What is the evidence for the safety and effectiveness of surgical and non-surgical interventions for patients with morbid obesity?

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LEVEL OF EVIDENCE CONSIDERED IN TECHNICAL BRIEFS

Technical Briefs are rapidly produced assessments of the best available evidence for a topic of highly limited scope. They are less rigorous than systematic reviews. Best evidence is indicated by research designs which are least susceptible to bias according to the National Health and Medical Research Council’s (NHMRC) criteria (see Section 2).

Where methodologically acceptable and applicable, appraised evidence is limited to systematic reviews, meta-analyses, evidence-based clinical practice guidelines, health technology assessments and randomised controlled trials (RCTs). Where not available, poorer quality evidence may be considered.

CONFLICT OF INTEREST

None.
## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AGBnd</td>
<td>adjustable gastric banding</td>
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<tr>
<td>ABGP</td>
<td>adjustable banded gastroplasty</td>
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<tr>
<td>AHRQ</td>
<td>Agency for Healthcare Research and Quality</td>
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<tr>
<td>AMED</td>
<td>Allied and Complementary Medicine Database</td>
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<tr>
<td>ASERNIP-S</td>
<td>Australian Safety and Efficacy Register of New Interventional Procedures - Surgical</td>
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<tr>
<td>ASGBnd</td>
<td>adjustable silicon gastric banding</td>
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<tr>
<td>BIOSIS</td>
<td>Biological Sciences Database</td>
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<tr>
<td>BNI</td>
<td>British Nursing Index</td>
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<td>BPD</td>
<td>biliopancreatic diversion</td>
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<td>BPD/DS</td>
<td>lateral gastrectomy with duodenal switch</td>
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<td>BMI</td>
<td>body mass index</td>
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<td>CINAHL</td>
<td>Nursing and Allied Health Database Index</td>
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<tr>
<td>c.f.</td>
<td>compared with</td>
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<tr>
<td>DARE</td>
<td>Database of Abstracts of Reviews of Effects</td>
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<td>EED</td>
<td>NHS Economic Evaluation Database</td>
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<tr>
<td>GBnd</td>
<td>gastric banding</td>
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<tr>
<td>GG</td>
<td>gastrogastrostomy (horizontal gastroplasty)</td>
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<tr>
<td>GP</td>
<td>gastroplasty (gastric partitioning)</td>
</tr>
<tr>
<td>HGP</td>
<td>horizontal gastroplasty</td>
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<tr>
<td>HMIC</td>
<td>UK Department of Health Health Management Information Consortium</td>
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<td>HTA</td>
<td>Health Technology Assessment</td>
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<tr>
<td>ICSI</td>
<td>Institute for Clinical Systems Improvement</td>
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<tr>
<td>ICU</td>
<td>intensive care unit</td>
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<tr>
<td>LAGBnd</td>
<td>laparoscopic adjustable gastric banding (Lap Band® or Swedish Adjustable Gastric Band)</td>
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<td>LRYGB</td>
<td>laparoscopic (Roux-en-Y) gastric bypass</td>
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<tr>
<td>LVBGP</td>
<td>laparoscopic vertical banded gastroplasty</td>
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<tr>
<td>JB</td>
<td>jejunoileal bypass</td>
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<tr>
<td>MSAC</td>
<td>Medical Services Advisory Committee</td>
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<tr>
<td>MUHC</td>
<td>McGill University Health Care Centre</td>
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<td>NHMRC</td>
<td>National Health and Medical Research Council (Australia)</td>
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<td>NICE</td>
<td>National Institute for Clinical Evidence</td>
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<td>NHS</td>
<td>National Health Service (UK)</td>
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<tr>
<td>RCT</td>
<td>randomised controlled trial</td>
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<tr>
<td>RYGB</td>
<td>gastric bypass (Roux-en-Y gastric bypass)</td>
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<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>SOS</td>
<td>Swedish Obese Subjects intervention trial</td>
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<td>SRGP</td>
<td>silastic ring gastroplasty</td>
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<td>SSCI</td>
<td>Social Science Citation Index</td>
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<tr>
<td>STEER</td>
<td>Succinct Timely Evaluated Evidence Review</td>
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<td>TAU</td>
<td>Technology Assessment Unit</td>
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<td>TRIP</td>
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<tr>
<td>QALY</td>
<td>quality-adjusted life-year</td>
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<td>QoL</td>
<td>Quality of life</td>
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<td>VLCD</td>
<td>very-low calorie diet</td>
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<td>VBGP</td>
<td>vertical banded gastroplasty</td>
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**GLOSSARY**

Surgical procedures in the published literature are often synonymous with one-another but are differentiated by name or by being performed with open or laparoscopic surgical techniques. The following procedures are described.

**Biliopancreatic diversion / bypass – (Scopinaro’s procedure) (BPD/BPB), lateral gastrectomy with duodenal switch (BPD/DS)**

A biliopancreatic bypass is a malabsorptive surgical procedure and also includes a gastric restriction which involves the removal of portions of the stomach. The resulting stomach pouch is directly connected to the end segment of the small intestine and this bypasses the duodenum and jejunum, thereby diverting bile and pancreatic juice into the distal ileum. Possible complications include malnutrition, anaemia, ulcers, hair-loss, strong body odour and loose stools. There are several variants which have been developed to overcome these problems.

**Body mass index (BMI)**

Anthropometric measure, defined as weight in kilograms divided by the square of height in metres (kg/m²). This index mathematically relates height and weight as an indicator of body fat. This measure correlates closely with body density and thickness.

**Adjustable banded gastroplasty (ABGP), gastrogastrostomy (horizontal gastroplasty) (GG), gastroplasty (gastric partitioning) (GP), horizontal gastroplasty (HGP), laparoscopic vertical banded gastroplasty (LVBGP), vertical banded gastroplasty (VBGP)**

Vertical or horizontal gastroplasty is a restrictive surgical procedure involving the use of staples to divide the stomach into two sections, with vertical gastroplasty having the advantage over horizontal gastroplasty by placing the gastroplasty along the wall of the stomach with the least curvature and thickest wall to inhibit stretching. With horizontal gastroplasty staples are placed traversely across the entire stomach and this creates a channel between the upper and lower stomach (gastrogastrostomy) (Lefevre and Aronson, 2003a). Vertical banded gastroplasty is the more commonly undertaken procedure and is performed with both open and more typically laparoscopic techniques. This involves the creation of a small pouch in the upper section of the stomach with a small opening to allow food to pass into the rest of the stomach. The small opening is reinforced with a mesh to prevent stretching. The combined small upper stomach pouch and opening restricts food intake and slows food passage so a patient feels satiated and will therefore eat less and lose weight. This surgical procedure is not malabsorptive and the small stomach pouch can stretch with overeating and if the stoma is too small this can induce vomiting (Medical Services Advisory Committee, 2003). Other complications can include leakage, stenosis, ulcer, infection and partition staple failure.

**Adjustable silicon gastric banding (ASGBnd), laparoscopic adjustable gastric banding (LAGBnd), open gastric banding (GBnd)**

Gastric banding (adjustable and non-adjustable) is a restrictive surgical procedure where a banding device is fitted around the upper stomach section, dividing the stomach into two parts which are connected by a small outlet or stoma. The upper pouch is usually 15-30 mL of capacity and combined with the small stoma restricts food intake and slows food passage so a patient feels satiated, the rationale being that the patient will eat less and lose weight. Originally gastric bands were non-adjustable and fitted via an open surgical procedure but laparoscopic adjustable gastric banding has mostly replaced this. A fitted adjustable band can be adjusted as it can be filled or aspirated with saline to adjust the rate of stomach emptying through modifying the size of the stoma. Both Lap Band® and Swedish Adjustable Gastric Band are similar silicone bands connected via a silicone tube to a titanium reservoir with an access port placed under the skin of the patient’s abdomen. The access port is covered with a self-sealing silicone membrane through which saline can be administered or aspirated (Medical Services Advisory Committee, 2003).

**Open (Roux-en-Y and resectional) gastric bypass (RYGB), laparoscopic (Roux-en-Y) gastric bypass (LRYGB), long-limb gastric bypass (LLGBY)**

The Roux-en-Y gastric bypass is a combination surgical procedure involving both malabsorptive and restrictive methods. This procedure is widely used and has been performed with both open and laparoscopic surgical techniques. A small pouch is created in the stomach by vertical banding or
stapling of the upper stomach area or by resection (removal of part of the stomach), a subtotal
gastrectomy with a Roux-en-Y reconstruction. A section of the small intestine is attached to the pouch
and food passes directly from the pouch into the jejunum. The small stomach pouch restricts food
intake and the ingested food is not mixed with digestive enzymes produced by the stomach thereby
limiting absorption with resulting weight loss. This procedure is largely irreversible, complications
include partition staple failure, leaks, hernias, vomiting and dumping syndrome (Medical Services
Advisory Committee, 2003). Long limb gastric (or distal) bypass is very similar to standard gastric
bypass, except the length of the Roux-limb is considerably longer and this bypasses a greater
proportion of the small intestine increasing the degree of malabsorption. This has similar
complications to standard gastric bypass but longer term complications may include malnutrition
caused by malabsorption.

**Jejunoileal bypass (JB)**
A malabsorptive surgical procedure. It joins the proximal jejunum to the end of the ileum where it
bypasses a large section of the gastrointestinal tract. It is no longer performed and has been associated
with liver failure and cirrhosis.

**Morbid obesity**
Commonly defined as a sub-population of obese individuals (Body Mass Index (BMI) 30 kg/m$^2$
or greater) whose BMI is in the category of 40 kg/m$^2$ or greater or a BMI of 35 kg/m$^2$ or greater where
there are associated serious obesity-related comorbidities. This can be also be defined as individuals
who are in excess of 200% or 45 kg over ideal weight, with ideal weight being a weight at any given
age, sex and body frame associated with maximum life expectancy (Logan et al., 2000). Morbid
obesity is a well known risk factor for other common diseases including hypertension,
hypercholesterolemia, cardiomyopathy, diabetes, gallbladder disease, pancreatitis, certain kinds of
cancers (colorectal, prostate, gallbladder and gynaecological), sleep apnea, and also psychological and
social dysfunction. In view of its association with many systemic illnesses, morbid obesity itself is
recognised as a disease process (Logan et al., 2000). A sub-population of morbidly obese patients
known as “super-morbidly obese” or “super-obese” patients are defined as having a BMI equal to or
greater than 50 kg/m$^2$. 
Section 1: Summary

The review updates the New Zealand Ministry of Health on the evidence for the safety, clinical and cost-effectiveness of surgical and non-surgical interventions for patients with morbid obesity defined as persons with a BMI = 40 kg/m² or BMI = 35 kg/m² with significant obesity related co-morbidities. Systematic and non-systematic literature reviews have been undertaken internationally by Health Technology Assessment Agencies (HTA) evaluating surgical and non-surgical interventions for patients with morbid obesity. The purpose of this Technical Brief was to provide a descriptive overview of the HTA review material published between 2000 and 2004 and also to incorporate recent evidence from studies published in peer reviewed journals for 2003 and 2004 not already included in the HTA reviews.

CONCLUSIONS

- Internationally there are a variety of surgical procedures and non-surgical treatments that have been used for treating morbid obesity. This was reflected in the included literature for this review which encompasses systematic and non-systematic reviews of numerous primary studies that were heterogeneous in terms of the surgical procedures and non-surgical treatments compared but also in the study methods used.

- The evidence regarding the safety, clinical and cost-effectiveness of surgical and non-surgical interventions for patients with morbid obesity was mostly restricted to lower Level III-2 evidence according to the Australian NHMRC hierarchy of evidence. The levels of evidence assigned to these reviews reflected the lower quality and designs of the primary studies included, with a lack of high quality studies having more rigorous study designs (e.g. RCTs). There were few RCTs directly comparing surgical with conventional interventions in morbidly obese patients. There was also a limited number studies with some form of cost-effectiveness analysis.

- The included literature reviews clearly demonstrated that morbidly obese patients receiving surgical interventions undergo significantly greater and more sustained weight loss and resolution of obesity-related co-morbidities but risk more serious complications compared to those patients who receive usual care such as behavioural, motivational, psychological, and pharmacological interventions. Surgical interventions for morbid obesity all carry some risk of complications but are substantially less than the health risks associated with morbid obesity itself.

- The baseline weight of patients in studies evaluating surgical interventions was far heavier when compared with patients in studies evaluating non-surgical interventions. This is because non-surgical treatments are generally intended for overweight patients (BMI < 35) and there is little place for offering surgery to these patients with lower BMI. Surgical interventions are intended for morbidly obese (BMI = 40 kg/m² or BMI = 35 kg/m² with significant obesity related co-morbidities) or severely obese patients (BMI = 50 kg/m²). As a result there was little material looking specifically at non-surgical interventions for patients with morbid obesity. Overall, the material reported only small weight reductions in patients at up to 2 years follow-up and the resolution of some obesity-related co-morbidities from non-surgical interventions. The quality of these studies was lacking in terms of study design and execution and the external validity of the findings of these studies is limited when trying to extrapolate these to morbidly obese patients. No systematic review was identified looking specifically at non-surgical or surgical interventions for morbidly obese adolescent and paediatric patients.

- The most frequently used surgical procedures undertaken today are gastric bypass (open or laparoscopic), laparoscopic gastric banding and to a lesser extent biliopancreatic diversion. The various gastroplasty procedures are now less commonly used and have been superceded by laparoscopic adjustable banding techniques. Open gastric bypass with Roux-en-Y was the most common surgical procedure for morbidly obese patients evaluated by the literature. The procedure was compared to other surgical procedures such as vertical banded gastroplasty, horizontal and
silastic ring gastroplasty, and open gastric banding. Open versus laparoscopic gastric bypass and laparoscopic adjustable gastric banding was also compared in a number of reviews.

The evidence reviewed indicated that surgical management of morbidly obese patients was more effective but posed greater risk to patients of serious complications than conventional non-surgical management. What was less clear from the limited evidence available was the relative safety and effectiveness of various surgical procedures. Weight loss was generally greater after gastric bypass and biliopancreatic diversion procedures than laparoscopic adjustable banding (lap-band) procedures, although the later procedure is probably, at least initially, safer. On average, patients achieved greater excess-weight loss (>50%) and co-morbidities improved or even resolved after these three procedures. Because of the relatively short-term follow-up in studies on banding procedures (mostly less than 5 years) and the likelihood of more revision operations being required in the long-term for these operations, minor differences in the safety of the initial operation are not clinically significant, as revision operations are usually considerably more dangerous than the initial banding operation. Longer operative time but reduced length of hospital stay was evident with laparoscopic surgery. The generally accepted and commonly reported mortality rates for these three procedures, in average risk patients, was less than 1%. From a longer term perspective all three procedures appear to be effective but gastric bypass and biliopancreatic diversion may have advantages over banding procedures as the latter, though simpler, is more likely to require maintenance and revision which may negate any apparent early safety advantage of the banding technique.

Specific comparisons on the relative safety and effectiveness of gastric bypass (RYGB), laparoscopic adjustable banding (LAGBnd), various forms of gastroplasty, and biliopancreatic diversion (BPD) follow:

- Open gastric bypass was generally more effective than gastroplasty at 1-3 years follow-up. Reviews comparing open gastric surgery procedures Roux-en-Y gastric bypass (RYGB) and vertical banded gastroplasty (VBGP) indicated that both VBGP and RYGB procedures were generally safe but RYGB was more effective than VBGP in terms of enabling greater weight loss, and having fewer revisions, re-operations and/or conversions. There was an increased risk of serious metabolic complications with RYGB but long-term data on adverse events was limited. Both procedures appeared to produce a substantial reduction in excess weight, sustained for up to 7 years, with mean weight loss of over 50% of excess weight reported at up to 2-years post-surgery. There was though a lack of quality evidence because of methodological weaknesses in the included studies and many studies were case series.

- Open gastric bypass (RYGB) was compared with the less surgically invasive laparoscopic gastric bypass (LRYGB). These studies indicated that open and laparoscopic gastric bypass procedures were similar in terms of effectiveness (weight loss and improvement in co-morbidities) at 1 year follow-up. There is a slightly different spectrum of complications associated with these procedures and there was limited data on long-term complications but short-term data indicated that anastomatic leaks were more frequent with laparoscopic gastric bypass. The evidence reviewed consisted mostly of diverse single-arm clinical series with few high quality comparative studies.

- Open gastric bypass (RYGB) compared with biliopancreatic diversion (BPD) or variants in super-obese patients (persons with a BMI = 50 kg/m²) was similar in terms of weight loss but there was insufficient data available to make definitive conclusions on these comparisons.

- Open gastric bypass (RYGB) was compared with laparoscopic adjustable gastric banding (LAGBnd) (including Lap-Band® or the Swedish Adjustable Gastric band). Although based on lower quality level evidence, particularly single-arm studies, LAGBnd was at least as safe as the open RYGB with post-operative complications and morbidity and mortality being comparable in patients receiving either procedure. Safety data was limited as there was a lack of data on long-term complications for gastric banding such as erosion of the band through the gastric wall. However, LAGBnd was less effective in producing weight loss than open RYGB at up to 3-years follow-up but weight loss was sustained by both procedures up to 5-years follow-up and was equally effective in terms of the resolution of obesity related co-morbidities. The length of procedure was longer but hospital stay was shorter for patients
receiving LAGBnd. Patient follow-up was seen as having a significant role in weight loss for patients having had laparoscopic adjustable gastric banding (LAGBnd) because of the need for band adjustment.

- Laparoscopic adjustable gastric banding (LAGBnd) was equally effective as vertical banded gastroplasty (VBGP) in terms of weight loss, patient satisfaction and resolution of obesity related co-morbidities but these outcomes were maintained longer in LAGBnd patients. However, it was difficult to determine the long-term efficacy of LAGBnd, as follow-up periods were much shorter than those from data available for VBGP.

- Findings from two systematic reviews indicated that vertical banded gastroplasty (VBGP) was more effective than horizontal gastroplasty (HGP) and that adjustable banded gastroplasty was more effective than vertical banded gastroplasty.

Overall, surgery appeared to be cost-effective compared to conventional treatments or no treatment, with laparoscopic surgery possibly more cost-effective than open surgery because of reduced length of hospital stay. However, it was not possible to adequately determine the best surgical procedure based on the limited number of cost-effectiveness studies, the data available from these studies, and the differing assumptions made for each economic analysis. Studies on the cost-effectiveness of a limited number of surgical procedures was restricted to particular health care settings. For example, the cost-effectiveness of LAGBnd in the Australian setting was slightly dominated by open gastric bypass (RYGB) with equivalent effectiveness but slightly lower costs. Whereas in an analysis based on the Quebec healthcare system the direct costs between the two procedures were comparable apart from the costs of the gastric band. For this setting it was concluded that it would be necessary to demonstrate a clinically meaningful benefit of LAGBnd over RYBG due to the extra cost of performing a LAGBnd procedure to the Quebec healthcare system. In another Quebec based study there was a significant reduction in initial excess weight and BMI for bariatric surgery patients but high initial direct health-care costs at one year were offset by significantly lower cumulative healthcare costs at five years, with costs being amortised over 3-5 years.

With the vast amount of published literature available on interventions for patients with obesity/morbid obesity, time and resource limitations, and the type of output required by the Ministry of Health, the material evaluated was restricted to secondary literature from HTA and Cochrane Collaboration reviews and to the most recently published primary studies. The included reviews were diverse in terms of the surgical and non-surgical interventions compared and the review methods used. They were also limited by the subjective way in which reviews combined primary research studies to assess the overall evidence as meta-analysis was not possible because of diverse outcomes data between studies. In some cases there was a high degree of overlap between reviews in terms of included studies, so some duplication of results and conclusions was unavoidable. The body of evidence reviewed was constrained by the design and conduct of the included reviews and by the quality of the underlying primary studies making up the evidence base under evaluation.

There were few RCTs included in the relevant reviews or in the latest primary research studies comparing medical versus surgical interventions for patients with morbid obesity. A far greater number of studies have been conducted on comparing conventional treatments for over-weight and obese patients. There was a lack of studies on the surgical management of patients with super-obesity as well as on the surgical management of morbidly obese children and adolescents. The included reviews of primary studies were limited by the lack of quality in the included studies of robust RCT study designs, instead studies were characterised by poor study methodology, small sample sizes, baseline differences in patient comparison groups, the inclusion of obese or over-weight patients in patient samples, inadequate reporting of results, limited patient follow-up, a lack of complication and adverse event data, a lack of quality of life (QoL) data and the uncontrolled effects on outcomes of surgeon learning curves where surgical technique improves with practice for newer procedures.
The results of these particular reviews may not be externally generalisable/applicable to all morbidly obese patients undergoing a particular bariatric surgical procedure or conventional treatment. This was due to the degree of study heterogeneity, particularly in patient selection criteria and baseline characteristics which limited the generalisability of review results (on interventions) being applied to all morbidly obese patients.
Section 2: Background and methods

BACKGROUND

This Technical Brief was requested by Dr Andrew Holmes, Manager, Clinical Services Strategy, Clinical Services Directorate, Ministry of Health, New Zealand Government.

Obesity has become a significant health problem worldwide, reaching pandemic proportions in countries such as the United States and is a significant risk factor for a number of other common diseases including cardiovascular disease and type 2 diabetes and is associated with an increased all-cause mortality at any age (Clegg et al., 2002). It is also associated with decreased quality of life such as social stigma and has significant direct and indirect healthcare costs and societal costs through lost earnings from sickness and mortality (Clegg et al., 2001). Not only is the prevalence of obesity continuing to increase, the degree of obesity continues to rise as evidence shows that the prevalence of morbid obesity is also increasing (Bond et al., 2004). Obesity is internationally defined as a body mass index \[\text{BMI} = \text{weight in kg} / (\text{height in metres})^2\] of \(\geq 30 \text{ kg/m}^2\). The definition of morbid obesity is defined as patients with a BMI \(\geq 40 \text{ kg/m}^2\) or BMI \(\geq 35 \text{ kg/m}^2\) with significant obesity related co-morbidities and super-obese patients defined as persons having a BMI \(\geq 50 \text{ kg/m}^2\). Surgery is usually indicated for persons with morbid obesity where they have not responded to conventional treatments.

Generally, non-surgical conventional treatments have had only limited success in treating patients with morbid obesity to obtain significant and sustained weight loss. The literature indicates that surgical interventions tend to provide greater and more sustained weight loss for morbidly obese patients than do non-surgical interventions. These non-surgical interventions or conventional treatments consist of pharmacological, behavioural, dietary, exercise and complementary therapies designed to reduce weight or prevent weight gain and are prescribed individually or in combination to patients. Pharmacological medications act as appetite suppressants or lipase inhibitors and include medications such as sibutramine, orlistat, fluoxetine, phentermine, diethylpropion, bupropion, zonisamide, topiramate and sertraline.

Bariatric surgical treatments for morbidly obese patients are aimed at weight reduction and have reportedly had greater success in achieving both significant and sustained weight loss and the resolution of obesity related co-morbidities such as impaired glucose intolerance, type 2 diabetes, hypertension and dyslipidaemia and associated cardiovascular disease risk, and have usually been undertaken as a last resort where conventional treatments have failed. The two main types of surgical intervention are malabsorptive and restrictive surgery. Malabsorptive surgery bypasses sections of the gastrointestinal tract thereby limiting the absorption of food. Restrictive surgery restricts the size of the stomach so a sense of fullness is achieved with less food. Surgical techniques have developed and been employed in the last few decades with the restrictive procedure jejunoileal bypass being one of the earliest procedures, but this has been phased out and the most commonly used surgical procedures are gastric bypass (open or laparoscopic), laparoscopic gastric banding and to a lesser extent biliopancreatic diversion. The various gastroplasty procedures are in less common use than they used to be and have been largely superceded by laparoscopic adjustable banding techniques. The combination restrictive/malabsorptive procedure gastric-bypass with Roux-en-Y anastomosis (RYGB) is now the current standard. The literature contains numerous studies comparing RYGB with alternative procedures including vertical banded gastroplasty (VBGP), and horizontal gastroplasty (HGP) (Shekelle et al., 2004). More recently, less-invasive techniques involving laparoscopic technology have been employed for bariatric surgery. These include laparoscopic gastric-bypass (L(RY)GB) and laparoscopic gastric banding (LAGBnd) and have been compared to open gastric bypass and open gastric banding (Lefevre & Aronson, 2003a).

There are non-medical benefits associated with major weight loss including increased self-esteem and self confidence, increased physical capabilities, and greater work and social opportunities. Although
surgical interventions for morbidly obese patients may provide greater improvements in quality of life measures and in co-morbid conditions, such interventions are not without the risk of serious adverse effects compared to non-surgical interventions. Complications also include conversions when a surgeon begins with one procedure e.g. laparoscopic surgery but is forced to convert to open surgery due to events such as incorrect band placement. Re-operation also can occur from complications resulting from earlier surgery such as band slippage and reflux disease.

The number of systematic and non-systematic literature reviews published by international Health Technology Assessment (HTA) organisations and collaborations such as the Cochrane Collaboration is extensive in this area and this Technical Brief includes those reviews published between 2000 and 2004 and an update of recent comparative studies published in 2003 and 2004 on the clinical and cost-effectiveness of surgical and non-surgical interventions for patients with morbid obesity.

The Technical Brief is divided into three sections:

- the first section contains overall conclusions
- the second section contains background and methods
- the third section contains an overview, detailed evidence tables and assessment of the overall evidence on the safety, clinical-effectiveness, and cost-effectiveness of interventions for morbid obesity.

**METHODS**

**Study inclusion and exclusion criteria**

Inclusion and exclusion criteria were applied to the abstracts captured by the literature searches to identify those reviews to be retrieved as full text and those primary research studies to be reviewed from abstract form only and included in the update of the latest published research evidence.

Published peer reviewed studies were considered if they used one of the following study designs:

- Health Technology Assessment (HTA) or Cochrane systematic or non-systematic review or meta-analysis
- controlled clinical trials (randomised, quasi-randomised, non-randomised)
- comparative studies (e.g., cohort and case-control design).

Levels of evidence are based on the notion that experimental study designs minimize or eliminate bias more effectively than non-experimental designs.

**Inclusion criteria**

The following criteria were used to include studies for overview:

- Reviews/studies with a patient sample of morbidly obese patients with BMI = 40 kg/m² or BMI = 35 kg/m² with significant co-morbidities such as impaired glucose intolerance or type 2 diabetes, hypertension and dyslipidaemia and associated cardiovascular disease risk.
- Reviews/studies examining evidence for the safety and/or clinical effectiveness and/or cost-effectiveness of malabsorptive and restrictive surgical interventions.
- Reviews/studies examining evidence for the safety and/or clinical effectiveness and/or cost-effectiveness of non-surgical interventions including pharmacological, behavioural, dietary, exercise and complementary therapies.
- Reviews/studies with a comparison group of morbidly obese patients who received conventional non-surgical therapies, malabsorptive or restrictive surgical procedures, placebo or no intervention.
Reviews/studies where primary outcomes considered include one or more of the following:
- BMI (decrease/increase)
- excess weight loss
- co-morbidities resolution
- mortality
- morbidity
- psychosocial outcomes such as quality of life and patient satisfaction measures

Reviews/studies written in English and published from January 2000 onwards for HTA/Cochrane reviews and published from January 2003 to September 2004 for other studies.

Exclusion criteria

The following criteria were used to exclude studies from overview:
- Reviews/studies where the patient population was substantially classified (>50%) as obese patients (and not morbidly obese) with BMI less than 40.
- Reviews/studies with inadequate description of methodology and/or results or significant error or methodological problems.
- Narrative reviews, expert opinion, letters to the editor, comments, editorials, conference proceedings, books and book chapters.

MAIN SEARCH TERMS

A search was done of review databases for existing secondary research (systematic reviews, health technology assessments, and guidelines) on surgical and non-surgical interventions for morbid obesity. This search located 57 potential items of which 21 were retrieved in full text.

A broad search of Medline, the Cochrane Controlled Trials Register, Cinahl, and Embase was also done for any primary research studies published in 2003 and 2004 which may have appeared since the secondary research was published. The Scottish Intercollegiate Guidelines Network (SIGN) filters for randomised trials, systematic reviews, and observational studies for each database were modified slightly and used to limit the search to studies with high quality research design. This search identified 389 potentially relevant articles of which 13 were included in the update on the latest published evidence.

Main search terms

MeSH headings
- Obesity-morbid, gastric bypass, gastroplasty.

Additional free text keywords (used in all sources)
- Morbid obesity, obesity, surgery, gastric band$tw.
SEARCH SOURCES

Bibliographic databases
- Medline
- Embase
- Cinahl
- Cochrane Controlled Trials Register

Review databases
- Cochrane Database of Systematic Reviews
- Health Technology Assessment database
- NHS Economic Evaluation database
- Database of Abstracts of Reviews of Effects
- ACP Journal Club

Guidelines
- US Guidelines Clearing House
- National Electronic Library for Health Guidelines Finder
- Scottish Intercollegiate Guidelines Network

OVERVIEW METHODOLOGY

The evidence presented in the selected secondary research studies was classified using the dimensions of evidence defined by the National Health and Medical Research Council (NHMRC, 2000). The designations of the levels of evidence are shown in Table 1 below.

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Study design</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Evidence obtained from a systematic review of all relevant randomised controlled trials</td>
</tr>
<tr>
<td>II</td>
<td>Evidence obtained from at least one properly-designed randomised controlled trial</td>
</tr>
<tr>
<td>III-1</td>
<td>Evidence obtained from well-designed pseudorandomised controlled trials (alternate allocation or some other method)</td>
</tr>
<tr>
<td>III-2</td>
<td>Evidence obtained from comparative studies (including systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case-control studies, or interrupted time series with a control group</td>
</tr>
<tr>
<td>III-3</td>
<td>Evidence obtained from comparative studies with historical control, two or more single arm studies, or interrupted time series without a parallel control group</td>
</tr>
<tr>
<td>IV</td>
<td>Evidence obtained from descriptive studies - e.g., case series, either post-test or pre-test/post-test designs</td>
</tr>
</tbody>
</table>

*Modified from NHMRC (2000)

The Evidence Tables for HTA reviews in Section 3 of the Technical Brief present key information summaries described below:

- **study citation, source and design:** including authors, organisation, year published, country of origin, study design and level of evidence
- **intervention and methods:** the specific interventions and methods
- **results:** review results including characteristics and limitations of the literature included in the HTA review.
RESULTS

From the above search strategy, 57 potentially relevant HTA/Cochrane review abstracts were identified, of which 21 reviews were retrieved in full text and 12 of these included in the Technical Brief (see tables in Section 3). Two reviews looked at non-surgical interventions compared to surgical interventions while eight other reviews looked at comparisons between various surgical procedures which in some cases also included comparisons with non-surgical interventions. Three of the HTA reviews included some form of economic analysis on the cost-effectiveness of various interventions for patients with morbid obesity. Two recent and extensive HTA systematic reviews examined the clinical and economic consequences of interventions (primarily conventional non-surgical) for obese patients. These reviews also included morbidly obese patients in the study samples. While not strictly within the inclusion criteria for morbid obesity, these were included in the summary but not in the evidence tables because of the amount of material covered on non-surgical interventions. In addition 389 journal article abstracts were captured from the search and of these 13 relevant primary studies were identified and the key findings of these studies incorporated into an update of the latest evidence published in 2003 and 2004.

Eight of the reviews were graded as level III-2 evidence using the dimensions of evidence defined by the National Health and Medical Research Council (NHMRC, 2000) as they were reviews containing a very limited number of RCTs combined mostly with comparative studies (with concurrent controls and patient allocation not randomised), cohort studies, case-control studies and single-arm study designs. A further two systematic reviews were graded as level II evidence as these were systematic reviews of almost entirely RCTs. Four studies were produced by organisations in the USA, four from the United Kingdom, two from Canada, and two from Australia.

OVERVIEW

Recent RCTs or comparative studies published in 2003 and 2004 on surgical interventions for patients with morbid obesity

Thirteen relevant primary studies, including three RCTs not included in HTA reviews were included from literature published in 2003 and 2004. This material compared various laparoscopic bariatric surgical procedures or compared these with similar open surgery procedures. The other search material consisted mostly of single-arm studies, particularly prospective and retrospective studies of case series of patients reporting on laparoscopic bariatric surgical procedures. Although the outcomes evaluated in these studies were relevant and the material described both early and ongoing clinical experience with various surgical techniques and reported results in terms of effectiveness and complications (including the “learning curve effects” of surgeons undertaking newer procedures) the relative safety and efficacy of these differing procedures could not be compared because there were no comparison groups. A brief overview of the included comparative studies follows. These studies were cited from abstract form only and not retrieved as full-text articles.

Laparoscopic bariatric surgery techniques

Two RCTs compared laparoscopic vertical banded gastroplasty with other laparoscopic procedures. One study reported laparoscopic adjustable silicone gastric banding (LAGBnd) to be safer and more effective than laparoscopic vertical banded gastroplasty (LVBGP), while in the other study
laparoscopic gastric bypass (LRYGB) showed greater effectiveness than laparoscopic vertical banded gastroplasty (LVBGP).

One RCT by Morino et al. (2003) with 100 patients compared laparoscopic adjustable silicone gastric banding (LAGBnd) with laparoscopic vertical banded gastroplasty (LVBGP). Results at 23 years follow-up demonstrated that LVBGP was more effective in excess-weight loss and had fewer late complications and re-operations than did LAGBnd. The latter procedure though required shorter operative times and hospital stay. The other RCT by Lee et al. (2004) with 80 patients compared laparoscopic vertical banded gastroplasty (LVBGP) with laparoscopic gastric bypass (LRYGB) at 2-years follow-up. Both study arms demonstrated significant excess-weight loss but the LRYGB group showed greater weight loss, better QoL scores and greater decreases in obesity related co-morbidities than the LVBGP study-arm.

Laparoscopic versus open gastric bypass

Four studies examining laparoscopic versus open gastric bypass reported similar results in terms of weight loss but laparoscopic gastric bypass patients tended to have shorter hospital stays. Complications were both evident in both procedures but varied between the procedures with overall safety being unclear.

An RCT by Lujan et al., 2004 with 104 patients compared laparoscopic versus open gastric bypass and reported similar results for each study arm in terms of mid-term weight loss but laparoscopic gastric bypass patients had shorter hospital stays and fewer abdominal wall complications than patients undergoing open gastric bypass procedures. Immediate post-operative outcomes indicated no advantage for hand-assisted laparoscopic RYGB versus open RYGB surgery (Sundborn et al., 2004). A retrospective chart and hospital record review of morbidity and mortality associated with open and laparoscopic RYGB (451 vs 328 patients) found similar weight loss in both groups of patients at follow-up. Complications such as anastomotic stenosis were more common in laparoscopic RYGB patients while ventral hernia and wound infection were more common in open RYGB patients. Anastomotic leaks and small bowel obstruction were common in both groups of patients (Smith et al., 2004). A prospective matched paired analysis of post-operative outcomes at one year compared two groups of 80 patients and reported similar excess weight loss and minor complications for open and laparoscopic gastric bypass (Courcoulas et al., 2003). A greater number of major complications (e.g. internal hernias requiring re-operation) occurred in the laparoscopic gastric bypass surgery group compared with the open bypass surgery group but these did not reach significance and patients returned to normal activities sooner. Early excess weight loss at 3-9 months was significantly better for the laparoscopic gastric bypass surgery group.

Open gastric bypass surgery with lateral gastrectomy with duodenal switch

One study by Deveney et al. (2004) compared open RYGB surgery with lateral gastrectomy with duodenal switch (BPD/DS) and reported similar excess weight loss results, incidence of anastomotic leaks and mortality but increased hospital stays for patients receiving gastrectomy with duodenal switch.

Bariatric surgical procedures in super-obese patients

One study compared open with laparoscopic biliopancreatic diversion (BPD) and the other study compared open BPD with laparoscopic adjustable banding (LAGBnd) in super-obese patients. Both studies found BPD to be effective in excess-weight reduction, however BPD was associated with major complications and it was recommended that more studies be undertaken to better determine the safety and effectiveness of surgical interventions for super-obese patients.

A retrospective study with 54 super-obese patients with BMI ≥ 50 compared open with laparoscopic biliopancreatic diversion with duodenal switch (BPD-DS) and reported the on feasibility of both procedures in super-obese patients. Both procedures were associated with notable morbidity and mortality with the author’s concluding that more studies were needed to assess the safety and effectiveness of surgical interventions for patients with super-obesity (Kim et al., 2003). The second study by Dolan et al. (2004) examined biliopancreatic diversion (BPD) compared with laparoscopic adjustable gastric banding (LAGBnd) in super-obese patients with 2-years follow-up post-operation.
BPD resulted in significantly greater excess weight loss but longer hospital stays and higher complication rates than in LAGBnd patients.

**Bariatric surgery versus non-surgery**

A matched double cohort study by Christou et al. (2004) compared 1,035 treatment-arm patients having undergone bariatric surgery with 5,746 control-arm patients not having undergone surgery. The study reported that bariatric surgery resulted in a significant reduction in excess-weight and co-morbidities associated with morbid obesity compared to controls who had no surgery. The mortality rate was 0.7% in the surgery cohort compared with 6.2% in the control cohort.

**Cost-effectiveness evaluations**

Three cost-effectiveness studies compared the medical costs of bariatric surgical interventions with the pre-intervention medical costs of pharmaceuticals administered for treating obesity and obesity-related co-morbidities. Although the results from these studies indicated high initial post-operative costs, the resolution of particularly obesity-related co-morbidities meant significant savings in the longer term, with the costs of surgery being offset in the medium to longer term.

The retrospective study of 100 patients by Monk et al. (2004) reported a significant reduction in post-operative compared to pre-operative average monthly medical expenditure per patient (US$ 135 vs US$ 317) after RYGB surgery. Savings in long-term medical expenses offset the initial costs of RYGB. Similarly in the study by Potteiger et al. (2004) there was a significant reduction in obesity related co-morbidities medication (diabetic, anti-hypertensive pharmaceuticals) costs in patients having had RYGB surgical procedures. A matched observational double cohort study by Sampalis et al. (2004) compared the direct healthcare costs for bariatric surgery patients with an age-gender matched control cohort of non-surgical patients based on hospitalisation per 1000 patients. Not only was there a significant reduction in initial excess weight and BMI for bariatric surgery patients but high initial direct health-care costs at one year were offset by significantly lower cumulative healthcare costs at five years ($19.5m versus $25.2m), with costs being amortised over 3-5 years.

**HTA and Cochrane reviews on surgical and non-surgical interventions for morbid obesity (also refer to the evidence tables in Section 3)**

Twelve relevant HTA and Cochrane reviews on surgical and non-surgical interventions for patients with morbid obesity were identified that were published between 2000 and 2004. These are summarised as follows.

**Reviews comparing various bariatric surgical procedures including gastric bypass, vertical banded gastroplasty, horizontal gastroplasty, open/laparoscopic surgery, and conventional treatments**

A systematic review on surgical interventions for patients with morbid obesity by Clegg et al. (2002) (level II grade evidence) from the UK National Institute for Clinical Evidence (NICE) made the following conclusions:

- Surgery for people with morbid obesity was associated with significant weight loss that was generally maintained for up to 8 years compared to conventional treatments where there was little overall sustained weight loss. Surgery was associated with improved QoL and reduced co-morbidities but there were high risks associated with surgery.

- Comparisons of various surgical procedures demonstrated that gastric bypass (RYGB) was more effective than gastroplasty for achieving weight reduction but that it is a complex procedure and can cause significant metabolic complications. Vertical banded gastroplasty (VBGP) was more effective than horizontal gastroplasty (HGP). Although differences were not significant, gastric banding was associated with greater long term weight loss, greater patient satisfaction, and fewer re-operations than vertical banded gastroplasty (VBGP). It was also least invasive of the procedures, with no permanent alteration of the anatomy. Laparoscopic and open surgery were equally effective but laparoscopic surgery operations took longer, resulted in little difference in
complications but had a shortened length of hospital stay. Jejunoileal bypass (JB) was effective in obtaining weight loss but was associated with serious complications such as liver disease.

Surgery was cost-effective when compared to conventional treatment and laparoscopic surgery was likely to be more cost-effective than open surgery because of reduced length of hospital stay. It was not possible to determine the best surgical interventions on the basis of cost-effectiveness.

A systematic review on surgery for morbid obesity by Colquitt et al. (2003) from the UK Cochrane Metabolic and Endocrine Disorders Group (level II grade evidence) concluded the following:

- Nearly all of the studies in this systematic review were included in the systematic review by Clegg et al. (2002), therefore its conclusions are similar.
- Surgery for people with morbid obesity was associated with greater weight loss (23-28 kg at 2 years) compared to conventional treatments where there was little overall sustained weight loss. Surgery was associated with improved QoL and reduced co-morbidities but there were high risks associated with surgery.
- Comparisons of various surgical procedures demonstrated that gastric bypass (RYGB) was more effective in achieving weight reduction for patients and had fewer revisions, re-operations and/or conversions than gastrectomy, but that it could cause significant complications. Adjustable banded gastroplasty (ABGP) resulted in greater weight loss and fewer complications and re-operations than vertical banded gastroplasty (VBGP). Although differences were not significant, gastric banding (GBnd) was associated with greater long-term weight loss, greater patient satisfaction, and fewer re-operations than vertical banded gastroplasty (VBGP), but more vomiting than horizontal gastroplasty (HGP). Laparoscopic and open surgery procedures produced similar weight loss but laparoscopic surgery resulted in fewer serious complications, a shortened length of hospital stay and return to normal activities sooner.
- The overall conclusion of this review was that the limited evidence is suggestive of surgery being more effective than conventional management for weight loss in patients with morbid obesity but that the comparative safety and effectiveness of the various surgical procedures is not clear.

Open versus laparoscopic gastric bypass and gastric banding procedures

An assessment by the Technology Evaluation Centre (TEC) of the Blue Cross and Blue Shield Association (Lefèvre et al. 2003a) (level III-2 grade evidence) determined whether or not less-invasive techniques applied to bariatric surgery such as laparoscopic gastric bypass (LRYGB) and laparoscopic gastric banding (LAGBnd) improved patient outcomes compared to open gastric bypass and also whether or not variations in gastric bypass (long-limb gastric bypass, bilio-pancreatic diversion) improved outcomes in super-obese patients (BMI = 50 kg/m²). The review concluded:

- An overview of the substantial literature on gastric bypass with Roux-en-Y anastomosis (RYGB) demonstrated greater clinical effectiveness of this procedure over other procedures. The majority of studies included in the analysis compared open RYGB with vertical banded gastroplasty (VBGP) while others compared RYGB with horizontal gastroplasty (HGP), open gastric banding (GBnd) and silastic ring gastroplasty (SRGP). These studies consistently showed that gastric bypass (RYGB) achieved greater excess weight loss than comparative procedures. In addition, there were no increases in complications compared with comparative procedures. Two other systematic reviews of single-arm studies on gastric bypass were overviewed as well. The analysis of this material demonstrated that excess-weight loss in patients following open RYGB ranged from 62-78% at one year follow-up and 63-70% at three year follow-up. Short and long-term adverse effects were difficult to ascertain from the data provided by the included studies.

- An assessment of the safety and effectiveness of open RYGB compared with laparoscopic gastric bypass (LRYGB), laparoscopic gastric banding (Lap-Band® or Swedish Adjustable Gastric Band) (LAGBnd) and bilio-pancreatic diversion or variants (distal gastric bypass or long-limb gastric bypass) for super-obese patients was undertaken. Few comparative and high quality trials were identified with much of the literature reviewed being single-arm studies with outcomes data on one procedure. There were numerous sources of variability reported in these studies in terms of patient
outcomes, follow-up, complications, surgical procedure, skill resources, patient characteristics and selection criteria.

Comparing the efficacy and safety of open RYGB with laparoscopic gastric bypass (LRYGB) there was a lack of high quality comparative studies and consistent data on adverse events. Data on excess-weight loss at one year demonstrated that both procedures were similar. Long-term data on complications were not sufficient to draw strong conclusions on safety although the data indicated that short-term serious adverse events such as anastomotic leaks may be more frequent with laparoscopic gastric bypass.

In comparing the efficacy and safety of open RYGB with laparoscopic gastric banding (Lap-Band® and/or Swedish Adjustable Gastric Band) (LAGBnd) there was similarly a lack of high quality comparative studies and most included studies were single arm clinical series. There was notable excess-weight loss at one year follow-up for laparoscopic gastric banding, but the overall percentage excess-weight loss was less than that for open gastric bypass (RYGB) and the data for a longer follow-up period was insufficient to draw strong conclusions. Short-term adverse events for laparoscopic gastric banding were reported to be low compared with open gastric bypass. Long-term data on complications for laparoscopic gastric banding such as erosion of the band through the gastric wall was limited and could not be adequately compared with complication rates for open gastric bypass.

A comparison of the efficacy and safety of open RYGB with biliopancreatic diversion or variants (distal gastric bypass or long-limb gastric bypass) in super-obese patients (BMI = 50 kg/m²) identified a limited amount of literature with no high quality comparative studies. The biggest source of data was from a voluntary registry but this data provided no controlled comparison group with open RYGB. The available evidence indicated that patient weight loss at one year was comparable with open RYGB but that there was insufficient data to make meaningful comparisons of complication rates between the procedures.

A systematic review by the Australian Medical Services Advisory Committee (MSAC 2003) (level III-2 grade evidence) reviewed laparoscopic adjustable gastric banding (LAGBnd) for morbid obesity. The value of LAGBnd in treating morbidly obese patients (BMI = 35 kg/m²) who had not responded to non-surgical interventions was evaluated and this was compared to open Roux-en-Y gastric bypass (RYGB) and vertical-banded gastroplasty (VBGP). This review built upon reviews on LAGBnd conducted by the Australian Safety and Efficacy Register of New Interventions-Surgical (ASERNIP-S) group (Chapman et al., 2002) and National Institute for Clinical Evidence (NICE) economic analysis (Clegg et al., 2001). The review concluded:

An assessment of the safety of LAGBnd safety was based upon lower NHMRC graded Level III and IV evidence which indicated that LAGBnd was at least as safe as its comparators open RYGB and VBGP. LAGBnd had a lower rate of mortality and re-operation than its comparator procedures but a shorter follow-up period may be the more valid reason for this.

An assessment of the clinical effectiveness of LAGBnd was based upon lower NHMRC graded Level III and Level IV evidence and no RCTs comparing LAGBnd with open RYGB or VBGP were identified. LAGBnd was found to be less effective in enabling weight loss than open RYGB and open RYGB patients were more satisfied with their procedure than LAGBnd patients. The length of procedure was longer and length of hospital stay was shorter for LAGBnd patients than RYGB patients.

LAGBnd was equally effective in enabling weight loss as VBGP but weight loss was maintained for longer in patients undergoing LAGBnd compared with VBGP. No significant differences were apparent in patients undergoing LAGBnd or VBGP procedures in terms of QoL measures, length of procedure and length of hospital stay. Obesity-related co-morbidities were resolved with all three procedures, however, no procedure was determined to be significantly better than the others in the resolution of co-morbidities. Level IV evidence indicated that weight loss may be maintained up to 7-years after the LAGBnd procedure.

A cost-effectiveness comparison of LAGBnd and VBGP, excluding revisions and complications, showed that LAGBnd was estimated to be more costly per patient treated in Australia. For
LAGBnd compared to open RYGB the cost difference was insignificant. The additional incremental cost was due to LAGBnd adjustment procedures and greater prosthetic and theatre costs not offset by reduced length of patient stay and reduced ICU costs. If included, lower rates of revision and complications would reduce the incremental cost. Based on updated National Institute for Clinical Evidence (NICE) economic analysis, LAGBnd had a net clinical effectiveness benefit over VBGP There were limitations in the methodology used for this estimate.

The NICE economic analysis found LAGBnd to be more costly and less effective than open RYGB (90% laparoscopic, 10% open) but more expensive and more effective than VBGP. The MSAC review suggested that RYGB is slightly preferable to LAGBnd in the Australian setting (equivalent effectiveness but slightly lower expected costs) but this could change if higher mortality associated with open RYGB is deemed to be more important than greater weight loss that is achieved with open RYGB.

The Technology Assessment Unit (TAU) of the McGill University Health Centre (MUHC) (level III-2 grade evidence) evaluated the safety, clinical effectiveness and cost-effectiveness of laparoscopic adjustable gastric banding (LAGBnd) for morbid obesity (Chen et al., 2004). Outcomes for the LAGBnd procedure were also compared with open Roux-en-Y gastric bypass (RYGB), which is also performed as a laparoscopic procedure (LR-en-Y gastric bypass or LRYGB) and these two laparoscopic procedures were compared for cost-effectiveness. The review was based on the systematic review by Chapman et al. (2002) produced by the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical (ASERNIPS). This review only included studies published up to June 2001. The TAU review updated this to include 19 additional studies published between May 2001 and February 2004. Conclusions were based upon cohort studies of mixed quality and follow-up periods as no RCTs were identified comparing LAGBnd with open RYGB. The review concluded:

Excess-weight loss from LAGBnd compared to open RYGB excess-weight loss was similar at three years follow-up and was sustained for both procedures at five years follow-up. There was no comparative data for laparoscopic RYGB. Both procedures had similar conversion rates from laparoscopic surgery to open surgery from complications. Operative mortality rates associated with LAGBnd were between 0.02-0.11% and for LRYGB this was 0.23%. Post-operative complications for the two procedures were similar, although following LAGBnd, corrective intra-abdominal surgery was relatively simple whereas following open RYGB it was considerably more serious. The reduction of obesity-related co-morbidities from bariatric surgery was substantial for all three (LAGBnd, open RYGB, LRYGB) procedures, and quality of life measures following LAGBnd showed significant improvement.

The cost to the MUHC for a LAGBnd procedure using the Swedish adjustable gastric band with two years follow-up costs, including the cost of complications was estimated to be CDN$ 7,771 and the equivalent for LRYGB was CDN$ 5,582. Apart from the cost of the gastric band, the direct costs for LAGBnd compared to LRYGB was similar. The estimated budgetary impact on the MUHC each year based on 150 surgical procedures using LRYGB when compared to LAGBnd (with the Swedish band) translated into a net saving of 59 additional LRYGB procedures.

In conclusion, the evidence supported LAGBnd as an effective procedure with an adequate safety record up to five years where data was available. The benefits of weight loss and reduced mortality and morbidity rates were comparable to open RYGB. No RCTs comparing the two procedures were identified, therefore it was difficult to determine the superior procedure. In terms of the Quebec health system the review identified an effective alternative in the LRYGB procedure, although it would be necessary to demonstrate clinically meaningful benefit of LAGBnd over LRYGB, in view of the 39% extra cost of performing a LAGBnd procedure compared to a LRYGB procedure.

A technology assessment (non-systematic review) by the Institute for Clinical Systems Improvement (ICSI) (level III-2 grade evidence) reported on vertical banded gastroplasty (VBGP) and open Roux-en-Y gastric bypass (RYGB) (Logan et al., 2000). This report originated in 1994, was updated in 1996 and again updated in 2000 with the incorporation of new evidence. The review concluded:
The 1996 update review concluded that both VBGP and open RYGB procedures are generally safe and reported mortality was less than 1.5% in centers with experience in these procedures. Both procedures produced substantial reductions in excess-weight, and this was sustained for up to five years. There was a lack of quality studies in the available evidence, as all of the studies with weight loss outcomes were clinical case series and follow-up often lacked objectivity to adequately assess complications and long-term postsurgical events. Where available, better quality studies provided evidence on post-surgical improvements in glucose intolerance while lower quality case reports indicated the resolution of other co-morbidities. Larger, longer-term and better designed studies were seen to be needed to better demonstrate comparative efficacy, improvements in co-morbidities and long-term survival.

An updated review of more recent evidence (Logan et al., 2000) found that both procedures produced sustainable weight loss for up to seven years or longer, with mean weight loss of over 50% of excess-weight reported at two years post-surgery. The review also reported as before that both procedures were generally safe with mortality of less than 1.5%. The quality of the evidence was low because of methodological weaknesses in the included studies, with many studies being clinical case series. However, several prospective cohort studies demonstrated improvements in glucose intolerance, hypertension, arthritis and some forms of hyperlipidemia for both procedures. Long-term weight loss, co-morbidity improvements and long-term survival, as in the previous earlier reviews could better ascertain with well designed studies. Clinical case reports suggested that open RYGB may be better at maintaining weight loss and co-morbidity reversal, but more data was needed.

A comprehensive systematic review by the Australian Safety and Efficacy Register of New Interventional Procedures-Surgical (ASERNIP-S) group (level III-2 evidence grade) reviewed literature on the safety and clinical effectiveness of laparoscopic adjustable gastric banding (LAGBnd) for patients with morbid obesity (Chapman et al., 2002). Studies ranged from Level II RCTs to Level IV clinical case series, these were identified from 121 potentially eligible articles. Studies on laparoscopic adjustable gastric banding (LAGBnd) (including Lap-Band® or the Swedish Adjustable Gastric Band) with and without comparison procedures open Roux-en-Y gastric bypass (RYGB) or vertical banded gastroplasty (VBGP) were included. The review concluded:

- Many included studies were limited by methodological weaknesses and reporting errors. Mortality associated with LAGBnd was no greater than that associated with open RYGB or VBGP in the short-term but long-term mortality outcomes could not be adequately determined.

- Overall LAGBnd was considered safer than open RYGB and VBGP but less effective for weight loss than open RYGB at up to two years follow-up and for 2-4 years follow-up the relative efficacy was unclear. It was difficult to determine the long-term efficacy of LAGBnd as follow-up periods were much shorter than those for RYGB and VBGP.

A non-systematic review on laparoscopic adjustable gastric banding (LAGBnd) (level III-2 grade evidence) by the Alberta Heritage Foundation (Schneider, 2000) assessed a group of nine studies from a concurrently published ASERNIP-S systematic review on laparoscopic adjustable gastric banding for the treatment of obesity (Chapman, 2000). Refer to the updated ASERNIP-S review in Chapman et al., 2002 included above. The review by Schneider (2000) concluded:

- The quality of the evidence from the included studies was of no better than average quality. All nine included studies reported decreases in BMI and weight and excess-weight loss after LAGBnd surgery. Additional well-designed studies with at least five year outcomes evaluation were considered to be required to better determine the relative safety and efficacy of the LAGBnd procedure compared to other procedures.

- Complications from LAGBnd such as band slippage, leaking bands and infection of the access port were reported in two studies and occurred in 12% of patients, while re-operations were required in 4% of cases.
Non-surgical (conventional) interventions for patients with morbid obesity

Two HTA reviews were included that compared surgical interventions with non-surgical interventions for patients with morbid obesity. More information is included in the evidence tables in Section 3.

A companion assessment to the review by Lefevre and Aronson (2003b) from the Technology Evaluation Centre (TEC) of the Blue Cross and Blue Shield Association compared the outcomes in patients receiving surgical with non-surgical interventions for morbid obesity (Lefevre & Aronson, 2003a (level III-2 grade evidence)). The objectives of this review was to compare weight loss, morbidity, mortality and quality of life outcomes in patients receiving either surgical or non-surgical interventions. The safety and efficacy of these various interventions were not assessed in this review as surgical interventions were assessed in the companion review outlined above. The review concluded:

- There was good evidence that surgical interventions improve outcomes for morbidly obese patients compared to non-surgical interventions. The best evidence was from the high-quality Swedish Obese Subjects (SOS) intervention trial, with results from six years of follow-up reported in six different articles meeting the review inclusion criteria. Weight loss for surgical patients was significantly greater than those receiving non-surgical interventions. Obesity-related co-morbid conditions such as diabetes improved significantly for surgical patients compared to non-surgical intervention patients. Although the incidence of hypertension and hypertriglyceridemia decreased at two years after surgery this was not maintained for longer follow-up periods. There was also improvements in the quality of life measures of patients receiving surgical interventions compared to those receiving usual care.

- Eleven single-arm studies reported on patient weight loss and other health outcomes resulting from various surgical procedures. These demonstrated improved outcomes for patients in these clinical series but provided no comparison with non-surgical interventions.

A Succinct and Timely Evaluated Evidence Review (STEER) (level III-2 grade evidence) produced by the Wessex Institute for Health Research & Development at the University of Southampton (Allgood, 2001) assessed the weight loss effects of surgical interventions compared with behavioural, motivational and psychological interventions for patients with morbid obesity. The evidence from an included systematic review of 15 RCTs plus one other RCT and one non-randomised trial indicated that surgical interventions were more effective in producing weight loss in patients with morbid obesity in the short-term than non-surgical interventions or placebo. Although study quality was generally poor and the included systematic review had studies with over-weight and obese patient populations thereby limiting applicability of its findings to morbidly obese patients, data was suggestive of improved quality of life outcomes but also serious adverse effects associated with surgery.

Two other extensive and very recent systematic reviews (Avenell et al., 2004; Shekelle et al., 2004) included here but not in the evidence tables looked at studies on non-surgical treatments for obese patients but also included studies on surgical interventions for patients with morbid obesity. In the studies dealing with non-surgical interventions the baseline patient BMI was defined as BMI = 30, whereas included studies dealing with surgical interventions had notably higher baseline BMIs in the morbid obesity categories of BMI = 40 or BMI = 35 with significant obesity-related co-morbidities. Surgical treatments of morbidly obese patients are usually indicated for patients who have not responded to conventional treatments and are not usually intended or appropriate for those with a BMI of less than 30. The validity of the findings from studies looking at non-surgical interventions for obese patients are limited when trying to extrapolate these to morbidly obese patients, as similar actual weight loss in the two groups of patients can result in quite different outcomes such as complications, quality of life and the resolution of obesity related co-morbidities.

The systematic review by Avenell et al. (2004) undertaken by the NHS R&D Health Technology Assessment (HTA) Programme, evaluated obesity treatments in adults to determine those that achieve weight reduction, risk factor modification or improved clinical outcomes. A total of 84 RCTs with at least one year follow-up were included, covering both non-surgical and surgical interventions. Study samples of obese subjects with a median or mean minimum BMI of 28 kg/m² was the cut-off for inclusion. Comparisons were made with other non-surgical interventions or placebo controls. An economic analysis evaluating the cost-effectiveness of obesity treatments was also performed. There were limitations in the evidence as many included studies had methodological problems such as small
The evidence for the safety and effectiveness of surgical and non-surgical interventions for patients with morbid obesity?

sample sizes, inadequate reporting, limited follow-up, and few quality of life data. The systematic review concluded:

- The drugs orlistat, sibutramine and metformin added to a dietary programme were associated with a small weight reduction (< 5 kg) and a reduction in various obesity-related risk factors after 18 months to two years. Low-fat diets (including 600 Kcal/day deficit diets) were shown to be associated with a small weight reduction (< 6 kg) after 12-months to three years, prevention of type-2 diabetes and control of hypertension. There was insufficient evidence to assess the benefits of low-calorie or very low-calorie diet programmes.

- Low fat diet combined with exercise programmes, with or without behavioural therapy, demonstrated improved control over hypertension and type-2 diabetes, with responses for up to three years. The addition of exercise programmes to dietary programmes produced some weight loss and a reduction in risk factors in the first year. The addition of behavioural therapy programmes to dietary programmes also produced some weight loss in the first year. It was not clear if the combination of both exercise and behaviour therapy improved the effect of diet on weight loss.

- Family therapy programmes improved weight loss compared to that for individual therapy programmes up to two years. Women who had intentional weight loss within one year had a reduction in the risk of obesity-related death, such as risk of CVD death, cancer and diabetes death. Males only had a reduced risk of diabetes-related death. Longer-term weight loss and the reduced risk of developing obesity-related conditions was apparent from the limited literature review on surgery for obesity.

- Economic analysis evaluating the cost-effectiveness of obesity treatments demonstrated that targeted drug or surgical interventions will cost per additional life-year or quality-adjusted life-year (QALY) no more than £13,000. Cost-savings from treatment of patients with type-2 diabetes with metformin were evident. Targeted surgical interventions for people with severe obesity were likely to be cost-effective, with an estimated £2,329 cost per additional life-year. Economic modeling of diet and exercise programmes over a six year period for patients with impaired glucose intolerance was initially a very high cost per additional QALY and by the 6th year this cost per QALY was £13,389. These results were very sensitive to the quality of life weightings used, as limited data was available and the results may be conservative as they did not include cost savings from diseases other than diabetes. The costs of combined dietary and exercise interventions appeared to be comparable to drug treatments in patients with impaired glucose intolerance.

The second systematic review by Shekelle et al. (2004) prepared by the RAND Evidence-Based Practice Center for the Agency for Healthcare Research and Quality (AHRQ) assessed the safety and effectiveness of pharmacological treatments for weight loss in adults and children with obesity, and the safety and effectiveness of surgical treatments for weight loss in adults and children with morbid obesity. The relative safety and effectiveness of various types of bariatric surgery (restrictive, bypass and combined procedures) was also assessed. The review concluded:

- Overall, 78 pharmacological studies were included and quality assessed, made up of the number of studies reporting on sertraline (1), zonisamide (1), orlistat (49), bupropion (5), topiramate (9), and fluoxetine (13). All of these studies were assessed by meta-analysis, except sertraline and zonisamide. A total of 167 surgical studies reporting on weight loss and/or complications were also assessed. The weight loss analysis included 89 studies, the mortality analysis included 134 studies, and the complications analysis included 128 studies, with some studies being included in more than one analysis. Limitations in the design and execution of studies included in this review were not used to define their relative importance in the meta-analysis. Most studies of orlistat and fluoxetine had a Jadad score (a quality score associated with less bias) of 3 or greater. Publication bias was assessed in the meta-analyses and only in one instance was identified for orlistat at 12-months follow-up. There was evidence of study heterogeneity for all medications in all meta-analyses undertaken. The follow-up times assessed in the pharmacological studies were considerably shorter compared to surgical studies which contained a wide variability in follow-up periods. The generalisability of findings were limited to the actual study participants given the stringent selection criteria to exclude certain co-morbidities.
The results of the pharmacological analysis found the following: a previously published meta-analysis of sibutramine vs placebo showed mean weight loss of 3.4 kg at 6-months and 4.5 kg at 12-months, small improvements in co-morbidities but moderate increases in blood pressure and heart rates. A meta-analysis of included primary studies on orlistat vs placebo found mean weight loss of 2.5 kg at 6-months and 2.8 kg at 12-months. There was an increase in gastrointestinal complications in patients on orlistat. An already published review of phentermine vs placebo studies found weight loss of mean 3.6 kg at 6-months and diethylpropion vs placebo studies 3.0 kg at 6-months but no complications were reported. No new RCTs were identified since publication of this meta-analysis. Meta-analysis of fluoxetine vs placebo studies found a mean weight loss of 4.7 kg at 6-months and 3.0 kg at 12-months. There was an increase in side effects such as nausea/vomiting, sleep disorders, fatigue and diarrhea. Meta-analysis of three studies on bupropion vs placebo for weight loss showed a reduction of 2.8 kg at 6 and 12-months and side effects of a dry mouth and insomnia. A total of six studies of topiramate vs placebo for weight loss in abstract form only were included in meta-analysis and showed a 6.5% decrease in weight from pre-treatment.

Overall, the RCT data indicated that a range of pharmacological treatments all enhance weight loss for the first 6-months and probably up to 12-months when used in conjunction with diet and other interventions. The amount of weight loss is however small (<5 kg at 12-months) and the clinical significance of this in obese patients is unclear. Orlistat and sibutramine were the most studied medications, and other less well studied treatments included phentermine, diethylpropion, fluoxetine, bupropion and topiramate. Side effects varied by drug. Meta-analysis was based on placebo compared trials and relative efficacy was not compared, nor optimal treatment duration, age, gender, and race analysis. Most drugs appeared to be effective in promoting only modest weight loss.

Bariatric surgical treatments are commonly performed in patients with morbid obesity, BMI = 40 and result in significant and sustained weight loss compared to non-surgical treatments. All of the studies on RYGB, VBGP and adjustable banding procedures reported substantial weight loss, with RYGB providing greater weight loss than VBGP procedures. For patients with BMI = 40, surgery resulted in greater weight loss and resolution of co-morbidities than did conventional medical treatments. For patients in the BMI = 35-40 category, limited data were suggestive of greater and sustained weight loss for bariatric surgical treatments compared to non-surgical treatments. Post-operative mortality rates in experienced centers were low (<1%). There were few clinical trials comparing outcomes between different procedures and the existing limited data indicates that there may be important clinical differences in adverse events. Minor complications were quite prevalent in the included studies. Laparoscopic surgical procedures resulted in fewer wound complications than open procedures.

**EVIDENCE TABLES**

Studies in the evidence tables are organised by year and alphabetical order as follows:

- **Table 2 (page 19)** Health Technology Assessment (HTA) reviews of non-surgical interventions compared to surgical interventions for patients with morbid obesity.

- **Table 3 (pages 20-31)** Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity.
### Table 2. Health Technology Assessment (HTA) review of non-surgical interventions compared to surgical interventions for patients with morbid obesity

<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
<th>Interventions and methods</th>
<th>Results - comparative studies including RCTs of surgical versus non-surgical interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allgood (2001)</td>
<td>Surgical interventions for weight reduction compared to non-surgical (behavioural, motivational, psychological) interventions.</td>
<td>$\text{One good quality systematic review was included with 15 RCTs, though the included studies were generally of poor methodological quality and included overweight and obese subjects. The weight loss associated with surgical interventions was significantly greater than for non-surgical interventions or placebo and weight loss was maintained for longer. Six RCTs found significantly greater weight loss from gastric bypass than after gastroplasty but no longer-term effects and increased complications were associated with either surgery. Also re-operation rates were reported to be 12% to 33% after gastroplasty.}$</td>
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<tr>
<td>The Wessex Institute STEER report Systematic review Evidence grade III-2 UK</td>
<td>Participants diagnosed with morbid obesity, BMI = 40. Search: to 2001, English only, Medline, Embase, DARE, NHS, Cochrane databases.</td>
<td>$\text{One randomised (abstract only), one non-randomised controlled trial (Swedish SOS study) and two clinical case series (with surgical outcomes but no control group) were also included. The RCT found weight loss to be significantly greater in patients having surgery compared to those receiving dietary interventions at 40 weeks follow-up. The SOS trial showed that surgery resulted in significantly greater weight loss than non-surgical interventions at two years of follow-up.}$</td>
</tr>
<tr>
<td>Lefevre &amp; Aronson (2003b) Technology Evaluation Centre (TEC) Blue Cross and Blue Shield Association Non-systematic review Evidence grade III-2 USA</td>
<td>An overview of the comparative and single-arm studies with 1+ years follow-up comparing patient outcomes from surgical and nonsurgical interventions. Participants diagnosed with morbid obesity with BMI = 40 or BMI 35-40 and significant co-morbidities. Search: 1985-2003, English only, Medline, Current Contents, Cochrane, PubMed.</td>
<td>$\text{The Swedish Obese Subjects (SOS) intervention trial with results from six different articles meeting the inclusion criteria. This ongoing non-randomised comparative study had over 1,000 patients enrolled and follow-up data for some patients for at least six years.}$</td>
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<td>$\text{Weight loss for surgical patients was markedly greater than those receiving usual care non-surgical interventions (16% decline in body weight versus an increase of 0.8% at six years). Co-morbidities such as diabetes significantly improved, with an incidence rate of 3.6% for surgical patients versus 18.5%, for non-surgical intervention patients ($p=0.0001$) at a mean follow-up period of 5.5 years.}$</td>
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<td>$\text{The incidence of hypertension decreased at two years after surgery (0.2% versus 6.3%, $p&lt;0.001$) and the incidence of hypertriglyceridemia also declined (0.8% versus 7.7%, $p&lt;0.001$). This was not maintained for longer follow-up periods. There were also improvements in the quality of life measures for patients receiving surgery compared to those receiving usual care.}$</td>
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<td>$\text{One smaller RCT (n=60) supported findings from the SOS study, where longer-term follow-up showed that the low-calorie diet group had greater relapse. Eleven single-arm studies were also included which reported on patient weight loss and other health outcomes resulting from various surgical procedures. Improved outcomes were evident for patients receiving these interventions and these results concurred with the patient arm in the SOS study receiving surgery but provided no comparison with non-surgical interventions.}$</td>
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</table>
Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity

<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
<th>Interventions and methods</th>
<th>Results – comparative studies of laparoscopic adjustable gastric banding, open and laparoscopic (Roux-en-Y) gastric bypass surgical procedures</th>
<th>Clinical efficacy and safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen et al. (2004)</td>
<td>Safety and effectiveness of laparoscopic adjustable gastric banding (LAGBnd) (including Lap-Band® and the Swedish Gastric band) with comparison procedures Roux-en-Y gastric bypass (RYGB) and laparoscopic (LR-en-Y) gastric bypass (LRYGB) for a cost-effectiveness comparison.</td>
<td>This review was based on the systematic review by the Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIPs) on laparoscopic adjustable gastric banding LAGBnd (Chapman et al., 2002), the review only included studies published up to June 2001. This TAU review updates the ASERNIPs review to include 19 additional studies published between May 2001 and February 2004. The overall review conclusions were based upon cohort studies of mixed quality and follow-up periods, and no RCTs were identified comparing LAGBnd with open RYGB.</td>
<td>LAGBnd enabled excess weight loss averaging 50% and open RYGB 60%, slightly greater at three years and was sustained for both procedures up to five years. Conversion rates to open surgery from complications were similar in both laparoscopic procedures. Operative mortality rates associated with LAGBnd were between 0.02-0.11%. For open RYGB this was 0.23%. Post-operative complications between these two procedures were comparable. The reduction in obesity related co-morbidities following bariatric surgery was substantial for both procedures, with quality of life measures of patients following LAGBnd surgery showing significant improvement. One comparative study indicated that patients attitudes were more positive about open RYGB than LAGBnd.</td>
</tr>
<tr>
<td>Technology Assessment Unit McGill University Systematic review Evidence grade III-2 Canada</td>
<td>Participants: patients diagnosed with morbid obesity with a BMI = 40 or BMI 35-40 and the presence of significant co-morbidities. Search: to February 2004, English only, selected journals, HTA, DARE, NHS, Cochrane, TRIP, Medscape, professional organisation websites. No critical appraisal, lack of information about review methods.</td>
<td></td>
<td>The cost to the McGill University Health Centre for a LAGBnd procedure using the Swedish Band including two years follow-up and complications costs, was estimated to be CDN$7,771, and the equivalent LRYGB procedure CDN$ 5,582. The direct costs for LAGBnd (CDN$ 9,418) c.f. LRYGB (CDN$ 7,064) were comparable, apart from the cost of the gastric band. The estimated budgetary saving for the MUHC each year based upon 150 surgical procedures using LRYGB would be a net saving of CDN$ 328,320 if compared to if all 150 procedures were undertaken using LAGBnd (using the Swedish band), a saving equivalent to 59 additional LRYGB procedures.</td>
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</table>
**Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity (continued)**

<table>
<thead>
<tr>
<th>Authors, study design, country, Evidence grading</th>
<th>Interventions and methods</th>
<th>Results – RCTs and non-RCTs of various non-surgical treatments and surgical procedures</th>
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</thead>
<tbody>
<tr>
<td>Coquitt et al. (2003) Cochrane Group Systematic Review Evidence grade II UK</td>
<td>RCTs and non-RCT, comparing different surgical procedures and comparing non-surgical management for morbid obesity. Participants: diagnosed with morbid obesity with BMI = 40 or BMI 35-40 and significant co-morbidities and failure of previous non-surgical interventions. Meta-analysis was not possible due to the variation in surgical interventions used, measures of weight change and length of follow-up. Search: to 2001, Medline, PubMed, Embase, CINAHL, BMI, PsychINFO, SSCI, Cochrane database, BIOSIS, AMED, reference lists, Web of Science, National Research registry. Critical appraisal, two reviewers.</td>
<td>A total of 18 RCTs and 1 non-RCT was included in this systematic review. Surgery c.f. conventional (nonsurgical) treatment: 2 RCTs, 1 non-RCT. Gastric surgery resulted in significantly greater weight loss (23-28 kg) by two years than for conventional treatment and in one study (21 kg weight loss) was maintained at 8 years. There was a reduction in co-morbidities and improvement in QoL but some side effects/complications resulted from surgical procedures. A total of 18 RCTs and 1 non-RCT was included in this systematic review. Surgery c.f. conventional (nonsurgical) treatment: 2 RCTs, 1 non-RCT. Gastric surgery resulted in significantly greater weight loss (23-28 kg) by two years than for conventional treatment and in one study (21 kg weight loss) was maintained at 8 years. There was a reduction in co-morbidities and improvement in QoL but some side effects/complications resulted from surgical procedures. Open gastric bypass (RYGB) c.f. gastroplasty (GP) 11 RCTs. Open gastric bypass (RYGB) c.f. gastroplasty (GP) 11 RCTs. Open gastric bypass (RYGB) c.f. gastroplasty (GP) 11 RCTs. QoL was not assessed in any of the gastric bypass trials. Most trials had a risk of bias. Side effects were more evident after open RYGB than different forms of gastroplasty (GP). Revisions, re-operations, and/or conversions were more common following gastroplasty (for vertical 2-53% of patients, horizontal 1-19% of patients). Additional procedures were more common after gastric bypass. Open RYGB c.f. VBGP 4 RCTs. Two studies found significant excess weight loss with open RYGB c.f. VBGP at 12 months and even greater difference at five years. Two other studies found no significant difference in weight loss at 3-5 years. Open RYGB c.f. VBGP c.f. G Bnd 1 RCT. Greater mean excess weight loss with open RYGB at 18 months, but not statistically significant. RYGB c.f. HGP 5 RCT. Significantly greater weight loss for patients undergoing RYGB at 12 months with 35% to 42% excess weight loss c.f. 16% to 29% for HGP. Improvement in co-morbidities was reported in three RCTs. Open RYGB c.f. VBGP c.f. G G 1 RCT. A significantly greater number of patients undergoing gastric bypass (67%) had significant weight excess loss maintained at three years c.f. VBGP (48%) and GG (17%). VBGP c.f., HGP 1 RCT. After surgery the VBGP group lost an average of 10kg while the HGP group gained weight. Study bias risk. VBGP c.f., AG Bnd 1 RCT. Greater weight loss over five years with AG Bnd (43 kg) c.f. VBGP (35 kg). Study bias risk. Open vs laparoscopic RYGB vs LRYGB 2 RCTS. There was similar results for weight loss and patient satisfaction, but laparoscopic surgery took longer in theatre, but patients had quicker recovery. There was little difference in complications. Study bias risk. Open vs laparoscopic ASGBnd 1 RCT. Smaller weight loss at 12 months (&gt;-34 kg), laparoscopic surgery led to shorter hospital stays and fewer re-admissions. There was little difference in complications. Study bias risk.</td>
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<tr>
<td>Authors, study design, country, evidence grading</td>
<td>Interventions and methods</td>
<td>Results – comparative studies including RCTs of gastric bypass compared to other surgical procedures</td>
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</table>
| Lefevre & Aronson (2003a) Technology Evaluation Centre (TEC) Blue Cross and Blue Shield Association Systematic review Evidence grade III-2 USA | Overview of comparative studies with 1+ years follow-up on gastric bypass with Roux-en-Y anastomosis (RYGB) compared with other established surgical procedures | Open gastric bypass with Roux-en-Y anastomosis (RYGB) c.f. vertical banded gastroplasty (VBGP)
9 comparative studies with 1 RCT, n=3,780 patients
All trials showed greater excess weight loss (28-43%) with open RYGB and 19-36% more patients with over 50% loss of excess weight compared to VBGP. There was limited data on complications but more of these with open RYGB, although there were low serious complications but longer term side effects such as vomiting was reported in both groups and there were high revision rates for VBGP. |
| Lefevre & Aronson (2003a) Technology Evaluation Centre (TEC) Blue Cross and Blue Shield Association Systematic review Evidence grade III-2 USA | Participants diagnosed with morbid obesity with BMI ≥ 40 or BMI 35-40 and significant comorbidities and failure of previous nonsurgical interventions. Also patients with super obesity BMI ≥ 50 as a special sub-group. Search: 1985-2003, English only, Medline, Current Contents, Cochrane, PubMed. Advisory committee, critical appraisal. | Open gastric bypass with Roux-en-Y anastomosis (RYGB) c.f. horizontal gastroplasty (HGP)
(2 comparative studies, n=261 patients)
All trials showed greater excess weight loss (54-129%) with open RYGB and 49% more patients with over 50% loss of excess weight compared to HGP. There was limited data on complications but low incidence of serious complications. |
| Lefevre & Aronson (2003a) Technology Evaluation Centre (TEC) Blue Cross and Blue Shield Association Systematic review Evidence grade III-2 USA | Open gastric bypass with Roux-en-Y anastomosis (RYGB) c.f. open gastric banding (GBnd)
(2 comparative studies, n=285 patients)
All trials showed greater excess weight loss (13.3kg greater) with open RYGB and 39% more patients with over 50% loss of excess weight. No data on complications was reported. | Open gastric bypass with Roux-en-Y anastomosis (RYGB) c.f. Silastic ring gastroplasty (SRGP)
(1 comparative study, n=817)
One trial showed greater excess weight loss (34%) with open RYGB but comparative data was limited. There was limited data on complications but were of greater incidence with open RYGB. |
Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity (continued)

<table>
<thead>
<tr>
<th>Authors, study design, country, Evidence grading</th>
<th>Interventions and inclusion criteria</th>
<th>Results – comparative and single-arm studies of gastric bypass compared to laparoscopic and minimally invasive surgical procedures</th>
<th>Clinical efficacy and safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lefevre  &amp; Aronson (2003a) Technology Evaluation Centre (TEC) Blue Cross and Blue Shield Association Systematic review Evidence grade III-2 USA (continued)</td>
<td>Assessment of comparative studies with 1+ years follow-up on the effectiveness of minimally invasive and alternate procedures compared with the ‘gold standard’ open gastric bypass (RYGB). Participants diagnosed with morbid obesity with BMI =40 or BMI 35-40 and significant co-morbidities and failure of previous nonsurgical interventions. Also patients with super obesity BMI =50 as a special sub-group. Search: 1985-2003, English only, Medline, Current Contents, Cochrane, PubMed. Advisory committee, critical appraisal.</td>
<td>Open gastric bypass with Roux-en-Y anastomosis (RYGB) c.f. laparoscopic gastric bypass (LRYGB) (3 comparative studies, n=278 and 8 single-arm studies n=3,539 patients). The comparative studies were all of poor quality, two were RCTs and one a non-randomised trial. Weight loss outcomes at one year were similar between groups, where reported and adverse events were inadequately reported in all three studies. No definite conclusions were made about weight loss and complications because of the methodological limitations in these studies. Six of the eight single-arm studies reported weight loss at one year in the range of 56-77%, similar to that of open RYGB at 62-78%. Significantly fewer patients were available for an analysis at longer periods of follow-up. Complications were reported for all of these studies with deaths being infrequent but insufficient data (though higher incidence of anastomotic leaks for LRYGB) to make conclusions in other short and long-term complications.</td>
<td>Gastric bypass with Rouxen-Y anastomosis (RYGB) c.f. laparoscopic gastric banding (LAGBnd) (Lap-Band® or Swedish Adjustable Gastric Band) (1 comparative study, n=261 patients and 32 single-arm studies with 23 using Lap-Band®, 6 Swedish Adjustable Gastric Band and 3 studies with patients treated with both types of gastric band, 12,549 patients). The comparative study reported that 93% versus 54% of patients receiving open RYGB achieved over 50% excess weight loss compared with LAGBnd and no complications data were reported. For single-arm studies there was a high degree of incomplete data on outcomes. With Lap-Band®, 14 studies reported excess weight loss at one year in the range of 35-58%, markedly lower than that for gastric bypass (56-78%). At three years only 8 studies reported results, 37-77%, which overlapped that of open RYGB for the same period of follow-up. Data on complications demonstrated that short-term adverse events were few with LAGBnd, and lower than RYGB, while long-term adverse events could not be easily characterised from the data available or compared to those of gastric bypass.</td>
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<td>Gastric bypass with Rouxen-Y anastomosis (RYGB) c.f. biliopancreatic diversion or variants (distal gastric bypass or long-limb gastric bypass) for super-obese patients (2 comparative studies, n=1,905 patients and 3 single-arm studies, n=863 patients). The comparative studies were rated poor quality and reported excess weight loss was in the 55-77% range, similar to that of open standard RYGB and reported complications higher with open standard RYGB than with long-limb gastric bypass but small numbers of patients meant comparisons were not possible in one study. The single-arm studies provided little data on follow-up, with one study reporting excess weight loss at one year of 57-74% and three years 56-77%, similar to standard open RYGB. Complications were low for those reported but limited for comparison purposes.</td>
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<tr>
<td>Authors, study design, country, evidence grading</td>
<td>Interventions and methods</td>
<td>Results – comparative studies including RCTs of laparoscopic gastric banding, open vertical banded gastroplasty, open (Roux-en-Y) gastric bypass - surgical procedures</td>
<td>Clinical efficacy and safety</td>
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<tr>
<td>Medical Services Advisory committee (2003)</td>
<td>Surgical interventions for morbid obesity: RCTs of LAGBnd, open VBG or open RYGB (Roux-en-Y) and non RCTs comparing LAGBnd with open RYGB (Roux-en-Y) or open VBG. Non-comparative studies of LAGBnd also included as supportive evidence of the safety and effectiveness of LAGBnd. Participants: patients diagnosed with morbid obesity with a BMI ≥35 who have failed to lose weight from non-surgical conventional approaches. Search: Medline, Embase, Cochrane databases, NICE, DARE, HTA, EED databases, English only. Critical appraisal, 2 reviewers, advisory committee.</td>
<td>No RCTs or systematic reviews of RCTs comparing LAGBnd with open RYGB or VBG identified. Non-RCT comparative studies comparing LAGBnd to open RYGB or VBG (level III-2 and III-3 evidence). LAGBnd c.f. VBG (3 studies) LAGBnd c.f. RYGB (3 studies) LAGBnd c.f. RYGB c.f. VBG (1 study). On the basis of lower level (NHMRC graded Level III and Level IV) evidence LAGBnd was as safe as its open VBG and RYGB comparators. LAGBnd had a lower rate of mortality and re-operation than open VBG and RYGB procedures but this may be artificial due to shorter follow-up periods. LAGBnd was less effective than open RYGB in terms of enabling weight loss and LAGBnd patients were less satisfied than those having the open RYGB procedure. Hospital length of stay was lower for LAGBnd patients. LAGBnd was as equally effective as open VBG in terms of weight loss. There is some evidence that weight loss is maintained longer in patients who have undergone LAGBnd than in patients who have undergone open VBG. There were no significant differences in terms of QoL measures, length of procedure and length of hospital stay in patients with open VBG or LAGBnd. Open RYGB patient hospital length of stay and operations were longer due to their complexity and extent compared with open VBG or LAGBnd. There was insufficient evidence to show that any one of the three procedures was better than any other at resolving obesity related co-morbidities. RCTs with a single arm with open RYGB, open VBG or LAGBnd (Level IV evidence). LAGBnd arm (2 RCTs), open RYGB and a VBG arm (3 RCTs), open RYGB arm (11 RCTs), open VBG arm (3 RCTs). Case series studies on LAGBnd but no comparison with open RYGB or VBG (Level IV evidence). LAGBnd consecutive case series with N&gt;200 patients (28 studies). NHMRC graded Level IV evidence from a limited number of patients indicated that weight loss could be maintained up to seven years after an LAGBnd procedure. Open RYGB patients lost weight for 1-2 years before maintaining weight at the lower level.</td>
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</table>
# Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity (continued)

<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
<th>Interventions and methods</th>
<th>Results – comparative studies including RCTs of laparoscopic gastric banding, open vertical banded gastroplasty, open (Roux-en-Y) gastric bypass surgical procedures</th>
<th>Cost-effectiveness</th>
</tr>
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<tbody>
<tr>
<td>Medical Services Advisory committee (2003)</td>
<td>Surgical interventions for morbid obesity: RCTs for LAGB, open VBG or open RYGB (Roux-en-Y) and non-RCTs comparing LAGB with open RYGB (Roux-en-Y) or open VBG. Non-comparative studies of LAGB also included as supportive evidence of the safety and effectiveness of LAGB. Participants: patients diagnosed with morbid obesity with a BMI ≥ 35 who have failed to lose weight from nonsurgical conventional approaches. Search: Medline, Embase, Cochrane databases, NICE, DARE, HTA, EED databases, English only. Critical appraisal, 2 reviewers, advisory committee.</td>
<td>Cost-effectiveness incorporating extra evidence published since the NICE review (2001) LAGB was estimated to cost $A912 more than open RYGB per patient treated in Australia. The evidence was not conclusive regarding the net treatment effect and increased cost of LAGB c.f. open RYGB. It was estimated that LAGB is $A3,665 more costly per patient treated in Australia c.f. open VBG, excluding complications and revisions. Weight loss was equivalent in the short-term but greater in LAGB patients in the longer term. The incremental cost reflected LAGB adjustment procedures, greater prosthetic, theatre and ICU costs not offset by the reduced hospital length of stay. Lower rates of revision and complications would reduce the incremental cost but no RCTs were available for unbiased estimation in a randomised population. Australian costing, excluding revisions/complications, found that at two years LAGB treatment was expected to be $1,000 per patient more expensive than open RYGB, unless higher mortality associated with open RYGB was deemed to be more important than greater weight loss. A maximum incremental cost-effectiveness ratio for LAGB c.f. VBG of $A26,178 (3665/0.14 (NICE QALY estimate)) per QALY gain per patient can be inferred.</td>
<td>This MSAC review updated the earlier National Institute for Clinical Evidence (NICE) review (Clegg et al., 2001) on the clinical and cost-effectiveness of surgery for people with morbid obesity. The NICE review indicated that: - incremental cost-effectiveness has a trade-off in weight loss versus mortality, with utility weights applied to effects for weight loss and mortality, over a 20-year period, in a cohort comprising 90% females, mean age 40 years, BMI 45, baseline body weight 135 kg. - LAGB had a lesser clinical benefit of 0.02 QALYs per patient ($1,168 extra cost per patient) c.f. RYGB, and LAGB greater net clinical benefit of 0.14 QALYs per patient ($1,031 extra cost per patient) than VBG. - the total net costs for treating morbid obesity (over 20 years) varied from £9,627 for VBG to £10,795 for silicon ASGB. Surgical procedures were more costly than usual conventional care, with net costs of £6,964 over 20 years. - surgery c.f. non-surgical management over 20 years offered QALYs at an additional net cost per QALY ranging from £7,064 for RYG, £11,459 for VBG and £10,195 for ASGB. The comparison between these procedures was not so clear with RYG c.f. VBG, with a small net cost per QALY gained of (£838/QALY), while ASGB was (£49,894/QALY). Refer to review by Clegg et al. (2002) which updates the NICE review material.</td>
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What Is The Evidence for the Safety and Effectiveness of Surgical and Non-Surgical Interventions for Patients With Morbid Obesity?
Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity (continued)

<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
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<th>Results – comparative studies including RCTs of laparoscopic adjustable gastric banding, Roux-en-Y gastric bypass, vertical banded gastroplasty compared to other surgical procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapman et al. (2002) ASERNIPSY Systematic review Evidence grade III-2 Australia</td>
<td>Laparoscopic adjustable gastric banding (LAGBnd) (including Lap-Band® or the Swedish Gastric band) with and without comparison procedures Roux-en-Y gastric bypass (RYGB) or vertical banded gastroplasty (VBGP).</td>
<td>NHMRC levels of evidence graded studies including one level II RCT, four level III-2 studies, eleven level III-3 studies and Level IV case series were identified from the 121 eligible articles. Six comparative studies compared LAGBnd with other procedures, 64 studies reported results for LAGBnd only and 57 studies reported results for other comparative surgical procedures. Many studies were limited by methodological weaknesses such as short-term follow-up, small sample sizes, baseline differences in patient comparison groups, the effect of surgeon learning curves for new procedures on outcomes and reporting inadequacies and errors.</td>
</tr>
</tbody>
</table>

In terms of the mortality associated with LAGBnd, this was no greater than that associated with open RYGB or VBGP in the short-term. It was not possible to determine long-term effects. The overall morbidity rate for LAGBnd was 11.3% (range 0-68%) whereas median morbidity rates for open RYGB and VBGP were 27.4% (0-77%) and 23.6% (0-93%) respectively.

At four years, excess weight loss (from three studies) was 44-68% in the LAGBnd group, 40-77% in the open VBGP group and 50-67% in the open RYGB group. The re-operation rates were 1.7-66.7% for LAGBnd and 1.4%-23.1% for open RYGB. The mean post-operative stay was 1.2-11.8 days and for LAGBnd and for open RYGB it was 1.6-8.4 days. Only one study compared the resolution of co-morbidities with the three procedures and found no difference between them.

Overall it was concluded that LAGBnd was safe compared with open RYGB and VBGP but less effective for weight loss than open RYGB. It was difficult to determine the long-term efficacy of LAGBnd as follow-up periods were much shorter than those from data available for open RYGB and VBGP.
<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
<th>Interventions and methods</th>
<th>Results – RCTs and non-RCTs of various non-surgical treatments and surgical procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clegg et al. (2002)</td>
<td>Clinical efficacy of randomised and non-randomised trials of 1+ years follow-up for surgical interventions compared with each other or non-surgical interventions.</td>
<td>A total of 17 RCTs and 1 non-RCT were included in the systematic review</td>
</tr>
<tr>
<td>NHS R&amp;D HTA Programme</td>
<td>Cost-effectiveness economic evaluations of surgery compared to usual care.</td>
<td>Surgery c.f. conventional (non-surgical) treatment: 2 RCT, 1 non-RCT</td>
</tr>
<tr>
<td>Systematic review</td>
<td>Intervention (restrictive or malabsorptive) procedures performed either as open or laparoscopic procedure.</td>
<td>Gastric surgery resulted in significantly greater weight loss (23-37 kg) by two years than conventional treatment and in one study (21 kg weight loss) was maintained at 8 years. There was a reduction in co-morbidities, improvement in QoL and side effects/complications from surgical procedures.</td>
</tr>
<tr>
<td>Evidence grade II UK</td>
<td>Participants diagnosed with morbid obesity with BMI = 40 or BMI 35-40 and significant co-morbidities and failure of previous non-surgical interventions.</td>
<td>Surgery c.f. surgery procedures: 15 RCTs.</td>
</tr>
<tr>
<td>Search: to 2001, Medline, Embase, PubMed, Cochrane database, PsychINFO, BNI, CINAHL, BIOSIS, Web of Science, National Research Register, HealthSTAR, EconLit, NHSEED, HNC.</td>
<td>- Open RYGB c.f. GP: 8 RCTs</td>
<td>Open RYGB was more beneficial with 6-14 kg more weight lost than gastroplasty (GP) for both HGP or VBGP. Weight loss was 25% greater at one year for open RYGB patients c.f. VBGP, and 33% at five years. There was similar weight loss for open RYGB c.f. HGP. There was a reduction in co-morbidities following gastric surgery. Side effects/complications were more common after open RYGB than variants of GP. Revisions, re-operations and/or conversions were more common after GP than open RYGB.</td>
</tr>
<tr>
<td>Critical appraisal, 2 reviewers, advisory committee</td>
<td>- Open RYGB c.f. JB: 2 RCTs</td>
<td>Slightly greater weight loss was recorded for JB (9% at 1-3 years) c.f. open RYGB. There were more re-operations and health complications for JB patients, especially liver disease but less surgery complications in JB patients c.f. open RYGB patients.</td>
</tr>
<tr>
<td></td>
<td>- Open VBGP c.f. HGP: 1 RCT</td>
<td>Patients with extensive weight loss pre-surgery. The VBGP group lost an average of 10 kg after surgery c.f. horizontal GP group, which gained weight.</td>
</tr>
<tr>
<td></td>
<td>- Open VBGP c.f. AGBl: 1 RCT</td>
<td>Greater weight loss over five years after AGBl, fewer side effects and greater patient satisfaction.</td>
</tr>
<tr>
<td></td>
<td>- Open RYGB c.f. laparoscopic RYGB: 2 RCTs</td>
<td>There were similar results for weight loss and patient satisfaction, but laparoscopic surgery took longer in theatre, but with quicker recovery. There was little difference in complications, LRYGB converted to open surgery in 2.5% and 23% of patients in the two studies.</td>
</tr>
<tr>
<td></td>
<td>- Open c.f. laparoscopic ASGB: 1 RCT</td>
<td>Similar weight lost at 12 months (&gt;34 kg), laparoscopic surgery led to shorter hospital stays, fewer re-admissions. Little difference in complications.</td>
</tr>
</tbody>
</table>
Table 3. Health Technology Assessment (HTA) reviews of surgical interventions for patients with morbid obesity (continued)

<table>
<thead>
<tr>
<th>Authors, study design, country, evidence grading</th>
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</tr>
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<tbody>
<tr>
<td>Systematic review</td>
<td>RCTs of surgical interventions for morbid obesity. Surgical procedures c.f. therapeutic, no treatment and other surgical procedures.</td>
<td>-RYGB c.f. VLCD 1 RCT. Open RYGB was more cost-effective than VLCD. The cost per pound lost was estimated to be US$250-US$750 for surgery and US$100-US$600 for medical therapy including all patients with 2-6 years of follow-up. If patients lost to follow-up were excluded, then the costs for surgery were US$230-US$260 and US$65-US$300 for medical therapy. After seven years all medical therapy patients regained weight to original levels.</td>
</tr>
<tr>
<td>Evidence grade II UK</td>
<td>Participants patients diagnosed with obesity or morbid obesity with BMI = 40.</td>
<td>-VBGP c.f. no treatment 1 RCT. VBGP was more cost-effective than no treatment. There was a saving of US$3,928-US$4,000 per quality-adjusted life-year (QALY). There was significant weight loss and improved QoL with VBGP c.f. no treatment. A gain of 12 QALY’s in a life-long scenario was estimated with VBGP.</td>
</tr>
<tr>
<td>(continued)</td>
<td>Search: to 2001, Medline, Embase, PubMed, Cochrane database, PsychINFO, BNI, CINAHL, AMED, BIOSIS, Web of Science, National Research Register, HealthSTAR, EconLit, NHS EED, HMC.</td>
<td>-Open RYGB c.f. laparoscopic VBGP 1 RCT. Laparoscopic VBGP had lower operating costs from short hospital stay. The average costs for laparoscopic VBGP were US$12,800 (1993/94) c.f. US$16,700 (1993/94) for open RYGB. Weight loss was not used to measure effectiveness.</td>
</tr>
<tr>
<td></td>
<td>Critical appraisal, 2 reviewers, advisory committee.</td>
<td>-Gastric surgery (GBnd, VBGP, RYGB) c.f. conventional management 1 RCT. The costs of surgical treatment was 16.5 million Swedish krona (SEK)/100 patients over a 10 year period. Outcomes at two years were a weight reduction of 30-40 kg and HRQoL improvement for the surgical group c.f. conventional management (outcomes not well described).</td>
</tr>
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<tr>
<td>Clegg et al. (2002) NHS R&amp;D HTA Programme</td>
<td>Economic evaluations of bariatric surgery</td>
<td>Surgical procedures c.f. nonsurgical management:</td>
</tr>
<tr>
<td>Systematic review</td>
<td>Surgical interventions for morbid obesity. Three types of the most clinically effective surgical procedures: RYGB (Roux-en-Y), VBGP and AGBnd and non-surgical management.</td>
<td>-Overall 20-year period incremental cost-effectiveness ratios (ICERs):</td>
</tr>
<tr>
<td>Evidence grade II UK</td>
<td>Participants: patients diagnosed with obesity or morbid obesity with BMI = 40.</td>
<td>RYGB net cost per QALY gained of £6,289</td>
</tr>
<tr>
<td>(continued)</td>
<td>Search: to 2001, Medline, Embase, PubMed, Cochrane database, PsychINFO, BNI, AMED, BIOSIS, Web of Science, National Research Register, HealthSTAR, EconLit, NHS EED, HMI.</td>
<td>VBGP net cost per QALY gained of £10,237</td>
</tr>
<tr>
<td></td>
<td>Critical appraisal, 2 reviewers, advisory committee.</td>
<td>AGBnd net cost per QALY gained of £8,527</td>
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<td></td>
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<td>Surgical procedures c.f. opponents surgical procedures:</td>
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<tr>
<td></td>
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<td>-Open RYGB c.f. open VBGP net cost per QALY gained of £742</td>
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<tr>
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<td></td>
<td>AGBnd c.f. RYGB net cost per QALY gained of £256,856</td>
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<tr>
<td></td>
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<td>Surgical procedures c.f. non-surgical management:</td>
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<td></td>
<td></td>
<td>-One-way sensitivity analysis</td>
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<td>Various scenarios for open RYGB surgery c.f. non-surgical management were assessed. With increases in the length of hospital stay from 7 days (open) and 6 days (laparoscopic) to 14 days increased cost/QALY to £10,323. Increases in pre/post operative care from an additional very-low calorie diet and dietitian increased the cost/QALY to £7,255. Non-surgical management increase in weight loss (BMI 45 to 42) increased the cost/QALY to £8,931. Whereas decreases in weight loss from surgery (BMI from 29 to 33) increased the cost/QALY to £9,155 and a BMI of 37 increased the cost/QALY to £16,819. Increases in the costs associated with service development (training cost &amp; lower efficiency costs) increased the cost/QALY to £20,768, and treating co-morbidities increased the cost/QALY to £6,715.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simplest assumptions were made with this evaluation due to limitations in the data. The clinical effectiveness of each procedure was variable, difficult to compare and restricted to short term (&lt;5 years) assessment. The effects of co-morbidities associated with morbid obesity other than diabetes and the effects on life expectancy were limited and excluded from evaluation. The baseline typical patient for the evaluation was aged 40 years, with BMI 45 but this disguises the actual variability of patients enrolled in trials.</td>
</tr>
<tr>
<td></td>
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<td>Conclusion on economic evaluation and sensitivity analysis: Surgery for morbid obesity appears to be cost-effective.</td>
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<td>Schneider (2002) Alberta Heritage Foundation Non-systematic review Evidence grade III-2 Canada</td>
<td>Laparoscopic adjustable gastric banding (LAGBnd) (including Lap-Band® or the Swedish Gastric Adjustable Band) with and without the comparison procedures Roux-en-Y gastric bypass (RYGB) or vertical banded gastroplasty (VBGP). Participants: patients with morbid obesity with a BMI = 40 or BMI 35-40 and significant co-morbidities. Search: 1993-1999, English only, pre-Medline, Medline, Embase, Best Evidence, HealthSTAR, HTA, DARE, EED, Cochrane databases. Critical appraisal</td>
<td>A subset of studies from a previous ASERNIPS systematic review (Chapman, 2000) was included. Nine studies were critically reviewed, including one RCT, two prospective comparative and six clinical case series studies. One prospective study compared open VBGP, LAGBnd and open RYGB. One RCT and one prospective study compared LAGBnd with open ASG Bnd and the other six single-arm studies evaluated LAGBnd. The evidence from these studies was described as fair to poor quality. All nine studies reported decreases in BMI, weight and excess weight loss after LAGBnd surgery. Complications associated with LAGBnd such as band slippage, leaking bands and infection of the access port were described in two studies. There were difficulties determining the efficacy of LAGBnd surgery compared to other procedures as there was a lack of well-designed studies with 5+ year outcome evaluation and such additional studies are required.</td>
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<th>Results – comparative studies including RCTs of gastric bypass vertical banded gastroplasty surgical procedures Clinical efficacy and safety</th>
</tr>
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<tr>
<td>Logan et al. (2000) Institute for Clinical Systems Improvement (ICSI) Non-systematic review Evidence grade III-2 USA</td>
<td>An update technology assessment on gastric restrictive surgery using Roux-en-Y gastric bypass (RYGB) and vertical banded gastroplasty (VBGP). Participants diagnosed with morbid obesity with BMI = 40 or BMI 35-40 and significant co-morbidities and failure of previous non-surgical interventions. Critical appraisal, advisory committee. No search strategy and review methodology.</td>
<td>Open gastric surgical procedures performed in US using vertical banded gastroplasty (VBGP) and Roux-en-Y gastric bypass (RYGB) were reviewed. This report was originally developed in 1994, updated in 1996 and again updated in 2000 with the incorporation of new evidence and 1998 clinical guidelines that were also produced by the National Institutes of Health expert panel for the identification, evaluation and treatment of overweight and obesity. The earlier 1996 update review concluded that both VBGP and RYGB procedures are generally safe with reported mortality of &lt;1.5% in centers with experience. Both procedures appear to produce a substantial reduction in excess weight, sustained for up to 5+ years. A lack of quality evidence was identified as all the studies with weight loss were clinical case series with inadequate follow-up to assess complications and long-term post-surgical events. Higher quality evidence from clinical trials showed post-surgical improvements in glucose intolerance, case reports indicated the resolution of other co-morbidities. The update review of recent evidence by the ICSI Technology Assessment Committee (ICSI, 2000) found that both procedures resulted in weight loss that can be sustainable for up to seven years or longer, with mean weight loss of over 50% of excess weight reported at up to two years post-surgery. Also that both procedures are generally safe with reported mortality of &lt;1.5% in experienced centers. There was some uncertainty about the quality of the evidence because of methodological weaknesses in the included studies. Many studies were case series, however prospective cohort studies were available and these demonstrated improvements in glucose intolerance, hypertension, arthritis and some forms of hyperlipidemia. More long-term weight loss, co-morbidity improvement and long-term survival data were needed from higher quality studies. Open RYGB may be better at maintaining weight loss and co-morbidity reversal but more data is needed.</td>
</tr>
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</table>
ASSESSMENT OF EVIDENCE AND LIMITATIONS

Study designs and levels of evidence

The evidence tables summarise the reviewed literature that satisfied the study inclusion criteria and examined the evidence regarding the safety, clinical and cost-effectiveness of surgical and non-surgical interventions for patients with morbid obesity. Overall, the level and quality of the study evidence was mostly restricted to lower Level III-2 evidence according to the Australian NHMRC hierarchy of evidence. There were five systematic and three non-systematic literature reviews, and these mostly comprised of studies with comparative and single-arm designs. A further two systematic reviews were graded as level II evidence and except for two non-randomised studies, were systematic reviews of RCTs, including a number of good quality trials. Two reviews (one systematic and one non-systematic), both graded level III-2 evidence, compared non-surgical with surgical interventions for patients with morbid obesity.

The included systematic and non-systematic HTA reviews were heterogeneous in terms of the surgical procedures and non-surgical treatments compared and the review methods used with variable study inclusion/exclusion criteria, search sources and strategies, and if undertaken, critical appraisal methods used. The overriding factor determining the levels of evidence assigned to these HTA reviews was the quality and designs of the included primary studies. Although the inclusion criteria used varied between reviews most reviews included primary studies with lower level III and IV evidence. This reflected the lack of higher quality studies with more rigorous study designs in the available published literature. Three HTA reviews included studies with some form of cost-effectiveness analysis. Evidence from recent primary research studies included three RCTs and ten comparative studies comparing various bariatric surgical procedures. No relevant studies were identified comparing non-surgical with surgical interventions.

Overall assessment of evidence regarding the safety and effectiveness of surgical and non-surgical interventions for patients with morbid obesity

Non-surgical compared with surgical interventions for morbid obesity

The evidence reviewed demonstrated that morbidly obese patients who received surgical interventions responded with significantly greater and more sustained weight loss and resolution of obesity-related co-morbidities, but risked more serious complications compared to those patients who received conventional (behavioural, motivational, psychological, and pharmacological) care. The most notable study in this area was the non-randomised Swedish Obese Subjects (SOS) comparative trial with over 1,000 patients and 6+ years of follow-up, although this study had a number of methodological limitations. There were few RCTs directly comparing conventional and surgical interventions in morbidly obese patients (Colquitt et al., 2003) compared to other study designs, although one systematic review of 15 poorer quality RCTs was included in the STEER review by Allgood (2001) and this compared surgical interventions for weight reduction with non-surgical interventions (excluding pharmacological interventions) but in predominantly over-weight and obese patients.

An important feature of the literature included in this overview was that the baseline weight of patients in studies evaluating surgical interventions was generally far heavier, around 120 kg, compared with only 80-100 kg in the non-surgical intervention literature. Patient BMIs in the literature looking at non-surgical interventions were marginally if at all over 40 kg/m², the common definition for morbid obesity (Avenell et al. 2004). This is because non-surgical treatments are generally only intended for over-weight patients (BMI < 30) whereas surgical interventions are intended for morbidly obese or severely obese patients and there is little place for offering surgery to patients with BMI < 30. Additionally, no systematic review was identified looking specifically at pharmaceutical and surgical interventions for morbid obesity in adolescent and paediatric patients. A small number of studies have been conducted in this area, but very few controlled trials with many clinical case series of obese adolescent populations with BMIs between 30-40 kg/m². A narrative summary of review findings concluded that there was insufficient data to draw conclusions about pharmaceutical interventions,
whilst the limited number of case series of bariatric surgery interventions reported benefits from weight loss and resolution of comorbidities but also surgical complications (Shekelle et al. 2004).

Two systematic reviews by Avenell et al. (2004) and Shekelle et al. (2004) focused on non-surgical interventions for obese patients, although studies on surgical interventions for morbidly obese adolescents and adults were also included in the systematic review by Shekelle et al. (2004). Various pharmacological studies included in both of these reviews reported small weight reductions between six months and two years and the resolution of some obesity-related co-morbidities. Studies on low-fat diets were reported to produce small weight reductions and combined with exercise or behavioural therapy programmes appeared to enhance weight loss as did family weight loss programmes with up to two years follow-up. Included studies generally lacked good quality design and execution. The external validity of the findings from studies looking at non-surgical interventions for obese patients was limited when trying to extrapolate them to morbidly obese patients, as similar actual weight loss in obese/morbidly obese groups of patients can result in quite different outcomes such as complications, quality of life and the resolution of obesity related co-morbidities. The generalisability of these study findings to morbidly obese patients was also limited by the characteristics of the study participants due to patient selection criteria.

Surgical interventions for morbid obesity

The evidence reviewed indicated that surgical management of morbidly obese patients was more effective than conventional non-surgical management. The relative safety and effectiveness of various surgical procedures was less apparent from the evidence available. The most frequently used surgical procedures used today are gastric bypass (open or laparoscopic), laparoscopic gastric banding and to a lesser extent biliopancreatic diversion. The various gastroplasty procedures are in less common use than they used to be and have been superceded by laparoscopic adjustable banding techniques. Generally laparoscopic and open surgery was of equivalent effectiveness for weight loss and complications were similar, although inadequate data was available, particularly on long-term complications. There was more substantive evidence available for gastric bypass procedures compared to other bariatric surgical procedures (Colquitt et al., 2003; Lefevre et al., 2003a; Clegg et al., 2002).

Open gastric bypass was more effective (in terms of enabling weight loss, and having fewer revisions, re-operations and/or conversions) than gastroplasty, however there was increased risk of serious metabolic complications with gastric bypass but long-term data on adverse events was limited (Logan et al., 2000). There was a lack of good quality evidence because of methodological weaknesses in the included studies and many studies were case series. However, prospective cohort studies were available and these demonstrated improvements particularly in obesity-related co-morbidities. Case reports suggested that RYGB may be better at maintaining weight loss and co-morbidity reversal, but more data was needed. Larger, longer-term and better designed studies were seen to be needed to better demonstrate long-term weight loss, co-morbidity improvements and long-term survival.

Vertical banded gastroplasty (VBGP) was more effective than horizontal gastroplasty (HGP) (Clegg et al., 2002) and adjustable banded gastroplasty was more effective than vertical banded gastroplasty (Colquitt et al., 2003).

A number of reviews compared gastric bypass (RYGB) with laparoscopic gastric bypass (LRYGB), laparoscopic gastric banding (LGBnd), and biliopancreatic diversion (BPD) or variants in super-obese patients. There were few comparative and high-quality trials in the evidence reviewed rather there was mostly diverse single-arm clinical series. These indicated that open and laparoscopic gastric bypass procedures were similar in terms of effectiveness. There was limited data on complications but short-term serious adverse events from anastomatic leaks were more frequent with laparoscopic gastric bypass. Studies comparing open gastric bypass (RYGB) with laparoscopic gastric banding LGBnd were mostly single-arm clinical series. These indicated that both procedures were similar in terms of weight loss effectiveness but that there was a lack of data on long-term complications for gastric banding such as erosion of the band through the gastric wall. Open gastric bypass compared with biliopancreatic diversion or variants in super-obese patients was similar in terms of weight loss but there was insufficient data available to make definitive conclusions on these comparisons.

Open gastric bypass (RYGB) and vertical banded gastroplasty (VBGP) were compared with laparoscopic adjustable gastric banding (LAGBnd) (Medical Services Advisory Committee, 2003).
Based on lower quality level evidence, LAGBnd was at least as safe as the comparators but LAGBnd was less effective in producing weight loss than RYGB. However, the length of hospital stay was shorter for patients receiving LAGBnd. Laparoscopic adjustable gastric banding (LAGBnd) was equally effective in terms of weight loss and resolution of co-morbidities as vertical banding gastroplasty but these outcomes were maintained for longer in LAGBnd patients. Open gastric bypass (RYGB) was compared with laparoscopic adjustable gastric banding (LAGBnd) in the review by Chen et al. (2004). The literature reviewed here included no RCTs and with only comparative studies of varying quality, it was not clear which was the superior procedure. Similar to the Medical Services Advisory Committee (2003) review, LAGBnd was considered to be less effective in producing weight loss than open RYGB (at 3-years follow-up). However, weight loss was sustained by both procedures at 5-years follow-up and they were equally effective in terms of the resolution of co-morbidities. Post-operative complications and morbidity and mortality were comparable in patients receiving either procedure. An earlier ASERNIP-S systematic review on laparoscopic adjustable gastric banding (LAGBnd) (Chapman et al., 2002) was also included in the Medical Services Advisory Committee (2003) and Chen et al. (2004) reviews. Overall the ASERNIP-S review concluded that LAGBnd (including Lap-Band® or the Swedish Gastric band) was as safe as open RYGB and VBGP, but less effective for weight loss than RYGB. It was difficult to determine the long-term efficacy of LAGBnd as follow-up periods were much shorter than those from data available for RYGB and VBGP.

Gastric banding was also not significantly different in terms of overall effectiveness (longer-term weight loss, patient satisfaction, fewer re-operations) than vertical banded gastroplasty (Colquitt et al., 2003; Clegg et al., 2002).

Patient follow-up was seen as having a significant role in weight loss for patients having had laparoscopic adjustable gastric banding (LAGBnd) because of the need for band adjustment compared with RYGB (Shen et al., 2004).

Non-medical benefits associated with significant weight loss was not looked at but includes things such as improved self-esteem and confidence, physical abilities, and social and employment opportunities.

**Cost-effectiveness of surgical procedures for morbid obesity**

Overall, surgery appeared to be cost-effective compared to conventional treatments or no treatment, with laparoscopic surgery more cost-effective than open surgery because of reduced length of hospital stay (Clegg et al., 2002). It was not possible to adequately determine the best surgical procedure based on the cost-effectiveness data available and assumptions made for the economic analysis.

LAGBnd in the Australian setting was slightly dominated by open gastric bypass (RYGB) which had equivalent effectiveness but slightly lower costs, although this was dependant upon the assumptions used in the economic analysis (Medical Services Advisory Committee, 2003). An earlier economic analysis by the National Institute for Clinical Effectiveness (NICE) used as the basis of this review (Clegg et al., 2001) found laparoscopic adjustable gastric banding to be more costly and less effective than RYGB.

The cost-effectiveness of laparoscopic adjustable gastric banding (LAGBnd) for morbid obesity was compared with laparoscopic gastric bypass (LRYGB) in the review by Chen et al. (2004). No RCTs were identified and it was difficult to determine the superior procedure. The direct costs between the two procedures were comparable, apart from the costs of the gastric band. In the context of the analysis (the Quebec healthcare system) it would be necessary to demonstrate the clinically meaningful superiority of LAGBnd over LRYBG due to the extra 39% cost of performing a LAGBnd procedure.

**Study limitations**

The limitations of the included reviews were at two levels, one concerning the design and conduct of the reviews of the relevant literature (systematic and non-systematic review) and the other concerning the design and conduct of the studies included in these reviews. The degree of certainty about the conclusions made in each of these reviews was governed by the review design and conduct as well as the internal validity of the included studies from the evidence base under evaluation.
The limitations of each specific review are not evaluated in the evidence tables. Instead a number of general limitations of the literature reviewed are outlined here.

In view of the large volume of published literature available on interventions for patients with obesity/morbid obesity, project time and resource limitations, and the type of output required by the Ministry of Health, the types of studies evaluated was limited to HTA and Cochrane Collaboration reviews and to recently published primary studies.

The systematic and non-systematic reviews included were diverse in terms of the surgical and non-surgical interventions compared and the review methods used. A notable methodological limitation was in the subjective way studies were combined for assessing the overall evidence base as meta-analysis was often not possible using any one or a number of outcomes for a particular surgical procedure or non-surgical treatment. The reviews also varied in the way material was analysed and reported and in the range of outcomes considered and measured. Often there was a diverse range of studies on differing surgical procedures and non-surgical treatments included in the same review, there were also differing measures of weight loss and other outcomes and varying lengths of follow-up period.

In a number of the reviews, the findings of comparative and single-arm studies were combined given the lack of studies with more rigorous study designs in order to give an overall assessment of the safety and effectiveness of various surgical procedures. This was particularly true of studies looking at newer laparoscopic surgical procedures.

There was also some overlap between reviews in terms of included studies as later published review included those studies included in earlier reviews. Duplication of results and conclusions was unavoidable given the incremental nature of sequentially published reviews covering similar topics (e.g. Colquitt et al., 2003 and Clegg et al., 2002).

There was marked variation in literature search strategies and sources used, ranging from minimal or non-specified (e.g. Logan et al., 2000) to comprehensive searches (e.g. Colquitt et al., 2003) (refer to evidence tables, section 3). Although this was part dependent on the research question(s) under investigation and study selection criteria, those reviews with minimal strategies and searches were more likely to have selection bias in the studies included.

There was also varying degrees and methods of critical appraisal. Some reviews did not undertake any critical appraisal (e.g. Chen et al., 2004) while others had extensive critical appraisal of the literature including the use of several reviewers and an advisory committee (e.g. Medical Services Advisory Committee, 2003).

Well conducted reviews of literature with adequate study design and execution were limited by the inferior quality of the included studies, through a lack of robust RCT study designs and poor study methodology. Among the study limitations were small sample sizes, baseline differences in patient study groups, the inclusion of obese or over-weight patients with BMI < 40, the inadequate reporting of results, limited patient follow-up, especially of complications and adverse events, a lack of QoL data and the effect of surgeon learning curves for newer procedures on outcomes and reporting inadequacies and errors. For example complications associated with newer laparoscopic surgical techniques with adjustable gastric banding devices (LAGBnd) were reported but data from these studies was undermined by patient selection bias, inadequate study methodology, and a lack of follow-up (Chapman et al., 2002). The incidence and type of complication associated with these newer techniques was also affected by the learning curve of surgeons improving over time with newer surgical techniques involved (Msika, 2003).

There were few RCTs comparing non-surgical versus surgical interventions for patients with morbid obesity. A far greater number of studies had been conducted for treatments of over-weight and obese patients.

There was a limited number of studies on cost-effectiveness (especially RCTs) in the reviews included in this Technical Brief. Often due to data limitations, studies on cost-effectiveness used differing methodologies, baseline patient characteristics, varying assumptions and were specific to a particular
health setting in their economic analysis. The varying clinical effectiveness of each procedure reported in studies was difficult to compare and generally restricted to short term (<5 years) assessment.

The literature contained only limited experience of surgical management for patients with super-obesity. Management problems, due to high morbidity/mortality, associated with existing techniques such as biliopancreatic surgery and limited experience with newer surgical techniques such as two-stage laparoscopic Roux-en-Y gastric bypass require further studies to adequately evaluate their clinical safety and effectiveness (Regan et al., 2003).

External generalisability of the results of reviews may not be applicable to all morbidly obese patients undergoing the same surgical procedure or conventional treatment. A lack of study generalisability was a common limitation. This was due to the degree of study heterogeneity, particularly in patient selection criteria and baseline characteristics which limited the generalisability of results (interventions) being applied to all morbidly obese patients.
REFERENCES

References marked with asterisk (*) were reviewed in abstract form only. See methodology section.


National Health and Medical Research Council (2000). How to use the evidence: assessment and application of scientific evidence. Canberra: NHMRC.


**APPENDIX 1: EXCLUDED REVIEWS AND REASON FOR EXCLUSION**


*English summary abstract only*


*Abstract summary article, pre-assessment*


*Clinical guideline*


*Pharmacological treatment for obese patients*


*Published prior to 2000*


*Clinical guideline*


*English summary abstract only*

Studies on treatments for patients with obesity rather than patients classified as morbidly obese, although a small proportion of these (not separately identified) likely to be included in samples.

APPENDIX 2: INCLUDED REVIEWED STUDIES


