



## Procedure incidence and in-hospital complication rates of bariatric surgery in the United States

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Manuscript received November 7, 2003; revised manuscript March 9, 2004

### Abstract

**Background:** Complication rates for bariatric surgery have been reported primarily from academic centers with specialized programs. The rates may not reflect those occurring in the community.

**Methods:** The National Hospital Discharge Survey (NHDS) database maintained by the Center for Disease Control (CDC) was queried to determine the national incidence and complication rate for bariatric surgery as performed in the United States.

**Results:** The number of bariatric procedures rapidly increased from 6,868 in 1996 to 45,473 in 2001, with most of the increase attributable to a very large rise in the annual number of Roux-en-Y gastric bypasses performed. The in-hospital complication rate was 9.6% and 8.6% of patients has a length of stay exceeding 7 days. Cholecystectomies were performed concurrently in 28% of cases and were not associated with increases in complication rates or longer hospital stays. For those undergoing surgery, the most common preoperative comorbid conditions were hypertension (34%), arthritis (27%), GERD (22%), sleep apnea (22%), and diabetes (18%).

**Conclusions:** The rate at which bariatric procedures are being performed is rapidly increasing, resulting in the need to establish practice standards. In-house complication rates derived from a cross section of US practices compare favorably with those reported from specialized centers. Based on these nationally representative data, the expected in-house clinically significant complication rate for bariatric operations is approximately 10%. As that is the average complication rate observed nationally, it serves as the benchmark to which bariatric surgery programs can compare themselves. © 2004 Excerpta Medica, Inc. All rights reserved.

*Keywords:* Gastric bypass; Vertical banded gastroplasty; Obesity; Complications; Length of stay; Cholecystectomy

The prevalence of obesity is increasing at an alarming rate [1–3]. Obesity causes diabetes, hypertension, hyperlipidemia, sleep apnea, and arthritis, resulting in reduced quality of life and life expectancy. For the very obese, medical therapy rarely results in sustained weight loss [4]. Long-term weight loss and risk reduction can only be achieved by antiobesity operations [5]. Although effective in treating obese patients, obesity operations were assumed to have high complication rates [6,7]. To resolve controversies regarding the surgical treatment of obesity, the National Institutes of Health convened a consensus panel in 1991 [8]. The panel recommended the vertical band gastroplasty of Roux-Y gastric bypass (RYGB) for person with a body mass index (BMI) exceeding 40 or those with a BMI greater

than 35 with severe, life-threatening, obesity-related disease. Since publication of their recommendations, anti-obesity operations have gained acceptance and are more frequently performed [9].

Because large patients have an inherently higher risk for surgical complications [6,7], many remain concerned about offering surgery for the obese. Several case series have shown that the morbidity and mortality for obesity operations is relatively low [10–14]. However, all these series have published results from centers and surgeons with specific expertise in performing obesity operations and, therefore, may not truly reflect the rate experienced in nonspecialized centers. Potentially, complication rates are higher in actual practice. For this reason we sought to determine the outcomes of obesity surgery as performed in the United States.

We used the National Hospital Discharge Survey (NHDS) to determine the nature and rate of complications

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Table 1  
National Hospital Discharge Survey (NHDS) results for obesity surgeries performed in the United States

Year	No. NHDS entries	Discharges represented	No. obesity operations	No./100,000 discharges	Mean LOS	Median LOS
1996	282,008	34,470,485	6,868	19.9	4.2	3
1997	300,484	34,704,006	9,119	26.3	4.4	4
1998	307,475	35,664,269	16,441	46.1	5.4	4
1999	300,460	35,858,135	17,834	49.7	5.2	4
2000	313,259	35,348,186	28,884	81.7	4.5	4
2001	330,210	36,311,258	45,473	125.2	4.6	3

The total number of NHDS database entries is relatively constant as are the total number of annual hospital discharges in the United States. There has been an exponential rise in the number of obesity operations performed as reflected in the total number and rate per 100,000 discharges.

LOS = length of stay.

occurring after obesity surgery. The NHDS collects hospital discharge information and is weighted against population census data to provide population representative information regarding disease rates that require hospitalization. The database was queried to determine how many obesity operations have been performed, what coexistent diseases were present in the population of patients undergoing these operations, and what complications occurred.

## Methods

The NHDS database was acquired from the Center for Disease Control (CDC) website (available at: <http://www.cdc.gov/nchs/about/major/hdasd/nhds.htm>) for the years 1996 to 2001. The NHDS field “weight” was used to provide national estimates for the numbers and socioeconomic characteristics of patients discharged. These weights were derived from census data by the NHDS and are population representative to provide estimates relevant to the total hospital activity in the United States. These estimates are not accurate if derived from fewer than 30 database entries. Therefore, weighted data were used for estimates of the total number of cases performed and some of the associated demographic information. Nonweighted data were used for analysis of individual complications rates when there were fewer than 30 database entries for the parameter measured. Cases encoded for diagnosis-related group (DRG) 288 (operating room procedures for obesity) were included for analysis. Two major categories of operations were found within DRG 288: gastric procedures for obesity treatment; and skin and soft tissue operations to remove excess skin and fat. We excluded the skin procedures (*International Classification of Diseases*, 9th revision, clinical modification [*ICD-9-CM*] 85.XX and 86.XX) and included operations coded as 44.XX or 45.XX under DRG 288 to obtain the operations performed for obesity treatment. Procedures were assumed to have been performed laparoscopically if in addition to the primary procedure code being a gastric case a secondary code was either 51.23 (laparoscopic cholecystectomy) or 54.21 (laparoscopy). Operations encoded with a primary procedure of 44.31 were considered to be RYGBs and those with 44.69, gastroplasties. Those with a primary

procedure code of 45.91 (small bowel anastomosis) with a secondary procedure code of 43.7X (partial gastrectomy with gastrojejunostomy) were considered to be biliopancreatic diversion operations. When the primary procedure code was 45.91 and the secondary procedure code was 43.6X (partial gastrectomy with duodenal anastomosis) or 43.89 (sleeve resection of the stomach) the procedures were assumed to be duodenal switches.

The number of cases associated with complications was determined from those have a diagnostic codes of 994.X (effects of other external causes), 995.X (certain adverse effects not elsewhere classified), 996.X (complications peculiar to certain specified procedures), 997.X (complications affecting specified body systems, not elsewhere classified), 998.X (other complications of procedures, NEC), 999.X (complications of medical care, not elsewhere classified). The typical length of stay (LOS) for obesity operations is 3 to 4 days. Lengths of stay more than 7 days are associated with complicated postoperative courses. We defined a prolonged length of stay (PLOS) as a length of stay greater than 7 days.

The contribution of risk factors to the development of complications was determined by logistic regression (SAS version 9; SAS Institute, Cary, North Carolina). Risk factors were identified, in part, using the Agency of Healthcare research and quality comorbidity software (available at: <http://www.ahrq.gov/data/hcup/comorbid.htm>). We also evaluated the impact incidental procedures had on complication rates. The factors assessed were age, sex, hospital size, laparoscopic case, concurrent lipectomy, concurrent cholecystectomy, valvular cardiac disease, paralysis, other neurologic disease, chronic obstructive pulmonary disease, depression, hypertension, hypothyroidism, renal failure, diabetes, and liver disease.

## Results

Table 1 summarizes the annual total number of hospital discharges and antiobesity operations performed in the United States. Each year approximately 300,000 hospital discharges are surveyed by the NHDS representative of 35,000,000 total discharges nationally. In 1996, 6,868 gas-

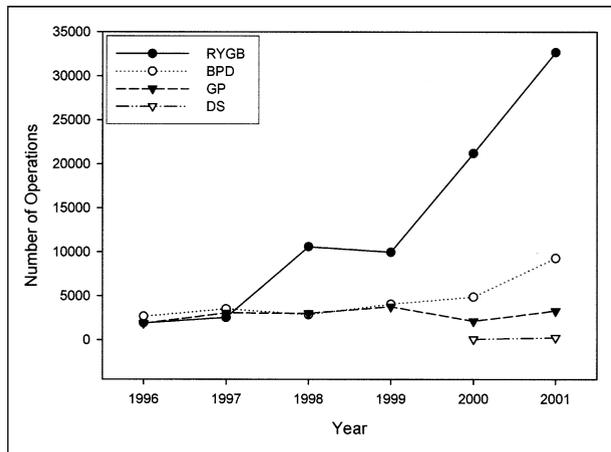


Fig. 1. Secular trends for bariatric surgery: the number of operations performed in the United States in the years 1996 to 2001. RYGP = Roux-en-Y gastric bypass; BPD = biliopancreatic diversion; GP = gastropasty; DS = duodenal switch.

tric procedures for obesity were performed, increasing almost sevenfold to 45,473 in 2001. Secular trends for the various bariatric operations are shown in Fig. 1. The growth of bariatric surgery is primarily due to an expansion in the number of RYGBs performed. Significant numbers of other types of operations were performed: in 2001, in addition to the 32,656 RYGBs there were 9,264 biliopancreatic diversion, 3,272 gastropasties, and 223 duodenal switch operations. These cases were performed in hospitals of all sizes: 14% in hospitals with fewer than 100 beds, 16% with 100 to 200 beds, 26% with 200 to 300 beds, 26% with 300 to 400 beds, and 16% in facilities with more than 500 beds. Patients ranged from 15 to 70 years of age, with 31 of 1,058 (2.9%) who were 60 to 70 years of age and 6 of 1058 (0.6%) who were 15 to 17 years old.

Between 1996 and 2001 there were 1,058 NHDS database entries for obesity operations. For analytical purposes these were treated as a cohort of 1,058 patients undergoing surgery. The frequency distribution for LOS after gastric surgery for obesity is demonstrated in Fig. 2. For the 1,058, 12.4% had a LOS of 2 days or less; 41.9% had a LOS of 3 days; 20.3%, 4 days; 16.8%, 5 to 6 days; and 8.6% (91 of 1,058 patients) had a stay of 7 days or more.

Table 2 demonstrates the 21 most frequent diagnoses that this cohort of patients had. The most common comorbid condition was hypertension occurring in nearly 34% of obese patients. Gastroesophageal reflux disease (GERD), arthritis, sleep apnea, diabetes, gallbladder disease, hernias, and pulmonary conditions were also frequently observed. Sixteen percent of patients undergoing weight loss surgery were men and 84% were women. The mean ( $\pm$ SD) age was  $40.2 \pm 9.8$  years. Ethnicity was not reported in 19% of cases and of the remainder, 84% were white and 13% black.

Table 3 demonstrates the most common procedures performed in addition to the gastric operation for obesity. Cholecystectomy was the most frequent followed by liver biopsy, hernia repair, gastrostomy placement, and adhesion-

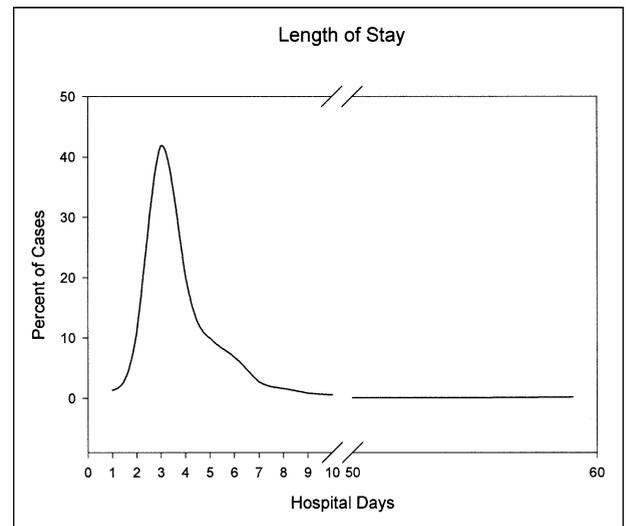


Fig. 2. Length of stay of the 1,058 cases assessed during the years 1996 to 2001. The typical length of stay is 3 to 4 days, with most patients being discharged by day 7.

olysis. Laparoscopy was reported in 4.6% of cases. Eleven patients (1.0%) underwent lipectomy concurrent with the gastric antiobesity operation. Of note, 1 of these patients had a prolonged hospital course because of postoperative hemorrhage causing hypotension and anemia.

Each database entry contained as many as seven diagnostic and four procedure codes. One hundred and one of the 1,058 (9.6%) patients had been encoded with ICD-9-CM diagnostic codes specific for treatment complications (994.X to 999.X). Of those, 56 had LOS of 2 to 6 days, and the remaining 45 (45%) had LOS ranging from 7 to 59 days.

Table 2

Diseases encoded in the National Hospital Discharge Survey database in addition to obesity for the 583 patients undergoing obesity surgery from 1996–2000

Diagnosis	Number	Percent
Hypertension	214	33.7
Gastroesophageal reflux disease	181	22.0
Osteoarthritis and arthritis	119	27.3
Sleep apnea	104	22.0
Diabetes	96	17.9
Cholecystitis	89	15.3
Abdominal wall hernia	79	13.6
Cholelithiasis	72	12.3
Asthma	49	8.4
Female urinary stress incontinence	45	7.7
Depression	43	7.4
Disorders of lipid metabolism	43	7.4
Dyspnea	39	6.7
Atelectasis and respiratory failure	37	6.3
Hypothyroidism	34	5.8
Chronic liver disease and cirrhosis	32	5.5
Peritoneal adhesions	21	3.6
Tobacco use disorder	16	2.7
Pneumonia	16	2.7
Congestive heart failure	13	2.2

Table 3  
Abdominal procedures performed concomitantly with gastric procedures for obesity

Procedure	Number	Percent
Cholecystectomy	271	25.6
Liver biopsy	106	18.2
Abdominal hernia repair	64	11.0
Gastrostomy	64	11.0
Lysis of adhesions	31	5.3
Laparoscopy	34	5.8

Table 4 lists the complications that were coded, the percentage of patients each occurred, and the LOS attributable to the complication. The most frequent complication was pneumonia, occurring in 2.6% of cases. Next most frequent was that classified as a 997.4 or complication of intestinal anastomosis or bypass. Four of the patients (0.4%) died postoperatively.

Linear logistic regression was used to determine the relationship between complication risk factors and their occurrence. The significant risk factors and odds ratios (with 95% confidence limits and *P* values) were as follows: male sex 1.76 (1.04 to 2.99, *P* = 0.04), and age 1.03 (1.01 to 1.05, *P* = 0.01). Patients with complications were older ( $42.5 \pm 1.2$  versus  $40.2 \pm 0.3$ , *P* = 0.03, *t* test) than patients without them. Of those with complications 23% were male compared with 15% male in the group without complications (*P* = 0.04, chi-square test). The concomitant performance of cholecystectomy did not result in greater complication rates: 21 of 289 complications (7.3%) in those undergoing incidental cholecystectomy compared with 80

of 769 (10.4%) for those who did not have this additional procedure (*P* = 12, chi-square test).

Most patients undergoing antiobesity operations were hospitalized for 3 days (40%). Another 22% were discharged by hospital day 4. Published series for gastric surgery demonstrate average LOS ranging from 3 to 4 days. The distribution of hospitalization days was non-Gaussian (Fig. 1). The Shapiro-Wilk test for normality revealed that the length of stay data did not follow a normal, Gaussian distribution (*P* < 0.01). Attempting to define abnormally long hospitalizations based on multiple standard deviations from the mean value would not be statistically valid in the face of a non-normally distributed data set. Thus, we assumed that because most patients are hospitalized for 3 to 4 days after antiobesity surgery and that 2 to 3 days extra of hospital care will account for most of the variation observed in managing patients with uncomplicated postoperative courses, that any hospitalization exceeding 7 days was associated with a complicated postoperative course. Ninety-one of the 1,058 (8.6%) had LOS exceeding 7 days, and of these 91, 45 (50%) had been encoded with complication-specific *ICD-9-CM* diagnostic codes.

## Comments

Obesity is increasing in the American population at an alarming rate [1–3]. Coincident with the increased prevalence has been greater acceptance for obesity surgery as a treatment for morbid obesity, a condition otherwise refractory to therapy. During the 6-year period we studied the rate at which gastric procedures for obesity were performed

Table 4  
Number and percentages of complications coded as *ICD-9-CM* 99.4X to 999.X

<i>ICD-9-CM</i> code	Description	Number	Percent	LOS (days)
996.5	Mechanical complication of other specified prosthetic device, implant, and graft	4	0.4	8.3 (5–17)
996.7	Other complications of internal (biological) (synthetic) prosthetic device, implant, and graft	8	0.8	10.5 (3–27)
997.1	Cardiorespiratory failure during or resulting from a procedure	10	0.9	12.9 (2–53)
997.3	Pneumonia (aspiration) resulting from a procedure	28	2.6	7.6 (3–35)
997.4	Complications of intestinal (internal) anastomosis and bypass, not elsewhere classified, except that involving urinary tract; hepatic failure specified as due to a procedure	24	2.3	15.0 (2–59)
997.5	Oliguria or anuria specified as due to procedure	7	0.7	11.3 (2–34)
998	Shock (endotoxic) (hypovolemic) (septic) during or resulting from a surgical procedure	3	0.3	30.7 (5–53)
998.11	Hemorrhage complicating a procedure	9	0.9	16.8 (3–59)
998.12	Hematoma complicating a procedure	1	0.1	14
998.2	Accidental puncture or laceration during procedure	12	1.1	5.9 (3–17)
998.3	Dehiscence of operation wound	1	0.1	11
998.4	Foreign body accidentally left during a procedure	1	0.1	3
998.59	Abscess: postoperative intraabdominal postoperative	10	0.9	22.8 (5–59)
998.6	Persistent postoperative fistula	1	0.1	4
998.8	Other specified complications of procedures, not elsewhere classified	7	0.7	6.6 (6–7)
999.2	Phlebitis after infusion, perfusion, or transfusion	1	0.1	3

All the complications listed in the patients undergoing gastric operation for obesity fell between *ICD-9-CM* 996.X and 999.X. The number refers to the number of times the complications was coded and appeared once per patient although patients could have multiple complication codes. LOS refers to the length of stay in days attributable to the complication. Values are given as the mean with the range of hospital days in parenthesis. The most common complication was that of aspiration pneumonia, affecting 2.7% of all patients.

*ICD-9-CM* = International Classification of Disease, 9<sup>th</sup> revision, clinical modification; LOS = length of stay.

increased sevenfold, from 19.9 to 125.2 procedures per 100,000 hospital discharges. In 2001 more than 45,000 operations were performed. With time there were more of every operation being performed but the major rate of increase was attributable to growth in the utilization of RYGB.

Two population-based assessments of bariatric surgery have been published. The Swedish registry reported an increasing trend in the performance of weight loss operations from the years 1987 to 1996. Most of the operations were gastroplasties, but toward the end of their observation period a greater number of gastric bypass procedures were performed [15]. In the United States a progressive rise in the number of operations was noted between the years 1990 and 1997 with an increasing fraction of the procedures being gastric bypass [9]. Our observations update these studies in that we have assessed these trends up to 2001. We have noted a sharp rise in the number of procedures performed after 1997, attributable mostly to a substantial increase in the number of RYGBs performed. We found that more than 45,000 bariatric procedures were performed in the United States in 2001. Given the increasing rate at which the operations are being performed, estimates from the American Society of Bariatric Surgeons that 100,000 procedures are being done annually seem reasonable.

Most series reporting the outcomes for antiobesity operations emanated from academic centers with highly specialized surgeons and treatment teams [6,7,10–14]. Given the complexity and high risk associated with obesity surgery, it is conceivable that results obtained from these specialized centers would not translate into community practice. Because the NHDS is obtained from discharge coding information obtained from a nationally representative sample of hospitals, it provides a cross-sectional estimation for treatment outcomes for medical care as actually practiced in the community. The fact that most of the operations reported in the database were from intermediate sized or small hospitals supports this observation. We found that the overall in-house complication rate was 9.6%, which compares favorably with reports from other tertiary referral centers.

Outcomes for bariatric surgery have dramatically improved in the past decade. In the 1980s hospital stays were 9 to 10 days compared with 3 to 4 days now. A typical series from the 1980s reported complications rates of 9% respiratory complications, 4% anastomotic leaks, and 6% of cases requiring reoperation [16], figures that are much lower now. Because our results represent national outcomes they can be used for establishing acceptable in-house complication rates. With the rapid expansion of bariatric programs new surgeons and hospitals will be performing these operations. As these programs become established, data from the NHDS can be used to assess outcomes for emerging bariatric programs to determine whether their in-house complication rates are within acceptable ranges.

A weakness of our conclusion is that the hospital discharges included in this analysis were only resulting from the admission associated with the primary obesity opera-

tion. A fraction of patients experiencing significant complications will have been discharged after an obesity operation then readmitted for treatment of the complication. Thus, we have potentially underestimated the true complication rate of antiobesity operations. Nevertheless, morbidity associated with obesity surgery as practiced in the United States appears to occur at acceptably low levels.

The most frequent complication was respiratory and, therefore, nonoperative and not necessarily specific to the obesity operations. Technical or procedure specific complications were relatively infrequent demonstrating that antiobesity operations are performed safely in community practices in the United States. Cholecystectomies are frequently performed in conjunction with antiobesity operations. Our data show that there is no extra morbidity is associated with incidental cholecystectomy. Respiratory complications are rarely described in reported series of bariatric procedures. However, like Pope et al [9], we found that these were the most frequently observed complications when an administrative database was surveyed. Why this should be the case cannot be determined from a database alone and warrants further investigation comparing community to specialized academic practices. In our experience, perioperative use of continuous positive air pressure eliminated postoperative pneumonias without increasing the rate of anastomotic complications [17].

The distribution of preoperative comorbid conditions for patients undergoing bariatric procedures has remained constant over the years. For those undergoing surgery, the most common preoperative comorbid conditions were hypertension (37%), GERD (31%), arthritis (20%), sleep apnea (17%), and diabetes (17%). This distribution is nearly identical to that reported in 1989 by Benotti [16], who found that hypertension was present in 36%, arthritis in 30%, and diabetes in 15% of patients undergoing weight loss surgery.

In conclusion, antiobesity operations are being performed at a rapidly increasing rate. Complication rates remain acceptably low, and national outcomes are similar to those reported from specialized centers.

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