Costs of bariatric surgery in a randomised control trial (RCT) comparing Roux en Y gastric bypass vs sleeve gastrectomy in morbidly obese diabetic patients

Siva T Gounder, Delendra Wijayanayaka, Rinki Murphy,Delwyn Armstrong, Richard Cutfield, David D Kim, Michael G Clarke, Nicholas J Evennett, Martin L Humphreys, Steven J Robinson, Michael WC Booth

ABSTRACT

AIM: To provide a longitudinal analysis of the direct healthcare costs of providing laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery service in the context of a randomised control trial (RCT) of obese patients with type 2 diabetes in Waitemata District Health Board, Auckland, New Zealand.

METHODS: The Waitemata District Health Board costing system was used to calculate costs in New Zealand Dollars (NZD) associated with all pre- and post-operative hospital clinic visits, peri-operative care, hospitalisations and medication costs up to one year after bariatric surgery. Healthcare costs of medications, laboratory investigations and hospital clinic visits for one year prior to enrolment into the RCT were also calculated.

RESULTS: One hundred and fourteen patients were randomised to undergo laparoscopic sleeve gastrectomy (LSG, n=58) or laparoscopic Roux en Y gastric bypass (LRYGB, n=56). Total costs one year pre-enrolment was $203,926 for all patients (mean $1,789 per patient). Total cost of surgery was $1,208,005 (mean $9,131 per LSG patient and mean $12,456 per LRYGB patient). Total cost one year post-operatively was $542,656 (mean $4,760 per patient). The total medication cost reduced from $118,993.72 (mean $1,044 per patient) to $31,304.93 (mean $274.60 per patient), p<0.005. The largest cost reduction was seen with annual diabetic medications reducing from $110,115.78 (mean $965.93 per patient) to $7,237.85 (mean $63.48 per patient), p<0.005.

CONCLUSIONS: Among patients with type 2 diabetes and morbid obesity undergoing LSG and LRYGB, health service costs were greater in the year after surgery than in the year before, although prescription costs were lower post-operatively. There was no significant difference in reduction in prescription cost by surgical procedure at 12 months. However, the LRYGB surgery was more expensive than LSG, primarily because of the longer operative time required.

The obesity has been classified as a disease by WHO. According to 2012 data, 40% of adolescents in New Zealand were either overweight or obese and this rate was third highest among OECD (Organisation for Economic Cooperation and Development) countries. Obesity increases the risk of metabolic comorbidities such as diabetes mellitus, obstructive sleep apnoea, hypertension, hyperlipidaemia, gout and malignancy with anticipated negative impact on quality of life and life expectancy.

Lifestyle interventions for obesity has been shown to be unsustainable in the longer term and therefore have limited role in long term management of hyperglycaemia in type 2 diabetes. Pharmacologic therapy for obesity is similarly limited by
longer-term efficacy and has issues with cost and availability particularly in the New Zealand setting. On the other hand, bariatric surgery has been shown to result in substantial weight loss that is maintained long term, and to provide up to 95% resolution of type 2 diabetes in morbidly obese patients.\textsuperscript{5,6} There are also significant improvements in other diseases such as hypertension, obstructive sleep apnoea and hyperlipidemia. Studies have also shown improved survival and quality of life after bariatric surgery.\textsuperscript{5-9}

Medication costs of patients before and after surgery have been shown to decrease for most obesity related diseases.\textsuperscript{10,11} Some patients come off medication completely. There is however an additional cost associated with recommended vitamins and other supplements to be taken long term.

Bariatric surgery has been shown to be relatively safe with less than 5% major complications and less than 0.5% mortality rate.\textsuperscript{12} This makes it comparable to the risk profile of a cholecystectomy when performed by experienced surgeons.\textsuperscript{13-15} Various surgery types are available and are catered to patient suitability and local expertise. Laparoscopic adjustable gastric banding is reducing in frequency because of high failure rates, increased long-term complications and inferior weight-loss compared to stapling procedures such as LSG and LRYGB. LSG is increasingly being performed worldwide.\textsuperscript{16} LRYGB is sometimes referred to as the gold standard bariatric operation\textsuperscript{17,18} and has been performed for the past few decades with consistent results.

The comparative costs of these surgery types LSG and LRYGB have not been studied in New Zealand.

### Method

This study looks at the costs of providing bariatric surgery at North Shore Hospital, Waitemata District Health Board, Auckland. This is in the context of a randomised controlled trial comparing LSG and LRYGB for the treatment of type 2 diabetes and obesity. Enrolment into the study concluded in October 2014 with 114 patients. Costs were calculated by the Waitemata District Health Board costing system and drug costs were estimated from Monthly Index of Medical Specialties (MIMS).

The costs incurred were collected and divided into the year prior to enrolment to the bariatric surgery program and one year after surgery. Every patient encounter with the Health Board was calculated using the in-house costing system which follows national costing standards. Costs were divided into bariatric surgery costs and all other department costs. This included outpatient (Figure 1) as well as inpatient costs (Figure 2). The bariatric surgery costs included every encounter with the bariatric service including consultant, dietitian, nurse specialist visits and all investigations ordered. Diabetes physician costs were included in “Other” costs.

Post-operative costs included all visits to the hospital and any subsequent related inpatient stays. This included bariatric surgery unit costs as well as any other clinical care in hospital. Treatment costs for complications were included. Post-operative clinical follow-up was standardised to one week, six weeks, three monthly to 12 months, 18 months, two years then annually until five years. Patients saw diabetes physicians annually. A standard protocol for metabolic medication adjustment was used after bariatric surgery to optimise management of metabolic comorbidities.

Non-attendance at clinic has no cost assigned although there is an undoubted lost opportunity cost together with an overhead of clerical, nursing and medical time. However, these costs are distributed across all actual bariatric surgery attendances. As the non-attendance rate for bariatric surgery is similar to that of all general surgical outpatient attendances, the non-attendance cost distribution is fair.

Medications used in the year post-surgery were recorded from prospective data collection and viewing prescriptions through the clinical information portal Concerto. Costs of each medication were obtained from MIMS to calculate the total medication cost per year for each patient.
Results

There were 114 patients including 59 females. The mean BMI was 43kg/m2 and mean age was 46 years. Fifty-eight patients underwent laparoscopic sleeve gastrectomy (LSG) and 56 laparoscopic Roux en Y Gastric Bypass (LRYGB) (Table 1).

The total cost of bariatric surgery admission for all patients was $1,208,005. The pre-operative and post-operative bariatric surgery costs were $142,445 and $353,986 respectively (Figures 1–3).

The mean operation costs for LSG and LRYGB were $9,131 and $12,456 respectively. The costs were increased with

<table>
<thead>
<tr>
<th>Table 1: Patient characteristics.</th>
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<tr>
<td><strong>Baseline characteristics of patients</strong></td>
</tr>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>Age – yr</td>
</tr>
<tr>
<td>Female sex – no. (%)</td>
</tr>
<tr>
<td>Ethnicity – no. (%)</td>
</tr>
<tr>
<td>NZ European</td>
</tr>
<tr>
<td>Maori</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Duration of diabetes – no. (%)</td>
</tr>
<tr>
<td>&lt;5 years</td>
</tr>
<tr>
<td>5–10 years</td>
</tr>
<tr>
<td>&gt;10 years</td>
</tr>
<tr>
<td>Use of insulin – no. (%)</td>
</tr>
<tr>
<td>Body weight – kg</td>
</tr>
<tr>
<td>Body mass index (kg/m2) – no. (%)</td>
</tr>
<tr>
<td>35–44.9</td>
</tr>
<tr>
<td>45–54.9</td>
</tr>
<tr>
<td>55–65</td>
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<tr>
<td>Waist circumference - cm</td>
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</tbody>
</table>

Figure 1: Outpatient costing basis.

<table>
<thead>
<tr>
<th>Cost group</th>
<th>Mean unit cost in sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist first consult</td>
<td>Gen Surg consultant per First Specialist Assessment: $220</td>
</tr>
<tr>
<td>Specialist follow-up consult</td>
<td>Gen Surg consultant per follow-up: $134</td>
</tr>
<tr>
<td>Clinical nurse specialist visit</td>
<td>Cost per visit: $121</td>
</tr>
<tr>
<td>Dietitian clinic visit</td>
<td>Cost per visit: $48</td>
</tr>
</tbody>
</table>
Figure 2: Perioperative costing basis.

<table>
<thead>
<tr>
<th>Cost group</th>
<th>Cost allocation basis</th>
<th>Unit cost in sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeon</td>
<td>Total surgeon cost split between theatre, inpatient days and outpatient events, then allocated between theatre events based on minutes in theatre</td>
<td>Surgeon per minute: $10.25</td>
</tr>
<tr>
<td>Anaesthetist</td>
<td>Total anaesthetist cost first split between theatre and pre-admit clinic events, then allocated between theatre events based on minutes in theatre</td>
<td>Anaesthetist per minute: $11.10</td>
</tr>
<tr>
<td>Theatre</td>
<td>Includes nursing, anaesthetic technicians, implant and theatre consumable costs, then allocated between theatre events based on minutes in theatre</td>
<td>Theatre per minute: $19.79</td>
</tr>
<tr>
<td>Ward doctor</td>
<td>Total general surgery doctor cost first split between theatre, inpatient days and outpatient events, then allocated to inpatient bed days evenly</td>
<td>Per bed day doctor cost: $166</td>
</tr>
<tr>
<td>Ward</td>
<td>Cost of nursing, ward consumables and admin costs shared between patients based on number of inpatient bed days</td>
<td>Ward bed day cost: $378</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>Pharmacist costs spread based on inpatient bed days plus individual medication costs</td>
<td>Pharmacy bed day cost: $37.78</td>
</tr>
<tr>
<td>Other</td>
<td>Radiology, laboratory, surgical pathology, diabetes specialist follow-up allied health and other</td>
<td></td>
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</table>

Figure 3: Total costs incurred by the bariatric patients in the study.

Total costs for all bariatric patients
12 months pre-enrolment to 12 mths post-surgery
(n=114)

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Pre-enrolment</th>
<th>Enrolment to Surgery</th>
<th>Bariatric surgery</th>
<th>Post surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Bariatric service*</td>
<td>Other</td>
<td>Bariatric service*</td>
</tr>
<tr>
<td></td>
<td>$100,090</td>
<td>$18,834</td>
<td>$1,208,005</td>
<td>$176,587</td>
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<tr>
<td></td>
<td>$103,836</td>
<td>$21,768</td>
<td>$1,289,846</td>
<td>$177,399</td>
</tr>
</tbody>
</table>

Inpatient | Outpatient
RYGB in keeping with increased theatre time required to perform this procedure compared to LSG (230 minutes vs 147 minutes). There was no significant difference in length of stay (Figure 4).

Nineteen patients had adverse events ranging from one leak, two stenosis, one upper gastrointestinal bleed, one marginal ulcer and one wound infection. There was no mortality. Mean cost for patients with complications at one year was $19,568 compared to $12,602 for those without (Figure 5).

Medication usage reduced as obesity-related diseases decreased; compared to 90% of patients being on diabetic medication prior to surgery, only 13% were still taking medication at one year. The per annum cost of diabetic medications for these patients dropped from $110,115 to $7,237 at one year. Decreases were also seen with other medications (Figures 6–8).

At 12 months, mean percentage weight-loss was significantly greater following LRYGB compared with LSG (-32.2±7.7% and -27.0±7.5%). Changes in BMI and weight were also greater after LRYGB. The percentage excess weight loss was superior following LRYGB vs LSG at 84% vs 70% respectively (p<0.01).

Comparing LSG vs LRYGB, 91% vs 89% of patients required pharmacological therapy.
Discussion

The economic burden of obesity is increasing worldwide. It has direct costs to healthcare caused by treating obesity related disease as well as indirect costs such as loss of work productivity due to sick leave, disability benefits and loss of years of productive lives due to obesity-related premature mortality.19,20 The OECD Update 2014 has listed New Zealand as having the third-highest obesity rates in the world among member states.21 A study by Lal et al22 showed that New Zealand healthcare costs attributable to obesity...
were estimated to be NZ$686m or 4.5% of New Zealand’s total healthcare expenditure in 2006. The combined costs of healthcare and lost productivity using Human Capital approach were $911 million dollars in 2006. In addition to increased healthcare costs compared to normal weight patients,23,24 obese patients have reduced life expectancy as well.25

In this study, we looked at the direct healthcare costs involved in providing bariatric surgery in a public hospital. The patients were participants of a randomised control trial and had a defined schedule of follow-up in clinics with robust data collection. The mean cost of bariatric surgery in our hospital is $12,602. The pre-operative costs coming up to $1,249 per patient and post-operative cost at one year being $3,105 per patient. This is less expensive compared to other countries such as the US where the cost of surgery alone is approximately USD$25,000.26,30 Czernichow et al27 has demonstrated that the initial cost and immediate post-op costs of bariatric surgery patients tend to increase compared to a non-surgical cohort. However, it is surmised that cost savings will occur in the longer term.

Cremiux et al showed that that it takes up to four years for the long-term healthcare cost savings to be realized.28 Cost-effectiveness of bariatric surgery is well established.29–31,39,40 Keating et al showed surgical therapy patients gained a mean 9.4 additional years in diabetes remission, 1.6 additional life-years (undiscounted) and 1.2 discounted QALYs. The Swedish Obesity Study has demonstrated improved life expectancy and reduced cancer incidence in obese patients undergoing bariatric surgery.32,33

In this study we found a decrease in medication usage for obesity related diseases. This was observed immediately after surgery. Diabetes medication usage showing a dramatic decrease from $110,115 to $7,237 at one year and reduction of patients on diabetic medication from 90% to 13% at one year. The long-term remission rates of diabetes as well as prevention of diabetes are the main objectives of the RCT.34 It will be important to monitor the long-term durability of these procedures as well as costs incurred. The primary endpoint of this RCT is glycaemic control at five years. It is our intention to monitor the ongoing costs in the interim of these patients. There is increasing pressure to provide more bariatric surgery in the public hospital sector in New Zealand. It is important that we continue to monitor the costs and benefits of such programs.

There are limitations of this study. There was no medical arm in this RCT, therefore we did not have a randomised control group of patients to compare with. This was considered in the early design phase of the trial but it was felt that recruitment would

Figure 8: Mean annual medication cost per patient.
be difficult. To date all studies demonstrate medically treated obesity to be inferior to bariatric surgery.35–37 However, operative costs are significant. Diligent clinical follow-up adds to these costs but benefits are already being seen in medication reductions, diabetes remission and improved quality of life (unpublished data).

Clinical workup and follow-up encounters are similar to our non-trial bariatric patients (apart from appointments with diabetes physicians), therefore although these patients are within the context of a randomised controlled trial, cost estimates are comparable to our routine non-trial follow-up patients.

Procedure costs are higher for LRYGB than LSG and may be a factor in determining which operation may be preferable given the skill mix of the surgical team, the hospital budget and numbers performed. However, longer term follow-up assesses the durability of these procedures and will aid surgeons and hospitals in performing appropriate and cost-effective surgery.

**Conclusion**

Bariatric surgery provides a definitive treatment option for obesity and related illnesses. The cost of providing this service is comparatively less expensive in New Zealand compared to other countries. This study confirms the initial beneficial effects observed with remission of diabetes and reduced medication usage. At 12 months LRYGB costs more than LSG mainly due to longer operating time and associated costs. However, greater weight loss is seen with LRYGB; despite this, glycaemic control is similar. Long-term follow-up and further reporting of ongoing costs and outcomes will be required to assess the durability and cost-effectiveness of these procedures.

**Competing interests:**

Nil.

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REFERENCES:


26. Maciejewski ML, Arterburn DE. Cost-effectiveness of bariatric


