The Third Annual HealthGrades Bariatric Surgery Trends In American Hospitals Study

July 2008

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Executive Summary

Bariatric surgery is recognized as an effective treatment for extreme obesity, a condition affecting approximately 4.7 percent of the U.S. population.[1] In addition to average weight loss equivalent to one-third of an individual's body weight, patients undergoing bariatric surgery have also shown clinical improvements in the control of several comorbid conditions associated with extreme obesity such as diabetes, high blood pressure, and sleep apnea.[2] Because of these favorable outcomes, the number of bariatric surgeries has expectedly increased in recent years.

Like most major and invasive surgeries, bariatric surgery has many benefits that must be weighed against inherent risks. These risks include short-term operative complications or death, and long-term risks such as nutritional absorption deficiencies. In addition, patients that are appropriate candidates for the procedure often have conditions such as coronary artery disease, hypertension, diabetes and sleep apnea that may increase their surgical risk of developing complications. To assure the best short-term and long-term outcomes for patients undergoing bariatric surgery, it is imperative that bariatric surgery programs ensure appropriate patient selection, identify individual patient risks, and provide interventions to reduce these risks. Since this type of quality varies among bariatric surgery programs, it is important for consumers to have access to quality information when selecting a bariatric program.

Since 1998, HealthGrades has studied and measured outcomes associated with a wide array of common inpatient procedures and diagnoses at the nation's approximately 5,000 hospitals, and has published results on the Web to assist consumers in choosing a hospital. In this third annual report, HealthGrades studied and measured the risk-adjusted inhospital complication rate associated with bariatric surgery programs affiliated with hospitals in 17 states where data are publically available. In Part 1 of this *Third Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study*, over 63 million all-payer discharges from 2004 through 2006 were analyzed. Risk-adjusted complication rates were calculated and hospitals were assigned a 1-star (poor), 3-star (as expected), or 5-star (best) quality rating for bariatric surgery. Individual hospital quality results from this study are available at www.healthgrades.com.

For the second part of this study, HealthGrades analyzed overall trends associated with bariatric surgery from 2004 through 2006 among 680 hospitals located in 17 states and evaluated and analyzed the differences in inhospital complications between the 1-star, 3-star, and 5-star hospitals. The 17 states included in this study are:

Arizona	Maryland	Oregon	Washington
California	Massachusetts	Pennsylvania	Wisconsin
Florida	Nevada	Texas	
Iowa	New Jersey	Utah	
Maine	New York	Virginia	

Executive Summary of Findings

Key findings of this study include:

1 The overall number of inhospital procedures performed has declined from 2004 to 2006 and the number of self-pay patients has increased.

- In the 17 states evaluated, 154,451 procedures were performed. Of these 68,876 procedures were gastric bypass procedures, 1,291 were malabsorptive procedures, and 84,284 were laparoscopic procedures.
- During this study period, the number of inpatient procedures from 2004 to 2006 showed an overall 10 percent decline. Maryland, Massachusetts, Nevada, New York, and Oregon showed increases in the number of procedures performed but all other states studied showed a decline.
- In the 17 states evaluated in this study, 680 hospitals had at least one bariatric surgery case, but only 455 hospitals met the minimum volume of 30 cases over three years with at least five cases in 2006 required to receive a star rating.
- Of the 17 states studied, 51 percent of all procedures were performed in New York, Texas, Pennsylvania, and California.
- The number of self-pay patients increased to five percent in this study compared to almost four percent in the second annual study. From 2004 to 2006, there was a 112 percent increase in the number of self-pay patients.

2 A trend toward less-invasive laparoscopic procedures continues.

- Between 2004 and 2006, laparoscopic procedures accounted for 54 percent of all procedures, gastric bypass procedures accounted for 45 percent, and malabsorptive procedures accounted for one percent. In our previous study, laparoscopic procedures accounted for only 28 percent of all procedures (from 2003 to 2005).

3 Risk-adjusted inhospital complication rates increased during the study period and there were wide gaps in quality among the best-performing and worst-performing hospitals.

- From 2004 to 2006 the risk-adjusted complication rate increased six percent for all procedures. Gastric bypass procedures had the largest increase in risk-adjusted complications with a 17 percent increase. Laparoscopic procedures had a slight increase in risk-adjusted complications of just over one percent.
- Out of the 455 hospitals rated in the 17 states studied, 93 received a 5-star rating, 263 received a 3-star rating, and 99 received a 1-star rating.
- Five-star hospitals performed almost twice the volume of procedures compared to 1-star and 3-star facilities–an average of 526 procedures over the three years compared with 266 and 283 respectively.
- Higher volume was associated with fewer risk-adjusted complications. Facilities with an annual case volume of 125 procedures had the lowest risk-adjusted complications. Facilities performing less than 25 cases per year had the highest rate of risk-adjusted complications.
- A typical patient having a bariatric surgical procedure at a 5-star rated hospital in one of the 17 states studied has on average, a 65 percent lower chance of experiencing one or more inhospital complications than at a 1-star rated hospital and a 41 percent lower chance than at a 3-star rated hospital during 2004-2006.
- If all patients had received their bariatric surgery procedure at 5-star hospitals (from 2004 through 2006), 5,125 inhospital complications could have been potentially avoided in the 17 states studied.

Methods Part 1: The Bariatric Surgery Hospital Quality Rating Methodology

To help consumers evaluate and compare hospital performance, HealthGrades analyzed patient outcome data for all patients (all-payer data) provided by individual states for years 2004 through 2006. Ratings were based on HealthGrades' risk-adjusted methodology described in the *Multivariate Logistic Regression-Based Ratings* section of this report.

The purpose of risk adjustment is to obtain fair statistical comparisons among disparate populations or groups. Significant differences in demographic and clinical risk factors are found among patients treated in different hospitals. Risk adjustment of the data is needed to make accurate and valid comparisons of clinical outcomes at different hospitals.

Data Acquisition

For the bariatric surgery hospital ratings, all-payer state data were used in those states where state data are available. For multivariate logistic regression-based ratings (see below), HealthGrades conducted a series of data quality checks to preserve the integrity of the ratings. Based on the results of these checks, we excluded a limited number of cases because they were inappropriate for inclusion in the database or miscoded.

Examples of excluded patient records were:

- Patients who left the hospital against medical advice or who were transferred to another acute care hospital.
- Patients who were still in the hospital when the claim was filed.
- Patients with an invalid gender.

Methodology for Rating Hospitals

Fair and valid comparisons between hospital providers can be made only to the extent that the risk-adjustment methodology considers important differences in patient demographic and clinical characteristics. The risk-adjustment methodology used by HealthGrades defines risk factors as those clinical and demographic variables that influence patient outcomes in significant and systematic ways. Risk factors may include age, gender, specific procedure performed, and comorbid conditions such as hypertension, chronic renal failure, heart failure and diabetes.

Multivariate Logistic Regression-Based Ratings

The initial analysis of the data utilized 17 states of all-payer data from 2004 through 2006. Bariatric surgery patients were identified by their ICD-9 principal procedure of a bariatric surgical procedure and a principal diagnosis of obesity/morbid obesity (Table 1)—a definition previously described by Santry et al.[3] (Patients under the age of 18 years were excluded.)

For this population, potential risk factors and the outcome measures (complications) were then defined.

1. Potential risk factors were defined as all clinically relevant diagnoses occurring in more than 0.5 percent of the patients. In addition, patient demographic factors such as age and gender and the specific procedure performed on the patient were also considered. Some diagnosis codes were merged together (e.g., primary and secondary pulmonary hypertension) to minimize the impact of coding variations.
2. Complications were identified using previous peer-reviewed research[3,4] and through input from clinical and coding experts.

In some cases, an ICD-9 code can be either a risk or a complication. In these cases, a code is differentiated by the presence or absence of a 900 post-operative complication code. For example, in the case where a patient record contains "427.31 Atrial Fibrillation," that code is considered a risk if it occurs by itself and a complication if there is a

corresponding “997.1 Cardiac Complications NEC” code also present in the patient record. Outcomes were binary, with documented major complications either present or not. Mortality is considered a major complication. Table 2 lists the major complications for bariatric surgery.

Table 1: Bariatric Surgery Cohort and Related ICD-9 Codes

Principal Procedures and Diagnoses – Inclusions
Procedure 43.89, 44.31, 44.38, 44.39, 44.68, 44.95, or 45.91
Diagnosis 278.00, 278.01
Procedures – Exclusions
44.5, 44.94, 44.96, 44.97
Demographic – Exclusions
Patients under the age of 18 years

For a complete list of the over 400 diagnosis exclusion codes, please see the *Hospital Report Cards™ Bariatric Surgery Methodology* at www.healthgrades.com.

Table 2: Major Complications – Bariatric Surgery

Major Complications – Bariatric Surgery	
Respiratory Complications 31.1, 31.29, 480, 480.0, 480.1, 480.2, 480.3, 480.8, 480.9, 481, 482, 482.0, 482.1, 482.2, 482.3, 482.30, 482.31, 482.32, 482.39, 482.4, 482.40, 482.41, 482.49, 482.8, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 483, 483.0, 483.1, 483.8, 484, 484.1, 484.3, 484.5 484.6, 484.7, 484.8, 485, 486, 518.5, 518.81, 518.0, 997.3	Stroke 431, 433.00, 433.01, 433.10, 433.11, 433.20, 433.21, 433.30, 433.31, 433.80, 433.81, 433.90, 433.91, 434.00, 434.01, 434.10, 434.11, 434.90, 434.91, 436, 437.1
Cardiac Complications 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91, 427.0, 427.1, 427.41, 427.31, 427.89, 997.1	Digestive System Complications 560.0, 560.1, 560.2, 560.30, 560.39, 560.81, 560.89, 560.9, 564.2, 578.9, 997.4, 998.6
Urinary Complications/Acute Renal Failure 38.95, 39.95, 584.5, 584.8, 584.9, 599.0, 997.5	Hemorrhage/Surgical Wound Complications 44.61, 54.12, 54.61, 54.91, 54.92, 99.04, 998.0, 998.11, 998.12, 998.2, 998.31, 998.32
Splenic Injury 41.2, 41.43, 41.5, 41.95	Post-Operative Infections 038, 038.0, 038.1, 038.10, 038.11, 038.19, 038.2, 038.3, 038.4, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038, 998.51, 998.59
Pulmonary/Venous Embolism 415.11, 415.19, 453.8, 453.9	

For more details regarding the specific ICD-9 codes identified as complications, please see the *Hospital Report Cards™ Bariatric Surgery Methodology* at www.HealthGrades.com.

Developing the HealthGrades Bariatric Surgery Ratings

Developing the HealthGrades Bariatric Surgery ratings involved four steps.

1. First, the predicted value (predicted number of complications at each hospital) was obtained using a logistic regression model discussed in the next section.
2. Second, the predicted value was compared with the actual or observed number of complications. Only hospitals with at least 30 cases across three years of data and at least five cases in the most current year were included.
3. Third, a test was conducted to determine whether the difference between the predicted and actual values was statistically significant. This test was performed to make sure that differences were very unlikely to be caused by chance alone.
4. Fourth, a star rating was assigned based upon the outcome of the statistical test.

   The following rating system was applied to the data for all procedures and diagnoses:

   ★★★★★ Best—Actual performance was better than predicted and the difference was statistically significant.

   ★★★ As Expected—Actual performance was not significantly different from what was predicted.

   ★ Poor—Actual performance was worse than predicted and the difference was statistically significant.

Statistical Models

Using the list of potential risk factors described above, we used logistic regression to determine to what extent each potential risk factor was correlated with the quality measure (complications). A risk factor stayed in the model if it had an odds ratio greater than one (except clinically relevant procedures, cohort defining principal diagnoses, and some protective factors as documented in the medical literature were allowed to have an odds ratio less than one) and was also statistically significant ($p<0.05$).

Complications were *not* counted as risk factors as they were considered a result of care received during the admission. Table 3 lists several examples of risk factors for bariatric surgery. Risk factors are those diagnoses that are the most highly correlated with the outcomes studied (complications). The most highly correlated risk factors are not necessarily those with the highest volume.

The statistical model was checked for validity and finalized. The final model was highly significant, with a C-statistic of 0.668. This model was then used to estimate the probability of a complication for each patient in the cohort. Patients were then aggregated for each hospital to obtain the predicted number of complications for each hospital. Statistical significance tests were performed to identify, by hospital, whether the actual and predicted rates were significantly different.

Table 3: Top Five Diagnosis Risk Factors – Bariatric Surgery

Diag 518.0	PULMONARY COLLAPSE
Diag 285.9	ANEMIA, UNSPECIFIED
Diag V64.41	LAP PROCEDURE CONVERT TO OPEN
Diag 428.0	CONGESTIVE HEART FAILURE, UNSPECIFIED
Diag 427.89	CARDIAC DYSRYTHMIAS NEC

Limitations of the Data Models

It must be understood that while these models may be valuable in identifying hospitals that perform better than others, one should not use this information alone to determine the quality of care provided at each hospital. The models are limited by the following factors:

- Cases may have been coded incorrectly or incompletely by the hospital.
- The models can only account for risk factors that are coded into the billing data–if a particular risk factor was not coded into the billing data, such as a patient's socioeconomic status and health behavior, then it was not accounted for with these models.
- Although Health Grades, Inc. has taken steps to carefully compile these data using its methodology, no techniques are infallible, and therefore some information may be missing, outdated or incorrect.

Please note that a high ranking for a particular hospital is not a recommendation or endorsement by Health Grades, Inc. of a particular hospital; it means that the data associated with a particular hospital has met the foregoing qualifications. Only individual patients can decide whether a particular hospital is suited for their unique needs.

Also note that if more than one hospital reported to CMS under a single provider ID, HealthGrades analyzed patient outcome data for those hospitals as a single unit. Throughout this document, therefore, "hospital" refers to one hospital or a group of hospitals reporting under a single provider ID.

Results Part 1: Hospital Bariatric Surgery Ratings

HealthGrades' ratings of 455 hospitals, based on *The Third Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study*, can be found at www.healthgrades.com.

For bariatric surgery,

- 93 hospitals (20.4%) stand out as "best" performers (5-star rated)
- 263 hospitals (57.8%) were rated as "as expected" performers (3-star rated)
- 99 hospitals (21.8%) were rated as "poor" performers (1-star rated)

Results Part 2: Bariatric Surgery Trends

The purpose of the second part of the study was to evaluate trends in bariatric surgery procedures performed in the inpatient setting in hospitals located within 17 states. Procedure type and volume, payer type, and observed mortality and complication rates were also evaluated for trends. Overall performance comparisons between 5-, 3- and 1-star rated hospitals were compared using observed-to-expected ratios (O/E ratios).

- An O/E ratio of less than one means that the patient population measured had fewer complications than expected.
- An O/E of greater than one means that the patient population measured had more complications than expected.

The Number of Inpatient Procedures is Declining Nationally

Within the hospitals located in the 17 states studied, there was a total of 154,451 bariatric inpatient surgery procedures performed in 680 hospitals from 2004 through 2006 (Table 4). From 2004 to 2006, there was a 9.64 percent decline in inpatient procedures with 54,021 procedures performed in 2004 and 48,812 procedures in 2006.

State Trends: Majority of Procedures Performed in Four States

In evaluating procedures by state, the majority of procedures occurred in four states. Consistent with national trends, the number of inhospital procedures declined in the majority of states.

- Just four states, New York, Texas, Pennsylvania, and California accounted for 51.40 percent of the total cases from the 17 states studied (Table 4).
- Nevada had the single largest increase in procedures over the study period with a 56.70 percent increase in procedures performed (Table 4).
- New York, Massachusetts, Maryland, Oregon, and Nevada had increases in the rate of inhospital procedures performed (range: 56.70% to 11.84%) while all the other states saw a decrease (range: -1.12% to -36.21%) with Washington, Wisconsin, Florida, and Virginia showing the largest declines (range: -29.59% to -36.21%) (Table 4).

Table 4: Bariatric Surgery Hospital Volume Trends by State and Year (2004 - 2006)

State	2004	2005	2006	2004-2006	% of Total Cases (2004-2006)	% Change from 2004 to 2006
Arizona	2,172	1,752	1,630	5,554	3.60%	-24.95%
California	5,357	5,461	5,297	16,115	10.43%	-1.12%
Florida	6,415	4,512	4,366	15,293	9.90%	-31.94%
Iowa	1,041	759	757	2,557	1.66%	-27.28%
Maine	576	551	504	1,631	1.06%	-12.50%
Maryland	1,495	1,669	1,787	4,951	3.21%	19.53%
Massachusetts	2,903	2,733	3,318	8,954	5.80%	14.30%
Nevada	679	1,052	1,064	2,795	1.81%	56.70%
New Jersey	3,770	3,604	3,411	10,785	6.98%	-9.52%
New York	7,325	8,501	8,192	24,018	15.55%	11.84%
Oregon	731	745	887	2,363	1.53%	21.34%
Pennsylvania	7,119	6,711	5,736	19,566	12.67%	-19.43%
Texas	6,508	6,774	6,404	19,686	12.75%	-1.60%
Utah	782	781	595	2,158	1.40%	-23.91%
Virginia	3,930	3,162	2,767	9,859	6.38%	-29.59%
Washington	1,309	1,360	835	3,504	2.27%	-36.21%
Wisconsin	1,909	1,491	1,262	4,662	3.02%	-33.89%
All	54,021	51,618	48,812	154,451	100.00%	-9.64%

Payer Mix: Patients with Commercial Insurance Represent Majority of Patients

Patients with commercial insurance represent the majority of patients undergoing bariatric procedures in the U.S. today. Government risk plans and self-pay patients had the largest increase in procedures from 2004 to 2006.

- Commercial insurance accounted for 77.17 percent of the patients undergoing the procedure followed by Government insurance at 15.97 percent and self-pay at 5.12 percent (Table 5).
- The largest increases in rate of procedures were among those patients in Medicare risk (611.84%) and Medicaid risk plans (152.78%) followed by self-pay patients (112.40%) (Table 5).
- The rate of self-pay patients increased from 3.6 per 100 patients in the *Second Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study*[5] to five per 100 patients in this study. Over the three years of the current study, self-pay patients increased 112.40 percent.

Table 5: Bariatric Surgery Hospital Volume Trends by Payer and Year (2004 - 2006)

Payer	2004	2005	2006	2004-2006	% of Total Cases 2004-2006	% Change from 2004 to 2006
Blue Cross	12,290	9,252	8,608	30,150	19.52%	-29.96%
Blue Cross HMO	816	3,889	3,721	8,426	5.46%	356.00%
Champus	793	1,112	996	2,901	1.88%	25.60%
Fee-For-Service	13,581	6,333	5,684	25,598	16.57%	-58.15%
HMO	9,229	11,850	11,731	32,810	21.24%	27.11%
HMO/PPO	1,197	1,054	915	3,166	2.05%	-23.56%
Medicaid	1,234	1,312	1,184	3,730	2.42%	-4.05%
Medicaid Risk	826	1,882	2,088	4,796	3.11%	152.78%
Medicare	3,584	4,016	3,049	10,649	6.89%	-14.93%
Medicare Risk	76	274	541	891	0.58%	611.84%
Other	1,235	190	163	1,588	1.03%	-86.80%
Other Government	726	502	400	1,628	1.05%	-44.90%
PPO	6,252	6,798	5,992	19,042	12.33%	-4.16%
Self-pay	1,678	2,660	3,564	7,902	5.12%	112.40%
Unknown	485	470	152	1,107	0.72%	-68.66%
Worker's Compensation	19	24	24	67	0.04%	26.32%
All	54,021	51,618	48,812	154,451	100.00%	-9.64%

Movement Toward Less Invasive Laparoscopic Procedures

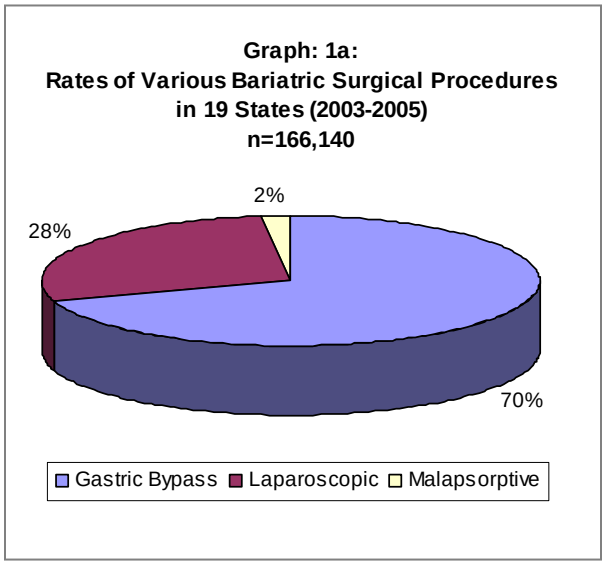
In the 17 states evaluated, from 2004 to 2006, there was a shift in the number of inpatient procedures from traditional invasive procedures to less-invasive laparoscopic procedures.

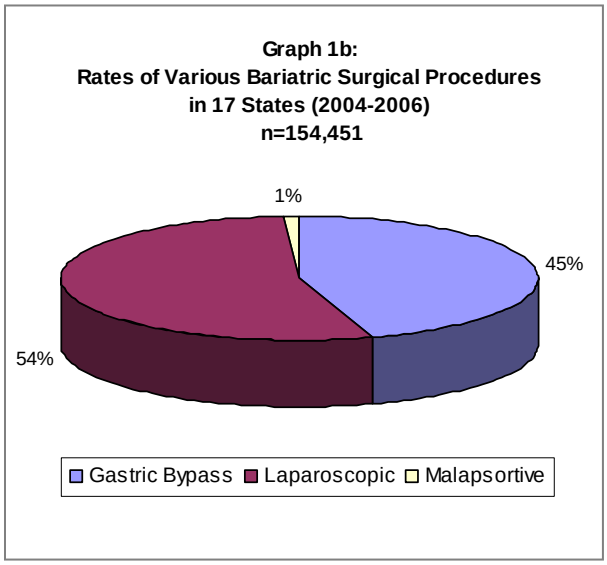
- From 2004 through 2006, open gastric bypass procedures declined by 81.82 percent while during the same time period, laparoscopic procedures increased 418.86 percent (Table 6).
- In 2004, laparoscopic procedures represented 14.24 percent of all procedures, and by 2006 they represented 81.76 percent of all bariatric procedures (Table 6).

Table 6: Frequency of Bariatric Surgery Codes by Year

ICD-9 Principle Procedure Code	Procedure Type	2004	2005	2006	Total	% Change
Gastric Bypass						
44.31	High Gastric Bypass	13,195	3,604	1,898	18,697	-85.62%
44.39	Other Gastroenterostomy	32,746	10,978	6,455	50,179	-80.29%
	Totals (and Average % Change)	45,941	14,582	8,353	68,876	-81.82%
Laparoscopic						
44.38	Laparoscopic Gastroenterostomy	6,488	30,009	30,280	66,777	366.71%
44.68	Laparoscopic Gastroplasty	281	1,394	1,288	2,963	358.36%
44.95	Laparoscopic Gastric Restrictive Procedure	923	5,278	8,343	14,544	803.90%
	Totals (and Average % Change)	7,692	36,681	39,911	84,284	418.86%
Malabsorptive						
45.91	Small-to-Small Intestinal Anastomosis	202	159	157	518	-22.28%
43.89	Other Partial Gastrectomy	186	196	391	773	110.22%
	Totals (and Average % Change)	388	355	548	1,291	41.24%

Graph 1: Change in Rate of Bariatric Surgical Procedures





Large Gaps in Quality Between Providers

In the first part of this study, hospital bariatric surgery programs were evaluated on their risk-adjusted inhospital complications and assigned a 1-star (poor performance), a 3-star (average performance), or 5-star (best performance). Out of the 680 hospitals initially evaluated in this study, 455 hospitals met the volume criteria of 30 cases over the three years and five cases in 2006 to receive a star rating. Of these 455 hospitals, 93 received a 5-star rating, 263 received a 3-star rating, and 99 received a 1-star rating (Table 10). Hospitals were aggregated into their appropriate peer group by star rating and evaluated as a group for differences in performance.

Overall, inhospital mortality is low with an average of less than one percent across all 17 states (Table 10).

Laparoscopic procedures had the lowest overall risk-adjusted complication rates with an observed-to-expected ratio of 0.99, followed by gastric bypass procedures at 1.00, and malabsorptive procedures having the highest at 1.32 (Table 7).

From 2004 to 2006, there was a statistically significant increase in risk-adjusted complications of 6.21 percent for inpatient bariatric procedures. Gastric bypass procedures have had the largest increase in risk-adjusted complications with an increase of 16.51 percent followed by laparoscopic procedures with an increase of 1.13 percent. The malabsorptive procedures (bileopancreatic diversions) were the only procedures to have a decrease in risk-adjusted complication rates of 7.85 percent over the study period.

Table 7: Risk-adjusted Complications for Inpatient Bariatric Procedures

Principle Procedure Type	Year	Case	Observed Rate of Inhospital Complications	Expected Rate of Inhospital Complications	Observed-to-Expected Ratio	Observed-to-Expected Ratio	Percent Change 2004 to 2006
Gastric Bypass							
	2004	45,941	10.05%	10.48%	.96	(0.93- 0.99)	16.51%
	2005	14,582	11.60%	10.98%	1.06	(1.01-1.10)	
	2006	8,353	12.80%	11.45%	1.12	(1.06-1.18)	
	2004-2006	68,876	10.71%	10.70%	1.00	(0.98-1.02)	
Laparoscopic							
	2004	7,692	6.80%	6.98%	.97	(0.89-1.06)	1.13%
	2005	36,681	6.92%	6.91%	1.00	(0.96-1.04)	
	2006	39,911	6.62%	6.71%	.99	(0.95-1.02)	
	2004-2006	84,284	6.77%	6.82%	.99	(0.97-1.02)	
Malabsorptive							
	2004	388	13.14%	10.34%	1.27	(0.99-1.56)	-7.85%
	2005	355	16.90%	10.78%	1.57	(1.28-1.86)	
	2006	548	11.68%	9.97%	1.17	(0.93-1.42)	
	2004-2006	1,291	13.56%	10.30%	1.32	(1.16-1.47)	
All Bariatric Surgery Procedures	2004	54,021	9.61%	9.98%	.96	(0.94- 0.99)	6.21%
	2005	51,618	8.31%	8.09%	1.03	(1.00-1.06)	
	2006	48,812	7.73%	7.56%	1.02	(0.99-1.05)	
	2004-2006	154,451	8.58%	8.58%	1.00	(0.98-1.02)	

The most frequently occurring complications among patients undergoing bariatric surgery are respiratory complications including post-operative pulmonary insufficiency followed by hemorrhages, operative lacerations, and gastrointestinal complications (Table 8).

Table 8: Top Five Inhospital Complications Associated with Bariatric Surgery (2004 – 2006)

Complication	Rate
Surgical Complication of Respiratory System	1.12%
Post-operative Pulmonary Insufficiency	1.06%
Hemorrhage Complicating a Procedure	1.11%
Accidental Operative Laceration	1.00%
Surgical Complication of Gastrointestinal System	1.13%
Overall	8.57%

During the study period, volume was an important indicator of inhospital complications. As volume increased, risk-adjusted complications had statistically significant decreases. Hospitals with highest volume of 375 cases or more during the three years of study had the lowest rate of risk-adjusted inhospital complications overall with an observed-to-expected ratio of 0.90. Hospitals with the lowest volumes of less than 25 cases per year had the highest rate of risk-adjusted inhospital complications with an observed-to-expected of 1.41 (Table 9).

Table 9: Inhospital Complication Rates 2004 through 2006 by Volume of Procedures Performed

Procedure Volume 2004 to 2006	Observed Rate of Inhospital Complications	Expected Rate of Inhospital Complications	Cases	Observed-to-Expected Ratio	*Confidence Interval*
< 75	12.75%	9.03%	7,309	1.41	(1.34-1.48)
75-149	10.88%	9.06%	12,125	1.20	(1.15-1.26)
150-374	9.60%	8.64%	36,257	1.11	(1.08-1.14)
375 +	7.62%	8.47%	98,760	.90	(0.88- 0.92)

Five-star hospitals had lower risk-adjusted and unadjusted complications rates than their 3-star and 1-star counterparts. The inhospital unadjusted complication rate in 5-star hospitals was 5.03 percent, compared to 8.19 percent at 3-star hospitals, and 15.33 percent at 1-star hospitals. After adjusting for patient risk factors, a typical patient having a bariatric surgical procedure at a 5-star rated hospital has on average, a 65.27 percent lower chance of experiencing one or more inhospital complications than at a 1-star rated hospital, and a 40.51 percent lower chance than at a 3-star rated hospital (Table 11).

Five-star hospitals also had lower overall inhospital complication rates than their 3-star and 1-star counterparts across every procedure type, both laparoscopic and open procedures (Table 12). The largest variation in complication rates was associated with laparoscopic gastroplasty (vertical band procedures) among 5-star and 1-star hospitals, 6.74 percent complications versus 1.73 percent (Table 12).

In addition, consistent with increased rates of complications, a patient having a procedure at a 1-star hospital could on average expect to extend their length of stay by almost one full day (3.13 days compared to 2.36 days) (Table 11).

To quantify the impact of this variation in quality, if all bariatric programs between 2004 and 2006 had performed at the level of 5-star hospitals, 5,125 inhospital complications could have been potentially avoided in the 17 states studied (Table 12).

Table 10: Bariatric Surgery Mortality and Age Across U.S. Hospitals (2004 - 2006)

Hospital Bariatric Surgery Star Rating	Number of Hospitals	Average Patient Age (Years)	Average Volume (2004-2006)	Inhospital Unadjusted Mortality Rate	*P* value (Mortality Compared to U.S.)
1-Star	99	43.17	266	0.18%	< 0.001
3-Star	263	42.98	283	0.10%	NS
5-Star	93	42.52	526	0.08%	0.015
U.S. Total*	680				
U.S. Average*		42.86	227	0.12%	

*U.S. total and average includes all hospitals (rated and not rated).

Table 11: Bariatric Surgery Complications and Length of Stay Across U.S. Hospitals (2004 - 2006)

Hospital Bariatric Surgery Star Rating	Observed Inhospital Complication Rate	Expected Inhospital Complication Rate	Observed-to-Expected Complication Ratio	*P* value (O:E Compared to U.S.)	Average Length of Stay (Days)
1-Star	15.33%	9.10%	1.69	< 0.001	3.13
3-Star	8.19%	8.32%	.98		2.70
5-Star	5.03%	8.59%	.59	< 0.001	2.36
U.S. Average*	8.58%	8.58%	1		2.69
Relative difference between 5-star compared to 1-star	67.20%	5.56%	65.27%		24.61%
Relative difference between 5-star compared to 3-star	38.59%	-3.22%	40.51%		12.29%

Table 12: Bariatric Surgery Hospital Outcomes by Procedure Type

ICD-9 Principle Procedure Code	Procedure Type	Star Rating	Case Volume	Observed Inhospital Complication Rate	Expected Inhospital Complication Rate	Observed-to-Expected Ratio	95% CI (O/E Ratio)	Relative Difference of 5-star Compared to 1-star	Relative Difference of 5-star Compared to 3-star	Number of Patients with Potentially Avoidable Inhospital Complications (as Compared to 5-star)
Gastric Bypass										
44.31	High Gastric Bypass	1	3,054	16.57%	9.66%	1.71	(1.61-1.82)	61.29%	35.51%	551
		3	6,920	9.80%	9.52%	1.03	(.96-1.10)			
		5	7,830	5.79%	8.72%	.66	(.59- .73)			
		U.S.*	18,697	9.31%	9.29%	1.00	(.96-1.05)			
44.39	Other Gastroenterostomy	1	8,810	20.34%	11.93%	1.71	(1.65-1.76)	67.95%	43.89%	2,292
		3	23,119	10.58%	10.87%	.97	(.94-1.01)			
		5	15,928	6.20%	11.34%	.55	(.50- .59)			
		U.S.*	50,179	11.23%	11.23%	1.00	(.98-1.02)			
Laparoscopic										
44.38	Laparoscopic Gastroenterostomy	1	11,383	13.77%	8.16%	1.69	(1.63-1.75)	64.19%	37.72%	1,972
		3	34,319	7.47%	7.69%	.97	(.93-1.01)			
		5	20,047	4.63%	7.67%	.60	(.56- .65)			
		U.S.*	66,777	7.77%	7.77%	1.00	(.97-1.03)			
44.68	Laparoscopic Gastroplasty	1	653	6.74%	4.91%	1.37	(1.04-1.70)	71.70%	62.10%	75
		3	1,517	4.61%	4.50%	1.03	(.80-1.25)			
		5	750	1.73%	4.46%	.39	(.06- .72)			
		U.S.*	2,963	4.32%	4.58%	.94	(.78-1.11)			
44.95	Laparoscopic Gastric Restrictive Procedure	1	2,238	4.11%	3.01%	1.36	(1.13-1.60)	63.38%	47.74%	162
		3	7,696	2.83%	2.96%	.96	(.83-1.08)			
		5	4,139	1.45%	2.90%	.50	(.32- .67)			
		U.S.*	14,544	2.66%	2.96%	.90	(.81- .99)			

Table 12: Bariatric Surgery Hospital Outcomes by Procedure Type (continued)

ICD-9 Procedure Code	Procedure Type	Star Rating	Case Volume	Observed Inhospital Complication Rate	Expected Inhospital Complication Rate	Observed-to-Expected Ratio	95% CI (O/E Ratio)	Relative Difference of 5-star Compared to 1-star	Relative Difference of 5-star Compared to 3-star	Number of Patients with Potentially Avoidable Inhospital Complications (as Compared to 5-star)
Malabsorptive										
45.91	Small-to-Small Intestinal Anastomosis	1	74	17.57%	11.41%	1.54	(.92-2.16)	44.27%	44.48%	31
		3	311	18.01%	11.65%	1.55	(1.25-1.84)			
		5	102	9.80%	11.42%	.86	(.33-1.39)			
		U.S.*	518	16.41%	11.50%	1.43	(1.19-1.66)			
43.89	Other Partial Gastrectomy	1	91	19.78%	11.07%	1.79	(1.23-2.34)	63.62%	46.67%	42
		3	578	11.25%	9.22%	1.22	(.97-1.47)			
		5	97	6.19%	9.51%	.65	(.05-1.25)			
		U.S.*	773	11.64%	9.50%	1.23	(1.02-1.44)			
All Bariatric Surgery Procedures		1	26,303	15.33%	9.10%	1.69	(1.65-1.72)	65.27%	40.51%	5,125
		3	74,460	8.19%	8.32%	.98	(.96-1.01)			
		5	48,893	5.03%	8.59%	.59	(.56- .61)			
		U.S.*	154,451	8.58%	8.58%	1.00	(.98-1.02)			

*U.S. includes aggregate performance of all hospitals (rated or unrated) that performed one or more bariatric surgery cases during the study period within the 17 states studied.

Discussion

The increase in prevalence of obesity and extreme obesity has been described as an epidemic with an estimated 60 million people meeting the criteria for obesity and 9 million people meeting the criteria for extreme obesity[6]. Individuals with obesity and extreme obesity are at greater risk for premature mortality and increased incidence of comorbid conditions such as diabetes, hypertension, arthritis and asthma[7]. These individuals have also reported a decreased quality of life[7]. For these individuals, bariatric surgery is largely accepted as the most successful long-term treatment. As such there has been an increase in the number of procedures performed in the U.S. in recent years. Because the individual outcome of the procedure is highly dependent on the quality of the organization where the procedure is performed, this *Third Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study* evaluates the differences in quality between inpatient bariatric surgery programs at different levels of performance.

Overall this study found that the number of inhospital procedures has declined in recent years. This finding is consistent with other research indicating a 50 percent increase in bariatric procedures performed in the outpatient setting from 2004 to 2006.[8]

The majority of procedures being performed are among patients with commercial insurance but the largest increase was seen among patients in government risk programs, both Medicare and Medicaid. Perhaps this shift is due in part to the economic impact of obesity and obesity-related health issues. Obesity has been associated with more healthcare costs than any other condition with one study estimating that 9.1 percent of total U.S. medical expenditures could be attributed to obesity[9].

This HealthGrades' study also found a major shift away from traditional open bariatric procedures to less invasive laparoscopic procedures. Laparoscopic procedures are attractive to potential patients because these procedures:

- Have lower peri-operative risk
- Have less short-term complications
- Require a shorter length of stay
- Have a faster recovery time

Therefore the trend towards these procedures is not surprising. However, some research suggests that these procedures may have substantial rates of long-term complications requiring procedure revisions. Additionally, there is at least short-term evidence to support that these procedures may have inferior weight loss[2]. As longer-term outcome data become available, it will be interesting to see if this trend towards the laparoscopic procedures continues.

Finally, this third annual study found that the risk-adjusted rate of inhospital complications had a statistically significant increase of six percent from 2004 to 2006 and, consistent with the first two studies, demonstrated large variation in quality among providers. The quality gaps are wide and consistent regardless of the type of procedure performed. Variation in quality between providers contributes to increased complication rates, longer lengths of stay, and increased mortality.

In this study, volume was an important indicator of quality. As volume increased, risk-adjusted complication rates showed statistically significant decreases. The American College of Surgeons Bariatric Surgery Center Network Program requires a minimum volume of 125 procedures annually to receive their highest accreditation[10]. In this study, hospitals that had a three-year volume consistent with this yearly volume requirement had the lowest risk-adjusted complications rates, supporting the link between volume and outcomes.

Five-star hospitals had nearly twice the volume of the 3-star hospitals, and over twice the volume of 1-star hospitals (Table 10). This may be one key to their consistent high-quality performance. In this study, 5-star hospitals have mortality rates statistically better than the average of all hospitals studied while 1-star hospitals had mortality rates that were statistically worse than the average of all hospitals studied. Five-star hospitals also had lower overall inhospital risk-adjusted complication rates than their 3-star and 1-star counterparts across every procedure type, both laparoscopic and open procedures. The largest gap between 5-star hospitals and their 1-star counterparts surprisingly was not seen in the open, more-invasive procedures but in the laparoscopic vertical banded gastroplasties.

The variation in quality that exists between providers reiterates the importance of readily available quality data to help consumers choose an appropriate provider to meet their individual needs. This study found that in the 17 states studied, if all hospitals performed at the rate of 5-star hospitals, 5,125 inhospital complications could have been potentially prevented. Since this study is limited to 17 states, clearly this represents the need to increase the availability in quality data in all states to provide consumers with the information they need to make a truly informed decision.

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