Incidence of bariatric surgery and postoperative outcomes: a population-based analysis in Western Australia

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ABSTRACT

Objective: To investigate the incidence of bariatric surgery and postoperative outcomes in a population-based cohort of patients in Western Australia over a 17-year period.

Design and setting: A population-based incidence study of all bariatric procedures ($n = 1403$) performed in WA hospitals over the period 1988–2004, based on hospital morbidity and death data from the WA Data Linkage System.

Main outcome measures: Changes in incidence of bariatric procedures over time; mortality and complications within 30 days after surgery; survival rates after surgery relative to age-, sex-, and period-matched survival rates in the general population; factors predictive of re-admission to hospital.

Results: The incidence of bariatric surgery increased from 1.2 procedures per 100 000 person-years in 1988 to 24.2 procedures per 100 000 person-years in 2004. Although some of this was ascribed to a rising prevalence of obesity generally, there was a 13-fold increase in the bariatric procedure rate within the obese population itself. At 5 years, the relative survival rate in bariatric patients was the same as the survival rate in the general population. Within the 30-day postoperative period, mortality was low (0.07%) and 9.6% of patients experienced complications. Those who had bypass-type procedures were more likely to be re-admitted within 30 days than those who had gastric reduction procedures (adjusted hazard ratio, 5.80 [95% CI, 3.42–9.84]).

Conclusion: The use of bariatric surgery increased 20-fold over the study period. Relative survival after surgery was in line with population norms. The observed low mortality rates and moderate level of complications are similar to findings in other studies in which the proportion of reduction procedures has been high.

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The mounting prevalence of obesity is a pervasive public health concern. In 2001, an estimated 15.5% of Australian men and 16.9% of Australian women were obese.[1] Increasing numbers of obese Australians are turning to bariatric surgery as a long-term treatment option.[2] Eligibility criteria for bariatric surgery centre around body mass index (BMI) measurements, with surgery indicated for patients with a BMI $> 40\,kg/m^2$ (or $> 35\,kg/m^2$ if serious comorbidities are present).

Australian Health Insurance Commission data point to a steady increase in the number of bariatric procedures, from 399 in 1993 to 2992 in 2003.[3] Adopted in the early 1990s, laparoscopic adjustable gastric banding (LAGB) is the bariatric procedure of choice in over 90% of cases in Australia. It involves reducing the amount of food that the stomach can hold, thus causing a feeling of fullness. Gastric bypass, the second most common procedure in Australia, is used in most other cases.[4] Several studies, including two systematic reviews, have found that mortality after reduction procedures is lower than after bypass or combination procedures,[5-7] and that overall morbidity is lower after LAGB procedures than after other bariatric procedures.[5] In Australia, isolated case series have shown that bariatric procedures can be safe and effective,[1] but to date there has been no population-based study to examine the use of bariatric surgery and postoperative outcomes. We present here the results of a retrospective statewide study carried out in Western Australia.

METHODS

Our study was based on data from the WA Data Linkage System, details of which are reported elsewhere.[8] Population-based de-identified hospital inpatient and death data from 1988 to 2004 were extracted from the Data Linkage System and used to examine the incidence of bariatric surgery and postoperative outcomes in the WA population.

Case definition

Data were requested for any patient assigned one of the following International classification of diseases (ICD) procedure codes:

- For the period July 1999 onwards: 30511-00, 30511-01, 30512-00–30512-02 (ICD-10-AM [ICD, 10th revision, Australian Modification]);
- For the period January 1988 to June 1999: 44.31, 44.39, 44.69 (ICD-9-CM [ICD, 9th revision, Clinical Modification]);

Prior to July 1999 (ie, the ICD-9-CM era), bariatric procedure codes were less specific and we required an accompanying obesity diagnosis with codes 278.00–278.1 (ICD-9-CM) or a diagnosis-related group code of 524 for obesity surgery to meet the case definition.

Cases were excluded if:

- the linked records indicated that there had been a diagnosis of cancer or gastrointestinal disease, such as peptic ulcer;
- the index procedure was performed during an emergency admission; or
- a code for revisional bariatric surgery accompanied the index procedure.

In this way, 89 initially eligible procedures were excluded, leaving 1403 bariatric surgery cases in which there was a high likelihood that the surgery was performed for obesity.

Statistical analysis

Age-standardised procedure rates (weighted according to the 2001 Australian population distribution) were calculated using stratified counts (by age, sex or procedure type) of procedures and population denominators from the Australian Bureau of Statistics. Using the estimated population of *obese* Australians in the denominator, rather than the total population, gave a more accurate assessment of trends in bariatric surgery rates over the period of our study. Obesity prevalence estimates from the Australian Institute of Health and Welfare's national health surveys of 1989–90,[9] 1995[10] and 2001[1] were used to interpolate annual prevalence estimates. The incidence rate in the obese population (IR_o) was derived from the formula $IR_o = IR_t/P_t$ where IR_t = incidence rate

1 Annual age-standardised* incidence rates of bariatric surgery in the general population, 1988–2004

* Rates standardised to the 2001 Australian population. ◆

in the total population and P_t = prevalence of obesity in the total population.

Demographic characteristics examined at the time of index surgery were age, sex, Indigenous status, payment classification (private/public, insured/uninsured), social disadvantage, and comorbidity. The Dartmouth–Manitoba version of the Charlson Comorbidity Index[11] was used to generate 17 comorbidity variables. Ischaemic heart disease, cardiac dysrhythmias and hypertensive disease were added to the list of comorbid conditions based on our experience in other surgical research.[12]

Social disadvantage at the time of index surgery was measured using the Australian Bureau of Statistics' Socio-Economic Indexes for Areas (SEIFA) classification.[13] One of the SEIFA indexes, the Index of Relative Socio-Economic Disadvantage (derived from income and education measures), was used to assign an indicator of socioeconomic disadvantage based on census collectors' districts supplied by the WA Data Linkage System. SEIFA analyses were restricted to admissions from 1991 onwards, the earliest year that collectors' districts were available for mapping residential addresses.

The date of hospital admission for the index procedure was taken as the date of surgery. Cumulative mortality at 5 years and re-admission within 30 days and within 1 year were calculated using actuarial methods. Thirty-day re-admission hazard ratios were derived using Cox proportional hazards regression, which modelled confounding and interactive effects of a number of covariates. A broad schema of ICD codes identified by Santry et al[14] formed the basis for identifying complications during the index admission or a re-admission within 30 days of the index separation. Only the first record of each particular complication was counted.

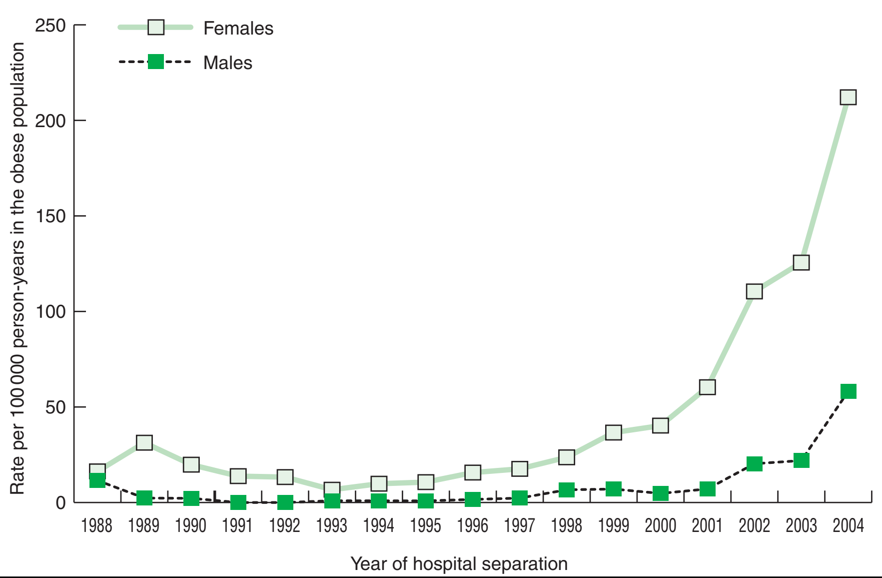
Relative survival at 1 year, 5 years and 10 years after surgery was estimated using a program originally developed by the Mayo Clinic[15] and modified to incorporate age, sex and period-specific mortality rates in the WA general population. The method expressed survival in bariatric surgery patients relative to that expected in a reference population (based on WA life tables) matched to the surgical patients by age, sex and calendar year.

RESULTS

The age-standardised procedure rate of first-time bariatric surgery increased from 1.2 to 24.2 procedures per 100 000 person-years (Box 1). In 2004, the rate was much higher in females than males (38.6 v 9.9 procedures per 100 000 person-years).

We estimated that during the study period the prevalence of obesity in the population rose from about 7.8% to 17.0% in males and from 8.6% to 18.2% in females. A replotting of procedure rates over time, using estimated numbers of obese people in the denominators, is shown in Box 2. In 1988, the incidence rate of bariatric surgery in the estimated obese population was 16.3 procedures per 100 000 person-years in women and 11.5 per 100 000 person-years in men, rising to a high of 212.1 and 58.2 procedures per 100 000 person-years in women and men, respectively, in 2004.

2 Annual age-standardised* incidence rates of bariatric surgery in the obese population, 1988–2004



* Rates standardised to the 2001 Australian population. ◆

3 Demographic characteristics of patients undergoing bariatric surgery, 1988–2004 ($n = 1403$)

	1988–1989	1990–1994	1995–1999	2000–2004
Number of index procedures	43	63	164	1133
Procedure type (%)				
Gastric reduction	100%	95.2%	98.8%	96.7%
Gastric bypass	0	4.8%	1.2%	3.3%
Mean age (years) (SD)	36.9 (8.7)	37.1 (9.5)	38.5 (9.1)	42.3 (10.2)
Age group (years) (%)				
< 18	0	1.6%	0	0.4%
18–34	37.2%	36.5%	35.4%	22.9%
35–49	55.8%	50.8%	52.4%	50.0%
50–64	7.0%	9.5%	11.0%	25.9%
> 64	0	1.6%	1.2%	1.0%
Proportion of female patients ($n = 1180$)	81.4%	93.7%	85.4%	83.5%
Proportion of Indigenous patients ($n = 9$)	0	0	0.6%	0.7%
Median length of stay (days)	7	7	4	2
Proportion of patients with comorbidities*				
0	na	90.5%	95.1%	84.3%
1	na	9.5%	4.9%	8.0%
⩾ 2	na	0	0	7.7%
Socioeconomic disadvantage quintile (%)†			($n = 144$)‡	($n = 1004$)‡
Extreme disadvantage	na	na	21.5%	18.4%
High disadvantage	na	na	23.6%	20.9%
Moderate disadvantage	na	na	19.4%	17.9%
Less disadvantage	na	na	18.1%	22.4%
Least disadvantage	na	na	17.4%	20.3%
Payment classification (%)				
Private, insured	79.1%	61.9%	73.8%	84.4%
Private, uninsured	18.6%	9.5%	18.3%	5.6%
Public	2.3%	28.6%	7.9%	9.4%
Other	0	0	0	0.6
Hospital type (%)				
Public	7.0%	34.9%	9.8%	8.6%
Private	93.0%	65.1%	90.2%	91.4%

na = not applicable. * Comorbidity data were unavailable for 1988–1989. † Based on the Socio-Economic Indexes for Areas (SEIFA) classification.[13] SEIFA analyses were restricted to admissions from 1991 onwards, the earliest year that collectors' districts were available for mapping residential addresses. ‡ Missing collectors' district values in the dataset precluded the calculation of socioeconomic disadvantage in the two time periods for 12% and 11% of the sample, respectively. ◆

Characteristics of the 1403 patients who underwent bariatric surgery are summarised in Box 3. Females accounted for 84.1% of all hospital separations over the period of the study. Nine procedures (0.6%) were performed on Indigenous patients. The mean age of patients having surgery increased steadily from 36.9 years in 1988–1989 to 42.3 years in 2000–2004 ($P < 0.001$). Length of hospital stay ranged from 1 to 136 days, with the median length of stay decreasing from 7 days in 1988–1989 to 2 days in 2000–2004. Of patients undergoing bypass-type procedures, 28.6% had at least one comorbid condition, compared with 13.3% of patients undergoing reduction procedures ($P = 0.005$).

Short-term (30-day) mortality in the cohort was 0.07%, representing one death that occurred during the index admission. Cumulative mortality at 5 years for all bariatric procedures was 1.0% (1.0% in patients having gastric reduction and 5.0% in patients having bypass-type surgery).

The 1-year relative survival rate after surgery was high, at 99.7% (95% CI, 99.3%–100.1%). At 5 years, no difference in survival was observed between patients who had had bariatric surgery and people in the general population (100.1% [95% CI, 99.5%–100.8%]). At 10 years, the relative survival was only slightly lower than general population norms (98.3% [95% CI, 95.6%–100.1%]).

A total of 223 complications occurred during the index admission or the 30-day postoperative period (Box 4). The most common complications were wound infections and wound dehiscence. Patients having bypass-type surgery were far more likely than patients having reduction surgery to experience a complication in the 30-day postoperative period (52.4% v 8.3%; $P < 0.001$).

At 30 days, the cumulative incidence of re-admission was 8.0%. Patients undergoing bypass-type procedures were more likely to be re-admitted than patients having reduction procedures (49.0% v 7.0%). Based on Cox regression analysis, before adjustment for other factors, patients undergoing bypass-type procedures had nearly nine times the rate of re-admission compared with those having reduction procedures (hazard ratio [HR], 8.60 [95% CI, 5.31–13.93]). After adjustment for covariates (Box 5), the HR remained elevated (adjusted HR, 5.80 [95% CI, 3.42–9.84]).

DISCUSSION

Over the period 1988–2004, use of bariatric surgery in WA increased 20-fold in the general population and 13-fold in the obese population. There was little evidence of differential survival outcomes between surgical patients and the general population. Gastric reduction was the most common bariatric procedure performed in WA. We found that reduction procedures were associated with lower mortality, less morbidity and shorter hospital stays than bypass-type procedures.

Our study was limited by the coding conventions applicable to administrative data. We categorised procedures as either reduction or bypass-type in accordance with a broad ICD coding schema that limited any finer specification. By necessity, additional criteria were applied to the case definition for the time period 1988–1999, which may have led to some under-enumeration of procedures. Without information on the degree of obesity in each patient, we were unable to adjust for severity of the condition, and our results must be considered in light of this. It is likely that our study, which

4 Complications occurring during the index admission or 30-day postoperative period

	Frequency	Proportion of patients*
Technical complication		
Additional procedures for complications	7	0.5%
Splenic	8	0.6%
Haemorrhagic	26	1.9%
Anastomotic	13	0.9%
Wound	36	2.6%
Obstruction	8	0.6%
Puncture/laceration during procedure	17	1.2%
Mechanical complications of an IPD	25	1.8%
Incisional hernia	11	0.8%
Systemic complication		
Pulmonary	28	2.0%
Cardiac	3	0.2%
Genitourinary	7	0.5%
Thromboembolic	8	0.6%
Digestive system	22	1.6%
Shock	4	0.3%
Total patients with at least one complication	*135*	*9.6%*

IPD = implanted prosthetic device. * Expressed as a percentage of the total number of index patients (n = 1403). ◆

was based on data from the WA Data Linkage System, underestimated levels of comorbidity and complications: in a separate validation study, we found that identifying comorbidity from WA administrative health data was about as effective as ascertainment by surveying general practitioners, but that both methods were less sensitive than direct review of hospital charts.[16]

In the 10 years to 2000, the rate of bariatric surgery (in procedures per 100 000 person-years) in the United States exceeded levels we observed for the same period in our study. However, during the period 2000–2004, WA saw a sixfold increase in bariatric procedure rates to reach levels higher than those reported in the US.[17] Our adjusted rates, using the obese population as the denominator, indicated that only a minor fraction of rising procedure rates could be ascribed to a higher prevalence of obesity. Rather, the factors likely to be driving the increase have been publicity about bariatric procedures, greater acceptability of LAGB relative to prior surgical options, and the growing number of practising surgeons.

Procedure rates were highest among non-Indigenous female patients, which concurs with previous studies.[18,19] However, contrary to other reports,[2,20] access to surgery in our study was similar across socioeconomic groups, despite over 80% of payments for surgery coming from private health insurance. In the past, possessing private health insurance has been an indicator of relatively high socioeconomic status, but current evidence suggests that recent federal policies aimed at improving the affordability of private health insurance may have increased its uptake in middle to lower income earners.[21]

The low 30-day postoperative mortality rate (0.07%) observed in our study is consistent with other estimates from populations in which gastric banding procedures predominate.[5,7] The cumulative 30-day re-admission incidence in our study (8.0%) is lower than the 11.4% reported in a US study,[22] which may reflect the predominance of bypass and stapling procedures in the US. Compared with our study, Encinosa et al,[23] in a US population-based study, found lower re-admission rates for postoperative conditions (6.5%) and complications (4.8%). However, re-admissions in their study were for selected complications in younger non-Medicaid patients. In our study, technical or systemic complications occurred in 9.6% of patients during the 30-day postoperative period, which is lower than rates reported in other studies. For example, in a US clinical series,[24] complications occurred in 19% of patients having lap-band procedures (a result that may have been related to the early learning curve experience encompassed by that study). Even with inclusion of all complications (whether arising during index surgery or within 30 days postoperatively), the risk of complications in our study remained lower than in other population-based analyses in which bypass procedures predominated.[14,22,23,25]

Our results indicate that bariatric surgery is a safe procedure, with excellent prospects of survival. Given that obesity is associated with increased mortality,[26,27] it is encouraging that postoperative survival rates in our cohort were in line with survival rates in the general population. It seems that Australia has adopted a treatment modality that poses low short-term risk in an otherwise high-risk population. Candidates for bariatric surgery should continue to be carefully selected

5 Risk of re-admission within 30 days, by patient and procedural characteristics

Variable	Crude re-admission HR	Adjusted re-admission HR*
Procedure type (reduction†/bypass)	8.60 (5.31–13.93)	5.80 (3.42–9.84)
Complication at index admission (no†/yes)	4.27 (2.74–6.64)	2.51 (1.49–4.23)
Year of separation‡	0.97 (0.93–1.02)	0.98 (0.94–1.03)
Number of comorbidities		
0	1.00	1.00
1	1.21 (0.63–2.31)	1.13 (0.58–2.19)
⩾2	1.85 (1.01–3.37)	1.30 (0.66–2.57)
Age (years)‡	1.00 (0.99–1.02)	0.99 (0.98–1.02)
Sex (male†/female)	1.11 (0.67–1.86)	1.32 (0.77–2.25)
Length of stay (index admission)‡	1.03 (1.02–1.03)	1.01 (1.00–1.03)

HR = hazard ratio. * HR adjusted for all other variables in table. † Reference category. ‡ Continuous variable. ◆

and counselled on the potential and inherent risks posed by this type of surgery.

In an increasingly obesogenic environment, demand for bariatric procedures will continue. The job for public health professionals is to persist in the work of preventing obesity. Clinicians have an equally important responsibility to ensure that clinical research is translated into evidence-based practice guidelines. Policymakers have a responsibility to facilitate equitable access to safe weight-loss procedures for those who need them.

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COMPETING INTERESTS

None identified.

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