A State-wide Review of Contemporary Outcomes of Gastric Bypass in Florida

Does Provider Volume Impact Outcomes?

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Objectives: To report contemporary outcomes of gastric bypass for obesity and to assess the relationship between provider volume and outcomes.

Background: Certain Florida-based insurers are denying patients access to bariatric surgery because of alleged high morbidity and mortality.

Settings and Patients: The prospectively collected and mandatory-reported Florida-wide hospital discharge database was analyzed. Restrictive procedures such as adjustable gastric banding and gastroplasty were excluded.

Results: The overall complication and in-hospital mortality rates in 19,174 patients who underwent gastric bypass from 1999 to 2003 were 9.3% (8.9–9.7) and 0.28% (0.21–0.36), respectively. Age and male gender were associated with increased duration of hospital stay ($P < 0.001$), increased in-hospital complications [age: odds ratio (OR) = 1.11, CI: 1.08–1.13; male: OR = 1.53, CI: 0.36–1.72] and increased in-hospital mortality (age: OR = 1.51, CI: 1.32–1.73; male: CI = 2.66, CI: 1.53–4.63), all $P < 0.001$. The odds of in-hospital complications significantly increased with diminishing surgeon or hospital procedure volume (surgeon: OR = 2.0, CI: 1.3–3.1; $P < 0.001$, 1–5 procedures relative to >500 procedures; hospital volume: OR = 2.1, CI: 1.2–3.5; $P < 0.001$, 1–9 procedures relative to >500 procedures). The percent change of in-hospital mortality in later years of the study was lowest, indicating higher mortality rates, for surgeons or hospitals with fewer (≤100) compared with higher (≥500) procedures.

Conclusion: Increased utilization of bariatric surgery in Florida is associated with overall favorable short-term outcomes. Older age and male gender were associated with increased morbidity and mortality. Surgeon and hospital procedure volume have an inverse relationship with in-hospital complications and mortality.

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The explosive growth in bariatric surgery has been fueled by a heightened awareness of the benefits of surgically induced weight loss, patient demand, and the increasing availability of laparoscopic bariatric surgery. According to the American Society for Bariatric Surgery (ASBS),[1] more than 120,000 bariatric procedures were undertaken nationwide in 2003.

Nevertheless, concerns about patient safety and escalating utilization of bariatric surgery have been highlighted throughout the lay press. These unsubstantiated claims are in sharp contrast with published rigorous scientific data that was highlighted by the Medicare Evidence Development & Coverage Advisory Committee (MCAC), which found strong evidence to support the safety and efficacy of bariatric surgery and resulted in a recent National Coverage Determination policy to cover surgery for all Medicare beneficiaries.[2,3] Nonetheless, population-based studies have yielded conflicting results of the safety of bariatric surgery by reporting mortality rates up to 9%[4,5] that appeared to be considerably higher than those reported in smaller clinical cohorts. Therefore, we undertook this analysis of the Florida Agency of Healthcare Administration (AHCA) Hospital Discharge Database to report contemporary outcomes of gastric bypass in Florida, and assess the relationship between provider volume and reported outcomes.

METHODS

This study was approved by the Institutional Review Board (IRB) of the University of South Florida and was conducted in compliance with the Health Insurance Portability and Accountability Act (HIPAA) regulations and guidelines. The Florida Agency of Health Care Administration Hospital Discharge Database was queried for all patients who underwent bariatric surgery from 1999 to 2003.

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The International Classification of Disease (ICD, 9th Edition)[6] diagnosis code for morbid obesity (278.01) and procedure codes for high gastric bypass (44.31) and gastroenterostomy (44.39) were the main query parameters. ICD codes for obesity (278.0) and obesity unspecified (278.00) were excluded. Therefore, procedures such as the laparoscopic adjustable gastric banding and various gastroplasties were excluded.

The results of the query were provided as UB-92 (Uniform Bill) forms which are hospital and surgeon specific but patient anonymous; we abstracted those forms for age, gender, postoperative complications, mortality, and duration of hospital stay (DOS).

Definition of Complications

UB-92 forms list up to 10 diagnoses based on ICD codes and Diagnosis-related Group (DRG) classifications. All patients with identified complications were reviewed individually and complications that are not related to the surgical procedure were excluded from this analysis. Those complications that were excluded are listed in Table 1.

Data Analysis

Physician and hospital identifiers were blinded and the data were submitted to an independent statistician (Scott Harmsen, Mayo Clinic, Rochester, MN) for analysis.

Descriptive statistics for patient age is reported as mean and standard deviation (SD); DOS was reported as median and 25th–75th percentiles; complications and mortality rates are reported as a percentage and 95% exact binomial confidence interval (CI). The α-level for all subsequent analysis and models was set at 0.05 for statistical significance. All analyses were done using SAS, version 8.2 (Cary, NC).

TABLE 1. List of Conditions as Listed in UB-92 Forms That Were not Considered Complications for the Purposes of This Study

Condition	ICD Code
Infectious and parasitic diseases	41.86, 70.3, 78.1, 79.99, 112, 112.1, 135
Neoplasms	153.3, 211.2, 214.3, 216.7, 218.9
Disorders of thyroid, parathyroid gland	240–242, 244, 246.9, 252
Diabetes mellitus	250, 250.13, 250.4, 250.6
Metabolic disorders	272, 274, 275, 277.1, 278
Diseases of blood, blood-forming organs	280, 282.4, 285.29, 286.2, 286.3, 287.3, 288.8, 289.59
Mental disorders	292, 296, 297.1, 300, 303–307, 309, 314.01
Disorders of nervous system	333.99, 337.1–337.22, 340, 345, 346.9, 348.3, 353, 354.1, 355.1, 356.9, 357.2, 358
Disorders of eye and adnexa	362.1, 362.11, 365.9
Diseases of circulatory system: heart disease	397, 412, 414, 414.01, 424, 424.1, 425.8, 429.3
Diseases of circulatory system: hypertensive diseases	401.1, 401.91, 402.01, 402.9, 403.9, 403.91
Other diseases of circulatory system	416.8, 416.9, 443.9, 451.2, 454.9, 455, 457.1, 458.8, 458.9, 459.81
Diseases of respiratory system	466, 473.9, 477.9, 478, 491.2, 491.21, 492.8, 493, 496, 515, 518.89, 519
Diseases of esophagus, stomach, and duodenum	530.11, 530.81, 530.89, 531.7, 535.1, 536.2, 536.3, 536.8, 537
Appendicitis	540.9, 543.9
Hernia of abdominal cavity	550.9, 552.1, 552.21, 552.8, 553.1, 553.2, 553.3
Diseases of digestive system	555.9, 556.9, 562.1, 564, 571.5, 571.8, 572, 573.8, 574.1, 575, 576.8
Diseases of genitourinary system	583.9, 593, 599.7
Disorders of female genital tract	256.4, 616, 620.2, 621.8, 625.6, 626.2, 626.6, 628.9
Diseases of skin and subcutaneous tissue	686.1, 694.4, 696, 698.9, 701.9, 702.1, 707.13, 707.19
Diseases of musculoskeletal system and connective tissue	710, 714, 715.09, 715.36, 716, 719.4, 719.7, 721–722, 724, 726.73, 728–729
Osteopathies, chondropathies, and acquired musculoskeletal deformities	736.41, 736.79
Congenital anomalies	745.41, 751.4, 751.69, 753.13, 756.12, 756.4
Symptoms, nonspecific abnormal findings	780, 782.3, 783, 784, 785.6, 786, 787.1, 788, 789.2, 790, 794.8, 796
Unspecified debility	799.3
Injury and poisoning	847.2, 873.32, 905.4, 911.2, 955.9, 985, 990, 996, 997.91, E859.2
Peripheral nerve- and plexus-blocking anesthetics	E938.6
Asymptomatic human immunodeficiency virus (HIV) infection status	V08.0
Persons with potential health hazards related to personal/family history	V10.4, V10.51, V10.8, V12, V13.01, V14.8, V15.5, V15.8
Sterilization	V25.2
Persons with a condition influencing their health status	V42.0, V43.6, V44.0, V45.01, V45.3, V45.4, V45.8
Persons encountering health services for specific procedures and aftercare	V54.0
Dietary surveillance and counseling	V65.3

Predictors of DOS

A multiple variable binary logistic regression model was used to assess the association between the dependent variable, duration of stay greater than or equal to the 90th percentile, and the independent variables of calendar year of procedure (as a linear effect), adjusting for patient age and gender. We chose to compare the 90th percentile of DOS because the data is not normally distributed.

Relationship of Calendar Year and Outcomes

A multiple variable binary logistic regression model was also used to assess the association between the dependent variable of in-hospital complication and calendar year of procedure (as a linear effect), adjusting for patient age, gender, as well as hospitals to account for the variation of complication rates among the hospitals in this study. Results of the regression model are reported as P value, odds ratio (OR), and 95% CI. This same model was fit for patient mortality, except that hospital was not included as an independent variable since there were only 53 in-hospital deaths over the 5-year period.

Relationship of Provider Volume and Outcomes

In-hospital complication and mortality rates were estimated by stratifying surgeons' procedure volume (1–5, 6–99, 100–199, 200–499, and ≥500 procedures over the 5 years of the study). Rates were estimated as (i) 100 times the ratio of the total number of complications/total number of procedures, within each of the strata, and (ii) as an estimate of a surgeon's complication rate within the volume strata so as to give each surgeon's complication rate an equal weight. In-hospital complication and mortality rates were similarly estimated by stratifying a hospital's procedure volume (1–9, 10–99, 100–199, 200–499, and ≥500 procedures over the 5 years of the study).

A multiple variable binary logistic regression model was used to examine the association between the dependent variable of in-hospital complication or in-hospital mortality and surgeon volume strata. The model included the independent variables of patient age, gender, calendar year of procedure (linear), and 4 terms representing surgeon's volume (1–5, 6–99, 100–199, 200–499), while the highest volume (≥500) was considered as the reference category. Results were reported as P value, OR, and 95% CI. Similarly, this model was used to examine the association between in-hospital complication or in-hospital mortality, and hospital procedure volume.

To further assess the relationship between provider volume and outcomes, the percent change in mortality rates during the 5 years of the study was estimated by considering a rate for the first 4 years (1999–2002; $r_{99,\ 02}$) and comparing it with the rate in the last year of the study (2003; r_{03}), calculated as $100 \times [(r_{99,\ 02} - r_{03})/r_{99,\ 02}]$. This estimate was stratified by surgeon's and hospital's procedure volume.

RESULTS

Utilization Trends and Patient Characteristics

The utilization of bariatric surgery increased dramatically during the study period. A total of 19,174 patients underwent bariatric surgery from 1999 to 2003. There was almost a 100-fold increase in the number of procedures in 2003 compared with 1993 (6906 versus 73 patients, respectively), and almost a 2-fold increase from 2001 to 2003 (3834 versus 6906 patients, respectively). Patient age increased slightly from 41 ± 11 years (mean ± SD) in 1999 to 42 ± 11 years in 2003. The percentage of men undergoing bariatric surgery ranged from 21% in 1999 to 19% in 2003.

Predictors of Extended DOS

The mean (25th, 75th percentiles) DOS decreased from 4 days[3,5] in 1999 to 3 days[2,4] in 2003. Alternatively, defining an extended DOS (≥90th percentile) as a stay of 6 days or more, 17.6% of procedures resulted in an extended DOS in 1999, and 8.1% in 2003 (Table 2). In a multiple variable binary logistic regression model which included patient age, gender, and calendar year of procedure as predictors, the odds of an extended DOS decreased about 25% per subsequent calendar year [(OR = 0.75, 95% CI: 0.73, 0.78), $P < 0.001$]. Older age ($P < 0.001$) and male gender ($P < 0.001$) were also significantly associated with a longer DOS; the odds of an extended DOS nearly doubled for each 20 years of patient age (OR = 1.9 per 20 years) and a male patient (OR = 1.4, relative to female) (Table 3).

TABLE 2. Number of Bariatric Procedures, Duration of Hospital Stay (DOS) in Days, In-Hospital Complications, and Mortality Rates by Calendar Year of Study

Year	No. Procedures	DOS Median (25th, 75th)	% ≥90th Percentile*	% Complications (95% CI)	% Mortality (95% CI)
1999	859	4 (3, 5)	17.6	9.7 (7.8–11.8)	0.35 (0.07–1.02)
2000	1,745	4 (3, 5)	18.3	10.9 (9.5–12.5)	0.46 (0.20–0.90)
2001	3,834	4 (3, 5)	13.1	10.5 (9.6–11.5)	0.39 (0.22–0.64)
2002	5,830	3 (3, 4)	10.1	9.8 (9.0–10.6)	0.26 (0.14–0.42)
2003	6,906	3 (2, 4)	8.1	7.7 (7.1–8.4)	0.17 (0.09–0.30)
1999–2003	19,174	3 (3, 4)	11.1	9.3 (8.9–9.7)	0.28 (0.21–0.36)

*Extended DOS defined as ≥90th percentile of DOS for gastric bypass in this study (6 d).
SD indicates standard deviation; CI, confidence intervals.

TABLE 3. The Association of Age, Gender, and Procedure Calendar Year on Duration of Hospital Stay of ≥6 d*

	Odds Ratio (95% CI)	*P* Value
Age (per 20 yrs)	1.9 (1.7, 2.1)	<0.001
Male gender	1.4 (1.3, 1.7)	<0.001
Procedure year	0.75 (0.73, 0.78)	<0.001

*Greater than or equal to the 90th percentile.

TABLE 4. The Effect of Hospital Volume, Age, Gender, and Procedure Year on In-Hospital Complications and Mortality*

	In-Hospital Complication		In-Hospital Mortality	
	P Value	OR (95% CI)	*P* Value	OR (95% CI)
Hospital	<0.001	†	‡	
Age/5 yrs	<0.001	1.11 (1.08–1.13)	<0.001	1.51 (1.32–1.73)
Male gender	<0.001	1.53 (0.36–1.72)	<0.001	2.66 (1.53–4.63)
Procedure year	0.025	0.95 (0.91–0.99)	0.007	0.75 (0.61–0.92)

*Assessed by multiple variable regression analysis. Older age and male gender increased the likelihood of in-hospital complications and mortality, whereas later procedure calendar year had a protective effect.

†Hospital procedure volume was included in the model for complications; nevertheless, since each hospital has a unique estimated odds ratio (OR) these values are not reported.

‡Hospital was not included in the model for mortality since there were a total 53 deaths only.

Predictors of In-Hospital Complications

The overall in-hospital complication rate was 9.3% (8.9–9.7) and ranged from 10.9% (9.5–12.5) in 2000 to 7.7% (7.1–8.4) in 2003 (Table 2).

In a multiple variable binary logistic regression model including patient age, gender, hospital, and calendar year of procedure, there was a significant association between calendar year and the odds of developing a complication ($P = 0.025$; [OR = 0.95; 95% CI: 0.91–0.99]); in other words, the odds of developing in-hospital complications decreased by approximately 5% in successive and later calendar years of the study. Older age and male gender were also significantly and independently associated with greater odds of developing in-hospital complications ($P < 0.001$, Table 4; age: OR = 1.11; 95% CI: 1.08–1.13 per 5 years of age; male gender: OR = 1.53, 95% CI: 0.36–1.72). Hospital procedure volume was also significantly associated with the odds of developing a complication ($P < 0.001$, Table 4).

Predictors of In-Hospital Mortality

The overall patient in-hospital mortality was 0.28% (0.21–0.36) and ranged from 0.46% in 2000 to 0.17% (0.09–0.30) in 2003 (Table 2).

In a multiple variable binary logistic regression model including patient age, gender, and calendar year of procedure there was a significant association between calendar year and the odds of in-hospital mortality ($P = 0.007$; [OR = 0.75; 95% CI: 0.61–0.92]). The odds of in-hospital mortality decreased by approximately 25% in the successive and later calendar years of the study. Older age and male gender were also significantly associated with greater odds of in-hospital mortality ($P < 0.001$, Table 4; age: OR = 1.5; 95% CI: 1.3–1.7 per 5 years of age; and male gender: OR = 2.7; 95% CI: 1.5–4.6).

Surgeon's Procedure Volume Versus In-Hospital Complications

Surgeons were stratified according to the number of bariatric procedures undertaken during the 5 years of this study (1–5, 6–99, 100–199, 200–499, and ≥500 procedures).

One hundred and one of the 197 (51%) surgeons undertook less than 5 bariatric procedures per year, more surgeons than in any other procedure volume category. Those 101 surgeons undertook a total of 153 procedures 1.5 procedure/surgeon; and complications were reported in 25/153 patients (16.3%); while in the highest procedure volume category (≥500 procedures), complications were reported in 801/9,390 patients (8.5%) during the study period. Additionally, a complication rate was estimated for each surgeon and these estimates were averaged and reported as "mean of surgeon complication rates" for each procedure volume category (Table 5).

In a multiple variable binary logistic regression model adjusting for patient age, gender, and procedure calendar year there was a significant association between surgeon's procedure volume and the odds of developing an in-hospital complication ($P < 0.001$). Among patients whose surgeon had undertaken 1–5 procedures in the 5 years of the study (relative to a patient whose surgeon had undertaken ≥500 procedures) the odds of developing a complication were 2.0 (95% CI: 1.3–3.1); whereas the odds were 1.4 (95% CI: 1.1–1.6) for surgeons who undertook 6–99 procedures (Table 5).

Surgeon's Procedure Volume Versus In-Hospital Mortality

The reported in-hospital mortality rate was 1.3% (2/153) for surgeons undertaking <5 procedures in the 5-year period of the study compared with 0.19% (18/9390) for the highest volume category (≥500 procedures). Additionally, the mortality rate was estimated for each surgeon and these estimates were averaged and reported as "mean of surgeon mortality rates" for each procedure volume category (Table 6).

Hospital's Procedure Volume Versus In-Hospital Complications

Similarly, we stratified hospitals by the number of procedures undertaken during the 5 years of the study (1–9, 10–99, 100–199, 200–499, and ≥500 procedures).

Eighteen of the 102 patients (17.6%) who underwent a procedure at a hospital that reported 1–9 procedures within the 5-year study period experienced a complication compared with 9.6% (1262/13,213) of patients at the highest hospital procedure volume category (≥500 procedures). The lowest complication rate (5%) was reported by hospitals that undertook 100–199 procedures (Table 5).

Additionally, the complication rate was estimated for each hospital and these estimates were averaged and reported as "mean of hospital complication rates" for within a volume category. The mean of in-hospital complication rates varied from a low of 5.4 ± 5.7% (100–199 procedures) to a high of

TABLE 5. The Association Between Surgeon Volume, Hospital Volume, and In-Hospital Complications*

Surgeon Volume

Total 5 yrs Procedure Volume	No. Surgeons	No. Procedures	No. (%) In-Hospital Complications	Mean ± SD (%) of Surgeon Complication Rates†	Logistic Regression‡	
					P value	OR (95% CI)
6–99	57	1,832	190 (10.4)	11.8 ± 14.1	0.002	2.0 (1.3–3.1)
100–199	10	1,392	98 (7.0)	7.0 ± 4.5	<0.001	1.4 (1.1–1.6)
200–499	17	6,407	668 (10.4)	10.0 ± 4.1	0.27	0.9 (0.7–1.1)
≥500	12	9,390	801 (8.5)	8.1 ± 3.3	<0.001	1.3 (1.1–1.4)

Hospital Volume

Total 5 yrs Procedure Volume	No. Hospitals	No. Procedures	No. (%) In-Hospital Complications	Mean ± SD (%) of Surgeon Complication Rates§	Logistic Regression‡	
					P value	OR (95% CI)
1–9	29				0.006	2.1 (1.2–3.5)
10–99	31	1,340	156 (11.6)	12.6 ± 11.2	0.005	1.3 (1.1–1.5)
100–199	10	1,321	66 (5.0)	5.4 ± 5.7	<0.001	0.6 (0.4–0.7)
200–499	9	3,198	280 (8.8)	8.3 ± 3.1	0.21	0.9 (0.8–1.1)
≥500	14	13,213	1,262 (9.6)	9.1 ± 3.8		1.0

*Assessed by multiple variable binary logistic regressions.

†Calculated by estimating the complication rate for each surgeon in the volume strata and then calculating the average complication rate across all surgeons in the strata.

‡Multiple variable binary logistic regression model adjusting for patient age, gender, and year of surgery relative to the highest volume category (≥500).

§Calculated by estimating the complication rate for each hospital in the volume strata and then calculating the average complication rate across all hospitals in the volume strata.

SD indicates standard deviation; OR, odds ratio; CI, confidence intervals.

20.4 ± 32.7% in the volume category of 1–9 procedures (Table 5).

In a multiple variable binary logistic regression model including patient age, gender, and procedure calendar year, there was a significant association between hospital procedure volume and the odds of developing an in-hospital complication ($P < 0.001$). The odds of developing a complication at a hospital that reported 1–9 procedures in the 5 years of the study (relative to a ≥500 procedures hospital) was 2.1 (95% CI:1.2–3.5, $P = 0.006$). The odds of developing a complication were the least in hospitals where 100–199 procedures were undertaken in the 5 years of the study (OR = 0.6, 95% CI:0.4–0.7; $P < 0.001$, relative to ≥500 procedure hospitals) (Table 5).

Hospital's Procedure Volume Versus In-Hospital Mortality

The mortality rate was estimated for each hospital and these estimates were averaged and reported as mean of hospital complication rates for each procedure volume category. The mortality rate was 2.9 ± 11.0% in 29 hospitals where 1–9 procedures were undertaken (total procedures in 5 years = 102), and was lowest (0.1 ± 0.3%) in the 10 hospitals where 100–199 procedures were undertaken in the 5-year period of the study. Additionally, the 53 deaths were not clustered; 33 deaths occurred at the 8 high-volume hospitals, 10 deaths at hospitals with volume of 100–499 procedures/5 years, and 10 deaths in lower-volume hospitals (Table 6).

Provider Procedure Volume and In-Hospital Mortality

We further assessed the relationship of surgeon's procedure volume and outcomes by determining the likelihood of in-hospital mortality if a patient were to have a bariatric procedure in the later years of the study, assuming that as years progressed, a surgeon's experience increased.

Accordingly, the change in mortality rates was estimated in the first 4 years (1999–2002) and the last year of this study (2003). The mean percent change in mortality rates for the 158 surgeons who undertook fewer than 100 procedures in total remained relatively stable with a decrease of 10.6% between the 2 periods of the study (1999–2002 versus 2003), whereas each of the higher-volume groups had a dramatically greater reduction (percent change) in mortality rates (Table 7).

Similarly, hospitals with fewer than 100 procedures reported higher death rates in the last year of the study (2003), a positive percent change (+44%) compared with the period from 1999 to 2002. The percent change of in-hospital mortality ranged from −46% to −100% (decrease) in higher-volume hospitals (Table 7).

DISCUSSION

The mushrooming growth of bariatric surgery has raised concerns about inappropriate utilization, physician and hospital credentialing, patient safety, and quality assurance. Many of these issues have been addressed by the American Society of Bariatric Surgery (ASBS) through setting practice, training, and

TABLE 6. In-Hospital Mortality Rates Stratified by Surgeon and Hospital Volumes

Surgeon Volume

Total 5 yrs Procedure Volume	No. Surgeons	No. Procedures	No. (%) In-Hospital Mortality	Mean ± SD (%) of Surgeon Mortality Rates*
1–5	101	153	2 (1.3)	1.32 ± 10.5
6–99	57	1,832	10 (0.5)	0.83 ± 2.6
100–199	10	1,392	4 (0.3)	0.27 ± 0.5
200–499	17	6,407	19 (0.3)	0.28 ± 0.3
≥500	12	9,390	18 (0.2)	0.22 ± 0.4

Hospital Volume

Total 5 yrs Procedure Volume	No. Hospitals	No. Procedures	No. (%) In-Hospital Mortality	Mean ± SD (%) of Surgeon Mortality Rates†
1–9	29	102	2 (2.0)	2.87 ± 11.0
10–99	31	1,340	8 (0.6)	0.62 ± 1.9
100–199	10	1,321	2 (0.2)	0.12 ± 0.3
200–499	9	3,198	8 (0.3)	0.22 ± 0.3
≥500	14	13,213	33 (0.3)	0.25 ± 0.3

*Calculated by estimating the mortality rate for each surgeon in the volume strata and then calculating the average mortality rate across all surgeons in the volume strata.

†Calculated by estimating the mortality rate for each hospital in the volume strata and then calculating the average mortality rate across all hospitals in the volume strata.

SD indicates standard deviation.

TABLE 7. Percent Change Estimates in Mortality Rates Between the Period From 1999–2002 and 2003, Stratified by Surgeon and Hospital Volumes

Stratified by Surgeon Volume

Total 5 yrs Procedure Volume	No. Surgeons	No. In-Hospital Deaths/No. Procedures (%) in 1999–2002	No. In-Hospital Deaths/No. Procedures (%) in 2003	% Change of In-Hospital Mortality Rate
≤99	158	6/937 (0.6)	6/1048 (0.6)	+10.6
100–199	10	3/675 (0.4)	1/717 (0.1)	+68.6
200–499	17	17/4421 (0.4)	2/1986 (0.1)	+73.8
≥500	12	15/6235 (0.2)	3/3155 (0.1)	+60.5

Stratified by Hospital Volume

Total 5 yrs Hospital Volume	No. Hospitals	No. In-Hospital Deaths/No. Procedures (%) in 1999–2002	No. In-Hospital Deaths/No. Procedures (%) in 2003	% Change of In-Hospital Mortality Rate
≤99	60	5/851 (0.6)	5/591 (0.9)	−44.0
100–199	10	1/464 (0.2)	1/857 (0.1)	+46.0
200–499	9	8/1972 (0.4)	0/1226 (0.0)	+100.0
≥500	14	27/8981 (0.3)	6/4232 (0.1)	+53.0

Percent change calculated as the [($Rate_{99-02}$−$Rate_{03}$)/$Rate_{99-02}$]. A positive (+) change indicates decreasing rates whereas a negative (−) indicates increasing mortality rates.

credentialing guidelines. More recently, the Surgical Review Corporation (SRC)[7] Centers of Excellence Program has been touted as a mechanism for quality assurance in bariatric surgery.

Concomitantly, rigorously tested scientific data has established the safety, efficacy, long-term resolution of co-morbidities, and healthcare cost savings of bariatric surgery in single, as well as, multicenter series.[8–10] The validity of these data was affirmed by Medicare's MCAC committee in November 2004[2] and the recent National Coverage Determination policy approving access and coverage for bariatric surgery to all Medicare beneficiaries.[3] Despite this positive backdrop of self-monitoring, peer-review, and robust scientific evidence, insurance companies have restricted access of patients to bariatric surgery because of allegedly poor outcomes.

In undertaking this study, we aimed to report contemporary outcomes of gastric bypass in Florida and to assess the association of provider volume and these outcomes. This data which is the largest single study of patients who underwent bariatric surgery reaffirms the safety of bariatric surgery. In more than 19,000 patients who underwent bariatric surgery over 5 years, the overall in-hospital complication rate is 9.3% and the in-hospital mortality is 0.28%.

We used the AHCA mandatory-reported hospital discharge database because it is well maintained in Florida and is considered one of the best in the nation. These data encompass a wide variety of university and community-based providers as well as geographically and economically diverse communities. In addition, the process of data entry and reporting is free from physician and observer bias, thereby making this administrative database a powerful tool to analyze secular trends in utilization and outcomes studies. Nonetheless, this data set is limited to in-hospital events and does not capture data from subsequent events thereby limiting its use to determine 30-day mortality and long-term complications.

As expected, we observed a significant association between older age, male gender, prolonged DOS and in-hospital complications and mortality. The impact of age and male gender on surgical outcomes has been confirmed by other investigators in bariatric surgery and other surgical disciplines.[11–13]

To assess the relationship between provider volume and outcomes, we used multiple variable binary logistic regression analyses and stratified providers according to their yearly number of procedures as a surrogate of experience. As groups of providers were collapsed to facilitate statistical analysis, few trends emerged; providers with <5 procedures/y had the highest complication rates and in-hospital mortality, and those same providers represented 50% of all surgeons and 30% of hospitals in this study. Providers with a total volume of 100–199 procedures/5 y had the lowest in-hospital complications and mortality rates, suggesting that selection of low-risk patients may be a factor in securing favorable outcomes early on in the experience of these providers. Finally, the 53 deaths were not clustered in low-volume hospitals.

Because this study might have captured providers who are either in their early learning curve or "trying out" bariatric surgery, we proceeded to affirm the relationship of providers' volume to experience by determining whether patients who underwent gastric bypass in the later calendar years of the study had better outcomes. In both univariate and multivariate analysis, procedure calendar year (having surgery at the later years) had a protective effect and reduced the likelihood of complications and in-hospital mortality. We further confirmed these findings by estimating the change in death rates between the first 4 years and the last year of the study. We chose to compare the first 4 years with the last year of the study because procedure volume of low-volume surgeons and hospitals increased considerably beginning in 2002. Therefore, including 2002 in the first period gave us a more robust denominator for calculating mortality rates in both periods. Further analysis of additional years (2004 and 2005) will be needed to determine whether the trend towards reduction in complications in the later period of the study (2003) can be sustained.

The relationship of provider volume and outcomes has been characterized for many surgical procedures[14] and more recently for bariatric surgery. In the state of Pennsylvania,[15] risk-adjusted in-hospital morbidity and mortality decreased several folds with increasing surgeon or hospital procedure volume.

Similarly, in a study of 24,166 patients who underwent gastric bypass within the Health System Consortium of Academic Centers the observed mortality was significantly lower at high-volume (>100 procedures/y) compared with low-volume hospitals (0.3% versus 1.2%, respectively).[16] In a population-based study from the state of Washington an inverse relationship was found between surgeon's experience and 30-day mortality after gastric bypass.[4]

Intuitively, other risk factors such as age and a heavy burden of medical comorbidities may potentiate the increased risk associated with lower provider volume and experience.[5] In a study of 16,155 Medicare beneficiaries who underwent gastric bypass, the risk of early (30 days) and late death (1 year) was several fold higher for patients who are older than 65 years and whose surgeon has undertaken <15 procedures (early mortality: 9% versus 1.1%; late mortality: 2.1% versus 3.6%, low versus high volume). Nonetheless, a study that analyzed outcomes of 5876 gastric bypass procedures from the Nationwide Inpatient Sample Database found a significant difference in morbidity (14.2% versus 7.8%) between low- and high-volume centers in univariate but not in multivariate analysis.[12]

The impact of surgeon's experience on outcomes may be independent of hospital volume as outlined by a recent study[17] that demonstrated that the likelihood of complications is higher for low-volume surgeons whether they use a low- or high-volume hospital compared with high-volume surgeons. Our study confirms that there is a significant association between provider volume and adverse outcomes. The in-hospital complications and mortality rates observed in our study are similar to those reported by others[4,8,12,13,15,16] and, therefore, are representative of the nationwide cohort of bariatric surgery patients.

This study has several limitations. Although the administrative nature of this database minimizes observer and physician bias, patients are not risk-stratified and therefore the reported outcomes are not risk-adjusted. We minimized this shortcoming by accounting for interactions among known risk factors such as age and male gender and observed morbidity and mortality rates. Moreover, patient identifiers (including dates of birth and procedure) and clinical characteristics are censored in the AHCA database, thereby severely limiting our ability to obtain long-term mortality and morbidity data or events from subsequent hospitalizations. This data captures in-hospital events during the index admission for gastric bypass and therefore may underestimate overall mortality and morbidity.

Second, this study estimates a surgeon's experience based on reported caseload, but does not account for "experienced" surgeons who moved to Florida and were building a clinical practice during the study period. Therefore, we assessed the relationship of adverse outcomes and volume by dividing the study into 2 periods 1999–2002 and 2003 to minimize the effect of providers "dropping in" or "out" of bariatric surgery. Additional data from subsequent years (2004 and 2005) will be needed to determine whether the observed trends will be sustained.

Third, we used volume as a surrogate of quality because it is the only reproducible and currently available measure of quality. However, volume is only one attribute of the 3 pillars of quality: structure, process, and outcome.

Fourth, these data are representative of gastric bypass and may not be applicable to other bariatric procedures. Notwithstanding, these data on in-hospital outcomes of gastric bypass clearly define contemporary secular trends in utilization and outcomes. The inverse relationship between provider volume and outcomes is robust and has significant implications on establishing credentialing and practice guidelines.

In conclusion, gastric bypass in Florida is associated with overall favorable short-term and in-hospital outcomes. Older age and male gender were associated with increased in-hospital morbidity and mortality. Surgeon and Hospital procedure volume have an inverse relationship with in-hospital complications and mortality. Lessons learned from Florida have important implications nationwide.

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