

National Trends in Bariatric Surgery, 1996-2002

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Background: Surgical therapy for the long-term treatment of obesity (“bariatric surgery”) in individuals whose body mass index (calculated as weight in kilograms divided by the square of height in meters) is 40 or higher or in those who have significant obesity-related comorbidities and a body mass index of 35 or higher is one of few interventions shown to be effective. Many aspects of recent national bariatric surgery trends are unclear, including the ages of individuals undergoing such procedures and the economic burden borne by public vs private payers.

Hypothesis: Population-adjusted rates of bariatric surgery are rapidly increasing and have economic implications that differ for private vs public payers.

Design and Setting: We examined hospitalization and charge data from the Nationwide Inpatient Sample from 1996 through 2002, representative of national patterns for children and adults. We derived nationally weighted estimates of population-adjusted hospitalization rates and inflation-adjusted charges for bariatric surgery. We also examined the relative economic burden for public vs private payers for bariatric surgery discharges.

Results: Population-adjusted rates of bariatric surgery in

the overall sample increased more than 7-fold in the study period, from 3.5 per 100 000 US population in 1996 to 24.0 per 100 000 in 2002. During this period, among youth (<20 years old), rates increased from 0.23 per 100 000 to 0.73 per 100 000; and among elderly persons (>65 years old), rates increased from 0.30 per 100 000 to 1.69 per 100 000. The rate increased most dramatically among those aged 20 to 65 years, who composed 97% or more of bariatric surgery discharges annually. Increases in bariatric surgical volume corresponded with increasing economic consequences overall, exceeding \$2 billion in annual charges by 2002 (mean, \$29 107 per discharge). Since 2000, private payers have been charged for more than 80% of the national total; annual charges to Medicare and Medicaid have been comparatively modest, but each exceeded \$100 million by 2002.

Conclusions: National rates of bariatric surgery have increased markedly among children and adults, with attendant economic consequences, principally for private insurers. This trend may reflect the dearth of effective primary care and preventive interventions to address the obesity epidemic.

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IN THE FACE OF A GROWING NATIONAL epidemic of obesity in all age groups in the United States,^{1,2} surgical therapy is one of few obesity interventions shown to be effective in the long term.³⁻⁵ Bariatric surgery, for which individuals with extreme obesity (body mass index [BMI] [calculated as weight in kilograms divided by the square of height in meters] ≥ 40 or BMI ≥ 35 in the presence of significant comorbidities) are eligible, includes procedures such as gastric bypass, gastric banding, gastroplasty, and biliopancreatic diversion or duodenal switch. A recent meta-analysis³ including more than 22 000 patients concluded that bariatric surgery has led to significant reductions in BMI and excess weight and improvements in conditions such as type 2 diabetes mellitus, hyperlipidemia, hypertension, and sleep apnea.

Following the development of national guidelines for the use of bariatric surgery in 1991,⁶ rates of bariatric surgery dis-

charges from US hospitals for adults doubled through 1997,⁷ and continued to increase through 2003.⁸ However, key aspects of more recent national bariatric surgery trends are unclear, including the ages of individuals undergoing such procedures (considering that expert recommendations were recently issued regarding bariatric surgery in children⁹), the sex balance among patients, and the comparative economic implications of bariatric surgery trends for public vs private payers.

See Invited Critique at end of article

We analyzed a national database of inpatient discharge information that permitted examination of these critical aspects of bariatric surgery trends in the United States, in an effort to inform national deliberation about the use of bariatric surgery and implications for ongoing efforts to combat obesity.

Table 1. Characteristics of the Study Sample*

Characteristic	1996	1997	1998	1999	2000	2001	2002
Estimated No. of bariatric surgery discharges	9409	12 295	13 173	22 638	30 438	54 557	69 273
Female sex	84.2	83.4	81.5	82.0	85.3	84.2	84.6
Length of stay, mean, d	4.92	4.79	4.95	4.41	3.65	3.79	3.71
In-hospital deaths	†	†	0.9	0.5	0.5	0.3	0.2
Charge, 2002 US \$‡	21 647 (18 846-24 449)	20 480 (18 206-22 754)	24 849 (21 427-28 273)	25 988 (21 043-30 933)	24 741 (19 614-29 869)	26 662 (22 556-30 770)	29 107 (25 924-32 290)
Proportion of discharges by payer§							
Medicare	10.2	10.3	8.3	8.3	6.2	5.6	5.9
Medicaid	7.1	7.6	7.0	6.6	7.2	4.7	5.0
Private	75.9	68.2	75.9	75.5	80.7	82.6	83.1
Self-pay	3.7	7.4	5.2	6.5	3.6	3.3	3.4
Other	3.1	6.2	3.0	1.6	2.1	2.7	2.6

*Data are given as percentage of the sample at each year unless otherwise indicated.

†The unweighted mortality frequency was fewer than 70 cases in the data set, so an estimate could not be generated.

‡Data are given as mean (95% confidence interval).

§Weighted column percentages may not total 100 because of rounding.

METHODS

DATA SOURCE

The Nationwide Inpatient Sample (NIS) is a component of the Healthcare Cost and Utilization Project, a set of health care databases developed through partnership among federal and state governments and health care institutions, sponsored by the Agency for Healthcare Research and Quality.¹⁰ The NIS is based on hospital discharge abstracts and contains deidentified patient-level clinical and resource use data for patients with Medicare, Medicaid, and private insurance, and for the uninsured.

The data set is designed as a 20% sample of all US nonfederal hospital discharges each year, drawn from 900 to 1000 US hospitals, including public hospitals, children's hospitals, and academic medical centers, but excluding chemical dependency treatment facilities, long-term hospitals, and psychiatric hospitals. For sampling purposes, the universe of US hospitals is divided into strata using 5 hospital characteristics: census region, urban or rural location, ownership or control, bed size, and teaching status. The NIS is a stratified probability sample of hospitals in states that participate in the Healthcare Cost and Utilization Project, which permits the generation of discharge-level weights in the data set that allow inference of findings to the national level.¹⁰

We analyzed the most recent data available from the NIS database (1996 through 2002, annually) to examine trends in the use of bariatric surgery. To calculate hospitalization rates per 100 000 population, we used US census data^{11,12} to obtain population denominators for the overall US population and for specific age groups of interest: younger than 20 years, aged 20 to 65 years, and older than 65 years. To interpret the analyses of discharge-related hospital charges in constant dollars, we standardized all hospital charges to 2002 US dollars (to match the final year of available data) using the consumer price index.¹³

CASE IDENTIFICATION

Similar to previously published methods,⁷ we identified individuals who had undergone bariatric surgery based on a combination of the *International Classification of Diseases, Ninth Revision, Clinical Modification* and *Current Procedural Terminology* codes. Patients with an *International Classification of Diseases, Ninth Revision, Clinical Modification* code for obesity (278.xx)

and a procedure code for gastric bypass (44.31 or 44.39) or gastroplasty (44.69) were included; open and laparoscopic procedures were reflected in these codes.

VARIABLES

We characterized individuals undergoing bariatric surgery with respect to sex, age, documented comorbidities, and the characteristics of their hospitalization, including length of stay, mean hospital charge, expected primary payer, and in-hospital mortality. Age was determined at hospital admission. Payers included Medicare, Medicaid, private, and other (including self-pay).

ANALYSES

For each year in the study period, our primary study outcomes were the estimated number of bariatric surgery procedures performed in the United States overall and in specific age groups and the population-standardized estimated bariatric surgery frequencies overall and in specific age groups. We applied sampling weights provided by the NIS for each year of data to generate point estimates and 95% confidence intervals around economic estimates. Secondary study outcomes included the annual proportions of bariatric surgery procedures associated with each payer, the related economic burden of bariatric surgery for each payer (adjusted to 2002 US dollars), and the frequencies of common comorbidities.

We examined trends for each of the patient characteristics and hospitalization variables. The robustness of national estimates based on discharge weights in the NIS requires a minimum of 70 unweighted observations in each cell, a threshold that was attained for all analyses except in-hospital mortality in 1996 and 1997.

We conducted all analyses using SAS statistical software, version 8.2 (SAS Institute Inc, Cary, NC). Except for the sample description, all results are presented using weighted values.

RESULTS

SAMPLE CHARACTERISTICS

The annual national frequency of hospital discharges that included bariatric surgery increased 7-fold from 1996

through 2002 (**Table 1**). As the discharge frequency increased, the proportion of discharges for women remained consistently above 80%.

The mean length of stay for these discharges decreased by about 1 day during the study period, while the in-hospital mortality was less than 1% in all years for which an estimate could be reliably generated. Mean hospital charges (all in 2002 US dollars) per bariatric surgery discharge increased somewhat, although year-to-year differences were significant only for 1996 vs 2002.

Hypertension was the most commonly listed comorbidity for individuals who underwent bariatric surgery in the study period, appearing in 33% to 44% of cases overall depending on the year, without a longitudinal trend. Esophageal reflux (28%), sleep apnea (26%), diabetes mellitus (18%), depression (15%), and asthma (12%) (all percentages for 2002) were the other *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnoses listed most frequently during the study period. Prevalence rates of comorbidities were generally lower for adolescents and higher for elderly persons than for those aged 20 to 65 years (**Table 2**).

Table 2. Most Commonly Listed Comorbidities for Individuals Undergoing Bariatric Surgery in the United States, 2002

Age Group and Comorbidity	Individuals Affected, %*
<20 y	
Depression	17
Hypertension	14
Esophageal reflux	14
Sleep apnea	11
Chronic cholelithiasis	11
Asthma	8
20-65 y	
Hypertension	44
Esophageal reflux	28
Sleep apnea	26
Diabetes mellitus	19
Depression	15
Asthma	13
>65 y	
Hypertension	63
Diabetes mellitus	36
Sleep apnea	32
Esophageal reflux	22
Unspecified hyperlipidemia	18
Atrial fibrillation	15

*Data are given as the weighted proportion of all individuals in each age group.

POPULATION-ADJUSTED TRENDS

Population-adjusted frequencies of inpatient bariatric procedures in the overall sample increased steadily from 3.5 per 100 000 population in 1996 to 24.0 per 100 000 in 2002.

Among youth (aged <20 years), the rate increased from 0.23 per 100 000 in 1996 to 0.73 per 100 000 in 2002; and among elderly persons (aged >65 years), the rate increased from 0.30 per 100 000 in 1996 to 1.69 per 100 000 in 2002. The rate increased most dramatically among those aged 20 to 65 years, for whom the rate was 5.8 per 100 000 in 1996 and 37.0 per 100 000 in 2002.

INSURANCE COVERAGE AND ECONOMIC CONSEQUENCES

The proportion of all bariatric surgery discharges with private insurers as the expected payers increased somewhat from 1996 through 2002, while the proportions with Medicare and Medicaid as expected payers generally declined (Table 1).

The dramatic increase in overall volume of bariatric surgery discharges translated into steadily increasing economic consequences overall, exceeding \$2 billion annually in 2002. Increasing trends were evident for specific payers as well, as shown in **Table 3**, for Medicare, Medicaid, and private insurers. The mean total charge did not differ significantly among payer types (data not shown).

COMMENT

The population-adjusted annual frequency of bariatric surgery rapidly increased from 1996 through 2002, and consequently so did the annual national aggregate hospital charges for such procedures, which exceeded \$2 billion in 2002. Although the economic implications of bariatric surgery discharges have increased substantially for payers over time and exceeded \$100 million annually for Medicare and Medicaid in 2002, the share shouldered by private payers has gradually increased to more than 80% each year since 2000.

The broadening scope of the national epidemic of obesity, in which 2.9% of adults had extreme obesity (BMI, ≥ 40) from 1988 to 1994¹⁴ vs 4.9% from 1998 to 2002,² explains only part of the observed increase in the frequency of bariatric procedures. Other possible explanations include increasing rates of comorbidities among individuals with a BMI of 35 or more, increasing availability of bariatric surgery from more trained physicians at an increasing number of health care institutions, broad-

Table 3. Economic Trends in Bariatric Surgery Hospital Charges by Anticipated Payer in the United States, 1996-2002*

Selected Payer†	1996	1997	1998	1999	2000	2001	2002
Medicare	22.9 (17.2-28.6)	36.6 (29.7-43.6)	30.6 (25.9-35.4)	54.3 (44.0-64.6)	58.7 (49.1-68.4)	99.1 (81.2-120.0)	132.0 (117.0-147.0)
Medicaid	15.7 (8.7-22.7)	17.2 (14.4-19.9)	22.2 (18.0-26.3)	42.0 (33.7-50.4)	65.9 (52.3-79.4)	65.1 (53.4-76.8)	115.0 (79.6-150.0)
Private	152 (133-170)	167 (148-186)	246 (208-285)	444 (360-528)	589 (463-714)	1165 (979-1351)	1662 (1474-1850)
Overall	204 (177-230)	252 (224-280)	327 (282-372)	588 (476-700)	753 (597-909)	1454 (1231-1679)	2016 (1796-2237)

*Data are given as mean (95% confidence interval) of total charges, in millions of US dollars (2002).

†Other charges not shown include those specified in the data set as self-pay and other.

ened coverage for such procedures in private health plans, and expanding willingness among eligible patients to undergo the procedures as they become more common.

Private payers are shouldering an increasing share of the expenditures for bariatric surgical discharges over time. Our data indicate that this trend is not attributable to shifts in the age groups undergoing such procedures. Rather, this trend likely corresponds to broadening patterns of coverage for bariatric surgery among private payers. Bariatric surgery, which has a track record of therapeutic success compared with many other therapies for obesity,³⁻⁵ may be an increasingly attractive option for private insurance plans and employers that face rapidly increasing health care costs attributed to obesity and related comorbidities¹⁵ as rates of severe obesity increase over time.² For individuals who are obese but are not candidates for bariatric surgery, physicians and payers continue the challenging search for effective combinations of behavioral (diet and exercise) and pharmacotherapeutic options.¹⁶

The federal Centers for Medicare and Medicaid Services recently altered the consideration of obesity as a treatable illness,¹⁷ which likely portends future increases in the economic commitment to bariatric surgery from government plans. While only 9.8% of nonelderly adults (the predominant group undergoing bariatric surgery) are beneficiaries of either Medicaid or Medicare,¹⁸ 32.9% of persons aged 60 years or older are obese (BMI, ≥ 30) and 9.6% of persons in the same group are extremely obese (BMI, ≥ 40).² The latter group is eligible for bariatric surgery based on BMI criteria alone, and will soon be eligible for Medicare benefits based on age criteria if they are not enrolled already.

To our knowledge, this is the first study to also examine patterns of bariatric surgery discharges among youth. The increase in the population-adjusted bariatric surgery rate for children and adolescents reported herein preceded the publication of expert recommendations in 2004 regarding such procedures.⁹ While questions of age appropriateness, proper consent, and long-term postoperative management await broader national consensus, it seems that a combination of patients' circumstances and surgeons' willingness to perform such procedures in this age group are driving the longitudinal trends we observed. The same may be said of bariatric surgery trends among elderly persons.

Our findings may be limited by the potential misattribution or inadvertent exclusion of *International Classification of Diseases, Ninth Revision, Clinical Modification* codes or procedural codes pertinent to the study. This may be particularly the case for codes pertinent to obesity, given the popular perception that payers will not reimburse for that diagnosis. Nevertheless, the population-adjusted rate and the female-predominant sex ratio we found match well with a previously published analysis⁷ of national bariatric surgical data.

Another potential limitation is that the NIS does not permit identification of hospital discharges for persons who need to undergo a subsequent operation vs an initial operation. To the extent that such readmissions occur, the rates we report will overestimate the rate of initial procedures. Studies of readmission would best be performed with direct access to medical records or with

payer claims analyses, but such analyses are unlikely to provide a national perspective.

In conclusion, as the national obesity epidemic persists, and particularly if it worsens to affect not only more individuals but involve more extremely obese individuals, we expect that weight management programs and the payers who finance them will continue to look to bariatric surgery as a viable option with an acceptably low in-hospital mortality rate, even with multiple comorbidities. Recent trends indicate a rapidly increasing fiscal commitment on the part of private and public payers to bariatric surgical procedures, which in turn reflects the need for more effective primary care and preventive interventions to combat obesity before surgical remedies are warranted.

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