risk model takes into account POA coding in determining expected deaths. Palliative care patients (v66.7) are included in the risk model. "Do not resuscitate (DNR)" patients (v49.86) coded as POA are excluded.</p> <p>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.</p>	<p>We rank systems, by comparison group, on the difference between observed and expected deaths, expressed in normalized standard deviation units (z-score)^{27,28}. Health systems 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 to reduce the influence of chance fluctuation.</p> <p>The MEDPAR data set includes both Medicare fee-for-service claims and Medicare Advantage (HMO) encounter records.</p> <p>Systems with observed values statistically worse than expected (99% confidence), and whose values are above the high trim point (75th percentile of statistical outliers), are not eligible to be named benchmark health systems.</p>	Lower

Risk-adjusted complications index			
Why we include this element	Calculation	Comment	Favorable values are
<p>Keeping patients free from potentially avoidable complications is an important goal for all healthcare providers. A lower complications index indicates fewer patients with complications, considering what would be expected based on patient characteristics. Like the mortality index, this measure can show where complications did not occur but were expected, or the reverse, given the patient's condition.</p>	<p>We calculate a complications index value based on the aggregate number of cases with observed complications for all member hospitals in each system, divided by the number of normalized expected complications, given the risk of complications for each patient. Expected complications are derived by processing MEDPAR patient record data through our proprietary complications risk model, which is designed to predict the likelihood of complications during hospitalization. This model accounts for patient-level characteristics (age, sex, principal diagnosis, comorbid conditions, and other characteristics). We normalize the expected values using the observed-to-expected ratio for in-study health systems, by comparison group. Complications rates are calculated from normative data for two patient risk groups: medical and surgical.</p> <p>The complications risk model takes into account POA coding in determining expected complications. Also, conditions that are present on admission are not counted as observed complications.</p> <p>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.</p>	<p>We rank systems 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 to reduce the influence of chance fluctuation.</p> <p>The MEDPAR data set includes both Medicare fee-for-service claims and Medicare Advantage (HMO) encounter records.</p> <p>Systems with observed values statistically worse than expected (99% confidence), and whose values are above the high trim point (75th percentile of statistical outliers), are not eligible to be named benchmark health systems.</p>	Lower

Core measures mean percent

Why we include this element	Calculation	Comment	Favorable values are
<p>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.</p>	<p>CMS reports the percentage of eligible patients who received each core measure, as well as the eligible patient count. For each included core measure, we calculate an aggregate core measure percent for each system. This is done by multiplying the system member hospital eligible patient count by the reported percent who received it. The result is the recipient count for each member hospital. We sum the recipient patient counts and divide by the sum of eligible patients for member hospitals of each system. This value is multiplied by 100 to produce the system-level core measure percent for the individual core measure.</p> <p>We calculate the arithmetic mean of the system-level core measure percent values for the included measures (AMI, HF, pneumonia, COPD, stroke) to produce the ranked composite measure. Note: We reverse the percent value for VTE-6, where lower percentages mean better performance, in order to include it in the composite.</p>	<p>We rank systems 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, see Appendix C.</p> <p>Core measures are reported by the hospitals for all eligible patients.</p>	<p>Higher</p> <p>Exception: VTE-6: Patients who developed a blood clot while in the hospital who did not get treatment that could have prevented it (lower percentages are better).</p>

Mean 30-day risk-adjusted mortality rate

Why we include this element	Calculation	Comment	Favorable values are
<p>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 health system provided to inpatients with these particular conditions may have contributed to their longer-term survival. In addition, tracking these measures may help health systems identify patients at risk for post-discharge problems and target improvements in discharge planning and after-care processes. Health systems that score well may be better prepared for a pay-for-performance structure.</p>	<p>Data is from the CMS Hospital Compare data set. CMS calculates a 30-day mortality rate for each patient condition using three years of MEDPAR data, combined. We aggregate this data to produce a rate for each 30-day measure for each system. This is done by multiplying the hospital-level reported patient count (eligible patients) by the reported hospital rate to determine the number of patients who died within 30 days of admission. We sum the calculated deaths and divide by the sum of eligible patients for member hospitals of each system. This value is multiplied by 100 to produce the system-level 30-day mortality rate for each measure, expressed as a percent. 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.</p> <p>We calculate the arithmetic mean of the system-level included 30-day mortality rates (AMI, HF, pneumonia, COPD, and stroke) to produce the ranked composite measure.</p>	<p>We rank systems by comparison group, based on the mean rate for included 30-day mortality measures (AMI, HF, pneumonia, COPD, and stroke).</p> <p>The CMS Hospital Compare data for 30-day mortality is based on Medicare fee-for-service claims only.</p>	<p>Lower</p>

Mean 30-day risk-adjusted readmission rate

Why we include this element	Calculation	Comment	Favorable values are
<p>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. Because these measures are part of the CMS Value-Based Purchasing Program, they are now being watched 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 after-care processes. Hospitals that score well may be better prepared for a pay-for-performance structure.</p>	<p>Data is from the CMS Hospital Compare data set. CMS calculates a 30-day readmission rate for each patient condition using three years of MEDPAR data, combined. We aggregate this data to produce a rate for each 30-day measure for each system. This is done by multiplying the hospital-level reported patient count (eligible patients) by the reported hospital rate to determine the number of patients who were readmitted within 30 days of discharge. We sum the calculated readmissions and divide by the sum of eligible patients for member hospitals of each system. This value is multiplied by 100 to produce the system-level 30-day readmission rate for each measure, expressed as a percent. 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.</p> <p>We calculate the arithmetic mean of the system-level included 30-day readmission rates (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke) to produce the ranked composite measure.</p>	<p>We rank systems by comparison group, based on the mean rate for included 30-day readmission measures (AMI, HF, pneumonia, hip/knee arthroplasty, COPD, and stroke).</p> <p>The CMS Hospital Compare data for 30-day readmissions is based on Medicare fee-for-service claims only.</p>	Lower

Severity-adjusted average length of stay

Why we include this element	Calculation	Comment	Favorable values are
<p>A lower severity-adjusted average LOS generally indicates more efficient consumption of hospital resources and reduced risk to patients.</p>	<p>We calculate an LOS index value for each health system by dividing the sum of the actual LOS of member hospitals by the sum of the normalized expected LOS for the hospitals in the system. Expected LOS adjusts for difference in severity of illness using a linear regression model. We normalize the expected values using the observed-to-expected ratio for in-study health systems, by comparison group. The LOS risk model takes into account POA coding in determining expected length of stay.</p> <p>We convert the LOS index into days by multiplying each system's LOS index by the grand mean LOS for all in-study health systems. We calculate grand mean LOS by summing in-study health systems' LOS and dividing that by the number of health systems.</p>	<p>We rank systems on their severity-adjusted average LOS.</p> <p>The MEDPAR data set includes both Medicare fee-for-service claims and Medicare Advantage (HMO) encounter records.</p>	Lower

Mean emergency department throughput measure

Why we include this element	Calculation	Comment	Favorable values are
<p>The hospital ED is an important access point to healthcare for many people. A key factor in evaluating ED performance is process "throughput," or 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.</p>	<p>Data is from the CMS Hospital Compare data set. CMS reports the median minutes for each ED throughput measure, as well as the total number of ED visits, including admitted patients. We include three of the available ED measures in calculating a system aggregate measure. For each ED measure, we calculate the weighted median minutes by multiplying the median minutes by the ED visits. We sum the weighted minutes for system member hospitals and divide by the sum of ED visits for the hospitals to produce the system-level weighted minutes for each measure. We calculate the arithmetic mean of the three included ED measures to produce the ranked composite ED measure.</p>	<p>We rank systems on the mean ED throughput measure in minutes. 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.</p>	<p>Lower</p>

Medicare spending per beneficiary index

Why we include this element	Calculation	Comment	Favorable values are
<p>MSPB helps 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.</p>	<p>Data is from the CMS Hospital Compare data set. CMS calculates the cost of care for each admitted patient, including Medicare Part A and Part B costs. CMS aggregates costs associated with the index admission from three days preadmission, through inpatient stay, and 30 days post-admission. This cost is divided by the median national cost. CMS applies both numerator and denominator adjustments. We calculate the system-level measure by weighting each member hospital index by the hospital's MEDPAR discharges for the most current year in the study. We sum the weighted values and divide by the sum of the MEDPAR discharges of all member hospitals. This produces a weighted MSPB index for each system.</p> <p>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.</p>	<p>We rank hospitals on the MSPB index.</p> <p>CMS calculates the cost of care for each admitted patient, including both Medicare Part A and Part B costs.</p>	<p>Lower</p>

Hospital Consumer Assessment of Healthcare Providers and Systems score (patient rating of overall hospital performance)

Why we include this element	Calculation	Comment	Favorable values are
<p>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 likely has a direct effect on its ability to remain competitive in the marketplace.</p>	<p>Data is from CMS Hospital Compare data set. We used the data published by CMS for 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 percentage by CMS.</p> <ul style="list-style-type: none"> ▪ 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) <p>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 hospital HCAHPS score.</p> <p>To calculate the aggregate system score, we multiply each member hospital HCAHPS score by their MEDPAR discharges, sum the weighted scores, and divide by the sum of the member hospital discharges.</p>	<p>We rank systems based on the weighted average hospital HCAHPS score. The highest possible HCAHPS score is 300 (100% of patients rate the health system hospitals high). The lowest HCAHPS score is 100 (100% of patients rate the hospitals low).</p> <p>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.</p>	Higher

Determining the 15 Top Health Systems

Ranking

We rank health systems based on their performance on each of the included measures relative to the other in-study systems, by comparison group. We sum the ranks, giving all measures equal weight, and re-rank overall to arrive at a final rank for the system. The top five health systems with the best final rank in each of the three comparison groups are selected as the winners (15 total winners). The ranked performance measures are listed in Table 12.

Table 12. Ranked performance measures and weights

Ranked measure	Weight in overall ranking
Risk-adjusted inpatient mortality	1
Risk-adjusted complications	1
Core measures mean percent	1
Mean 30-day mortality rate	1
Mean 30-day readmission rate	1
Severity-adjusted average LOS	1
Mean ED throughput	1
MSPB index	1
HCAHPS score (overall rating question)	1

Winner exclusions

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

A system 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.
2. We calculate the 75th percentile index value for mortality and complications, including data only for systems that meet condition number 1 above. These values are used as the high trim points for those health systems. Systems with mortality or complications index values above the respective trim points are winner-excluded.

Measure of “systemness”: The performance-weighted alignment score

For several years, we have reported a performance-weighted alignment score that measures whether a system is consistently delivering top performance in each community served. It can bring focus to leadership goal-setting and contribute to the development of a system “brand” that represents reliable delivery of high value across all system sites.

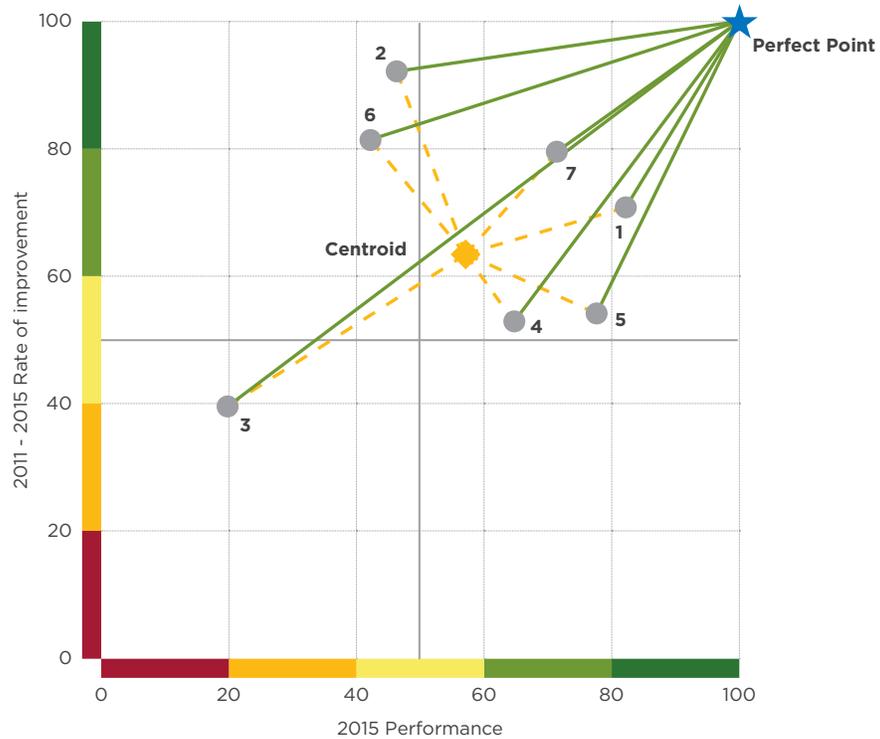
Methodology

Each system performance-weighted alignment score is the average of the distance of each member hospital from their central point (centroid [measure of alignment]) and the distance of each of those hospitals from the 100th percentile point (perfect point [measure of performance]), weighted by the distance from the perfect point. A score is calculated for overall performance and for each individual measure.

The system performance-weighted alignment scores are ranked by comparison group and reported as rank percentiles. Higher percentiles mean better performance.

The profiled system performance is compared to the median alignment scores for the systems that were in the top quintile on both performance and improvement (top performance and improvement group). This group is selected using the study ranked metrics; not member hospital alignment. We find that high alignment has not yet been achieved uniformly across all measures, even in this high-performing group.

Example:



Truven Health policy on revocation of a 15 Top Health Systems award

To preserve the integrity of the study, it is the policy of Truven Health to revoke a 15 Top Health Systems award if a system is found to have submitted inaccurate or misleading data to any data source used in the study.

At the discretion of Truven Health, the circumstances under which a 15 Top Health Systems award could be revoked include, but are not limited to, the following:

- Discovery by Truven Health staff, through statistical analysis or other means, that a health system has submitted inaccurate data
- Discovery of media or internet reports of governmental or accrediting agency investigations or sanctions for actions by a health system that could have an adverse impact on the integrity of the 15 Top Health Systems studies or award winner selection

Appendix A: Health system winners and their member hospitals

Health system/hospital name	Location	Hospital Medicare ID
Asante		
Asante Ashland Community Hospital	Ashland, OR	380005
Asante Rogue Regional Medical Center	Medford, OR	380018
Asante Three Rivers Medical Center	Grants Pass, OR	380002
HealthPartners		
Bloomington, MN		
Park Nicollet Methodist Hospital	St. Louis Park, MN	240053
Lakeview Hospital	Stillwater, MN	240066
Regions Hospital	Saint Paul, MN	240106
Amery Hospital & Clinic	Amery, WI	521308
Hudson Hospital	Hudson, WI	521335
Westfields Hospital & Clinic	New Richmond, WI	521345
Kettering Health Network		
Dayton, OH		
Fort Hamilton Hughes Memorial Hospital	Hamilton, OH	360132
Grandview Hospital & Medical Center	Dayton, OH	360133
Greene Memorial Hospital	Xenia, OH	360026
Kettering Medical Center	Kettering, OH	360079
Soin Medical Center	Beavercreek, OH	360360
Sycamore Medical Center	Miamisburg, OH	360239
Lakeland Health		
St. Joseph, MI		
Lakeland Medical Center, St. Joseph	St. Joseph, MI	230021
Lakeland Hospital, Watervliet	Watervliet, MI	230078
Lovelace Health System		
Albuquerque, NM		
Lovelace Medical Center	Albuquerque, NM	320009
Lovelace Regional Hospital - Roswell	Roswell, NM	320086
Lovelace Westside Hospital	Albuquerque, NM	320074
Lovelace Women's Hospital	Albuquerque, NM	320017
Maury Regional Health		
Columbia, TN		
Marshall Medical Center	Lewisburg, TN	441309
Maury Regional Hospital	Columbia, TN	440073
Wayne Medical Center	Waynesboro, TN	440010
Mayo Foundation		
Rochester, MN		
Mayo Clinic Hospital	Phoenix, AZ	030103
Mayo Clinic	Jacksonville, FL	100151
Mayo Clinic Health System in Waycross	Waycross, GA	110003
Veterans Memorial Hospital	Waukon, IA	161318
Mayo Regional Hospital	Dover Foxcroft, ME	201309
Mayo Clinic - Saint Marys Hospital	Rochester, MN	240010
Mayo Clinic Health System in Albert Lea	Albert Lea, MN	240043

Note: Winning systems are listed alphabetically by name. Member hospitals are listed alphabetically by state, then alphabetically by name.

Health system/hospital name	Location	Hospital Medicare ID
Mayo Clinic Health System in Cannon Falls	Cannon Falls, MN	241346
Mayo Clinic Health System in Fairmont	Fairmont, MN	240166
Mayo Clinic Health System in Red Wing	Red Wing, MN	240018
Mayo Clinic Health System in Lake City	Lake City, MN	241338
Mayo Clinic Health System in Mankato	Mankato, MN	240093
Mayo Clinic Health System in New Prague	New Prague, MN	241361
Mayo Clinic Health System in Springfield	Springfield, MN	241352
Mayo Clinic Health System St. James	St. James, MN	241333
Mayo Clinic Health System in Waseca	Waseca, MN	241345
Crossing Rivers Health Medical Center	Prairie du Chien, WI	521330
Mayo Clinic Health System Chippewa Valley	Bloomer, WI	521314
Mayo Clinic Health System in Eau Claire	Eau Claire, WI	520070
Mayo Clinic Health System Franciscan Healthcare	La Crosse, WI	520004
Mayo Clinic Health System - Northland	Barron, WI	521315
Mayo Clinic Health System - Oakridge	Osseo, WI	521302
Mayo Clinic Health System in Red Cedar	Menomonie, WI	521340
Mayo Clinic Health System Franciscan Healthcare	Sparta, WI	521305
Tomah Memorial Hospital	Tomah, WI	521320
Mercy	Chesterfield, MO	
Mercy Hospital Berryville	Berryville, AR	041329
Mercy Hospital Booneville	Booneville, AR	041318
Mercy Hospital Fort Smith	Fort Smith, AR	040062
Mercy Hospital Rogers	Rogers, AR	040010
Mercy Hospital Turner Memorial	Ozark, AR	041303
Mercy Hospital Waldron	Waldron, AR	041305
North Logan Mercy Hospital	Paris, AR	041300
Mercy Hospital Columbus	Columbus, KS	171308
Mercy Hospital Fort Scott	Fort Scott, KS	170058
Mercy Hospital Independence	Independence, KS	170010
Mercy Hospital Aurora	Aurora, MO	261316
Mercy Hospital Carthage	Carthage, MO	261338
Mercy Hospital Cassville	Cassville, MO	261317
Mercy Hospital Jefferson	Festus, MO	260023
Mercy Hospital Joplin	Joplin, MO	260001
Mercy Hospital Lebanon	Lebanon, MO	260059
Mercy Hospital Lincoln	Troy, MO	261319
Mercy Hospital Springfield	Springfield, MO	260065
Mercy Hospital St. Louis	St. Louis, MO	260020
Mercy Hospital Washington	Washington, MO	260052
Mercy McCune Brooks Hospital	Carthage, MO	260228
Mercy St. Francis Hospital	Mountain View, MO	261335
Mercy Health Love County	Marietta, OK	371306
Mercy Hospital Ada	Ada, OK	370020
Mercy Hospital Ardmore	Ardmore, OK	370047

Note: Winning systems are listed alphabetically by name. Member hospitals are listed alphabetically by state, then alphabetically by name.

Health system/hospital name	Location	Hospital Medicare ID
Mercy Hospital El Reno	El Reno, OK	370011
Mercy Hospital Healdton	Healdton, OK	371310
Mercy Hospital Kingfisher	Kingfisher, OK	371313
Mercy Hospital Logan County	Guthrie, OK	371317
Mercy Hospital Oklahoma City	Oklahoma City, OK	370013
Mercy Hospital Tishomingo	Tishomingo, OK	371304
Mercy Hospital Watonga	Watonga, OK	371302
Mercy Health Southwest Ohio Region	Cincinnati, OH	
Clermont Hospital	Batavia, OH	360236
Jewish Hospital	Cincinnati, OH	360016
Mercy Health Anderson Hospital	Cincinnati, OH	360001
Mercy Health Fairfield Hospital	Fairfield, OH	360056
Mercy Health West Hospital	Cincinnati, OH	360234
Mission Health	Asheville, NC	
Angel Medical Center	Franklin, NC	341326
Blue Ridge Regional Hospital	Spruce Pine, NC	340011
Blue Ridge Regional CAH	Spruce Pine, NC	341329
Highlands-Cashiers Hospital	Highlands, NC	341316
Mission Hospital	Asheville, NC	340002
McDowell Hospital	Marion, NC	340087
Transylvania Regional Hospital	Brevard, NC	341319
Parkview Health	Fort Wayne, IN	
Parkview Ortho Hospital	Fort Wayne, IN	150167
Parkview Huntington Hospital	Huntington, IN	150091
Parkview LaGrange Hospital	LaGrange, IN	151323
Parkview Noble Hospital	Kendallville, IN	150146
Parkview Regional Medical Center	Fort Wayne, IN	150021
Parkview Wabash Hospital	Wabash, IN	151310
Parkview Whitley Hospital	Columbia City, IN	150101
Roper St. Francis Healthcare	Charleston, SC	
Bon Secours St. Francis Hospital	Charleston, SC	420065
Roper Hospital	Charleston, SC	420087
Roper St. Francis Mount Pleasant Hospital	Mount Pleasant, SC	420104
Scripps Health	San Diego, CA	
Scripps Green Hospital	La Jolla, CA	050424
Scripps Memorial Hospital Encinitas	Encinitas, CA	050503
Scripps Memorial Hospital La Jolla	La Jolla, CA	050324
Scripps Mercy Hospital	San Diego, CA	050077
Spectrum Health	Grand Rapids, MI	
Spectrum Health Big Rapids Hospital	Big Rapids, MI	230093
Spectrum Health Blodgett & Butterworth Hospitals	Grand Rapids, MI	230038
Spectrum Health Gerber Memorial	Fremont, MI	231338
Spectrum Health Kelsey Hospital	Lakeview, MI	231317
Spectrum Health Ludington Hospital	Ludington, MI	230110

Note: Winning systems are listed alphabetically by name. Member hospitals are listed alphabetically by state, then alphabetically by name.

Health system/hospital name	Location	Hospital Medicare ID
Spectrum Health Pennock	Hastings, MI	230040
Spectrum Health Reed City Hospital	Reed City, MI	231323
Spectrum Health United Hospital	Greenville, MI	230035
Spectrum Health Zeeland Community Hospital	Zeeland, MI	230003
St. Luke's Health System	Boise, ID	
St. Luke's Elmore Medical Center	Mountain Home, ID	131311
St. Luke's Jerome Medical Center	Jerome, ID	131310
St. Luke's Magic Valley Medical Center	Twin Falls, ID	130002
St. Luke's McCall Medical Center	McCall, ID	131312
St. Luke's Wood River Medical Center	Ketchum, ID	131323
St. Luke's Boise Medical Center	Boise, ID	130006

Note: Winning systems are listed alphabetically by name. Member hospitals are listed alphabetically by state, then alphabetically by name.

Appendix B: The top quintile: Highest- performing health systems

Large health systems	
System name	Location
Advocate Health Care	Downers Grove, IL
Allina Health System	Minneapolis, MN
Avera Health	Sioux Falls, SD
Baylor Scott & White Health	Dallas, TX
Centura Health	Englewood, CO
Houston Methodist	Houston, TX
Indiana University Health	Indianapolis, IN
Intermountain Health Care	Salt Lake City, UT
Mayo Foundation	Rochester, MN
Memorial Healthcare System	Hollywood, FL
Mercy	Chesterfield, MO
Northwestern Medicine	Chicago, IL
OSF Healthcare System	Peoria, IL
SCL Health	Denver, CO
Scripps Health	San Diego, CA
Spectrum Health	Grand Rapids, MI
St. Luke's Health System	Boise, ID
St. Vincent Health	Indianapolis, IN
Sutter Health	Sacramento, CA
Sutter Health Valley Area	Sacramento, CA
Texas Health Resources	Arlington, TX
UHealth	Aurora, CO
Medium health systems	
System name	Location
Alegent Creighton Health	Omaha, NE
Ardent Health Services	Nashville, TN
Baptist Health of Northeast Florida	Jacksonville, FL
Froedtert & the Medical College of Wisconsin	Milwaukee, WI
HCA MidAmerica (North)	Kansas City, MO
HCA Mountain Division	Salt Lake City, UT
HealthPartners	Bloomington, MN
HonorHealth	Scottsdale, AZ
Kettering Health Network	Dayton, OH
Legacy Health System	Portland, OR
Main Line Health	Bryn Mawr, PA
Mercy Health	Muskegon, MI

Note: Health systems are ordered alphabetically. This year's 15 Top Health Systems (2017) are in bold, blue text.

Medium health systems

System name	Location
Mercy Health Southwest Ohio Region	Cincinnati, OH
Ministry Health Care	Milwaukee, WI
Mission Health	Asheville, NC
Ochsner Health System	New Orleans, LA
Parkview Health	Fort Wayne, IN
ProMedica Health System	Toledo, OH
Saint Joseph Mercy Health System	Ann Arbor, MI
Samaritan Health Services	Corvallis, OR
SCL Denver Region	Denver, CO
St. Elizabeth Healthcare	Fort Thomas, KY
TriHealth	Cincinnati, OH

Small health systems

System name	Location
Alexian Brothers Health System	Arlington Heights, IL
Asante	Medford, OR
Cape Cod Healthcare	Hyannis, MA
Centegra Health System	Crystal Lake, IL
CHI St. Joseph Health	Bryan, TX
Franciscan Sisters of Christian Charity	Manitowoc, WI
Genesis Health System	Davenport, IA
Good Shepherd Health System	Longview, TX
Lakeland Health	St. Joseph, MI
Lovelace Health System	Albuquerque, NM
LSU Health System	Baton Rouge, LA
Maury Regional Health	Columbia, TN
MidMichigan Health	Midland, MI
Northern Arizona Healthcare	Flagstaff, AZ
Palomar Health	San Diego, CA
Penn Highlands Healthcare	DuBois, PA
PIH Health	Whittier, CA
ProHealth Care	Waukesha, WI
Roper St. Francis Healthcare	Charleston, SC
Saint Alphonsus Health System	Boise, ID
Saint Joseph Regional Health System	Mishawaka, IN
Southern Illinois Healthcare	Carbondale, IL
Susquehanna Health System	Williamsport, PA
Tanner Health System	Carrollton, GA

Note: Health systems are ordered alphabetically. This year's 15 Top Health Systems are in bold, blue text.

Appendix C: Methodology details

Methods for identifying patient severity

To make valid normative comparisons of health system outcomes, it is necessary to adjust raw data to accommodate differences that result from the variety and severity of admitted cases.

Truven Health Analytics®, part of the IBM Watson Health™ business, 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 (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 collection²⁹⁻³³. 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)³⁴ 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, producing 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 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) 2013 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 "O" has been appearing. The percentage of diagnosis codes with POA code "O" are displayed in the table below. This phenomenon has led to an artificial rise in the number of conditions that appear to be occurring during the hospital stay.

Percentage of diagnosis codes with POA indicator code of "O" 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 treat all diagnosis codes on the CMS exempt list as "exempt," regardless of POA coding
2. We treat all principal diagnoses as present on admission
3. We treat 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

Risk-adjusted mortality index models

Truven Health has developed an overall mortality risk model. From this 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 where the patient age was less than 65 years; and where the 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”³⁵. 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 was used to estimate the risk of mortality for each patient. This was done by weighting the patient records of the hospital by the logistic regression coefficients associated with the corresponding terms in the model and intercept term. This produced 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)²⁹⁻³³. This model considers 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 groups for assignment of risk instead of using the individual diagnosis, procedure, and interaction effects.

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. Following are the complications used in the model.

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 acute myocardial infarction (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 groupings³⁶⁻³⁹, including health system, hospital, service line, or MS-DRG classification. This model considers 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 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 like 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 an 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.

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 two days of arriving at the hospital
STK-4	Ischemic stroke patients who got medicine to break up a blood clot within three 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

If a health system is missing one or more core measure values, the comparison group median core measure value is substituted for each missing core measure when we calculate the health system core measure mean percent. In addition, the median core measure value is substituted if a health system has one or more core measures with relative standard error greater than or equal to 0.30. This is done because the percent values are statistically unreliable in that case.

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 Hospital Compare files as a three-year combined data set. 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 measures used in this study have been endorsed by the NQF.

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)²⁶. All readmissions that occur 30 days after discharge to an 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.

CMS does not calculate rates for hospitals where the number of cases is too small (fewer than 25). If a health system has no available hospital rates for all 30-day mortality or 30-day readmission measures, we exclude the system. If one or two individual 30-day mortality or 30-day readmission rates are missing, we substitute the comparison group median rate for the affected measure.

The ranked measures in this study were the mean of the individual 30-day mortality rates and the mean of the individual 30-day readmission rates.

Average length of stay

We use the Truven Health proprietary severity-adjusted resource demand methodology for the LOS performance measure⁴⁰. The LOS 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 include three emergency department (ED) throughput measures from the CMS Hospital Compare data set in our study. The hospital ED is an important access point to healthcare for many people. A key factor in evaluating ED performance is process “throughput,” or 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 choose 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. See table below for complete description of each measure.

The measure data from CMS Hospital Compare is published in median minutes. Our ranked metric is the calculated mean of the three included measures. The hospital's comparison group median ED measure value is substituted for a missing measure for the purpose of calculating the composite measure. Hospitals missing all three included measures are excluded from the study.

ED throughput measures

ED-1b	Average time patients spent in the ED, before they were admitted to the hospital as an inpatient
OP-18b	Average time patients spent in the ED before being sent home
OP-21	Average time patients who came to the ED with broken bones had to wait before receiving pain medication

Medicare spending per beneficiary index

The Medicare spending 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”⁴¹.

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 if 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 for various risk factors including case mix, age, and hierarchical condition category (HCC) indicators.

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' perceptions of 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' perceptions 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](https://www.hospitalcompare.hhs.gov), or through a link on [medicare.gov](https://www.medicare.gov). A downloadable version of HCAHPS results is available.

Although we are reporting health system performance on all HCAHPS questions, only performance on the overall hospital rating question, "How do patients rate the hospital, overall?" is used to rank health system performance.

At the hospital level, 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).

To calculate the system-level score, we multiply the HCAHPS scores for every hospital in the system by the total MEDPAR discharges at the hospital in the most current included year. This produces the hospital weighted HCAHPS score.

To calculate the HCAHPS score for each health system, we sum the member hospital weighted HCAHPS scores, sum the member hospital MEDPAR discharges, then divide the sum of the weighted HCAHPS scores by the sum of the discharges. This produces the health system mean weighted HCAHPS score, which is the measure used in the study.

We apply this same methodology to each individual HCAHPS question to produce mean weighted HCAHPS scores for the systems. These values are reported for information only in the study.

Methodology for financial performance measures

Data sources

The financial measures included in this study were from the annual audited, consolidated financial statements of in-study health systems, when they were available. Consolidated balance sheets and consolidated statements of operations were used. More than 63% (63.2%) of all in-study health systems** had audited financial statements available. This included data for over 80% (81.3%) of parent and other independent health systems, while audited financials were generally not available for subsystems (2.6%). Audited financial statements were obtained from the following sites:

- Electronic Municipal Market Access (EMMA)
- DAC Bond
- US Securities and Exchange Commission (EDGAR)

* Exception: The “would refer” question has only two response categories—“yes” and “no.”

** We include subsystems in our study, as well as their parent systems and independent systems with no subsystems. Subsystems do not have audited financial statements. They are included in the parent organization statements.

Calculations

Operating margin (percentage):

$(\text{Operating revenue minus total operating expense}) / (\text{total operating revenue} * 100)$

Long-term debt-to-capitalization ratio:

$(\text{Long-term debt}) / (\text{long-term debt} + \text{unrestricted net assets})$

Performance measure normalization

The mortality, complications, and average LOS measures are normalized, based on the in-study population, by comparison group, to provide a more easily interpreted comparison among health systems. We assign each health system in the study to one of three comparison groups based on the sum of member hospitals' total operating expense. (Detailed descriptions of the comparison groups can be found in the Methodology section of this document.)

For the mortality and complications measures, we base our ranking on the difference between observed and normalized expected events, expressed in standard deviation units (z-scores). We normalize the individual health system expected values by multiplying them by the ratio of the observed-to-expected values for their comparison group. The normalized z-scores are then calculated using the observed, normalized expected and record count.

For the average 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 health system. We normalize the individual health system expected value by multiplying it by the ratio of the observed-to-expected value for the comparison group. The health system's normalized index is then calculated by dividing the health system'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 health systems (grand mean LOS).

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 value⁴².

We also did not report percent change when the metrics were already percentages. In these cases, we reported 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

Appendix D: All health systems in study

Health system name	Location
Abrazo Health Care	Phoenix, AZ
Adventist Florida Hospital	Orlando, FL
Adventist Health Central Valley Network	Hanford, CA
Adventist Health System	Winter Park, FL
Adventist Health West	Roseville, CA
Adventist Healthcare	Rockville, MD
Advocate Health Care	Downers Grove, IL
AHMC Healthcare Inc.	Alhambra, CA
Alameda Health System	Alameda, CA
Alecto Healthcare Services	Long Beach, CA
Alegent Creighton Health	Omaha, NE
Alexian Brothers Health System	Arlington Heights, IL
Allegheny Health Network	Pittsburgh, PA
Allegiance Health Management	Shreveport, LA
Allina Health System	Minneapolis, MN
Alta Hospitals System LLC	Los Angeles, CA
Anderson Regional Medical Center	Meridian, MS
Appalachian Regional Healthcare (ARH)	Lexington, KY
Ardent Health Services	Nashville, TN
Asante	Medford, OR
Ascension Health	St. Louis, MO
Atlantic Health System	Morristown, NJ
Aurora Health Care	Milwaukee, WI
Avanti Health System LLC	El Segundo, CA
Avera Health	Sioux Falls, SD
Banner Health	Phoenix, AZ
Baptist Health	Montgomery, AL
Baptist Health (AR)	Little Rock, AR
Baptist Health Care (FL)	Pensacola, FL
Baptist Health of Northeast Florida	Jacksonville, FL
Baptist Health South Florida	Coral Gables, FL
Baptist Health System (MS)	Jackson, MS
Baptist Health System Inc. (AL)	Birmingham, AL
Baptist Healthcare System (KY)	Louisville, KY
Baptist Memorial Health Care Corp	Memphis, TN
Barnabas Health	West Orange, NJ
BayCare Health System	Clearwater, FL
Bayhealth	Dover, DE
Baylor Scott & White Health	Dallas, TX
Baystate Health	Springfield, MA

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
Beacon Health System	South Bend, IN
Beaumont Health	Royal Oak, MI
BJC Health System	St. Louis, MO
Blue Mountain Health System	Lehighton, PA
Bon Secours Health System	Marriottsville, MD
Bronson Healthcare Group	Kalamazoo, MI
Broward Health	Fort Lauderdale, FL
Cape Cod Healthcare	Hyannis, MA
Capella Healthcare	Franklin, TN
Capital Health System	Trenton, NJ
Care New England Health System	Providence, RI
CareGroup Healthcare System	Boston, MA
CarePoint Health	Bayonne, NJ
Carilion Health System	Roanoke, VA
Carolinas HealthCare System	Charlotte, NC
Carondelet Health Network	Tucson, AZ
Carondelet Health System	Kansas City, MO
Catholic Health	Buffalo, NY
Catholic Health Initiatives	Denver, CO
Catholic Health Services of Long Island	Rockville Centre, NY
Centegra Health System	Crystal Lake, IL
Centra Health	Lynchburg, VA
Central Florida Health Alliance	Leesburg, FL
Centura Health	Englewood, CO
CHI St Joseph Health	Bryan, TX
CHI St Luke's Health	Houston, TX
CHI St. Vincent	Little Rock, AR
Christus Health	Irving, TX
Citrus Valley Health Partners	Covina, CA
Cleveland Clinic	Cleveland, OH
College Health Enterprises	Santa Fe Springs, CA
Columbia Health System	Milwaukee, WI
Columbus Regional Healthcare System	Columbus, GA
Community Foundation of Northwest Indiana	Munster, IN
Community Health Network	Indianapolis, IN
Community Health Systems	Franklin, TN
Community Hospital Corp	Plano, TX
Community Medical Centers	Fresno, CA
Community Memorial Health System	Ventura, CA
Conemaugh Health System	Johnstown, PA
Cook County Bureau of Health Services	Chicago, IL
Cottage Health System	Santa Barbara, CA
Covenant Health	Knoxville, TN
Covenant Health Systems (Northeast)	Syracuse, NY
CoxHealth	Springfield, MO
Crozer-Keystone Health System	Springfield, PA

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
Dartmouth Hitchcock Health	Lebanon, NH
Daughters of Charity Health System	Los Altos Hills, CA
DCH Health System	Tuscaloosa, AL
Dekalb Regional Healthcare System	Decatur, GA
Detroit Medical Center	Detroit, MI
Dignity Health	San Francisco, CA
Dimensions Health Corporation	Cheverly, MD
Duke LifePoint	Durham, NC
Duke University Health System	Durham, NC
East Texas Medical Center Regional Healthcare System	Tyler, TX
Eastern Connecticut Health Network	Manchester, CT
Eastern Maine Healthcare Systems	Brewer, ME
Einstein Healthcare Network	Philadelphia, PA
Emory Healthcare	Atlanta, GA
Essentia Health	Duluth, MN
Excela Health	Greensburg, PA
Exempla Healthcare	Denver, CO
Fairview Health Services	Minneapolis, MN
Forrest Health	Hattiesburg, MS
Franciscan Alliance	Mishawaka, IN
Franciscan Health System	Tacoma, WA
Franciscan Missionaries of Our Lady Health System	Baton Rouge, LA
Franciscan Sisters of Christian Charity	Manitowoc, WI
Froedtert & the Medical College of Wisconsin	Milwaukee, WI
Geisinger Health System	Danville, PA
Genesis Health System	Davenport, IA
Good Shepherd Health System	Longview, TX
Greater Hudson Valley Health System	Middletown, NY
Greenville Hospital System	Greenville, SC
Guthrie Healthcare System	Sayre, PA
Hartford HealthCare	Hartford, CT
Hawaii Health Systems Corporation	Honolulu, HI
Hawaii Pacific Health	Honolulu, HI
HCA	Nashville, TN
HCA Capital Division	Richmond, VA
HCA Central and West Texas Division	Austin, TX
HCA Continental Division	Denver, CO
HCA East Florida Division	Ft. Lauderdale, FL
HCA Far West Division	Las Vegas, NV
HCA Gulf Coast Division	Houston, TX
HCA MidAmerica (North)	Kansas City, MO
HCA MidAmerica (South)	Kansas City, MO
HCA Mountain Division	Salt Lake City, UT
HCA North Florida Division	Tallahassee, FL
HCA North Texas Division	Dallas, TX
HCA San Antonio Division	San Antonio, TX

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
HCA South Atlantic Division	Charleston, SC
HCA Tristar Division	Nashville, TN
HCA West Florida Division	Tampa, FL
Health Alliance of the Hudson Valley	Kingston, NY
Health First	Rockledge, FL
Health Group of Alabama	Huntsville, AL
Health Quest System	Poughkeepsie, NY
HealthEast Care System	Saint Paul, MN
HealthPartners	Bloomington, MN
Henry Ford Health System	Detroit, MI
Heritage Valley Health System	Beaver, PA
HighPoint Health System	Gallatin, TN
Hillcrest HealthCare System	Tulsa, OK
HonorHealth	Scottsdale, AZ
Hospital Sisters Health System	Springfield, IL
Houston Healthcare	Warner Robins, GA
Houston Methodist	Houston, TX
Humility of Mary Health Partners	Youngstown, OH
IASIS Healthcare	Franklin, TN
Indiana University Health	Indianapolis, IN
Infirmary Health Systems	Mobile, AL
InMed Group Inc.	Montgomery, AL
Inova Health System	Falls Church, VA
Inspira Health Network	Vineland, NJ
Integrated Healthcare Holding Inc.	Santa Ana, CA
Integrus Health	Oklahoma City, OK
Intermountain Health Care	Salt Lake City, UT
John D. Archbold Memorial Hospital	Thomasville, GA
John Muir Health	Walnut Creek, CA
Johns Hopkins Health System	Baltimore, MD
KentuckyOne Health	Lexington, KY
Kettering Health Network	Dayton, OH
Lahey Health System	Burlington, MA
Lakeland Health	St. Joseph, MI
Lee Memorial Health System	Fort Myers, FL
Legacy Health System	Portland, OR
Lehigh Valley Network	Allentown, PA
LifeBridge Health	Baltimore, MD
LifePoint Hospitals Inc.	Brentwood, TN
Lifespan Corporation	Providence, RI
Los Angeles County - Department of Health Services	Los Angeles, CA
Lourdes Health System	Camden, NJ
Lovelace Health System	Albuquerque, NM
Loyola University Health System	Maywood, IL
LSU Health System	Baton Rouge, LA
Main Line Health	Bryn Mawr, PA

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
MaineHealth	Portland, ME
Mary Washington Healthcare	Fredericksburg, VA
Maury Regional Health	Columbia, TN
Mayo Foundation	Rochester, MN
McLaren Health Care Corp	Flint, MI
McLeod Health	Florence, SC
MediSys Health Network	Jamaica, NY
MedStar Health	Columbia, MD
Memorial Healthcare System	Hollywood, FL
Memorial Hermann Healthcare System	Houston, TX
MemorialCare Health System	Fountain Valley, CA
Mercy	Chesterfield, MO
Mercy Health	Muskegon, MI
Mercy Health (OH)	Cincinnati, OH
Mercy Health Network	Des Moines, IA
Mercy Health Partners (Northern OH)	Toledo, OH
Mercy Health Southwest Ohio Region	Cincinnati, OH
Mercy Health System of Southeastern Pennsylvania	Philadelphia, PA
Meridian Health	Neptune, NJ
Methodist Health System (TX)	Dallas, TX
Methodist Healthcare	Memphis, TN
MidMichigan Health	Midland, MI
Ministry Health Care	Milwaukee, WI
Mission Health	Asheville, NC
Montefiore Health System	Bronx, NY
Mount Carmel Health System	Columbus, OH
Mount Sinai Health System	New York, NY
Mountain States Health Alliance	Johnson City, TN
Multicare Medical Center	Tacoma, WA
Munson Healthcare	Traverse City, MI
Nebraska Medicine	Omaha, NE
Nebraska Methodist Health System	Omaha, NE
New York City Health and Hospitals Corporation (HHC)	New York, NY
New York-Presbyterian Healthcare System	New York, NY
North Mississippi Health Services	Tupelo, MS
Northern Arizona Healthcare	Flagstaff, AZ
NorthShore University HealthSystem	Evanston, IL
Northside Hospital System	Atlanta, GA
Northwell Health	Great Neck, NY
Northwestern Medicine	Chicago, IL
Novant Health	Winston-Salem, NC
Ochsner Health System	New Orleans, LA
Ohio Valley Health Services & Education Corp	Wheeling, WV
OhioHealth	Columbus, OH
Orlando Health	Orlando, FL
OSF Healthcare System	Peoria, IL

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Health system name	Location
Pallottine Health Services	Huntington, WV
Palmetto Health	Columbia, SC
Palomar Health	San Diego, CA
Parkview Health	Fort Wayne, IN
Partners Healthcare	Boston, MA
PeaceHealth	Bellevue, OR
Penn Highlands Healthcare	DuBois, PA
Phoebe Putney Health System	Albany, GA
Piedmont Healthcare Inc.	Atlanta, GA
Premier Health Partners	Dayton, OH
Presbyterian Healthcare Services	Albuquerque, NM
Presence Health	Mokena, IL
Prime Healthcare Services	Ontario, CA
Progressive Acute Care LLC	Mandeville, LA
ProHealth Care	Waukesha, WI
ProMedica Health System	Toledo, OH
Providence Health & Services	Renton, WA
Regional Health	Rapid City, SD
RegionalCare Hospital Partners	Brentwood, TN
Renown Health	Reno, NV
Riverside Health System	Newport News, VA
Robert Wood Johnson Health Network	New Brunswick, NY
Rochester Regional Health System	Rochester, NY
Roper St. Francis Healthcare	Charleston, SC
Sacred Heart Health System	Pensacola, FL
Saint Alphonsus Health System	Boise, ID
Saint Francis Health System	Tulsa, OK
Saint Joseph Mercy Health System	Ann Arbor, MI
Saint Joseph Regional Health System	Mishawaka, IN
Saint Luke's Health System	Kansas City, MO
Saint Thomas Health	Nashville, TN
Samaritan Health Services	Corvallis, OR
Sanford Health	Sioux Falls, SD
Schuylkill Health System	Pottsville, PA
SCL Health	Denver, CO
Scripps Health	San Diego, CA
Sentara Healthcare	Norfolk, VA
Seton Healthcare Network	Austin, TX
Shands HealthCare	Gainesville, FL
Sharp Healthcare Corporation	San Diego, CA
Sisters of Charity Health System	Cleveland, OH
South Texas Health System	Edinburg, TX
Southeast Georgia Health System	Brunswick, GA
Southern Illinois Healthcare	Carbondale, IL
Southwest Healthcare Services	Scottsdale, AZ
Sparrow Health System	Lansing, MI

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
Spartanburg Regional Healthcare System	Spartanburg, SC
Spectrum Health	Grand Rapids, MI
SSM Health	Saint Louis, MO
St. Charles Health System	Bend, OR
St. Elizabeth Healthcare	Fort Thomas, KY
St. John Health System	Tulsa, OK
St. John Providence Health (MI)	Detroit, MI
St. Joseph Health System	Orange, CA
St. Joseph/Candler Health System	Savannah, GA
St. Luke's Health System	Boise, ID
St. Peters Health Partners	Albany, NY
St. Vincent Health	Indianapolis, IN
St. Vincents Health System (AL)	Birmingham, AL
St. Vincent's Healthcare	Jacksonville, FL
Steward Health Care System	Boston, MA
Success Health	Boca Raton, FL
Summa Health System	Akron, OH
SunLink Health Systems	Atlanta, GA
Susquehanna Health System	Williamsport, PA
Sutter Bay Division	Sacramento, CA
Sutter Health	Sacramento, CA
Sutter Valley Division	Sacramento, CA
Swedish	Seattle, WA
Tanner Health System	Carrollton, GA
Temple University Health System	Philadelphia, PA
Tenet California	Anaheim, CA
Tenet Central	Dallas, TX
Tenet Florida	Fort Lauderdale, FL
Tenet Healthcare Corporation	Dallas, TX
Tenet Southern	Atlanta, GA
Texas Health Resources	Arlington, TX
The Manatee Healthcare System	Bradenton, FL
The University of Vermont Health Network	Burlington, VT
The Valley Health System	Las Vegas, NV
ThedaCare	Appleton, WI
TriHealth	Cincinnati, OH
Trinity Health	Livonia, MI
Trinity Regional Health System	Moline, IL
Truman Medical Center Inc.	Kansas City, MO
UAB Health System	Birmingham, AL
UC Health	Cincinnati, OH
UM Upper Chesapeake Health	Bel Air, MD
UMass Memorial Health Care	Worcester, MA
United Health Services	Binghamton, NY
UnityPoint Health	Des Moines, IA
Universal Health Services Inc.	King of Prussia, PA

Note: This year's 15 Top Health Systems (2017) are in bold, blue text.

Health system name	Location
University Hospitals Health System	Cleveland, OH
University of California Health System	Los Angeles, CA
University of Colorado Health	Aurora, CO
University of Maryland Medical System	Baltimore, MD
University of Mississippi Medical Center	Jackson, MS
University of New Mexico Hospitals	Albuquerque, NM
University of North Carolina Health	Chapel Hill, NC
University of Pennsylvania Health System	Philadelphia, PA
University of Rochester Medical Center	Rochester, NY
University of Texas System	Austin, TX
UPMC Health System	Pittsburgh, PA
UT Southwestern Medical Center	Dallas, TX
Valley Baptist Health System	Harlingen, TX
Valley Health System	Winchester, VA
Valley Health System (CA)	Hemet, CA
Via Christi Health	Wichita, KS
Vidant Health	Greenville, NC
Virtua Health	Marlton, NJ
WakeMed	Raleigh, NC
Wellmont Health System	Kingsport, AL
WellSpan Health	York, PA
WellStar Health System	Marietta, GA
West Tennessee Healthcare	Jackson, TN
West Virginia United Health System	Fairmont, WV
Wheaton Franciscan Southeast Wisconsin	Glendale, WI
Wheaton Franciscan Healthcare	Waterloo, IA
Wheeling Hospital	Wheeling, WV
Willis-Knighton Health Systems	Shreveport, LA
Yale New Haven Health Services	New Haven, CT

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