



The First Annual HealthGrades

Bariatric Surgery Trends in American Hospitals Study

November 2006



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HEALTHGRADES

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(Updated March 2007)

Executive Summary

Bariatric surgery is the most effective therapy available for morbid obesity. As a result, bariatric surgery has proliferated across the United States in recent years. Despite this proliferation, bariatric surgery is not yet a regulated or credentialed surgical subspecialty. Because of the increased demand and the known profitability of the surgery, an increasing number of hospitals and surgeons have been offering this procedure; however, there is little information on hospital- or physician-specific bariatric surgery outcomes.

Since 1998, HealthGrades has studied and measured outcomes associated with a wide array of common inpatient procedures and diagnoses at the nation's 5,000 plus hospitals and published the results of its annual research on the Web to assist consumers in choosing a hospital. In this first study of its kind, HealthGrades studied and measured the risk-adjusted in-hospital complication rate associated with bariatric surgery programs affiliated with hospitals in 17 states. In Part 1 of the *First Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study*, millions of all-payer discharges from 2002 through 2004 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.

This study demonstrates that there is significant variation in in-hospital outcomes associated with bariatric surgery. This finding underscores that bariatric surgery, while the most beneficial intervention for morbid obesity, carries significant risk, which can vary widely depending on the hospital. Thus, with the large increase in morbid obesity, there is enormous value and importance in this type of quality information being readily available to prospective patients when making decisions about where to get their medical treatments.

For the second part of this study, HealthGrades analyzed overall trends associated with bariatric surgery from 2002 through 2004 among 710 hospitals located in 17 states. The 17 states included in this study are:

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

Summary of Findings

Key findings of this study include:

- 1 Within the hospitals located in the 17 states studied, 147,022 bariatric surgery procedures were performed from 2002 to 2004. The number of surgeries increased by 45 percent in 2004 compared to 2002 (55,198 and 38,050, respectively).
 - Of the 710 hospitals that performed at least one case during the study period, 264 hospitals (37%) performed fewer than 30 cases during 2002-2004, leaving 446 hospitals with adequate volume to receive a rating.
 - During 2002-2004, 82 percent of all patients had private insurance compared with only 12 percent who had Medicare or Medicaid.
 - During 2002-2004, only three out of every 100 patients were self-pay, but this number increased by 74 percent in 2004 compared to 2002 (1,686 and 971 respectively).
 - Ninety-six percent of all bariatric surgeries performed were gastric bypass or laparoscopic procedures.
 - Among the 17 states studied, half of all the procedures were performed in just four states—New York, Florida, Texas and Pennsylvania.
 - Iowa, Maryland, and Wisconsin had the largest growth in number of procedures performed, with twice as many cases in 2004 compared to 2002.
- 2 Large quality gaps existed between the “best” and the “worst” hospitals across most bariatric procedures studied.
 - Of the 446 hospitals that received a rating, 101 (22.6%) received a 5-star (best) rating; 240 (53.8%) received a 3-star (average) rating; 105 (23.5%) received a 1-star (worst) rating.
 - Five-star rated hospitals had, on average, almost twice the number of procedures during the three-year study period compared to 1-star rated hospitals (526 and 285, respectively).
 - A typical patient receiving a bariatric surgery procedure in a 5-star rated hospital would have, on average, a 63 percent lower chance of developing one or more major in-hospital complications compared to a 1-star rated hospital and a 40 percent lower chance compared to a 3-star rated hospital. The most common major complications include respiratory, bleeding, and cardiac complications.
 - Two hundred and forty-four patients died in-hospital from complications of bariatric surgery during the study period. The average U.S. mortality rate during the study period was 0.17 percent, or two patients per 1,000. The mortality rate was significantly lower for 5-star hospitals compared to all other U.S. hospitals.
 - The average length of stay was 14 percent shorter in 5-star hospitals as compared to the national average.
- 3 If all hospitals performed at the level of a 5-star rated hospital, **6,100 out of the 147,022 patients could have potentially avoided one or more major in-hospital complications** from 2002 to 2004.

Introduction

The majority of adults in the United States are overweight or obese,¹ and obesity is a leading cause of death. Bariatric surgery is the only effective intervention for weight loss in the morbidly obese.^{2,3} The past decade has seen dramatic growth in demand for bariatric surgery^{4,5} resulting in an increasing number of hospitals performing this procedure. Despite the increased demand and number of hospitals performing this complex procedure, the consistency in quality and safety of this surgery nationwide has not been well defined.^{6,7} The resulting exponential growth of bariatric surgery has resulted in increased scrutiny by third-party payers and the media, and demand for information regarding the safety of bariatric surgery.

HealthGrades' research⁸ has found significant variation in the quality and safety of care across a wide array of procedures and diagnoses provided by the nation's hospitals that has persisted over the last eight years despite numerous quality initiatives at the hospital, local, state and federal level. As such, it is imperative for patients to gather easy-to-use information and learn as much about their healthcare and prospective hospitals and physicians as possible.

HealthGrades' star rating system tells consumers whether a particular hospital's performance has been "best" (5-star), "as expected" (3-star), or "poor" (1-star) for a particular procedure or diagnosis. Hospital ratings are based on patient outcomes, specifically, risk-adjusted mortality or complications. Because no two hospitals or their patients' risk profiles are alike, HealthGrades has developed extensive risk-adjustment algorithms to ensure fair, apples-to-apples comparisons.

The *First Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study's* objective is to identify, quantify and report trends in bariatric surgery for 710 hospitals nationwide by measuring risk-adjusted in-hospital complications, simplifying the reporting of hospital performance using a star rating system that can be easily interpreted by users, and making this available to consumers for free.

Methods Part 1: The Bariatric Surgery Hospital Quality Rating Method

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 2002 through 2004. 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 between 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. The methodology is disease-specific and outcome-specific. This means that individual risk models are constructed and tailored for each clinical condition or procedure using multivariate logistic regression.

Multivariate Logistic Regression-Based Ratings

The initial analysis of the data utilized 17 states of all payer data from 2002 through 2004. Bariatric surgery patients were identified by their ICD-9-CM principal procedure of a bariatric surgical procedure and a principal diagnosis of obesity/morbid obesity (see Table 1)—a definition previously described by Santry et al.^{7,10} Patients under the age of 18 were excluded.

For this population, potential risk factors and the outcome measure (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^{9,10} 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-CM Codes

Principal Procedures and Diagnoses – Inclusions:	
Procedure 43.89, 44.31, 44.38, 44.39, 44.68, 44.93, 44.95, 45.51, or 45.91 with diagnosis 278.00 or 278.01 also present	
Procedures – Exclusions:	Demographics – Exclusions:
44.5, 44.94, 44.96, 44.97	Patients less than 18 years of age

Table 2: Major Complications – Bariatric Surgery

Major Complications – Bariatric Surgery			
038	SEPTICEMIA	434.91	CRBL ART OC NOS W INFRCT
038.0	STREPTOCOCCAL SEPTICEMIA	436	CVA
038.1	STAPHYLOCOCCAL SEPTICEMIA	437.1	AC CEREBROVASC INSUF NOS
038.10	STAPHYLOCOCC SEPTICEM, NOS	453.8	VENOUS THROMBOSIS NEC
038.11	SEPTICEMIA-STAPH AUREUS	453.9	VENOUS THROMBOSIS NOS
038.19	STAPHYLOCOCC SEPTICEM, NEC	480	VIRAL PNEUMONIA
038.2	PNEUMOCOCCAL SEPTICEMIA	480.0	PNEUMONIA DT ADENOVIRUS
038.3	SEPTICEMIA DT ANAEROBES	480.1	PNEUMONIA DUE TO RSV
038.4	SEPTICEMIA GRAM-NEGS, NEC	480.2	PNEUMON-PARAINFLUENZA VR
038.40	SEPTICEMIA GRAM-NEGS, NOS	480.3	PNEUMONIA DT SARS
038.41	SEPTICEMIA-H. INFLUENZAE	480.8	PNEUMONIA DT VIRUS, NEC
038.42	SEPTICEMIA DT E. COLI	480.9	VIRAL PNEUMONIA, NOS
038.43	SEPTICEMIA - PSEUDOMONAS	481	PNEUMOCOCCAL PNEUMONIA
038.44	SEPTICEMIA DT SERRATIA	482	OTHR BACTERIAL PNEUMONIA
038.49	SEPTICEMIA GRAM-NEG, NEC	482.0	PNEUMONIA-K. PNEUMONIAE
038.8	OTH SPECIFIED SEPTICEMIA	482.1	PNEUMONIA DT PSEUDOMONAS
038.9	UNSPECIFIED SEPTICEMIA	482.2	PNEUMONIA-H. INFLUENZAE
410.01	AMI-ANTEROLATERAL-INITIAL	482.3	PNEUMONIA-STREPTOCOCCUS
410.11	AMI-ANT WALL, NEC-INITIAL	482.30	PNEUMONIA-STREPTOCOC
410.21	AMI-INFEROLATERAL-INITIAL	482.31	PNEUMONIA-GROUP A STREP
410.31	AMI INFEROPOST, INITIAL	482.32	PNEUMONIA-GROUP B STREP
410.41	AMI INFERIOR WALL, INIT	482.39	PNEUMONIA DT STREP, NEC
410.51	AMI-LAT WALL, NEC-INITIAL	482.4	PNEUMONIA-STAPHYLOCOCCUS
410.61	AMI-TRUE POST WL-INITIAL	482.40	STAPH PNEUMONIA, NOS
410.71	AMI-SUBEND INFRCT-INIT'L	482.41	STAPH AUREUS PNEUMONIA
410.81	AMI-SITE, NEC-INITIAL EPI	482.49	STAPH PNEUMONIA, NEC
410.91	AMI-SITE, NOS-INITIAL EPI	482.8	PNEUMONIA-BACTERIA, NEC
415.11	IATROGEN PULM EMB/INFARC	482.81	PNEUMONIA DT ANAEROBES
415.19	PULM EMBOL/INFARCT NEC	482.82	PNEUMONIA-E. COLI
427.0	PAROXYSMAL SVT	482.83	PNEUMONIA-GRM NG BAC, NEC
427.1	PAROXYSML VENT TACHYCARD	482.84	LEGIONNAIRES' DISEASE
427.31	ATRIAL FIBRILLATION	482.89	PNEUMONIA-BACTERIA, NEC
427.41	VENTRICULAR FIBRILLATION	482.9	BACTERIAL PNEUMONIA, NOS
431	INTRACEREBRAL HEMORRHAGE	483	PNEUMONIA-OTHER ORGANISM
433.00	OCL BSLR ART WO INFRCT	483.0	PNEUMONIA-M. PNEUMONIAE
433.01	OCL BSLR ART W INFRCT	483.1	PNEUMONIA DT CHLAMYDIA
433.10	OCL CRTD ART WO INFRCT	483.8	PNEUMONIA DT ORGANSM, NEC
433.11	OCL CRTD ART W INFRCT	484	PNEUMONIA-OTH INFECT DIS
433.20	OCL VRTB ART WO INFRCT	484.1	PNEUMONIA-CM INCLUSN DIS
433.21	OCL VRTB ART W INFRCT	484.3	PNEUMONIA-WHOOPING COUGH
433.30	OCL MLT BI ART WO INFRCT	484.5	PNEUMONIA IN ANTHRAX
433.31	OCL MLT BI ART W INFRCT	484.6	PNEUMONIA-ASPERGILLOSIS
433.80	OCL SPCF ART WO INFRCT	484.7	PNEUMON-SYST MYCOSES, NEC
433.81	OCL SPCF ART W INFRCT	484.8	PNEUMON IN INFCT DIS, NEC
433.90	OCL ART NOS WO INFRCT	485	BRONCHOPNEUM-ORGNISM, NOS
433.91	OCL ART NOS W INFRCT	486	PNEUMONIA-ORGANISM, NOS
434.00	CRBL THRMBS WO INFRCT	518.0	PULMONARY COLLAPSE
434.01	CRBL THRMBS W INFRCT	518.5	PULM INSUF PST TRAUM/SRG
434.10	CRBL EMBLSM WO INFRCT	518.81	RESPIRATORY FAILURE
434.11	CRBL EMBLSM W INFRCT	560.1	PARALYTIC ILEUS
434.90	CRBL ART OC NOS WO INFRCT	560.2	VOLVULUS

Major Complications – Bariatric Surgery - Continued

560.30	IMPACTION OF INTESTINE, UNSPEC	997.3	RESPIR COMPLICATIONS, NEC
560.39	OTHER IMPACTION OF INTESTINE	997.4	DIGESTIVE SYST COMPL, NEC
560.81	INTESTINAL ADHES W OBSTR	997.5	URINARY COMPLICATION, NEC
560.89	INTESTINAL OBSTRUCT NEC	998.0	POSTOPERATIVE SHOCK, NEC
560.9	INTESTINAL OBSTRUCTN, NOS	998.11	HEMORRHAGE COMPLIC PROC
564.2	POSTGASTRIC SURGERY SYNDROMES	998.12	HEMATOMA COMPLIC PROC
578.9	HEMORRHAGE OF GI TRACT, UNSPEC	998.2	ACC PUNCTUR/LAC-PROC, NEC
584.5	AC REN FAIL-LES TUBL, NEC	998.31	DISRUPT INTERNL OP WOUND
584.8	AC REN FAIL-PATH LES, NEC	998.32	DISRUPT EXTERNL OP WOUND
584.9	ACUTE RENAL FAILURE, NOS	998.51	INFECTED POSTOP SEROMA
599.0	URIN TRACT INFECTION NOS	998.59	POSTOPERATIV INFECTN, NEC
997.1	CARDIAC COMPLICATION, NEC	998.6	PERSISTENT POSTOP FISTULA, NEC

Dependent Complications - Bariatric Surgery

Must occur with 997.1 Cardiac Complications

427.31 ATRIAL FIBRILLATION

Must occur with 997.3 Respiratory Complications

518.0 PULMONARY COLLAPSE

Developing HealthGrades Bariatric Surgery Ratings

Developing the HealthGrades Bariatric Surgery ratings involved four steps.

1. First, the predicted value (predicted complications) was obtained using logistic regression models 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 one 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 outcome 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 0.642. This model was then used to estimate the probability of the outcome for each patient in the cohort. Patients were then aggregated for each hospital to obtain the predicted outcome for each hospital. Statistical significance tests were performed for each patient cohort to identify, by hospital, whether the actual and predicted rates were significantly different.

Table 3: Example Risk Factors – Bariatric Surgery

Diag 493.20	CHRN OBSTRCTV ASTHMA NOS
Diag 428.0	CONGESTIVE HEART FAILURE
Diag 285.9	ANEMIA, UNSPECIFIED
Diag 496	CHR AIRWAY OBSTRUCT NEC
Diag 427.89	CARDIAC DYSRHYTHMIAS 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 446 hospitals, based on the *First Annual HealthGrades Bariatric Surgery Trends in American Hospitals Study*, can be found at www.healthgrades.com.

For bariatric surgery,

- 101 hospitals (22.6%) stand out as “best” performers (5-star rated)
- 240 hospitals (53.8%) were rated as “as expected” performers (3-star rated)
- 105 hospitals (23.5%) were rated as “poor” performers (1-star rated)

Methods Part 2: Bariatric Surgery Trends

The purpose of the second part of the study was to evaluate trends in bariatric surgery in hospitals located within the 17 states that provide all-patient data. In Part I, the actual (observed) and predicted (expected) in-hospital complication rates associated with various bariatric surgery procedures were calculated and aggregated for each hospital.

In Part 2, procedure type and volume, payer type, and observed mortality 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.

Results Part 2: National Bariatric Surgery Trends

Within the hospitals located in the 17 states studied:

- 147,022 bariatric surgery procedures were performed in 710 hospitals from 2002 through 2004 (Tables 4a, 4b, and 5).
- Nearly half (48.47%) of all the procedures were performed in just four states—New York, Florida, Texas and Pennsylvania.
- Iowa, Maryland, and Wisconsin had the largest growth (range: 97.46% to 109.05%) in number of procedures performed, resulting in almost twice as many cases in 2004 compared to 2002 (Table 6).

Of the 710 hospitals that performed at least one bariatric surgery in 2002 through 2004:

- 37.2 percent (n=264) performed fewer than 30 cases during the study period or fewer than five in 2004, and did not receive a star rating.
- The remaining 446 hospitals performed more than 30 cases during the study period and received a star rating.
- In addition, there was a 45.07 percent increase in the number of procedures performed from 2002 to 2004 (from 38,050 to 55,198) (Table 5).
- Eighty-two percent of patients had private insurance compared with only 12 percent who had Medicare or Medicaid.
- Approximately three out of 100 patients (2.90%) were self-pay, but the number increased by 73.64 percent in 2004 compared to 2002 (1,686 and 971, respectively) (Table 5).

Table 4a: Bariatric Surgery Trends Across U.S. Hospitals (2002 - 2004)

Hospital Bariatric Surgery Star Rating	Number of Hospitals	Average Patient Age (Years)	Average Volume (2002-2004)	Inhospital Mortality Rate	Pvalue (volume & mortality compared to U.S.)
1-Star	105	42.02	285	0.30%	< 0.001
3-Star	240	42.01	283	0.16%	NS
5-Star	101	42.08	526	0.08%	< 0.001
U.S. Average	710	42.03	205	0.17%	-

Table 4b: Bariatric Surgery Trends Across U.S. Hospitals (2002 - 2004)

Hospital Bariatric Surgery Star Rating	Observed Inhospital Complication Rate	Expected Inhospital Complication Rate	Observed to Expected Complication Ratio	Pvalue (O:E compared to U.S.)	Average Length of Stay (days)
1-Star	17.65%	10.88%	1.62	< 0.001	3.88
3-Star	10.26%	10.44%	0.98	NS	3.29
5-Star	6.00%	10.01%	0.60	< 0.001	2.79
U.S. Average	10.37%	10.37%	1.00	-	3.26
Relative difference between 5-star compared to 1-star	66.00%	7.96%	63.06%	< 0.001	15.98%
Relative difference between 5-star and the U.S. Average	42.13%	3.46%	40.06%	< 0.001	14.34%

Table 5: Bariatric Surgery Hospital Volume Trends by Payer and Year

Payer	2002	2003	2004	2002-2004	% of Total Cases 2002-2004	Change from 2002 to 2004
Blue Cross	5,640	9,475	12,892	28,007	19.05%	128.58%
Blue Cross HMO	2,523	3,054	800	6,377	4.34%	-68.29%
Champus	600	883	855	2,338	1.59%	42.50%
Fee-For-Service	10,071	13,545	13,665	37,281	25.36%	35.69%
HMO	7,870	10,971	8,979	27,820	18.92%	14.09%
HMO/PPO	771	1,097	1,543	3,411	2.32%	100.13%
Medicaid	2,390	3,314	1,388	7,092	4.82%	-41.92%
Medicaid Risk	428	762	817	2,007	1.37%	90.89%
Medicare	1,901	2,892	3,562	8,355	5.68%	87.38%
Medicare Risk	153	248	77	478	0.33%	-49.67%
Other	1,168	1,441	1,257	3,866	2.63%	7.62%
Other Government	656	760	995	2,411	1.64%	51.68%
PPO	2,095	3,441	6,189	11,725	7.97%	195.42%
Self-pay	971	1,601	1,686	4,258	2.90%	73.64%
Unknown	783	250	474	1,507	1.03%	-39.46%
Worker's Compensation	30	40	19	89	0.06%	-36.67%
All	38,050	53,774	55,198	147,022	100.00%	45.07%

Table 6: Bariatric Surgery Hospital Volume Trends by State and Year

State	2002	2003	2004	2002-2004	% of Total Cases (2002-2004)	Change from 2002 to 2004
Arizona	1,167	2,260	2,145	5,572	3.79%	83.80%
California	3,549	4,682	5,260	13,491	9.18%	48.21%
Florida	5,242	6,776	6,382	18,400	12.52%	21.75%
Iowa	511	1,498	1,009	3,018	2.05%	97.46%
Maine	386	471	565	1,422	0.97%	46.37%
Maryland	707	1,123	1,478	3,308	2.25%	109.05%
Massachusetts	1,880	2,612	2,859	7,351	5.00%	52.07%
Nevada	432	637	678	1,747	1.19%	56.94%
New Jersey	2,793	3,858	3,735	10,386	7.06%	33.73%
New York	4,309	6,382	7,279	17,970	12.22%	68.93%
North Carolina	1,964	2,621	2,570	7,155	4.87%	30.86%
Pennsylvania	4,128	6,215	6,972	17,315	11.78%	68.90%
Texas	4,826	6,293	6,452	17,571	11.95%	33.69%
Utah	1,014	1,001	773	2,788	1.90%	-23.77%
Virginia	3,376	4,196	3,893	11,465	7.80%	15.31%
Washington	862	1,518	1,298	3,678	2.50%	50.58%
Wisconsin	904	1,631	1,850	4,385	2.98%	104.65%
All	38,050	53,774	55,198	147,022	100.00%	45.07%

Ninety-six percent of all bariatric surgeries performed from 2002 through 2004 in the 17 states studied were gastric bypass or laparoscopic procedures (Table 7). Five-star rated hospitals had lower than expected in-hospital complication rates across most bariatric procedure types. This finding was also associated with significantly lower observed complication rates and significantly better risk-adjusted outcomes.

Substantial variation in volume, mortality, average length of stay and risk-adjusted in-hospital complications across hospitals was noted. Five-star rated hospitals had, on average, significantly higher total volume during the three-year study period compared to 3-star and 1-star rated hospitals (526 vs. 238, and 285 respectively). While the average U.S. mortality rate during the study period was very low (0.17%, or 2 patients per 1,000), 5-star rated hospitals had a 54.67 percent lower ($P < 0.001$) in-hospital mortality rate (0.08%) compared to the U.S. average and a 75.29 percent lower ($P < 0.001$) in-hospital mortality rate compared to 1-star rated hospitals (0.30%).

Unadjusted and adjusted in-hospital complications for 5-star hospitals were 66.00 percent and 63.06 percent lower ($P < 0.001$), respectively, compared to 1-star rated hospitals and 42.13 percent and 40.06 percent lower ($P < 0.001$), respectively, compared to the U.S. average (Tables 4a, 4b, and 7). Using the 5-star observed to expected complications ratio as a benchmark of performance, **6,100 out of the 147,022 patients could have potentially avoided one or more major in-hospital complications** from 2002 to 2004 if all hospitals performed at the level of a 5-star rated hospital.

Table 7: Bariatric Surgery Hospital Outcomes by Procedure Type

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)
Gastric Bypass										
44.31	High Gastric Bypass	1	16,478	17.90%	10.97%	1.63	1.59 - 1.68	62.04%	36.71%	3,254
		3	30,613	10.37%	10.59%	0.98	0.94 - 1.01			
		5	31,058	6.20%	10.00%	0.62	0.58 - 0.65			
		U.S.*	81,766	10.45%	10.45%	1.00	0.98 - 1.02			
44.39	Other Gastroenterostomy	1	10,827	17.77%	11.00%	1.62	1.56 - 1.67	64.10%	40.35%	2,310
		3	22,776	10.20%	10.49%	0.97	0.93 - 1.01			
		5	16,879	5.91%	10.19%	0.58	0.53 - 0.63			
		U.S.*	51,893	10.54%	10.50%	1.00	0.98 - 1.03			
Laparoscopic										
44.38	Laparoscopic Gastroenterostomy	1	1,109	13.07%	7.59%	1.72	1.51 - 1.94	63.10%	36.13%	178
		3	2,814	7.64%	7.68%	0.99	0.86 - 1.13			
		5	2,402	4.66%	7.34%	0.64	0.49 - 0.78			
		U.S.*	6,559	7.50%	7.55%	0.99	0.91 - 1.08			
44.68	Laparoscopic Gastroplasty	1	26	0.00%	7.34%	0.00	0.00 - 1.42	-	14.85%	-1
		3	138	7.25%	7.31%	0.99	0.37 - 1.61			
		5	111	5.41%	6.41%	0.84	0.11 - 1.58			
		U.S.*	290	5.52%	6.92%	0.80	0.36 - 1.23			
44.95	Laparoscopic Gastric Restrictive Procedure	1	98	4.08%	6.18%	0.66	0.00 - 1.46	62.20%	-12.01%	1
		3	426	1.41%	6.32%	0.22	0.00 - 0.60			
		5	280	1.43%	5.72%	0.25	0.00 - 0.74			
		U.S.*	898	1.56%	6.06%	0.26	0.00 - 0.52			

Table 7: 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										
43.89	Other Partial Gastrectomy	1	17	11.76%	11.20%	1.05	0.00 - 2.47	32.05%	45.51%	24
		3	258	17.44%	13.31%	1.31	0.98 - 1.64			
		5	84	8.33%	11.67%	0.71	0.09 - 1.34			
		U.S.*	366	15.85%	13.00%	1.22	0.94 - 1.50			
45.51	Isolation of Segment of Small Intestine	1	109	18.35%	10.37%	1.77	0.19 - 2.35	34.01%	-	6
		3	15	0.00%	10.27%	0.00	0.00 - 1.58			
		5	8	12.50%	10.71%	1.17	0.00 - 3.29			
		U.S.*	135	16.30%	10.35%	1.57	1.05 - 2.10			
45.91	Small-to-Small Intestinal Anastomosis	1	1,226	18.84%	12.09%	1.56	1.40 - 1.72	69.14%	60.72%	327
		3	1,453	15.42%	12.59%	1.22	1.08 - 1.37			
		5	2,349	5.87%	12.22%	0.48	0.37 - 0.60			
		U.S.*	5,110	12.33%	12.33%	1.00	0.92 - 1.08			
Other										
	Other	1	1	100.00%	5.64%	17.72	0.00 - 0.00	-69.33%	70.23%	1
		3	1	100.00%	5.48%	18.26	9.88 - 26.63			
		5	3	33.33%	6.13%	5.44	0.87 - 10.00			
		U.S.*	5	60.00%	5.90%	10.16	6.56 - 13.77			
All Bariatric Surgery Procedures		1	29,891	17.65%	10.88%	1.62	1.59 - 1.66	63.06%	40.06%	6,100
		3	58,494	10.26%	10.44%	0.98	0.96 - 1.01			
		5	53,174	6.00%	10.01%	0.60	0.57 - 0.63			
		U.S.*	147,022	10.37%	10.37%	1.00	0.98 - 1.02			

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

Discussion

This study of an adult all-patient population undergoing bariatric surgery in hospitals in 17 states from 2002 through 2004 found that bariatric surgery is rapidly proliferating, can be relatively safe, and is associated with low mortality, consistent with other recent studies.^{4,59-11} This study finds that the variation in outcomes among the hospitals studied is significant. The risk-adjusted in-hospital complication rate can be as low as five percent in the top-performing hospitals, and as high as 15 percent in the bottom-performing hospitals.

Assuming all hospitals could perform at the level of the top-performing hospitals **6,100 patients could have potentially avoided one or more major in-hospital complications**. We found that on average, almost one in 10 patients will develop one or more major in-hospital complications associated with a bariatric surgery hospitalization. This rate is lower than that reported by Nguyen et al. who reported a 16 percent complication rate among 29 University Health System Consortium (UHC) hospitals. One explanation for this lower in-hospital complication rate is that our study relied on administrative discharge data in contrast to Nguyen et al. who performed medical record review. Administrative data relies on physician documentation of complications and accurate coding. Thus, there may be missing data. Despite this limitation, administrative data are currently the only source of national population-based statistics in the absence of a comprehensive national bariatric surgery registry. Given the previously stated limitations of administrative data, we believe that our finding of an almost 10 percent average in-hospital complication rate likely represents an underestimation of the true complication rate.

Private insurance represented the majority of all reimbursements, and the number of self-pay patients steadily increased. Almost 4,300 cases in the 17 states studied were self-pay and experienced a 74 percent growth in number of cases from 2002 to 2004. This increase and willingness to self pay despite the \$30,000 cost¹² may be due to improved understanding and recognition of surgery as an effective therapy for morbid obesity, with consequent improvement or resolution of obesity-related comorbidities, such as diabetes and heart disease.

We found that **higher volume was associated with better outcomes**. Top-performing hospitals had, on average, almost twice the volume as bottom-performing hospitals (175 cases vs. 95 cases per year, respectively). Recent research by Nguyen et al. identified a significant volume-outcome relationship and that high volume hospitals, performing more than 100 cases annually, were associated with a shorter length of stay, lower morbidity, lower mortality, and decreased costs.¹³ In addition, a study by Flum et al. identified higher adjusted odds of death at 90 days for patients of surgeons with less than the median surgical volume of bariatric procedures.⁶ Lastly, 37 percent of the hospitals studied were not rated because they had fewer than 30 total cases during 2002 through 2004 or fewer than five cases in 2004. This likely reflects the relatively recent and rapid proliferation of new programs during the study period.

The *First Annual Bariatric Surgery Trends in American Hospitals Study* represents the first study to evaluate and report national trends and hospital-specific volume and outcomes on 710 hospitals. The resulting exponential growth of bariatric surgery has resulted in increased scrutiny by third-party payers and the media regarding the safety of bariatric surgery. Although our study found that bariatric surgery is relatively safe, the variation in in-hospital outcomes and volume among the hospitals studied was significant. This key finding should underscore the importance of appropriate patient selection, hospital and physician expertise, and patient and family access to hospital- and surgeon-specific volume and outcomes for informed decision making.

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