## 7.01.47 Bariatric Surgery

<table>
<thead>
<tr>
<th>Original Policy Date:</th>
<th>April 14, 1970</th>
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<tbody>
<tr>
<td>Effective Date:</td>
<td>May 1, 2020</td>
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<tr>
<td>Section:</td>
<td>7.0 Surgery</td>
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## Policy Statement

### Initial Bariatric Procedure

Bariatric surgery for the treatment of morbid obesity may be considered medically necessary when all of the following criteria are met:

- The patient is an adolescent or older with morbid obesity, and all of the following:
  - The patient and physician together have reviewed, completed and signed the Bariatric Surgery Decision Aid
  - The patient has reviewed, completed and signed the “CollaboRATE” survey
  - Documentation with either of the following:
    - A body mass index (BMI) greater than 40 kg/m²
    - A BMI greater than 35 kg/m² with at least one clinically significant obesity-related disease, including but not limited to:
      - Type 1 or 2 diabetes mellitus
      - Clinically significant obstructive sleep apnea; or obesity hypoventilation syndrome
      - Coronary artery disease, with documentation of atherosclerotic heart disease as evidenced by any of the following:
        - Stress study
        - Coronary angiography
        - History of heart failure
        - History of myocardial infarction
        - Prior coronary artery bypass
        - Prior percutaneous coronary intervention (PCI)
    - Hypertension (blood pressure greater than 140 mmHg systolic and/or 90 mmHg diastolic in spite of the concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic)
    - Painful or activity-limiting osteoarthritis involving the lower extremities, with radiographic documentation of joint space narrowing, osteophytes, subluxation, or subchondral sclerosis
    - Hyperlipidemia (LDL cholesterol of 160 mg/dL or higher), uncontrolled by diet and medical therapy
    - Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy (e.g., proton pump inhibitors, H2 blockers, and/or prokinetic agents titrated to maximal recommended dosages)
  - The patient has failed weight loss to a BMI less than 35 kg/m² at the time of surgery by conservative (including pharmacologic and nutrition counseling) measures for 3 of the past 6 months, despite one of the following:
    - Documentation of participation in a structured physician-supervised weight-loss program including an exercise program as tolerated or available
    - Serially-charted documentation, including notes from two clinician-directed follow-up visits, of participation in another managed weight-loss program including dietary control and exercise as tolerated or available (commercial, dietician, or diabetes management programs)
- The patient has been evaluated for, and has received, maximal therapy for any secondary (e.g., endocrine) causes of obesity, has been evaluated for and treated for any pulmonary, gastrointestinal (including GERD), neoplastic, and cardiac co-morbidities which may impact surgery, and has been medically cleared for surgery, as documented in the Pre-Operative Checklist.
The patient has received a comprehensive psychosocial-behavioral evaluation signed by a qualified mental health professional clearing the patient for surgery, as documented in the Psychosocial-Behavioral Checklist.

The patient has undergone educational counseling or a formal class giving a comprehensive understanding of the available bariatric surgery procedures, of how the patient’s life will be changed after surgery, the morbidity and mortality associated with this surgery, and the commitment required to make the lifestyle changes necessary to maintain the health improvements achieved through surgery.

No tobacco smoking for at least 6 weeks prior to surgery

No ongoing drug abuse or treatment within the past year.

The bariatric surgery is performed by properly credentialed surgeons, and preferably at Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) accredited hospitals that follow the American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines, including a multidisciplinary program experienced in obesity surgery that can provide all of the following:

- Nutritional counseling
- Exercise counseling
- Long-term monitoring including both of the following:
  - Psychosocial counseling
  - Support group meetings

**Revision Bariatric Surgery for Complications**

The first (or a subsequent) revision surgery to address perioperative or late complications of a bariatric procedure may be considered **medically necessary**, provided that these complications include, but are not limited to at least one of the following:

- Band slippage or herniation that cannot be corrected with manipulation or adjustment
- Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy
- Nonabsorption resulting in hypoglycemia or malnutrition
- Obstruction, stricture, erosion, or fistula
- Staple-line failure or leakage
- Symptomatic pouch enlargement (recurrent vomiting or nausea)
- Weight loss of 20% or more below ideal body weight

**Revision Bariatric Surgery for Inadequate Weight Loss**

Revision of a primary or a subsequent bariatric procedure that has failed due to inadequate weight loss may be considered **medically necessary** when all of the following are met:

- All initial primary bariatric surgery qualification criteria have been satisfied (see Initial Bariatric Procedure above)
- Two years have elapsed since prior bariatric surgery
- Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9)
- Ineffective weight loss attempts within the year prior to revision surgery, including but not limited to compliance with previous post operative nutrition plan and exercise program is documented

**Bariatric Surgery in Preadolescent Children**

Bariatric surgery is considered **investigational** for the treatment of morbid obesity in preadolescent children.

**Concomitant Hiatal Hernia Repair With Bariatric Surgery**

Repair of a hiatal hernia at the time of bariatric surgery may be considered **medically necessary** for patients who have a preoperatively diagnosed hiatal hernia with indications for surgical repair.
Repair of a hiatal hernia that is diagnosed at the time of bariatric surgery, or repair of a preoperatively diagnosed hiatal hernia in patients who do not have indications for surgical repair, is considered investigational.

Other Bariatric Surgery Procedures

Any of the following bariatric surgery procedures are considered investigational for the treatment of morbid obesity in adults who have failed weight loss by conservative measures:

- Vertical-banded gastroplasty
- Gastric bypass using a Billroth II type of anastomosis (mini-gastric bypass)
- Biliopancreatic diversion without duodenal switch
- Long-limb gastric bypass procedure (i.e., greater than 150 cm)
- Single anastomosis duodenileal bypass with sleeve gastrectomy
- Two-stage bariatric surgery procedures (e.g., sleeve gastrectomy as initial procedure followed by biliopancreatic diversion at a later time)
- Endoscopic procedures as a primary bariatric procedure or as a revision procedure (i.e., to treat weight gain after bariatric surgery to remedy large gastric stoma or large gastric pouches) including but not limited to:
  - Insertion of the StomaphyX™ device
  - Insertion of a gastric balloon
  - Endoscopic gastroplasty
  - Use of an endoscopically placed duodenojejunal sleeve
  - Laparoscopic gastric plication
  - Aspiration therapy device

Bariatric Surgery Contraindications

Bariatric surgery is considered not medically necessary for any of the following:

- Patients with a body mass index less than or equal to 35 kg/m² at the time of surgery
- Patients who are pregnant
- Patients with typical major surgery contraindications (active infection, uncontrolled bleeding diathesis, device allergies, etc.)
- Patients with use of tobacco products (no use within 6 weeks), or with history of recent alcohol or drug abuse (no treatment for alcohol or drug abuse within 1 year)
- Patients with an untreated or uncontrolled DSM-5 psychiatric disorder limiting compliance with medical and dietary post-surgical requirements
- Patients unwilling to comply with post-surgical medical and dietary requirements and required follow-up appointments

Policy Guidelines

The medical necessity criteria in this document govern the appropriate use of bariatric surgery, which is a surgical procedure performed for the treatment of morbid obesity. Morbid obesity is defined as a body mass index (BMI) greater than 40 kg/m² or greater than 35 kg/m² with associated complications. Bariatric surgery in adults with morbid obesity may include the following bariatric surgery procedures when criteria are met:

- Open gastric bypass using a Roux-en-Y anastomosis (for patients with prior abdominal surgery only)
- Laparoscopic gastric bypass using a Roux-en-Y anastomosis
- Laparoscopic adjustable gastric banding
- Sleeve gastrectomy
- Open or laparoscopic biliopancreatic bypass (i.e., Scopinaro procedure) with duodenal switch

Clinicians performing bariatric surgery must have appropriate clinical training and experience and have satisfactory outcomes as assessed by quality assurance monitoring. Bariatric surgery must be performed in a manner consistent with established standards of care.
Appropriate Use Criteria
Appropriate use criteria are intended to assist patients and clinicians, but are not intended to diminish the acknowledged difficulty or uncertainty of clinical decision making and cannot act as substitutes for sound clinical judgment and practice experience.

Decision Aids
Use of decision aids can promote shared decision making, and may improve patients understanding and enable them to make decisions that are fully informed and consistent with their preferences, values and goals. A decision aid is a tool used to inform patients about available treatments, along with potential benefits, risks and costs, during clinical encounters. The decision aid is intended for use following the patient pre-operative education course. The resulting decision aid is intended to be nondirective, encouraging clinicians to create a conversation with patients using their own communication styles, while simultaneously ensuring that key information is conveyed and that patient preferences are elicited.

CollaboRATE
Patient-centered health care is a central component of current health policy agendas. CollaboRATE is a 3-Item questionnaire that measures the level of shared decision making in the clinical encounter from the patient's perspective. In the questionnaire, the patient rates, on a scale of 1 to 9, the provider's efforts to understand the surgical plan of care from the patient's perspective. The CollaboRATE SDM tool has demonstrated discriminative validity, concurrent validity, intrarater reliability, and sensitivity to change.3

To access further information, please visit the following website: http://www.jmir.org/2014/1/e2/.

Recommendations from Qualified Mental Health Professionals
The minimal credentials for qualified mental health professionals who work with adults presenting with a desire for bariatric surgery include a master's degree or its equivalent or a more advanced degree (e.g., Ph.D., M.D., Ed.D., D.Sc., D.S.W., Psy.D., LCSW, or MFT) in a clinical behavioral science field with established competence in the assessment of adults who desire bariatric surgery. At least one of the professionals must be capable of adequately evaluating comorbid psychiatric conditions.

Bariatric Surgery in Children and Adolescents
The evidence for bariatric surgery in patients younger than age 18 years consists primarily of studies of adolescents, with a lack of evidence for younger children. Guidelines for bariatric surgery in adolescents are not uniform, with variability in weight-based criteria, ranging from a BMI of 35 kg/m2 with comorbidities to a BMI of 50 kg/m2. Most guidelines use weight-based criteria that parallel those for adult patients.

In addition to the weight-based criteria, there is greater emphasis on issues of developmental maturity, psychosocial status, and informed consent for adolescent patients. All guidelines mention these issues, but recommendations are not uniform for addressing them. The following are examples from U.S. guidelines that address issues of maturity and psychosocial status.

Adolescence begins with the onset of physiologically normal puberty and ends when an adult identity and behavior are accepted. This period of development corresponds roughly to the period between the ages of 10 and 19 years, which is consistent with the World Health Organization's definition of adolescence. There are no set ages, as the onset of both puberty and adulthood vary significantly, but at a minimum, patients should be post-pubertal (more commonly after age 13). For adolescent patients, greater consideration should be given to psychosocial and informed consent issues.

Clinically significant OSA in adults
Clinically significant OSA includes either of the following:
• An Apnea/Hypopnea Index (AHI), Respiratory Disturbance Index (RDI), or Respiratory Event Index (REI) of at least 15 events per hour
• An AHI, RDI, or REI of at least 5 events per hour in a patient with excessive daytime sleepiness (as determined by standard sleep questionnaires such as the Epworth Sleepiness Scale >10 or the Berlin Questionnaire with a score of at least 2 in Category 2) or hypertension (see Policy Guidelines section)

Clinically significant OSA in Children and adolescents
The presentation of OSA in children may differ from that of adults. Children frequently exhibit behavioral problems or hyperactivity rather than daytime sleepiness. Although the definition of severe OSA in children is not well established, an AHI or RDI greater than 1.5 events per hour is considered abnormal (an AHI or RDI greater than or equal to 10 events per hour may be considered severe). In addition, the first-line treatment in children is usually adenotonsillectomy. Continuous positive airway pressure (CPAP) is an option for children who are not candidates for surgery or who have an inadequate response to surgery.

Obesity-Hypoventilation Syndrome Defined as daytime alveolar hypoventilation (awake arterial PCO2>45 mm Hg or serum bicarbonate ≥27) among patients with body mass index ≥30 kg/m2 in the absence of other causes of hypoventilation.

Endocrine Society
The 2017 Endocrine Society Clinical Practice Guideline on Pediatric Obesity suggest bariatric surgery only under the following conditions (Styne et al, 2017)146:
• “The patient has attained Tanner 4 or 5 pubertal development and final or near-final adult height, the patient has a BMI of >40 kg/m2 or has a BMI of >35 kg/m2 and significant, extreme comorbidities
• Extreme obesity and comorbidities persist despite compliance with a formal program of lifestyle modification, with or without pharmacotherapy
• Psychological evaluation confirms the stability and competence of the family unit, psychological distress due to impaired QOL from obesity may be present, but the patient does not have an underlying untreated psychiatric illness
• The patient demonstrates the ability to adhere to the principles of healthy dietary and activity habits
• The patient has access to an experienced surgeon in a pediatric bariatric surgery center of excellence providing the necessary infrastructure for patient care, including a team capable of long-term follow-up of the metabolic and psychosocial needs of the patient and family.”

Institute for Clinical Systems Improvement
The 2013 Health Care Guideline on Prevention and Management of Obesity for Children and Adolescents states that bariatric surgery should only be considered in the pediatric population under the following conditions (Fitch et al, 2013)127:
• “The child has a BMI > 40 kg/m2 or has BMI above 35 kg/m2 and significant, severe comorbidities such as type 2 diabetes mellitus, obstructive sleep apnea, or pseudotumor cerebri.”
• “The child has attained Tanner 4 or 5 pubertal development or has a bone age ≥13 years in girls or ≥15 years in boys, thereby suggesting that the child has attained final or near-final adult height.”
• “Failure of ≥6 months of organized attempts at weight management....”
• “The adolescents should have decisional capacity and also demonstrate commitment to comprehensive medical and psychological evaluations both before and after surgery.”
• “A supportive family environment...”

The choice of procedure in adolescents may also differ from adults, but there is a lack consensus in guidelines or expert opinion as to the preferred procedure(s) for adolescents. The following
factors should be considered in the choice of bariatric surgery in adolescents (Aikenhead et al, 2011):

- As in adults, laparoscopic gastric bypass is the most common procedure in adolescents.
- Devices used for laparoscopic adjustable gastric banding do not have FDA-approval in the United States for individuals younger than age 18 years.
- Some guidelines for bariatric surgery in adolescents do not recommend biliopancreatic diversions because of the greater frequency of nutritional deficiencies on long-term follow-up, but other guidelines do not specify that biliopancreatic diversion not be done in adolescents.

**Hiatal Hernia Repair Guidelines**

The Society of American Gastrointestinal and Endoscopic Surgeons issued evidence-based guidelines for the management of hiatal hernia (Kohn et al, 2013). The society noted that the general methodologic quality of available studies is low. Recommendations for indications for repair are as follows:

- “Repair of a type I hernia [sliding hiatal hernias, where the gastroesophageal junction migrates above the diaphragm] in the absence of reflux disease is not necessary (moderate quality evidence, strong recommendation).
- All symptomatic paraesophageal hiatal hernias should be repaired (high quality evidence, strong recommendation), particularly those with acute obstructive symptoms or which have undergone volvulus.
- Routine elective repair of completely asymptomatic paraesophageal hernias may not always be indicated. Consideration for surgery should include the patient’s age and comorbidities (moderate quality evidence, weak recommendation).”

**Coding**

Hiatal hernia repair performed at the time of bariatric surgery would not be reported with the hiatal hernia repair code. There is no code for this specific surgery, therefore, it should be reported with code 43289 - Unlisted laparoscopy procedure, esophagus.

**Description**

Bariatric surgery is a treatment for morbid obesity in patients who fail to lose weight with conservative measures. There are numerous surgical techniques available. These techniques have heterogeneous mechanisms of action, with varying degrees of gastric restriction that create a small gastric pouch, which may lead to malabsorption of nutrients and metabolic changes, that result from gastric and intestinal surgery.

**Related Policies**

- Gastric Electrical Stimulation
- Transesophageal Endoscopic Therapies for Gastroesophageal Reflux Disease

**Benefit Application**

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member’s contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.
Regulatory Status

Forms of bariatric surgery performed without specific implantable devices are surgical procedures and, as such, are not subject to regulation by the U.S. Food and Drug Administration (FDA).

Table 1 shows forms of bariatric surgery with implantable devices approved by the FDA through the premarket approval process.

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<tr>
<th>Device</th>
<th>Manufacturer</th>
<th>PMA Date</th>
<th>Labeled Indications</th>
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<tr>
<td>AspireAssist System®</td>
<td>Aspire Bariatrics</td>
<td>Jun 2016</td>
<td>For long-term use in conjunction with lifestyle therapy and continuous medical monitoring in obese adults 22 years and older, with a BMI of 35.0 to 55.0 kg/m² and no contraindications to the procedure who have failed to achieve and maintain weight loss with nonsurgical weight loss therapy.</td>
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<tr>
<td>ORBERA® Intragastric Balloon System</td>
<td>Apollo Endosurgery</td>
<td>Aug 2015</td>
<td>For use in obese adults (BMI, 30-40 kg/m²) who have failed weight reduction with diet and exercise, and have no contraindications. Maximum placement time is 6 mo. Balloon placed endoscopically and inflated with saline.</td>
</tr>
<tr>
<td>ReShape® Integrated Dual Balloon System</td>
<td>ReShape Medical</td>
<td>Jul 2015</td>
<td>For use in obese adults (BMI, 30-40 kg/m²) and ≥1 comorbid conditions who have failed weight reduction with diet and exercise, and have no contraindications. Maximum placement time is 6 mo. Balloon delivered transorally and inflated with saline.</td>
</tr>
<tr>
<td>LAP-BAND® Adjustable Gastric Banding System (original applicant: Allergan)</td>
<td>Apollo Endosurgery</td>
<td>Apr 2010</td>
<td>For use in weight reduction for severely obese adults with BMI of at least 40 kg/m² or a BMI of at least 30 kg/m² with ≥1 severe comorbid conditions who have failed more conservative weight-reduction alternatives (e.g., supervised diet, exercise, behavior modification programs).</td>
</tr>
<tr>
<td>REALIZE® Adjustable Gastric Band</td>
<td>Ethicon Endosurgery</td>
<td>Nov 2007</td>
<td>For use in weight reduction for morbidly obese patients and for individuals with BMI of at least 40 kg/m², or a BMI of at least 35 kg/m² with ≥1 comorbid conditions, or those who are ≥45.4 kg over their estimated ideal weight. Indicated for use only in morbidly obese adults who have failed more conservative weight-reduction alternatives (e.g., supervised diet, exercise, behavior modification programs).</td>
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BMI: body mass index; FDA: Food and Drug Administration; PMA: premarket approval.

In February 2017, the FDA issued a letter to health care providers discussing the potential risks with liquid-filled intragastric balloons in response to reports of 2 types of adverse events related to the balloons. Several dozen reports concerned spontaneous overinflation of the balloons, which caused pain, swelling, and vomiting. The second set of adverse event reports indicated that acute pancreatitis developed in several patients due to compression of gastrointestinal structures. These reports involved both ReShape and ORBERA brands. The adverse events may require premature removal of the balloons.

In August 2017, the FDA issued a second letter to health care providers informing them of 5 unanticipated deaths occurring from 2016 through the time of the letter, due to intragastric balloons. The FDA recommended close monitoring of patients receiving these devices.

Rationale
Background

Bariatric Surgery

Bariatric surgery is performed to treat morbid (clinically severe) obesity. Morbid obesity is defined as a body mass index (BMI) greater than 40 kg/m² or a BMI greater than 35 kg/m² with associated complications including, but not limited to, diabetes, hypertension, or obstructive sleep apnea. Morbid obesity results in a very high-risk for weight-related complications, such as diabetes, hypertension, obstructive sleep apnea, and various types of cancers (for men: colon, rectal, prostate; for women: breast, uterine, ovarian), and a shortened lifespan. A morbidly obese man at age 20 can expect to live 13 fewer years than his counterpart with a normal BMI, which equates to a 22% reduction in life expectancy.

The first treatment of morbid obesity is dietary and lifestyle changes. Although this strategy may be effective in some patients, only a few morbidly obese individuals can reduce and control weight through diet and exercise. Most patients find it difficult to comply with these lifestyle modifications on a long-term basis.

When conservative measures fail, some patients may consider surgical approaches. A 1991 National Institutes of Health Consensus Conference defined surgical candidates as “those patients with a BMI of greater than 40 kg/m², or greater than 35 kg/m² in conjunction with severe comorbidities such as cardiopulmonary complications or severe diabetes.”

Resolution (cure) or improvement of type 2 diabetes after bariatric surgery and observations that glycemic control may improve immediately after surgery before a significant amount of weight is lost have promoted interest in a surgical approach to the treatment of type 2 diabetes. The various surgical procedures have different effects, and gastrointestinal rearrangement seems to confer additional antidiabetic benefits independent of weight loss and caloric restriction. The precise mechanisms are not clear, and multiple mechanisms may be involved. Gastrointestinal peptides, e.g., glucagon-like peptide-1, glucose-dependent insulinotropic peptide, and peptide YY, are secreted in response to contact with unabsorbed nutrients and by vagally mediated parasympathetic neural mechanisms. Glucagon-like peptide-1 is secreted by the L cells of the distal ileum in response to ingested nutrients and acts on pancreatic islets to augment glucose-dependent insulin secretion. It also slows gastric emptying, which delays digestion, blunts postprandial glycemia, and acts on the central nervous system to induce satiety and decrease food intake. Other effects may improve insulin sensitivity. Glucose-dependent insulinotropic peptide acts on pancreatic beta cells to increase insulin secretion through the same mechanisms as glucagon-like peptide-1, although it is less potent. Peptide YY is also secreted by the L cells of the distal intestine and increases satiety and delays gastric emptying.

Bariatric surgery is commonly used to address the morbidity caused by obesity, but current evidence shows its present impact on the obesity epidemic may be far from optimal. The current approach to bariatric surgery does not explicitly result in successful outcomes for patients, as evidenced by numerous clinical guidelines and recent studies. The Institute for Clinical and Economic Review (ICER) issued a report in 2015, which indicated that ICER did not consider the evidence to provide high levels of certainty for bariatric surgery because of unfavorable long-term outcomes and the durability of clinical benefit. While the evidence for bariatric surgery showed a moderate level of certainty, ICER recommended that bariatric surgery should only be considered when weight loss management approaches have failed or have had insufficient benefit.

Shared Decision Making

Shared Decision Making (SDM) is a process in which patients openly explore with the aid of their physician both the available evidence supporting each therapeutic intervention, and also determine what matters most to the patient. This allows both the physician and the patient to reach agreed-upon treatment decisions reflecting mutual goals and expected outcomes. The completion of the CollaboRATE survey and signing of the bariatric surgery decision aid by the member helps to assure the member’s personal preferences have been considered.
CollaboRATE
Patient-centered health care is a central component of current health policy agendas. CollaboRATE is a 3-Item questionnaire that measures the level of shared decision making in the clinical encounter from the patient’s perspective. In the questionnaire, the patient rates, on a scale of 1 to 9, the provider’s efforts to understand the surgical plan of care from the patient’s perspective. The CollaboRATE SDM tool has demonstrated discriminative validity, concurrent validity, intra-rater reliability, and sensitivity to change.

To access further information, please visit the following websites: http://www.jmir.org/2014/1/e2/; http://www.glynelwyn.com/collaborate-measure.html.

Bariatric Surgery Decision Aid
Decision aids use a shared, informed approach to clinical decision-making. Potential outcomes of decision aids include increased patient knowledge of available treatments, greater patient participation in decision-making, and improved patient health status and quality of life. Blue Shield of California considers the use of decision aids as a higher level of informed consent and requires patients to acknowledge receipt, review and sign the ECP Bariatric Surgery decision aid as a pre-authorization requirement.

Hospitals and clinicians are encouraged to contribute bariatric surgery data to the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) Qualified Clinical Data Registry.

Types of Bariatric Surgery Procedures
The following summarizes the most common bariatric surgery procedures.

Open Gastric Bypass
The original gastric bypass surgeries were based on the observation that postgastrectomy patients tended to lose weight. The current procedure (CPT code 43846) involves both a restrictive and a malabsorptive component, with the horizontal or vertical partition of the stomach performed in association with a Roux-en-Y procedure (i.e., a gastrojejunal anastomosis). Thus, the flow of food bypasses the duodenum and proximal small bowel. The procedure may also be associated with an unpleasant “dumping syndrome,” in which a large osmotic load delivered directly to the jejunum from the stomach produces abdominal pain and/or vomiting. The dumping syndrome may further reduce intake, particularly in “sweets eaters.” Surgical complications include leakage and operative margin ulceration at the anastomotic site. Because the normal flow of food is disrupted, there are more metabolic complications than with other gastric restrictive procedures, including iron deficiency anemia, vitamin B12 deficiency, and hypocalcemia, all of which can be corrected by oral supplementation. Another concern is the ability to evaluate the “blind” bypassed portion of the stomach. Gastric bypass may be performed with either an open or laparoscopic technique.

Note: In 2005, CPT code 43846 was revised to indicate that the short limb must be 150 cm or less, compared with the previous 100 cm. This change reflects the common practice in which the alimentary (i.e., jejunal limb) of a gastric bypass has been lengthened to 150 cm. This length also serves to distinguish a standard gastric bypass with a very long, or very, very long gastric bypass, as discussed further here.

Laparoscopic Gastric Bypass
CPT code 43644 was introduced in 2005 and described the same procedure as open gastric bypass (CPT code 43846), but performed laparoscopically.

Mini-Gastric Bypass
Recently, a variant of the gastric bypass, called the mini-gastric bypass (no specific CPT code), has been popularized. Using a laparoscopic approach, the stomach is segmented, similar to a
traditional gastric bypass, but instead of creating a Roux-en-Y anastomosis, the jejunum is anastomosed directly to the stomach, similar to a Billroth II procedure. This unique aspect of this procedure is not based on its laparoscopic approach but rather the type of anastomosis used. It should also be noted that CPT code 43846 explicitly describes a Roux-en-Y gastroenterostomy, which is not used in the mini-gastric bypass.

**Adjustable Gastric Banding**

Adjustable gastric banding (CPT code 43770) involves placing a gastric band around the exterior of the stomach. The band is attached to a reservoir implanted subcutaneously in the rectus sheath. Injecting the reservoir with saline will alter the diameter of the gastric band; therefore, the rate-limiting stoma in the stomach can be progressively narrowed to induce greater weight loss, or expanded if complications develop. Because the stomach is not entered, the surgery and any revisions, if necessary, are relatively simple.

Complications include slippage of the external band or band erosion through the gastric wall. Adjustable gastric banding has been widely used in Europe. Two banding devices are approved by the Food and Drug Administration (FDA) for marketing in the United States. The first to receive FDA approval was the LAP-BAND (original applicant, Allergan, BioEnterics, Carpinteria, CA; now Apollo Endosurgery, Austin, TX). The labeled indications for this device are as follows:

“THE LAP-BAND® SYSTEM IS INDICATED FOR USE IN WEIGHT REDUCTION FOR SEVERELY OBESE PATIENTS WITH A BODY MASS INDEX (BMI) OF AT LEAST 40 OR A BMI OF AT LEAST 35 WITH ONE OR MORE SEVERE COMORBID CONDITIONS, OR THOSE WHO ARE 100 LB OR MORE OVER THEIR ESTIMATED IDEAL WEIGHT ACCORDING TO THE 1983 METROPOLITAN LIFE INSURANCE TABLES (USE THE MIDPOINT FOR MEDIUM FRAME). IT IS INDICATED FOR USE ONLY IN SEVERELY OBESE ADULT PATIENTS WHO HAVE FAILED MORE CONSERVATIVE WEIGHT-REDUCTION ALTERNATIVES, SUCH AS SUPERVISED DIET, EXERCISE AND BEHAVIOR MODIFICATION PROGRAMS. PATIENTS WHO ELECT TO HAVE THIS SURGERY MUST MAKE THE COMMITMENT TO ACCEPT SIGNIFICANT CHANGES IN THEIR EATING HABITS FOR THE REST OF THEIR LIVES.”

In 2011, FDA-labeled indications for the LAP-BAND were expanded to include patients with a BMI from 30 to 34 kg/m² with at least 1 obesity-related comorbid condition.

The second adjustable gastric banding device approved by the FDA through the premarket approval process is the REALIZE® model (Ethicon Endo-Surgery, Cincinnati, OH). Labeled indications for this device are:

“THE REALIZE® DEVICE IS INDICATED FOR WEIGHT REDUCTION FOR MORBIDLY OBESE PATIENTS AND IS INDICATED FOR INDIVIDUALS WITH A BODY MASS INDEX OF AT LEAST 40 KG/M², OR A BMI OF AT LEAST 35 KG/M² WITH ONE OR MORE COMORBID CONDITIONS. THE BAND IS INDICATED FOR USE ONLY IN MORBIDLY OBESE ADULT PATIENTS WHO HAVE FAILED MORE CONSERVATIVE WEIGHT-REDUCTION ALTERNATIVES, SUCH AS SUPERVISED DIET, EXERCISE, AND BEHAVIOR MODIFICATION PROGRAMS.”

**Sleeve Gastrectomy**

A sleeve gastrectomy (SG; CPT code 43775) is an alternative approach to gastrectomy that can be performed on its own or in combination with malabsorptive procedures (most commonly biliopancreatic diversion [BPD] with duodenal switch). In this procedure, the greater curvature of the stomach is resected from the angle of His to the distal antrum, resulting in a stomach remnant shaped like a tube or sleeve. The pyloric sphincter is preserved, resulting in a more physiologic transit of food from the stomach to the duodenum and avoiding the dumping syndrome (overly rapid transport of food through the stomach into intestines) seen with distal gastrectomy. This procedure is relatively simple to perform and can be done as an open or laparoscopic procedure. Some surgeons have proposed the SG as the first in a 2-stage procedure for very high-risk patients. Weight loss following SG may improve a patient’s overall medical status and, thus, reduce the risk of a subsequent more extensive malabsorptive procedure (e.g., BPD).
Biliopancreatic Diversion

The BPD procedure (also known as the Scopinaro procedure; CPT code 43847), developed and used extensively in Italy, was designed to address drawbacks of the original intestinal bypass procedures that have been abandoned due to unacceptable metabolic complications. Many complications were thought to be related to bacterial overgrowth and toxin production in the blind, bypassed segment. In contrast, BPD consists of a subtotal gastrectomy and diversion of the biliopancreatic juices into the distal ileum by a long Roux-en-Y procedure. The procedure consists of the following components:

a. A distal gastrectomy induces temporary early satiety and/or the dumping syndrome in the early postoperative period, both of which limit food intake.

b. A 200-cm long “alimentary tract” consists of 200 cm of ileum connecting the stomach to a common distal segment.

c. A 300- to 400-cm “biliary tract” connects the duodenum, jejunum, and remaining ileum to the common distal segment.

d. A 50- to 100-cm “common tract” is where food from the alimentary tract mixes with biliopancreatic juices from the biliary tract. Food digestion and absorption, particularly of fats and starches, are therefore limited to this small segment of bowel, creating selective malabsorption. The length of the common segment will influence the degree of malabsorption.

e. Because of the high incidence of cholelithiasis associated with the procedure, patients typically undergo an associated cholecystectomy.

Many potential metabolic complications are related to BPD, including, most prominently, iron deficiency anemia, protein malnutrition, hypocalcemia, and bone demineralization. Protein malnutrition may require treatment with total parenteral nutrition. Also, several case reports have noted liver failure resulting in death or liver transplant.

Biliopancreatic Diversion with Duodenal Switch

CPT code 43845, which specifically identifies the duodenal switch procedure, was introduced in 2005. The duodenal switch procedure is a variant of the BPD previously described. In this procedure, instead of performing a distal gastrectomy, a SG is performed along the vertical axis of the stomach. This approach preserves the pylorus and initial segment of the duodenum, which is then Anastomosed to a segment of the ileum, similar to the BPD, to create the alimentary limb. Preservation of the pyloric sphincter is intended to ameliorate the dumping syndrome and decrease the incidence of ulcers at the duodenoileal anastomosis by providing a more physiologic transfer of stomach contents to the duodenum. The SG also decreases the volume of the stomach and decreases the parietal cell mass. However, the basic principle of the procedure is similar to that of the BPD, i.e., producing selective malabsorption by limiting the food digestion and absorption to a short common ileal segment.

Vertical-Banded Gastroplasty

Vertical-banded gastroplasty (CPT code 43842) was formerly one of the most common gastric restrictive procedures performed in the United States but has now been replaced by other restrictive procedures due to high rates of revisions and reoperations. In this procedure, the stomach is segmented along its vertical axis. In order to create a durable reinforced and rate-limiting stoma at the distal end of the pouch, a plug of the stomach is removed, and a propylene collar is placed through this hole and then stapled to itself. Because the normal flow of food is preserved, metabolic complications are uncommon. Complications include esophageal reflux, dilation, or obstruction of the stoma, with the latter two requiring reoperation. Dilation of the stoma is a common reason for weight regain. Vertical-banded gastroplasty may be performed using an open or laparoscopic approach.

Long-Limb Gastric Bypass (i.e., >150 cm)

Variations of gastric bypass procedures have been described, consisting primarily of long-limb Roux-en-Y procedures (CPT code 43847), which vary in the length of the alimentary and common limbs. For example, the stomach may be divided with a long segment of the jejunum...
(instead of ileum) anastomosed to the proximal gastric stump, creating the alimentary limb. The remaining pancreaticobiliary limb, consisting of stomach remnant, duodenum, and length of proximal jejunum, is then anastomosed to the ileum, creating a common limb of variable length in which the ingested food mixes with the pancreaticobiliary juices. While the long alimentary limb permits absorption of most nutrients, the short common limb primarily limits absorption of fats. The stomach may be bypassed in a variety of ways (e.g., resection or stapling along the horizontal or vertical axis). Unlike the traditional gastric bypass, which is a gastric restrictive procedure, these very long-limb Roux-en-Y gastric bypasses combine gastric restriction with some element of malabsorptive procedure, depending on the location of the anastomoses. Note that CPT code for gastric bypass (43846) explicitly describes a short limb (<150 cm) Roux-en-Y gastroenterostomy, and thus would not apply to long-limb gastric bypass.

**Laparoscopic Malabsorptive Procedure**
CPT code 43645 was introduced in 2005, to specifically describe a laparoscopic malabsorptive procedure. However, the code does not specifically describe any specific malabsorptive procedure.

**Endoluminal Bariatric Procedures**
With endoluminal bariatric (also called endosurgical, endoscopic, or natural orifice) procedures (no specific CPT code), access to the relevant anatomic structures is gained through the mouth without skin incisions. Primary and revision bariatric procedures are being developed to reduce risks associated with open and laparoscopic interventions. Examples of endoluminal bariatric procedures studies include gastroplasty using a transoral endoscopically guided stapler and placement of devices such as a duodenojejunal sleeve and gastric balloon.

**Laparoscopic Gastric Plication**
Laparoscopic gastric plication (no specific CPT code) is a bariatric surgery procedure that involves laparoscopic placement of sutures over the greater curvature (laparoscopic greater curvature plication) or anterior gastric region (laparoscopic anterior curvature plication) to create a tube-like stomach. The procedure involves 2 main steps—mobilization of the greater curvature of the stomach and suture plication of the stomach for achieving gastric restriction—but technique specifics are not standardized.

**Weight Loss Outcomes**
There is no uniform standard for reporting results of weight loss or for describing a successful procedure. Common methods of reporting the amount of body weight loss are the percent of ideal body weight achieved or percent of excess body weight (EBW) loss, with the latter most commonly reported. EBW is defined as actual weight minus “ideal weight” and “ideal weight” and is based on 1983 Metropolitan Life Insurance height-weight tables for “medium frame.”

These 2 reporting methods are generally preferred over the absolute amount of weight loss because they reflect the ultimate goal of surgery: to reduce weight to a range that minimizes obesity-related morbidity. Obviously, an increasing degree of obesity will require a greater amount of weight loss to achieve these target goals. There are different definitions of successful outcomes, but a successful procedure is often considered one in which at least 50% of EBW is lost, or when the patient returns to within 30% of ideal body weight. The results may also be expressed as the percentage of patients losing at least 50% of EBW. Table 2 summarizes the variations in reporting weight loss outcomes.

**Table 2. Weight Loss Outcomes**

<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Definition</th>
<th>Clinical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in weight</td>
<td>Absolute difference in weight pre- and post-treatment</td>
<td>Unclear relation to outcomes, especially in morbidly obese</td>
</tr>
<tr>
<td>Decrease in BMI</td>
<td>Absolute difference in BMI pre- and post-treatment</td>
<td>May be clinically significant if change in BMI clearly leads to change in risk category</td>
</tr>
</tbody>
</table>
### Outcome Measure | Definition | Clinical Significance
--- | --- | ---
Percent EBW loss | Amount of weight loss divided by EBW | Has anchor to help frame clinical significance; unclear threshold for clinical significance
Percent patients losing >50% of EBW | No. patients losing >50% EBW divided by total patients | Additional advantage of framing on per patient basis. Threshold for significance (>50%) arbitrary.
Percent ideal body weight | Final weight divided by ideal body weight | Has anchor to help frame clinical significance; unclear threshold for clinical significance

BMI: body mass index; EBW: excess body weight.

**Durability of Weight Loss**
Weight change (i.e., gain or loss) at yearly intervals is often reported. Weight loss at 1 year is considered the minimum length of time for evaluating these procedures; weight loss at 3 to 5 years is considered an intermediate time period for evaluating weight loss; and weight loss at 5 to 10 years or more is considered to represent long-term weight loss following bariatric surgery.

**Short-Term Complications (Operative and Perioperative Complications <30 Days)**
In general, the incidence of operative and perioperative complications is increased in obese patients, particularly in thromboembolism and wound healing. Other perioperative complications include anastomotic leaks, bleeding, bowel obstruction, and cardiopulmonary complications (e.g., pneumonia, myocardial infarction).

**Reoperation Rate**
Reoperation may be required to “take down” or revise the original procedure. Reoperation may be particularly common in vertical-banded gastroplasty due to pouch dilation.

**Long-Term Complications (Metabolic Adverse Events, Nutritional Deficiencies)**
Metabolic adverse events are of particular concern in malabsorptive procedures. Other long-term complications include anastomotic ulcers, esophagitis, and procedure-specific complications such as band erosion or migration for gastric banding surgeries.

**Improved Health Outcomes in Terms of Weight-Related Comorbidities**
Aside from psychosocial concerns, which may be considerable, one motivation for bariatric surgery is to decrease the incidence of complications of obesity, such as diabetes, cardiovascular risk factors (i.e., increased cholesterol, hypertension), obstructive sleep apnea, or arthritis. Unfortunately, these final health outcomes are not consistently reported.

**Literature Review**
Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life, and ability to function including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, 2 domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent one or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse
events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice. The following is a summary of the key literature to date.

Overview: Bariatric Surgery in Adults With Morbid Obesity

There is a vast literature on bariatric surgery for adults with morbid obesity. This literature is characterized by a preponderance of single-arm clinical series from individual institutions. These types of studies can be used to determine the amount of weight loss expected from surgery, the durability of the weight loss, and the rate of adverse events. However, these studies are not adequate for determining the comparative efficacy of bariatric surgery versus conservative treatment, or the comparative efficacy of different bariatric surgery techniques. Some comparative trials, including randomized and nonrandomized designs, compare bariatric surgery with conservative therapy and/or compare outcomes of different bariatric surgery procedures. RCTs of bariatric surgery have been performed but are limited and insufficient to draw conclusions about comparisons of bariatric surgery and conservative treatments for weight loss. RCTs are difficult in bariatric surgery because many experts consider it inappropriate or unethical to randomize patients to bariatric surgery. Also, most patients and clinicians have strong preferences for treatment, which result in a select population that might agree to randomization and, therefore, limited generalizability. As a result, the emphasis for this evidence review is on comparative nonrandomized trials of bariatric surgery and nonsurgical therapy or of different types of bariatric surgery procedures.

Swedish Obese Subjects Trial

The Swedish Obese Subjects (SOS) trial is the most influential study of bariatric surgery versus conservative treatment. The SOS trial started in 1987 with a registry containing a detailed questionnaire and clinical data on obese patients with a body mass index (BMI) greater than 34 kg/m² at 480 primary health care centers in Sweden. From this registry, patients who met eligibility criteria were recruited and offered bariatric surgery. Thus, SOS patients self-selected into treatment, and there were baseline differences between groups, primarily reflecting more excess weight and a higher incidence of comorbidities in the surgery group. A total of 2010 people chose surgery, and 2037 people chose conservative care. Each surgical patient was matched on 18 clinical variables with a patient from the registry who received nonsurgical treatment (usual care). Each surgeon chose the surgical procedure offered. Most procedures were vertical-banded gastroplasty (VBG; >70%), with gastric bypass (6%) and gastric banding (23%) procedures performed as well. Usual care in the SOS trial was the local practice of the primary care center and usually did not include pharmacologic treatment. Patients were followed at regular intervals with repeat questionnaires and physical examinations for at least 10 years.

Many publications from this trial have reported on methods, weight loss, and clinical outcomes. The following general conclusions can be drawn from the SOS study:

- Weight loss was greater with bariatric surgery than with conservative treatment. At 10 years of follow-up, weight loss in the surgery group was 16% of total body weight compared with a weight gain of 1.6% in the conservative treatment group.
- There was significant improvement in glucose control for diabetics and reduced incidence of new cases of diabetes.
- The effect on other cardiovascular risk factors (e.g., hypertension, lipidemia) was also positive, but less marked than that seen for diabetes.
- Mortality was reduced by 29% after a mean follow-up of 10.9 years.
- Quality of life improved in the 2- to 10-year follow-up period, with the degree of improvement in quality of life correlating with the amount of weight loss.

Longitudinal Assessment of Bariatric Surgery Consortium

The Longitudinal Assessment of Bariatric Surgery Consortium study is a large prospective, longitudinal, noncomparative study of patients who underwent Roux-en-Y gastric bypass (RYGB) or laparoscopic adjustable gastric banding (LAGB) with follow-up through 3 years.
postprocedure. The study enrolled 2458 subjects, with median a BMI 45.9 kg/m² (interquartile range [IQR], 41.7-51.5 kg/m²). For their first bariatric surgical procedure, 1738 participants underwent RYGB, 610 LAGB, and 110 other procedures. At 3-year follow-up, for 1533 RYGB patients with available data, the percentage of baseline weight lost was 31.5% (IQR, 24.6%-38.4%). For the 439 LAGB patients with available data at 3 years, the percentage of baseline weight loss was 15.9% (IQR, 7.9%-23.0%). At 3 years post-surgery, 67.5% and 28.5% of RYGB and LAGB patients, respectively, had at least partial diabetes remission. Dyslipidemia was in remission in 61.9% and 27.1% of RYGB and LAGB patients, respectively. Subsequent bariatric procedures (revision or reversal) were required in 0.3% (95% confidence interval [CI], 0.1% to 0.9%) of the RYGB patients and in 17.5% (95% CI, 13.8% to 21.9%) of LAGB patients.

National Patient-Centered Clinical Research Network - Bariatric Study

The National Patient-Centered Clinical Research Network (PCORnet) Bariatric Study is a large retrospective, comparative study of 65093 patients aged 20-79 years who underwent RYGB (n=32208), LAGB (n=29693), or sleeve gastrectomy (SG) (n=3192) with follow-up through 5 years postprocedure. Mean estimated percent total weight loss (TWL) was calculated at 1, 3, and 5 years in addition to 30-day rates of major adverse events. Study results are summarized in Table 3. This study demonstrates that RYGB is associated with a greater weight loss than SG (p<0.001) and that LAGB is associated with the lowest amount of weight loss as observed in a large and diverse patient cohort.

<table>
<thead>
<tr>
<th>Group (n)</th>
<th>Mean TWL, % (95% CI)</th>
<th>MAE Rate, % (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Year</td>
<td>3 Years</td>
</tr>
<tr>
<td>RYGB (19,029; 9225; 3676)</td>
<td>-31.2 (-31.3 to -31.1)</td>
<td>-29.0 (-29.2 to -28.8)</td>
</tr>
<tr>
<td>LAGB (1681; 943; 337)</td>
<td>-13.7 (-14.0 to -13.3)</td>
<td>-12.7 (-13.5 to -12.0)</td>
</tr>
<tr>
<td>SG (14,929; 5304; 1088)</td>
<td>-25.2 (-25.4 to -25.1)</td>
<td>-21.0 (-21.3 to -20.7)</td>
</tr>
</tbody>
</table>


a Number of patients evaluated at 1, 3, and 5 years, respectively.

Systematic Reviews

Numerous systematic reviews have compared the efficacy of bariatric surgery with conservative therapy or compared different types of bariatric surgery techniques, some of which are older and do not extend across the full range of available studies. Park et al. (2019) conducted a systematic review with a network meta-analysis evaluating the comparative efficacy of various bariatric surgery techniques against standard-of-care in the treatment of morbid obesity and diabetes. The literature search was conducted through February 2018, identifying 45 RCTs for inclusion on RYGB (2 studies vs. control), SG (3 studies vs. control), LAGB (5 studies vs. control), and biliopancreatic diversion (BPD) with duodenal switch (BPD-DS; 3 studies vs. RYGB). Based on 33 trials, superior efficacy for percent excess weight loss (EWL) compared to standard-of-care was seen for BPD-DS (mean difference [MD] 38.2% 95% CI, 7.3% to 69.1%), RYGB (MD 32.1% 95% CI, 3.1% to 61.1%), and SG (MD 32.5% 95% CI, 5.5% to 59.5%) at 6 months post-procedure. LAGB was not superior to standard-of-care (MD -0.2% -19.6% to 19.2%). At 3 years post-procedure, superior efficacy for percent EWL compared to standard-of-care was seen for RYGB (MD 45% 95% CI, 21.8% to 68.2%) and SG (MD 39.2% 95% CI, 15.2% to 63.3%). BPD-DS (relative risk [RR] 7.51; 95% CI, 1.91 to 29.54), RYGB (RR 7.51; 95% CI, 1.98 to 28.46), and SG (RR 6.69; 95% CI, 1.75 to 25.57) were all superior to standard-of-care with respect to remission rates at 3-5 years post-procedure and remission rates were not significantly different.
among procedures. SG was found to have a relatively lower risk of adverse events compared to RYGB.

Kang et al. (2017) conducted a systematic review with a network meta-analysis that compared the 3 most common types of bariatric surgery techniques: RYGB, SG, and LAGB. The literature search, conducted through July 2016, identified 11 RCTs for inclusion (8 RYGB vs. SG; 2 RYGB vs. LAGB; 1 SG vs. LAGB). Quality of the trials was assessed using the Jadad score, based on allocation concealment, blinding, intention-to-treat analysis, power calculation, and funding. Most trials had a Jadad score of 3 (scale range, 1-5). A meta-analysis for the outcome of BMI reduction (6 trials) showed that there was no difference between SG and RYGB (0.7; 95% CI, -1.6 to 3.1). A meta-analysis of RYGB and LAGB (2 trials) and a single trial of SG and LAGB showed that LAGB was not as effective as RYGB or SG (5.8; 95% CI, 2.3 to 9.1; and 5.1; 95% CI, 0.9 to 8.9; respectively). Meta-analyses for the outcome of percent EWL showed the same pattern, no difference comparing SG and RYGB (5 trials; -4.0; 95% CI, -14.0 to 8.2), and both SG and RYGB more effective than LAGB (2 trials; 22.0; 95% CI, 6.5 to 34.0; 1 trial; 26.0; 95% CI, 6.4 to 41.0; respectively).

Colquitt et al. (2014) updated 2003 and 2009 Cochrane reviews of bariatric surgery for obesity. They identified 22 randomized trials that compared bariatric surgery with nonsurgical obesity management or that compared different bariatric surgery procedures (total N=1798 participants; sample size range, 15-250 participants). All 7 RCTs comparing surgery with nonsurgical interventions found benefits of surgery on measures of weight change at 1- to 2-year follow-ups. However, reviewers noted that adverse event rates and reoperation rates were poorly reported across trials, and long-term follow-up (beyond 1-2 years) was limited. Gloy et al (2013) conducted a systematic review and meta-analysis of RCTs comparing current bariatric surgery techniques with nonsurgical treatment for patients with BMI of 30 kg/m² or more. Eleven studies (total N=796 patients) were included. Overall, patients after bariatric surgery lost more body weight than patients after nonsurgical treatment (MD, -26 kg; 95% CI, -31 to -21 kg; p<0.001). Remission of type 2 diabetes (T2D) was more likely for bariatric surgery patients than for nonsurgical patients (RR of T2D remission, 22.1; 95% CI, 3.2 to 154.3; p<0.0001); similarly, remission of metabolic syndrome was more likely for bariatric surgery patients (RR, 2.4; 95% CI, 1.6 to 3.6; p<0.001). After bariatric surgery, 21 (8%) of 261 patients required reoperations (5/124 after LAGB, 4/69 after RYGB, 1/49 after SG, 1/19 after BPD). Similar to the Colquitt et al (2014) meta-analysis, no studies reported longer-term follow-up (>2 years) and heterogeneity between studies were high. Chang et al (2014) published a systematic review and meta-analysis of RCTs and observational studies to evaluate the effectiveness and risks of bariatric surgery. Reviewers included 164 studies (37 RCTs, 127 observational studies), with a total of 161756 patients. Mean pre-surgery BMI was 45.62 kg/m² and, among the studies that provided information about obesity-related comorbidities, 26% of patients had T2D, 47% had hypertension, 28% had dyslipidemia, 7% had cardiovascular disease, and 25% had obstructive sleep apnea (OSA). Perioperative complications were relatively low, with a perioperative mortality rate in RCTs of 0.08% (95% CI, -0.01% to 0.24%) and in observational studies of 0.22% (95% CI, 0.14% to 0.31%). Complication rates were 17% (95% CI, 11% to 23%) for RCTs and 10% for observational studies (95% CI, 7% to 13%). At 1-year follow-up, mean change in BMI was -13.53 kg/m² (95% CI, -15.51 to -11.55 kg/m²) in RCTs and -11.79 kg/m² (95% CI, -13.89 to -9.69 kg/m²) in observational studies. Decreases in BMI were generally sustained over 2 to 4 years of follow-up among studies reporting this outcome.

Many systematic reviews have reported improvements in specific obesity-related comorbidities following bariatric surgery. These reviews have relied primarily on the results of observational studies and included the outcomes of hypertension, T2D, hyperlipidemia, cardiovascular events, quality of life, cancer, knee pain, and liver disease. Puzziferri et al. (2014) conducted a systematic review of studies of bariatric surgery reporting follow-up beyond 2 years, which included 29 studies (total N=7971 patients). At follow-up, which ranged from 2 to 5 years post procedure, the mean sample size-weighted percentage of
EWL was higher for gastric bypass (65.7%) than for gastric banding (45.0%). Reviewers noted that few studies reported sufficient long-term results to minimize bias.

**Section Summary: Bariatric Surgery in Adults With Morbid Obesity**
There is a lack of large-scale RCTs with long-term follow-up comparing bariatric surgery with nonsurgical treatment for the general population of patients with morbid obesity. Evidence from nonrandomized comparative studies and case series and meta-analyses of existing RCTs has consistently reported that bariatric surgery results in substantially greater weight loss than nonsurgical therapy. Data from the largest comparative study (the SOS study) has reported that bariatric surgery is associated with improvements in mortality, diabetes, cardiovascular risk factors, and quality of life.

**Evidence for Specific Types of Bariatric Surgery Procedures**
**Gastric Bypass for Adults with Morbid Obesity**
Clinical Context and Therapy Purpose
The purpose of gastric bypass is to provide a treatment option that is an alternative to or an improvement on existing therapies, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does gastric bypass improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity. Morbid obesity is defined as a BMI 40 kg/m² or more or a BMI 35 kg/m² or more with at least 1 clinically significant obesity-related disease such as diabetes, obstructive sleep apnea, coronary artery disease, or hypertension for which these complications or diseases are not controlled by best practice medical management.

Interventions
The therapy being considered is gastric bypass. The procedure involves both a restrictive and a malabsorptive component, with the horizontal or vertical partition of the stomach performed in association with a Roux-en-Y procedure (i.e., a gastrojejunal anastomosis); thus, food bypasses the duodenum and proximal small bowel.

Patients who are adults with morbid obesity are managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are overall survival (OS), change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity.

Negative outcomes can include surgical complications, including leakage and operative margin ulceration at the anastomotic, and metabolic complications, including iron deficiency anemia, vitamin B12 deficiency, and hypocalcemia.

The existing literature evaluating gastric bypass as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs.

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

d. Studies with duplicative or overlapping populations were excluded.
The body of literature on improved weight loss has been instrumental in establishing gastric bypass as the reference procedure to which other procedures are compared.

**Systematic Reviews**

Comparative trials summarized in the 2003 TEC Assessment consistently reported favorable outcomes for open gastric bypass compared with VBG, including 2 RCTs. Some nonrandomized trials that compared open gastric bypass with procedures other than VBG were also summarized in the TEC Assessment. While there were fewer trials for these other procedures, comparisons of open gastric bypass to gastric banding, horizontal gastroplasty, and silastic ring gastroplasty all reported that weight loss was superior with open gastric bypass. Metabolic abnormalities were seen more frequently in gastric bypass patients than in those receiving a VBG. Anemia, iron deficiency, vitamin B12 deficiency, and red blood cell folate-deficiency were commonly seen. Marginal ulcerations were also seen in gastric bypasses, particularly in those whose gastric pouches were too large and included acid-secreting parietal cells.

A 2005 TEC Assessment focused on laparoscopic gastric bypass, which intends to reproduce the open procedure via minimally invasive techniques. This technically complex surgery requires a dedicated team and a relatively high degree of skill and experience in laparoscopic technique. This Assessment reviewed 7 comparative trials of the open gastric bypass and laparoscopic gastric bypass, including 3 RCTs. Also, 18 large clinical series of laparoscopic gastric bypass were included. The Assessment concluded that weight loss at 1 year was similar for laparoscopic and open gastric bypass approaches. Longer follow-up periods were less well-reported but appeared to be similar for both approaches. While comparisons of complication rates were less certain, some patterns were evident and consistent across the data examined. The profile of adverse events differed between the 2 approaches, with each having advantages and disadvantages. Laparoscopic gastric bypass offered a less invasive procedure associated with decreased hospital stay and earlier return to usual activities. Mortality might be lower with the laparoscopic approach, although both procedures had mortality rates less than 1%. Postoperative wound infections and incisional hemias were also less frequent with laparoscopic gastric bypass. However, anastomotic problems, gastrointestinal tract bleeding, and bowel obstruction appeared to be higher with the laparoscopic approach, though not markedly higher. Given these data, the overall benefit-risk profile for these 2 approaches appeared to be similar.

Yan et al. (2016) published a systematic review of RCTs comparing gastric bypass with medical treatment in obese patients (i.e., BMI ≥30 kg/m²) who had T2D. The primary study outcome was remission of T2D, which was reported in 5 of the 6 studies. A pooled analysis found a significantly higher remission rate after gastric bypass than after medical treatment (odds ratio [OR], 76.37; 95% CI, 20.70 to 271.73; p<0.001). Also, a pooled analysis found a significantly lower final BMI in the gastric bypass group than in the medical treatment group (MD = -6.54 kg/m²; 95% CI, -9.28 to -3.80 kg/m²; p<0.001).

**Observational Studies**

Wadden et al. (2019) reported on end-of-trial results from the Look AHEAD: Action for Health in Diabetes (Look AHEAD) trial, which evaluated outcomes in patients with T2D and obesity who had self-selected to receive bariatric surgery after failing an assigned intensive lifestyle intervention (ILI) or a diabetes support and education (DSE) control therapy. Patients who received bariatric surgery were significantly more likely to be female (p<0.001), younger (p<0.001), and have higher BMI at randomization (p<0.001). Patients underwent 127 RYGB, 58 LAGB, and 11 SG procedures, respectively. End-of-trial assessments were completed at 4.3 years post-surgery compared to 9.6 years post-randomization for the DSE and ILI participants. Patients undergoing RYGB, LAGB, or SG surgical procedures lost a mean of 22.4% ± 1.0%, 13.0% ± 1.5%, and 16.2% ± 3.3% of baseline weight, respectively. Twelve patients (6.1%) receiving bariatric surgery were randomized with a BMI <35 kg/m². The mean BMI was 37.0 ± 5.1, 37.1 ± 5.3, and 42.1 ± 5.8 for DSE, ILI, and surgery groups, respectively (p<0.001). Overall, surgically-treated patients lost a mean of 19.3% of baseline weight, compared with 5.8% and 3.3% for the ILI and DSE.
participants. Full diabetes remission was achieved by 7.6% of bariatric surgery participants compared to 1.1% of ILI and 1.1% of DSE participants. Full remission was significantly more common in surgically treated participants in ILI (RR 6.72; 95% CI, 3.35 to 13.48; \( p < 0.001 \)) or DSE (RR 7.07; 95% CI, 3.49 to 14.30; \( p < 0.001 \)) groups. Significantly greater reductions in waist circumference (\( p < 0.001 \)), triglyceride levels (ILI: \( p = 0.03 \); DSE: \( p = 0.02 \)), and hemoglobin A1c (HbA1c) levels (\( p < 0.001 \)) were observed in surgically-treated patients compared to ILI or DSE groups. The study was limited by heterogeneity in baseline characteristics and choice of surgical procedure. Results were not stratified by surgery type or BMI range.

Section Summary: Gastric Bypass for Adults with Morbid Obesity

Gastric bypass has been extensively studied. TEC Assessments and other systematic reviews have found that gastric bypass improved health outcomes, including weight loss and remission of T2D. A TEC Assessment also found similar weight loss with open and laparoscopic gastric bypass.

Laparoscopic Adjustable Gastric Banding for Adults with Morbid Obesity

Clinical Context and Therapy Purpose
The purpose of LAGB is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does the LAGB procedure improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity.

Interventions
The therapy being considered is LAGB. Patients who are adults with morbid obesity are managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating LAGB as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 2 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
d. Studies with duplicative or overlapping populations were excluded.

e. **Systematic Reviews**

A 2006 TEC Assessment updated the evidence on LAGB and compared outcomes with gastric bypass. This Assessment concluded that, for patients considering bariatric surgery, there was sufficient evidence to permit an informed choice between gastric bypass and LAGB. An informed patient might reasonably choose open gastric bypass or LAGB as the preferred procedure. Preoperative counseling should include education on the comparative risks and benefits (e.g., extent of weight loss and frequency and timing of potential complications) of the 2 procedures to optimize choice based on preferences and shared decision making.

Weight loss outcomes from the studies reviewed in the Assessment confirmed that weight loss at 1 year was lower for LAGB than for open gastric bypass. The percentage of EWL at 1 year was approximately 40%, compared with 60% or higher for open gastric bypass. At time points beyond 1 year, some comparative studies have reported that the difference in weight loss between LAGB and open gastric bypass narrows, but other studies did not. Weight loss outcomes from the 9 single-arm series with the most complete follow-up did not support the hypothesis that the difference in weight loss shrinks after 1 to 2 years of follow-up. It appears more likely from the current data that attrition bias might have accounted for the diminution of the difference in weight loss over time, particularly when patients with bands removed or deflated were excluded from analysis.

These studies also confirmed that short-term (perioperative) complications are very low with LAGB and lower than with open gastric bypass or LAGB. Death was extremely rare, and serious perioperative complications probably occurred at rates less than 1%.

The reported rates of long-term adverse events vary considerably. In the comparative trials, reoperations were reported in approximately 25% of patients, while, in the single-arm studies, the composite rate for reoperations were approximately 50% lower (11.9%). The rates of other long-term complications were also highly variable; e.g., the range of rates for band slippage was 1% to 36% and the range for port access problems was 2% to 20%. These data on long-term complications remain suboptimal. The reporting of long-term complications in these trials was not systematic or consistent. While impossible to determine the precise rates of long-term complications from these data, it is likely that complications have been underreported in many studies due to incomplete follow-up and lack of systematic surveillance. A recent publication by Ibrahim et al (2017) reviewed 25042 Medicare beneficiaries who underwent LAGB surgery; 18.5% (n=4636) patients underwent 1 or more reoperation(s). Reoperation was prompted by the need for band removal (41.8%), band and port replacement (28.6%), and other requirements. The rates of long-term complications reported in some studies raise concern about the impact of these events on the overall benefit-risk profile for LAGB.

In comparing LAGB with open gastric bypass, there are tradeoffs in terms of risks and benefits. LAGB is a less invasive procedure associated with fewer procedural complications, decreased hospital stay and earlier return to usual activities. However, benefits defined by the amount of weight lost are lower for LAGB. The patterns of long-term complications also differ between the 2 procedures. For LAGB, longer-term adverse events related to the presence of a foreign body in the abdomen will occur and will result in reoperations and removal of the band in a minority of patients. Patients who have their bands removed can later be offered an alternative bariatric surgery procedure, such as gastric bypass.

A systematic review by Chakravarty et al. (2012) comparing LAGB with other bariatric surgery procedures drew conclusions similar to the TEC Assessment. Reviewers included 5 RCTs. The RCTs found that patients using LAGB lost weight, but less weight than with other procedures (e.g.,
gastric bypass or SG). However, the short-term complication rate was lower with LAGB, and no difference was found in quality of life after LAGB versus other procedures.

Dixon et al. (2018) published a prospective, industry-sponsored study of morbidly obese patients who underwent implantation of the adjustable gastric banding system (LAP-BAND)\(^44\). Between 2009 and 2013, 652 patients with a mean BMI of 45.4 kg/m\(^2\) were treated at 17 participating centers in the United States and Canada. At 5 years, the explant rate was 8.74\%(95% CI: 6.6–10.9\%). Excluding explants, 100 (15.3\%) reoperations were necessary during the follow-up period. A mean weight loss of 18.7\% was achieved by 2 years and maintained through 5-year follow-up. The study was limited by the lack of control group.

**Section Summary: Laparoscopic Adjustable Gastric Banding for Adults with Morbid Obesity**
Systematic reviews of the literature have concluded that LAGB is a reasonable alternative to gastric bypass. There is less weight loss with LAGB; however, the procedure is associated with fewer serious adverse events.

**Sleeve Gastrectomy for Adults with Morbid Obesity**

**Clinical Context and Therapy Purpose**
The purpose of SG is to provide a treatment option that is an alternative to or an improvement of existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does SG improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**
The relevant population of interest is individuals who are adults with morbid obesity.

**Interventions**
The therapy being considered is SG, an alternative approach to gastrectomy that can be performed on its own or in combination with malabsorptive procedures. In this procedure, the greater curvature of the stomach is resected from the angle of His to the distal antrum, resulting in a stomach remnant shaped like a tube or sleeve. This procedure can be done as an open or laparoscopic procedure.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating SG as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.
**Study Selection Criteria**

Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;

c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;

d. Studies with duplicative or overlapping populations were excluded.

**Systematic Reviews**

SG may be performed as a stand-alone procedure or in combination with a malabsorptive procedure, such as the BPD with BPD-DS. It has also been proposed as the first step in a 2-stage procedure, with gastric bypass or BPD as the second stage.

Osland et al. (2017) published a systematic review and meta-analysis of RCTs comparing laparoscopic vertical SG with RYGB (see Table 4). The literature search, conducted from 2000 to November 2015, identified 9 RCTs for inclusion (total N=865 patients). Four trials were included in meta-analyses comparing percent EWL between the 2 groups. Results at both 6- and 12-month follow-ups showed that the procedures are comparable (see Table 5).

A systematic review by Juodeikis and Brimas (2017) summarized evidence on long-term results after SG (see Table 3). Reviewers included an RCT and 19 retrospective studies, with a total of 2713 patients who received SG. Mean preoperative BMI was 46.9 kg/m². Mean duration of follow-up ranged from 5 to 11 years, and mean proportion of patients followed for 5 years was 68.5%. Seventeen studies (n=1501 patients) reported 5-year follow-up data. At 5 years, resolution of T2D, arterial hypertension, dyslipidemia, OSA, gastroesophageal reflux disease (GERD), and degenerative joint diseases also improved in most patients (see Table 5). Two studies reported weight loss after 7 and 8 years; percent EWL rates were 56.6% and 54.8% respectively.

In a meta-analysis of 21 randomized and nonrandomized studies (total N=18766 patients) comparing SG with laparoscopic RYGB for morbid obesity, Zhang et al. (2015) reported no significant difference in percent EWL from 0.5- to 1.5-year follow-ups (see Tables 3 and 4). However, after 1.5 years, RYGB was associated with higher percent EWL (2-year MD=5.77; 95% CI, 4.29 to 7.25; p<0.05). Adverse events were more frequent following RYGB (OR for major complication, 1.29; 95% CI, 1.22 to 3.22; p<0.01).

Trastulli et al. (2013) conducted a systematic review of 15 RCTs (total N=1191 patients) that compared SG with other bariatric procedures (see Table 4). Summary statistics were provided; meta-analyses were not conducted (see Table 5). Reviewers reported mean complication rates with SG of 12.1% (range, 10%-13.2%) compared with 20.9% with LAGB (range, 10%-26.4%). Percent EWL ranged from 49% to 81% with SG and from 62.1% to 94.4% with LAGB.

Brethauer et al. (2009) reviewed 36 studies (total N=2570 patients) in a systematic review of SG as a staged and primary procedure, the largest trials coming from European centers (see Table 4). Thirteen studies (n=821 patients) reported on high-risk patients having a staged approach and 24 studies (n=1749 patients) on SG as primary procedure. Mean percent EWL, reported in 24 studies (n=1662 patients), was 55.4% overall. Mean postoperative BMI, reported in 26 studies (n=1940 patients), decreased from a baseline of 51.2 to 37.1 kg/m². Other studies reported weight loss in terms of BMI decrease, the percentage of BMI lost, or percentage of total weight lost; all had significant reductions from baseline. Rates of major postoperative complications ranged from 0% to 23.8% for all studies and from 0% to 15.3% in studies with more than 100 patients. Leaks (2.2%), bleeding episodes requiring reoperation (1.2%), and postoperative strictures requiring endoscopic or surgical intervention (0.6%) were reported in the 33 studies (n=2570 patients). All extracted studies reported mortality data, with 5 deaths within 30 days of surgery (overall mortality rate, 0.19%; 2 in the high-risk/staged group, 3 in the primary procedure group).
Table 4. Systematic Review Characteristics for Sleeve Gastrectomy

<table>
<thead>
<tr>
<th>Study</th>
<th>Dates</th>
<th>Studies</th>
<th>Participants</th>
<th>Design</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osland et al. (2017)</td>
<td>2000-Nov 2017</td>
<td>9</td>
<td>SG=437; RYGB=428</td>
<td>RCTs</td>
<td>3 mo to 5 y</td>
</tr>
<tr>
<td>Juodeikis et al. (2017)</td>
<td>Through May 2016</td>
<td>20</td>
<td>1626</td>
<td>1 RCT; 19 retrospective</td>
<td>5 to 11 y</td>
</tr>
<tr>
<td>Zhang et al. (2015)</td>
<td>Through Oct 2013</td>
<td>21</td>
<td>18,766</td>
<td>8 RCTs; 13 nonrandomized comparative</td>
<td>1 to 5 y</td>
</tr>
<tr>
<td>Trastulli et al. (2013)</td>
<td>Through Nov 2012</td>
<td>15</td>
<td>1191</td>
<td>RCTs</td>
<td>6 mo to 3 y</td>
</tr>
<tr>
<td>Brethauer et al. (2009)</td>
<td>1996 to 2009</td>
<td>36</td>
<td>2570</td>
<td>2 RCTs; 1 cohort; 33 case series</td>
<td>3 mo to 5 y</td>
</tr>
</tbody>
</table>

RCT: randomized controlled trial; RYGB: Roux-en-Y gastric bypass; SG: sleeve gastrectomy.

Table 5. Systematic Review Results for Sleeve Gastrectomy

<table>
<thead>
<tr>
<th>Study</th>
<th>Percent EWL (95% CI)</th>
<th>Comorbidities (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osland et al. (2017)</td>
<td>Mean difference, SG and RYGB: 6 mo (3 trials): 0.5 (-5.0 to 6.0)</td>
<td>Not reported</td>
</tr>
<tr>
<td></td>
<td>12 mo (2 trials): 7.6 (-0.1 to 15.3)</td>
<td></td>
</tr>
<tr>
<td>Juodeikis et al. (2017)</td>
<td>Mean rates for SG: 5 y (17 trials): 58.4%</td>
<td>Remission/improvement:</td>
</tr>
<tr>
<td></td>
<td>7 y (2 trials): 56.6%</td>
<td>Type 2 diabetes: 77.8%</td>
</tr>
<tr>
<td></td>
<td>11 y (1 trial): 62.5%</td>
<td>Hypertension: 68.0%</td>
</tr>
<tr>
<td>Zhang et al. (2015)</td>
<td>Mean difference, RYGB, and SG: 6 mo (9 studies): 0.2 (-2.5 to 2.9)</td>
<td>Mean difference resolution, RYGB, and SG:</td>
</tr>
<tr>
<td></td>
<td>12 mo (15 studies): 2.9 (-0.2 to 6.0)</td>
<td>Type 2 diabetes (10 studies): 3.3 (2.0 to 5.5)</td>
</tr>
<tr>
<td></td>
<td>4 y (3 studies): 2.7 (0.2 to 5.2)</td>
<td>Hypertension (10 studies): 1.3 (0.7 to 2.4)</td>
</tr>
<tr>
<td>Trastulli et al. (2013)</td>
<td>Mean by procedure: SG: 49% to 81% LGB: 62% to 94% LAGB: 29% to 48%</td>
<td>Type 2 diabetes: SG, 67% to 100% LGB, 80% to 100%</td>
</tr>
<tr>
<td>Brethauer et al. (2009)</td>
<td>Mean rate overall for SG: 55% (range, 33%-85%)</td>
<td>Remission/improvement:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type 2 diabetes: &gt;70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Significant reductions also seen in hypertension, hyperlipidemia, and sleep apnea</td>
</tr>
</tbody>
</table>


Randomized Controlled Trials

Hofso et al. (2019) published the results of a single-center, triple-blind RCT comparing the efficacy of RYGB (n=54) versus SG (n=55) on diabetes remission and β-cell function in patients with obesity and T2D.50 Inclusion criteria included previously verified BMI ≥35 kg/m² and current BMI ≥33.0 kg/m², HbA1c ≥6.5% or use of antidiabetic medications with HbA1c ≥6.1%, and age ≥18 years. One-year follow-up was completed by 107 (98%) of 109 patients, with 1 patient in each group withdrawing after surgery. In the intention-to-treat population, diabetes remission rates were superior in the gastric bypass group than in the SG group (risk difference 27%, 95% CI, 10 to 44; RR 1.57, 95% CI, 1.14 to 2.16; p=0.0054). Results were similar in the per-protocol population (risk
difference 27%; 95% CI, 10 to 45; RR 1.57; 95% CI, 1.14 to 2.15; p=0.0036). The 2 procedures had a similar beneficial effect on β-cell function.

Peterli et al. (2018) published a randomized study of adults with morbid obesity treated with either laparoscopic sleeve gastrectomy (LSG) or RYGB.51 Two hundred five patients (mean age, 45.5 years; mean BMI, 43.9; 72% women) treated at 4 Swiss bariatric centers were randomly assigned to receive SG (n=101) or RYGB (n=104) with 5-year follow-up. Excess BMI loss was 61.6% for SG and 68.3% for RYGB (95% CI: -14.30 to -0.06; p=0.22). Gastric reflux remission was seen in 25.0% of SG and 60.4% of RYGB patients. Reoperations or interventions were necessary for 16/101 (15.8%) in the SG group and 23/104 (22.1%) of the RYGB group. The study was limited by the lack of analysis of diabetes remission information, and the results may not be generalizable.

Salminen et al. (2018) published a randomized trial Laparoscopic Gastric Bypass vs. Laparoscopic Sleeve Gastrectomy in the Treatment of Morbid Obesity (SLEEVEPASS) comparing 5-year outcomes of morbidly obese patients (n=240; mean age, 48 years; mean baseline BMI, 45.9; 69.6% women) who underwent either LSG (n=121) or RYGB (n=119).52 Five-year estimated mean percentage EWL was 49% (95% CI: 45–52%) for SG and 57% (95% CI: 53–61%) for gastric bypass. For SG and RYGB, respectively, rates of remission of T2D were 37% (n=15/41) and 45% (n=18/40; p>0.99). Medication for hypertension was discontinued in 20/68 (29%) SG patients and 37/73 (51%) RYGB patients (p=0.02). Overall 5-year morbidity rate was 19% for SG and 26% for RYGB (p=0.19), and there was no significant difference in quality of life between groups (p=0.85). The study was limited by the following: (1) only a small number (n=430) of bariatric procedures were performed in Finland at trial initiation in 2008, meaning a learning curve could account for some earlier technical complications, (2) the study had a higher reoperation rate for SG than other trials reported, (3) approximately 20% of patients were lost to follow-up, and (4) there was a lack of reliable information for diabetes duration at baseline.

An RCT comparing short-term outcomes of laparoscopic SG with gastric bypass was published in 2012.53 Trialists compared 30-day outcomes for 117 patients randomized to gastric bypass with 121 patients randomized to LSG. The rate of major complications (no deaths in either group) was 9.4% in the gastric bypass group compared with 5.8% in the LSG group (p=0.29). Minor complications were more common in the gastric bypass group than in the LSG group (17.1% vs. 7.4%, p=0.02). Fewer patients had complications in both groups, overall complications were combined major and minor complications (26.5% vs. 13.2%, p=0.01).

Karamanakos et al. (2008) carried out a double-blind RCT comparing outcomes of laparoscopic RYGB and LSG on body weight, appetite, fasting, and postprandial ghrelin and peptide YY (levels at 1, 3, 6, and 12 months after surgery).54 Thirty-two patients were randomized, half to each procedure. The decrease in body weight and BMI were marked and comparable in each group. EWL was greater after LSG than laparoscopic RYGB at 6 months (55.5% vs. 50.2%; p=0.04) and 12 months (69.7% vs. 60.5% p=0.05), all respectively. Fasting peptide YY levels increased after both surgical procedures. Appetite decreased in both groups but decreased more after LSG.

Himpens et al. (2006) reported on a randomized trial comparing LAGB with isolated LSG in 80 patients and reported 3-year follow-up.55 Median baseline BMI was 37 kg/m² (range, 30-47 kg/m²) in the LAGB group and 39 kg/m² (range, 30-53 kg/m²) in the SG group. Outcomes of weight loss, feeling of hunger, sweet-eating, GERD, complications, and reoperations were recorded at 1- and 3-year follow-ups. Median decrease in BMI in the gastric bypass group was 15.5 kg/m² (range, 5-39 kg/m²) after 1 year and 18 kg/m² (range, 0-39 kg/m²) at 3 years after LAGB. One year after SG, decrease in BMI was 25 kg/m² (range, 0-45 kg/m²) and 27.5 kg/m² (range, 0-48 kg/m²) after 3 years. Median EWL in the LAGB group was 41.4% after 1 year and 48% at 3 years. Median EWL after SG was 58% and 66% at 1 and 3 years, respectively. More patients having SG than LAGB reported a loss of craving for sweets, but the difference was not statistically significant; GERD appeared de novo in more SG than LAGB patients at 1 year, and the relation reversed at 3 years; between-group differences were not statistically significant at either time point. Two SG patients required reoperation for complications. Seven late
Complications required reoperation after LAGB, including pouch dilations treated by band removal (n=2) or conversion to RYGB (n=1), 1 gastric erosion treated by conversion to RYGB, and 3 system disconnections that required reconnection. Four patients had reoperations for lack of efficacy (2 LAGB patients underwent conversion to RYGB, 2 SG patients underwent conversion to duodenal switch). The trialists noted that the number of reoperations was significant in both groups and that the severity of complications was greater in the SG group.

Section Summary: Sleeve Gastrectomy for Adults with Morbid Obesity
Systematic reviews of RCTs and observational studies, evaluating SG alone and comparing SG with RYGB, have found that SG results in substantial weight loss, comparable to RYGB and that this weight loss is durable for at least 5 years. A meta-analysis found that short-term weight loss was similar after SG or gastric bypass. Long-term weight loss was greater after gastric bypass, but SG is associated with fewer adverse events.

BPD With Duodenal Switch for Adults with Morbid Obesity
Clinical Context and Therapy Purpose
The purpose of BPD-DS is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does the BPD-DS procedure improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity.

Interventions
The therapy being considered is BPD-DS.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating BPD-DS as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 15 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

d. Studies with duplicative or overlapping populations were excluded.

BPD may be performed with or without the duodenal switch procedure. In the BPD-DS, an SG is performed, preserving the pyloric sphincter. Preservation of the pyloric sphincter is intended to ameliorate the dumping syndrome and to decrease the incidence of ulcers at the duodeno-ileal anastomosis by providing a more physiologic transfer of stomach contents to the duodenum.

**Systematic Review**

In an evidence-based review of literature, Farrell et al (2009) summarized data on BPD with or without DS, RYGB (proximal), and LAGB, and reported that at a mean 1-year follow-up, EWL for BPD with or without DS (outcomes with and without DS not reported separately) was 72% (4 studies; n=896 patients), 67% for RYGB (7 studies; n=1627 patients), and 42% for LAGB (11 studies; n=4456 patients). At mean follow-up of 5 years, EWL for BPD with or without DS was 73% (3 studies; n=174 patients), 58% for RYGB (3 studies; n=176 patients), and 55% for LAGB (5 studies; n=640 patients). Reviewers noted that “given the marked paucity of prospectively collected comparative data among the different bariatric operations, it remains impossible to make definitive recommendations for one procedure over another.”

**Nonrandomized Comparative Studies**

Skogar et al. (2017) published results from a retrospective mail survey of patients undergoing BPD-DS (n=113) or RYGB (n=98) (see Table 6). Reduction in BMI was statistically larger in patients receiving BPD-DS compared with patients receiving RYGB (see Table 6). Both groups experienced significant reductions in diabetes and OSA. Significant reductions in dyslipidemia were only seen in the group receiving BPD-DS. The overall complication rate was lower for patients undergoing RYGB.

Strain et al. (2007) published a comparative study of 72 patients who underwent RYGB (n=50) or BPD (n=22) (see Table 6). Choice of surgery was by the surgeon and/or patient, and the patient populations differed by age and time since surgery. Weight loss at 1 year was greater for BPD, with a reduction in BMI of 10.6 kg/m² (23.3 lb) for BPD compared with 7.5 kg/m² (16.5 lb) for RYGB (p<0.001).

Prachand et al. (2006) published the largest comparative study of 350 super-obese patients with BMI greater than 22.7 kg (50 lb) who underwent RYGB (n=152) or Scopinaro BPD combined with the DeMeester BPD-DS (n=198) (see Table 6). In this retrospective study, the decision for surgery was made by the surgeon and/or patient. The BPD-DS patients differed from RYGB patients on baseline weight and BMI; mean weight was 167 kg (368 lb; range, 267-597 lb) in BPD-DS patients and 157 kg (346 lb; range, 240-505 lb) in the RYGB group, and mean BMI was 27 kg/m² (59 lb; range, 50-96 lb) in BPD-DS patients versus 26 kg/m² (56 lb; range, 50 to 84 lb) in the RYGB group. At 1 year, data were reported for 143 BPD-DS patients and 81 RYGB patients (see Table 7). EWL was greater for BPD (64.1%) versus RYGB (55.9% p<0.01), and the reduction in BMI was also greater with BPD (10.7 kg/m² [23.6 lb]) versus RYGB (8.8 kg/m² [19.4 lb]; p<0.001). Complications and data on the resolution of comorbidities were not reported.

Table 6. Nonrandomized Comparative Study Characteristics for Biliopancreatic Diversion with Duodenal Switch

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Dates</th>
<th>Participants</th>
<th>Follow-Up</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>RYGB: 98</td>
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<td></td>
<td>RYGB: 50</td>
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<td></td>
<td>BPD-DS: 19</td>
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</table>

Table 7. Nonrandomized Comparative Study Results for BPD-DS

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean Reduction in BMI (SD)</th>
<th>Percent Achieving ≥50% EWL</th>
<th>1 Year</th>
<th>2 Years</th>
<th>3 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presurgery, kg/m²</td>
<td>Postsurgery, kg/m²</td>
<td>p&lt;0.01</td>
<td>NR</td>
<td>NR</td>
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<tr>
<td>Skogar et al. (2017)§7,</td>
<td>56 (6.7)</td>
<td>52 (4.0)</td>
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<td>NR</td>
<td>NR</td>
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<tr>
<td>BPD-DS</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>RYG B</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Strain et al. (2007)§8,</td>
<td>54 (11.9)</td>
<td>48 (6.3)</td>
<td>&lt;0.001</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>BPD-DS</td>
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<tr>
<td>RYG B</td>
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<tr>
<td>Prachand et al. (2006)§9,</td>
<td>59 (6.7)</td>
<td>56 (6.8)</td>
<td>&lt;0.01</td>
<td>83.970.4</td>
<td>84.259.3</td>
</tr>
<tr>
<td>BPD-DS</td>
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<td></td>
<td></td>
<td>89.279.3</td>
<td></td>
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<tr>
<td>RYG B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>84.259.3</td>
</tr>
</tbody>
</table>

BMI: body mass index; BPD-DS: biliopancreatic diversion with duodenal switch; EWL: excess weight loss; NR: not reported; RYG B: Roux-en-Y gastric bypass; SD: standard deviation.

* Between groups, difference in change.

* p<0.05.

Case Series

Strain et al. (2017) reported on the nutrient status of 190 patients receiving BPD-DS after 9 years of follow-up.60 At baseline, the patients had a mean age of 43 years and mean BMI of 53 kg/m². All patients reported taking some supplements. Deficiencies in protein, iron, and calcium developed by year 3 and continued through the study. Zinc deficiencies developed by year 5. Folate levels increased during the study, probably due to the efficacy of the supplement. The authors warned that interventions need to be implemented to improve nutrient status in patients receiving BDP-DS.

The largest case series of this procedure is by Marceau et al. (2009), who reported on their 15-year experience with duodenal switch in 1423 patients from 1992 to 2005.61 Follow-up evaluations were available for 97% of patients. Survival rate was 92%. After a mean of 7 years (range, 2-15 years), 92% of patients with an initial BMI of 50 kg/m² or less obtained a BMI of 35 kg/m² or less, and 83% of patients with BMI greater than 50 kg/m² achieved a BMI of less than 40 kg/m². Diabetes medication was discontinued in 92% and decreased in others. Use of continuous positive airway pressure was discontinued in 92% of patients, and the prevalence of cardiac risk index greater than 5 decreased by 86%. Operative mortality was 1%, the revision rate was 0.7% and the reversal rate was 0.2%. Revision for failure to lose sufficient weight was needed in only 1.5% of patients. Severe anemia, vitamin deficiency, or bone damage were preventable or easily treated and without documented permanent damage.
Section Summary: Biliopancreatic Diversion with Duodenal Switch for Adults with Morbid Obesity
Nonrandomized comparative studies have found significantly higher weight loss after BPD-DS compared with gastric bypass at 1 year. A large case series found sustained weight loss after 7 years.

Biliopancreatic Diversion without Duodenal Switch for Adults with Morbid Obesity
Clinical Context and Therapy Purpose
The purpose of BPD without DS is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does the BPD without DS procedure improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity.

Interventions
The therapy being considered is BPD without DS. Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating BPD without DS as a treatment for morbid obesity has varying lengths of follow-up, ranging to 9 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Studies with duplicative or overlapping populations were excluded.

The available evidence on BPD-DS was reviewed in the 2006 TEC Assessment, and BPD outcomes, with or without DS, were compared with those of gastric bypass. One comparative trial and 7 single-arm series suggested that weight loss outcomes at 1 year were in the same range as for gastric bypass. While these data were not sufficient to distinguish small differences in weight loss between the 2 procedures, they did not support the hypothesis that BPD resulted in greater weight loss than open gastric bypass.
Complication rates have been poorly reported in these trials. The data have suggested that mortality is low (1%) and in the same range as for open gastric bypass. However, rates of other complications, especially long-term complications, cannot be determined from these data. Limited data have suggested that long-term nutritional and vitamin deficiencies occur at a high rate following BPD. Slater et al. (2004) focused specifically on vitamin and calcium deficiencies following BPD. They reported high rates of vitamin and calcium abnormalities in their population over a 4-year period. By year 4, 48% of patients had low calcium, and 63% had low levels of vitamin D. Other fat-soluble vitamins showed similar patterns of abnormalities. Low vitamin A was found in 69% of patients at 4 years, low vitamin K in 68%, and low zinc in 50% of patients. Dolan et al. (2004) reported similar data in a study that compared several technical variations of BPD. They reported low calcium levels in 12% to 34% of patients, low vitamin D in 22.2% to 70.6%, low vitamin A in 53% to 67%, and low vitamin K in 44% to 59%. Also, this study reported high rates of iron deficiency (11%-47%) and anemia (11%-40%).

Skroubis et al. (2006) randomized 130 patients with a BMI of 35 to 50 kg/m² to RYGB or BPD without DS using a variant of BPD that included RYGB in place of SG. All patients were followed for at least 2 years. Weight loss outcomes were superior for the BPD group at every interval examined up to 2 years. EWL at 1 year was 73.7% for RYGB and 83.1% for BPD (p<0.001); at 3 years, EWL was 72.6% for RYGB and 83.1% for BPD (p<0.001). There were more early complications in the RYGB group, but this difference was not statistically significant (6 complications vs. 1, respectively; p=0.12). Late complications also did not differ significantly between the RYGB group (16 complications) and BPD groups (22 complications; p=0.46).

Numerous clinical series of BPD have been published but high-quality trials directly comparing outcomes of this procedure with gastric bypass are lacking. The largest experience with BPD (total N=1217 patients) was reported by Scopinaro et al. (1996), who developed the procedure. With a follow-up of up to 9 years, the authors reported a durable EWL of 75%, suggesting that weight loss is greater with this procedure than with gastric restrictive procedures. Also, most patients reported disappearance or improvement of complications such as OSA, hypertension, hypercholesterolemia, and diabetes. The authors considered protein malnutrition the most serious metabolic complication, occurring in almost 12% of patients and responsible for 3 deaths. This complication could require inpatient treatment with total parental nutrition. To address protein malnutrition, 4% of patients underwent reoperation to elongate the common limb (thus increasing protein absorption) or to have the operation reversed, restoring normal intestinal continuity. The authors also found that protein malnutrition was strongly related to ethnicity and, presumably, patient eating habits, with an increased incidence among those from southern Italy where the diet contains more starch and carbohydrates than the north. Peripheral neuropathy may occur in the early postoperative period due to excessive food limitation but may be effectively treated with large doses of thiamine. Bone demineralization, due to decreased calcium absorption, was seen in about 33% of patients during the first 4 postoperative years. All patients were encouraged to maintain an oral calcium intake of 2 g/d, with monthly vitamin D supplementation.

Section Summary: Biliopancreatic Diversion without Duodenal Switch for Adults with Morbid Obesity

A TEC Assessment reviewed the available observational studies and concluded that weight loss was similar after BPD without the DS and gastric bypass. However, BPD without DS leads to complications, especially long-term nutritional and vitamin deficiencies.

Vertical-Banded Gastroplasty for Adults with Morbid Obesity

Clinical Context and Therapy Purpose

The purpose of VBG is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.
The question addressed in this evidence review is: Does the VBG procedure improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**
The relevant population of interest is individuals who are adults with morbid obesity.

**Interventions**
The therapy being considered is VBG. In this procedure, the stomach is segmented along its vertical axis, a plug of the stomach is removed, and a propylene collar is placed through this hole and then stapled to itself. It can be performed using an open or laparoscopic approach. Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. Negative outcomes associated with VBG include complications such as esophageal reflux, dilation, or obstruction of the stoma.

The existing literature evaluating VBG as a treatment for morbid obesity has varying lengths of follow-up, ranging from 3 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 3 to 10 years of follow-up is considered necessary to demonstrate efficacy.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
d. Studies with duplicative or overlapping populations were excluded.

VBG is a purely restrictive procedure that has been replaced by LAGB or SG. Weight loss with VBG is substantial, but there are high rates of revisions and reoperations due to staple line disruption, perforation, band erosion or disruption, and stenosis at the band site. Overall rates of revisions and reoperations at up to 10 years may be as high as 50%.

**Systematic Reviews**
Hseih et al. (2014) conducted a systematic review of studies reporting greater than 10-year follow-up for VBG, which included 3 studies with extractable data. Mean EWL was 61.4% from baseline to follow-up in the 3 studies, but reviewers noted a lack of long-term evidence related to outcomes following VBG.

A number of nonrandomized, comparative studies of open gastric bypass versus VBG were included in the 2003 TEC Assessment (N=8 studies, total N=3470 patients). All 8 studies reported greater amounts of weight loss with open gastric bypass. These studies reported a 44% to 70% improvement in TWL, a 28% to 43% improvement in the percent EWL, and 19% to 36% more
patients with more than 50% EWL for those undergoing gastric bypass compared with VBG. Comparison of adverse events was difficult because the data did not permit rigorous assessment. Nevertheless, the data suggested that the mortality rate for both surgeries was low overall. Serious perioperative adverse events were also infrequently reported, but somewhat higher for gastric bypass. Long-term adverse events were inconsistently reported, although it appeared that revision rates were higher for VBG.

**Randomized Controlled Trials**

A small body of literature has compared outcomes between VBG and open gastric bypass. The most rigorous of these comparative trials, the Adelaide Study (1990), randomized 310 morbidly obese patients to gastric bypass, VBG, or horizontal gastroplasty. The percentage of patients with greater than 50% EWL at 3-year follow-up was 67% for gastric bypass, 48% for VBG, and 17% for horizontal gastroplasty (p < 0.001). There were no demonstrable differences in adverse events across groups.

A second, smaller RCT by Sugerman et al. (1987) randomized 40 patients to a VBG or a gastric bypass procedure. After 9 months, the gastric bypass patients had significantly greater weight loss that was maintained at 3-year follow-up. The gastric bypass patients lost approximately 64% of excess weight, whereas the gastroplasty patients lost 37% of excess weight.

**Case Series**

Relatively high rates of complications, revisions, and reoperations led to the abandonment of VBG as a bariatric surgery procedure in the United States. An example of these results is a large case series with long-term follow-up by MacLean et al (1990), who reported on 201 patients undergoing VBG followed for a minimum of 2 years. Staple line perforation occurred in 48% of patients, and 36% underwent reoperation either to repair the perforation or to repair a stenosis at the rate-limiting orifice. However, the more than 50% of patients who maintained an intact staple line had a durable weight loss of 75% to 100% of excess weight.

**Section Summary: Vertical-Banded Gastroplasty for Adults with Morbid Obesity**

A TEC Assessment identified 8 nonrandomized comparative studies evaluating VBG with gastric bypass. The Assessment found that weight loss was significantly greater with open gastric bypass than with VBG. Also, VBG has relatively high rates of complications, revisions, and reoperations.

**Two-Stage Bariatric Surgery Procedures for Adults with Morbid Obesity**

**Clinical Context and Therapy Purpose**

The purpose of 2-stage bariatric surgery procedures is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Do 2-stage bariatric surgery procedures improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**

The relevant population of interest is individuals who are adults with morbid obesity.

**Interventions**

The therapy being considered is 2-stage bariatric surgery.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.
Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating 2-stage bariatric surgery as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1 to 5 years of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;

c. To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;

d. Studies with duplicative or overlapping populations were excluded.

Bariatric surgeries performed in 2 stages have been proposed as a treatment option, particularly for patients with "super-obesity" defined as a BMI greater than 50 kg/m². The rationale for a 2-stage procedure is that the risk of an extensive surgery is prohibitive in patients who are extremely obese. Therefore, a procedure with low-risk (usually an SG) is performed first. After the patient loses some weight, thus lowering the surgical risk, a second more extensive procedure (e.g. BPD) is performed.

Randomized Controlled Trial
Coffin et al. (2017) published results on the use of intragastric balloon (IGB) prior to a laparoscopic gastric bypass in patients with super-obesity.72 Patients with BMI greater than 45 kg/m² were randomized to an IGB (n=55) or standard medical care (n=60) during the 6 months prior to a planned laparoscopic gastric bypass procedure. Five patients had the IGB removed earlier than 6 months due to complications (n=3) or patient request (n=2). Patients receiving IGBs during the first 6 months of the study experienced significantly more BMI reduction (2.8 kg/m²; range 1.7-6.2 kg/m²) than patients receiving standard care (0.4 kg/m²; range 0.3-2.2 kg/m²). Weight loss during months 6 through 12, after the laparoscopic gastric bypass procedure, was greater in the patients who received standard of care before the procedure. Duration of hospitalization after laparoscopic gastric bypass and quality of life did not differ between groups.

Case Series
Most of the evidence on 2-stage procedures consists of case series of patients undergoing SG as the initial procedure. Many do not report on the second-stage surgery. A minority of patients undergoing first-stage surgery proceed to second-stage surgery. Cottam et al. (2006) reported on 126 patients with a mean BMI of 65 kg/m² who underwent LSG as the first phase of a planned 2-stage procedure.73 The incidence of major perioperative complications for LSG was 13%. After 1 year mean EWL was 46%. Thirty-six (29%) patients proceeded to the second-stage procedure, which was laparoscopic gastric bypass. The incidence of major complications following the second procedure was 8%.

In a similar study, Alexandrou et al. (2012) reported on 41 patients who underwent SG as the first-stage of a planned 2-stage procedure.74 After 1-year follow-up, 12 (29%) patients achieved a BMI of less than 35 kg/m² and were ineligible for the second-stage procedure. Of the remaining
28 patients, 10 (24%) underwent the second-stage procedure. The remaining 18 (44%) patients were eligible for but had not undergone, the second-stage procedure at the last follow-up. Patients who undergo 2-stage procedures are at risk for complications from both procedures. Silecchia et al. (2009) described the complication rates in 87 patients who underwent a stage 1 SG followed by BPD in 27 patients. For the first stage, 16.5% of patients had complications of bleeding, fistula, pulmonary embolism, acute renal failure, and abdominal abscess. For the 27 patients who underwent the second-stage BPD, 29.6% had major complications, including bleeding, duodeno-ileal stenosis, and rhabdomyolysis.

**Section Summary: Two-Stage Bariatric Surgery Procedures for Adults with Morbid Obesity**

The evidence from an RCT and several case series does not support a 2-stage bariatric surgery procedure for improving outcomes in patients with extreme levels of obesity. There is no evidence to suggest that weight loss is improved or that complications are reduced by this approach. Most patients who receive SG as the initial procedure lose sufficient weight during the first year so that a second procedure is no longer indicated. Also, patients undergoing a 2-stage procedure are at risk for complications from both procedures; therefore, it is likely that overall complications are increased by this approach.

**Laparoscopic Gastric Plication for Adults with Morbid Obesity**

**Clinical Context and Therapy Purpose**

The purpose of laparoscopic gastric plication is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does laparoscopic gastric plication improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**

The relevant population of interest is individuals who are adults with morbid obesity.

**Interventions**

The therapy being considered is laparoscopic gastric plication.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**

Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating laparoscopic gastric plication as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 12 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.
**Study Selection Criteria**

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess longer-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

Laparoscopic gastric plication is a bariatric procedure that involves laparoscopic placement of sutures over the greater curvature (laparoscopic greater curvature plication) or anterior gastric region (laparoscopic anterior curvature plication) to create a tube-like stomach. The procedure requires 2 main steps, mobilization of the greater curvature of the stomach and suture plication of the stomach for achieving gastric restriction but specific techniques are not standardized.

**Systematic Reviews**

Ji et al. (2014) reported on a systematic review of 14 studies reporting outcomes after laparoscopic gastric plication (see Table 8).76. Reviewers included a nonrandomized matched cohort analysis, 10 uncontrolled case series, and 3 case reports. The nonrandomized cohort study was small (N=19). Talebpour et al (2012) conducted the largest study and had the longest follow-up (800 patients; 12 years), at a single institution where the technique was developed.77. Only 3 studies identified included more than 100 patients. Mean preoperative BMI ranged from 31.2 to 44.5 kg/m². Mean percent EWL after the procedure was reported in 9 studies (n=1407 patients), and ranged from 31.8% to 74.4% at follow-up times ranging from 6 to 24 months (see Table 9). One study reported weight loss in terms of percent decrease in BMI, with a reported decrease at 6 and 12 months of 66.4% and 60.2%, respectively. One study compared anterior plication with greater curvature plication and reported increased weight loss with greater curvature plication (percent EWL 53.7% vs. 23.3%, respectively). Reporting of complications was heterogeneous across studies, but no deaths were reported, and the rate of major postoperative complications requiring reoperation ranged from 0% to 15.4% (average, 3.7%), most commonly due to gastric obstruction or gastric preformation. Surgical techniques were not standardized.

In a systematic review, Abdelbaki et al (2012) summarized outcomes from 7 studies of laparoscopic gastric plication, 2 of which enrolled more than 100 patients (total N=307 patients) (see Table 8).78. Results are summarized in Table 9. All studies reported some incidence of nausea and vomiting, most of which were mild. Twenty (6.5%) patients were readmitted, of whom 14 (4.6%) patients required reoperation, most commonly for gastric obstruction (8/14 [57%]).

<table>
<thead>
<tr>
<th>Table 8. Systematic Review Characteristics for Laparoscopic Gastric Plication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study</strong></td>
</tr>
<tr>
<td>Ji et al. (2014)76</td>
</tr>
<tr>
<td>Abdelbaki et al. (2012)78</td>
</tr>
</tbody>
</table>

NR: not reported.

<table>
<thead>
<tr>
<th>Table 9. Systematic Review Results for Laparoscopic Gastric Plication</th>
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<tbody>
<tr>
<td><strong>Study</strong></td>
</tr>
<tr>
<td>Ji et al. (2014)76</td>
</tr>
<tr>
<td>Abdelbaki et al. (2012)78</td>
</tr>
</tbody>
</table>
Randomized Controlled Trials
Sullivan et al. (2017) published results from the randomized, subject and evaluator-blinded, parallel-group, multicenter clinical trial using an endoscopic suturing device (G-CATH EZ™ suture anchor delivery catheter) for primary weight loss (ESSENTIAL), a randomized sham-controlled trial evaluating the efficacy and safety of endoscopic gastric plication (see Table 10). Patients (N=332) were randomized 2:1 to the active or sham procedure. All patients were provided low-intensity lifestyle therapy (LT). The primary endpoint was total body weight loss (TBWL) at 12-month follow-up. The MD in TBWL for patients receiving the procedure compared with patients receiving the sham procedure was 3.6% (95% CI, 2.1% to 5.1%). Significant differences between the active and sham groups were also reported in a change in weight from baseline, percent excess weight loss, BMI, and improvement in diabetes (see Table 11). No significant differences were detected in improvements in hyperlipidemia or hypertension between the treatment groups.

Talebpour et al. (2017) randomized patients to laparoscopic gastric plication (n=35) or laparoscopic SG (n=35) (see Table 10). Patients were followed for 2 years. Both procedures were equally effective based on weight reduction outcomes (see Table 11). Adverse events (e.g., nausea, hair loss, vitamin D deficiency, iron deficiency) were similar between groups. One death due to pulmonary thromboembolism occurred in the gastric plication group.

Table 10. RCT Characteristics for Laparoscopic Gastric Plication

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Countries</th>
<th>Sites</th>
<th>Dates</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sullivan et al. (2017)</td>
<td>U.S.</td>
<td>11</td>
<td>2013-2014</td>
<td>Patients 22-60 y BMI ≥30 kg/m² and ≥1 obesity-related comorbidity or BMI ≥35 kg/m² and with or without obesity-related comorbidity</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Endoscopic gastric plication (n=221)</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>Sham procedure (n=111)</td>
</tr>
<tr>
<td>Talebpour et al. (2017)</td>
<td>Iran</td>
<td>1</td>
<td>2012-2015</td>
<td>Patients with BMI ≥35 kg/m² and ≥1 obesity-related comorbidity or BMI ≥40 kg/m² and with or without obesity-related comorbidity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Laparoscopic gastric plication (n=35)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Laparoscopic sleeve gastrectomy (n=35)</td>
</tr>
</tbody>
</table>

BMI: body mass index.

Table 11. RCT Results for Laparoscopic Gastric Plication

<table>
<thead>
<tr>
<th>Study; Trial Name</th>
<th>BMI Reduction</th>
<th>Weight Lossa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Change (SD)b</td>
<td>Difference (95% CI)</td>
</tr>
<tr>
<td>Sullivan et al. (2017); ESSENTIAL</td>
<td>1.2 (0.6 to 1.9)</td>
<td>3.6 (2.1 to 5.1)</td>
</tr>
<tr>
<td>Endoscopic gastric plication</td>
<td>1.7</td>
<td>4.9 (7.0)</td>
</tr>
<tr>
<td>Sham</td>
<td>0.5</td>
<td>1.4 (5.6)</td>
</tr>
<tr>
<td>Talebpour et al. (2017)</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Laparoscopic gastric plication</td>
<td>30.1 (2.8)</td>
<td>72.9 (12.6)</td>
</tr>
<tr>
<td>Laparoscopic sleeve gastrectomy</td>
<td>30.5 (4.3)</td>
<td>72.3 (11.9)</td>
</tr>
</tbody>
</table>

BMI: body mass index; CI: confidence interval; ESSENTIAL: The randomized, subject and evaluator-blinded, parallel-group, multicenter clinical trial using an endoscopic suturing device (G-CATH EZ™ suture anchor delivery catheter) for primary weight loss; SD: standard deviation.
b At 12-month follow-up.
c At 24-month follow-up.
Observational Study
Pattanshetti et al. (2013) published results of a study that described the evolution of an LAGB plication procedure, a hybrid procedure involving both LAGB and greater curvature plication developed by the authors. Eighty patients were included, with a baseline mean BMI of 38.05 kg/m². At 6, 12, 18, and 24 months postsurgery, mean percent EWL was 42.6%, 56.4%, 57.6%, and 65.8%, respectively. Five postoperative complications required reoperation.

Section Summary: Laparoscopic Gastric Plication for Adults with Morbid Obesity
There is a shortage of comparative studies, especially RCTs, comparing the safety and efficacy of laparoscopic gastric plication with other bariatric surgery procedures. A 2014 systematic review identified only a single small comparative study, which was not randomized. Since the systematic review, 2 RCTs were published. One RCT compared endoscopic gastric plication with a sham procedure, reporting 1-year follow-up results in favor of the intervention. A second RCT compared laparoscopic gastric plication with sleeve gastrectomy, showing that the 2 procedures had similar outcomes after 2 years of follow-up. Longer-term follow-up and additional comparative studies are needed.

Single Anastomosis Duodeno-ileal Bypass With Sleeve Gastrectomy for Adults with Morbid Obesity
Clinical Context and Therapy Purpose
The purpose of single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does SADI-S improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity.

Interventions
The therapy being considered is SADI-S. Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating SADI-S as a treatment for morbid obesity has varying lengths of follow-up, ranging from 3 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

  a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

c. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

d. Studies with duplicative or overlapping populations were excluded.

No controlled trials of SADI-S were identified. Some case series have reported on weight loss and other clinical outcomes up to 5 years post-surgery. One larger series, by Sanchez-Pernaute et al. (2015), reported on 97 patients with obesity and T2D. The authors reported that control of diabetes, defined as HbA1c levels less than 6.0%, was achieved by between 70% and 84% of patients at different time points. Remission rates were higher for patients on oral therapy than those on insulin and were higher in patients with a shorter duration of diabetes.

Observational Studies

Torres et al. (2017) published a retrospective chart review of patients from their center receiving bariatric procedures, evaluating outcomes at 3-year follow-up. Outcomes were evaluated separately for patients with and without diabetes. For patients without diabetes, comparisons were made among patients who underwent RYGB (n=149) or SADI-S (n=106). For patients with diabetes, comparisons were made among patients who underwent RYGB (n=97), BPD-DS (n=77), or SADI-S (n=97). Among the patients without diabetes, significant differences favoring SADI-S over RYGB were found in: percent EWL; systolic blood pressure; total, high-density lipoprotein and low-density lipoprotein cholesterol; and insulin. Significant differences were not found in diastolic blood pressure or fasting glucose. Among the patients with T2D, remission rates using American Diabetic Association criteria were: 55%, 70% and 76% for patients receiving RYGB, BPD-DS, and SADI-S, respectively. Patients with diabetes who underwent BPD-DS or SADI-S achieved significantly lower total cholesterol and triglyceride levels compared with those undergoing RYGB after 3 years of follow-up.

Section Summary: Single Anastomosis Duodeno-ileo Bypass With Sleeve Gastrectomy for Adults with Morbid Obesity

No published controlled trials have evaluated SADI-S. There are a few case series, the largest of which had fewer than 100 patients. A comparative chart review found that patients without diabetes experienced significantly better weight loss and lipid profiles with SADI-S than with RYGB and patients who had diabetes experienced significantly higher rates of remission with SADI-S than with RYGB. Additional studies are needed.

Duodenojejunal Sleeve for Adults with Morbid Obesity

Clinical Context and Test Purpose

The purpose of the duodenojejunal sleeve procedure is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does the duodenojejunal sleeve procedure improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients

The relevant population of interest is individuals who are adults with morbid obesity.

Interventions

The therapy being considered is the duodenojejunal sleeve procedure.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.
Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity.

The existing literature evaluating duodenojejunal sleeve as a treatment for morbid obesity has varying lengths of follow-up, ranging from 3 to 6 months. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:
  a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
  b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
  c. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
  d. Studies with duplicative or overlapping populations were excluded.

The EndoBarrier (GI Dynamics) is a fluoropolymer sleeve that is reversibly fixated to the duodenal bulb and extends 80 cm into the small bowel, usually terminating in the proximal jejunum. A systematic review of the effect of EndoBarrier on weight loss and diabetes control outcomes was published in 2016.84 It included 5 small RCTs (total N=235 patients; range, 18-77 patients), with follow-up ranging from 12 to 24 weeks. Comparators were diet and/or other lifestyle modifications, and 2 studies had sham controls. All studies were judged to be at high-risk of bias using the Cochrane risk of bias tool. Combined results demonstrated that the EndoBarrier group had 12.6% greater EWL (95% CI, 9.0% to 16.2%) than medical therapy. For diabetes control outcomes, trends toward greater improvement in the EndoBarrier group were not statistically significant. MD in HbA1c level was -0.8% (95% CI, -1.8% to 0.3%) and the RR of reducing or discontinuing diabetic medications was 3.28 (95% CI, 0.54 to 10.73).

The largest single trial was a multicenter RCT published in 2014; it included 77 patients with T2D and a BMI greater than 30 kg/m².85 Patients were treated for 6 months with EndoBarrier or medical therapy. At 6 months, the EndoBarrier was removed, and patients were followed for an additional 6 months. Thirty-eight patients were randomized to the EndoBarrier group, and 31 (82%) of 38 completed 12 months of treatment. Thirty-nine patients were randomized to medical treatment, and 35 (90%) of 39 completed 12 months of treatment. At 6 months, the decrease in BMI was significantly greater in the EndoBarrier group than in the medical therapy group (3.3 kg/m² vs. 1.8 kg/m², p<0.05), and at 12 months the difference in BMI was of marginal statistical significance (2.2 kg/m² vs. 1.3 kg/m², p=0.06), respectively. HbA1c level was significantly lower in the EndoBarrier group at 6 months (7.0% vs. 7.9%, p<0.05), but at 12 months the difference between groups did not differ significantly (7.3% vs. 8.0%, p=0.95).

Section Summary: Duodenojejunal Sleeve for Adults with Morbid Obesity
A systematic review of evidence on a duodenojejunal sleeve included 5 RCTs and found significantly greater short-term weight loss (12-24 weeks) with duodenojejunal sleeves compared with medical therapy. There was no significant difference in symptom reduction associated with diabetes. However, all RCTs had small sample sizes and were judged by the systematic reviewers to be at high-risk of bias.
Intragastric Balloon Devices for Adults with Morbid Obesity

Clinical Context and Therapy Purpose

The purpose of IGB devices is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Do IGB devices improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**

The relevant population of interest is individuals who are adults with morbid obesity.

**Interventions**

The therapy being considered is IGB devices.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**

Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating IGB devices as a treatment for morbid obesity has varying lengths of follow-up, ranging from 5 to 10 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

**Study Selection Criteria**

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

IGB devices are placed in the stomach using an endoscope or swallowing to act as space-occupying devices to induce satiety. As of 2017, 3 IGB devices have the Food and Drug Administration (FDA) approval, all designed to stay in the stomach for no more than 6 months. The ReShape Duo is a saline-inflated dual-balloon system, Obalon is a swallowable 3-balloon system, and the OBERA Intragastric Balloon System (previously marketed outside of the United States as BioEnterics) is a saline-inflated silicone balloon.

**Systematic Reviews**

Several systematic reviews of RCTs evaluating IGB devices for the treatment of obesity have been published; none was limited to FDA-approved devices.86,87,88.
The systematic review by Tate et al (2017) focused on recent RCTs, published between 2006 and 2016. Additional inclusion criteria were: sham, lifestyle modification, or pharmacologic agent as a comparator; at least 1 outcome of body weight change; and study duration of 3 or more months. Eight RCTs were included in the review, with 4 contributing to the meta-analysis. The meta-analysis included 777 patients and showed a significant improvement in percent TBWL with IGB compared with control (5.5%; 95% CI, 4.3% to 6.8%). However, there was significant heterogeneity among the trials (I²=62%), so interpretation of results is limited. The percent TBWL with IGB is lower than expected with RYGB (reported 27%) or with the most efficacious pharmacologic agent (reported 9%).

Saber et al (2017) identified 20 RCTs reporting weight loss outcomes after IGB implantation or a non-IGB control intervention. IGB was compared with sham in 15 trials, behavioral modification in 4 trials, and pharmacotherapy in 1 trial. In 17 trials, patients received LT in addition to other interventions. Studies were published between 1987 and 2015 and sample sizes varied from 21 to 326 participants. Outcomes were reported between 3 and 6 months. In a meta-analysis of 7 RCTs reporting BMI loss as an outcome, there was a significantly greater BMI loss in the IGB group than in the control group (mean effect size [ES], 1.59 kg/m²; 95% CI, -0.84 to 4.03 kg/m²; p<0.001). Findings on other outcomes were similar. A meta-analysis of 4 studies reporting percent EWL favored the IGB group (ES=14.25%; 95% CI, 2.09% to 26.4%; p=0.02). Also, a meta-analysis of 6 studies reporting absolute weight loss favored the IGB group (ES=4.6 kg; 95% CI, 1.6 to 7.6 kg; p<0.001).

Although the review was not limited to FDA-approved devices, older devices were air-filled and newer devices, including the 2 approved by FDA in 2015, are fluid-filled. Sufficient data were available to conduct a sensitivity analysis of 3-month efficacy data. A meta-analysis of 4 studies did not find a significant difference in weight loss with air-filled IGB devices or a control intervention at 3 months (ES=0.26; 95% CI, -0.12 to 0.64; p=0.19). In contrast, a meta-analysis of 8 studies of fluid-filled devices found significantly better outcomes with the IGB than with control (ES=0.25; 95% CI, 0.05 to 0.45; p=0.02).

Randomized Controlled Trials

Pivotal trials on both FDA-approved devices have been published. Ponce et al (2015) published a multicenter sham-controlled double-blinded trial evaluating the ReShape Duo IGB. A total of 326 patients were randomized to 6 months of treatment with an IGB plus LT (n=187) or a sham device plus LT (n=126). Patients in the control group were given the option of active IGB treatment at 6 months. Key eligibility criteria were age 21 to 60 years, baseline BMI between 30 and 40 kg/m², 1 or more obesity-related comorbidities, and failure to lose sufficient weight in the past 36 months in a medically supervised weight loss program. A total of 176 IGB and 126 control patients (90% of the randomized population) completed the initial 6-month treatment and were included in the primary endpoint analysis. After 6 months, 77 patients in the control group opted to receive an IGB; these patients were also included in the IGB safety analysis.

Coprimary effectiveness outcomes, assessed at 6 months, were mean percent EWL and having at least 35% of patients in the IGB group achieving at least a 25% EWL. Both primary effectiveness outcomes were met. In the intention-to-treat analysis, the mean percent EWL at 6 months was 25.1% in the IGB group and 11.3% in the control group (p=0.004). The proportion of patients who achieved at least a 25% EWL was 48.8%, with a lower confidence bound of 41.6%. Most adverse events were anticipated accommodative symptoms (e.g., nausea, vomiting, abdominal pain), which generally resolved after 3 to 7 days; they were severe in 1% to 2% of patients and were successfully treated. Most device-related serious adverse events (75% [21/28]) were emergency department visits for treatment of accommodative symptoms. There were no deaths, intestinal obstructions, gastric perforations, or device migrations.

Courcoulas et al (2017) published a multicenter, pivotal RCT evaluating the Obera IGB in the United States (as noted, the device has been used in other countries). A total of 317 patients were randomized and initiated 6 months of treatment with an IGB plus LT (n=137) or LT only.
Patients were followed for an additional 6 months. Key eligibility criteria were age 18 to 65 years, baseline BMI between 30 and 40 kg/m², a history of obesity for at least 2 years, and having failed previous weight loss attempts. Nineteen patients in the IGB group and 121 in the control group completed the 6-month treatment period.

Coprimary effectiveness outcomes, assessed at 9 months, were mean percent EWL and difference in mean weight loss. Mean percent EWL at 9 months was 26.4% in the IGB group and 10.1% in the control group (difference, 16.2%; 95% CI, 12.3% to 20.2%; p<0.001). Mean weight loss at 9 months was -8.8 kg (-19.4 lb) in the IGB group and -3.2 kg (-7.1 lb) in the control group (p<0.001). There were also significant between-group differences in mean weight loss and mean percent EWL at 6 and 12 months.

As in the trial on the Reshape Duo device, most adverse events in the Obera pivotal trial were anticipated accommodative symptoms. A total of 139 (87%) patients reported nausea, 121 (76%) reported vomiting, and 92 (58%) reported abdominal pain. Fewer than 5% of these adverse events were serious; most were mild or moderate. Thirty patients in the device group had the IGB removed before month 6 because of an adverse event (n=15) or patient request (n=15). There were no deaths and 9 serious adverse events unrelated to device accommodation; among others, they included a case of gastric outlet obstruction and a case of gastric perforation with sepsis.

The Courcoulas et al (2017) pivotal trial was not blinded or sham-controlled; however, a double-blind sham-controlled randomized trial evaluating the BioEnterics IGB (previously called the Obera device) was published by Genco et al (2006). This crossover trial included 32 obese patients ages 25 to 50 years with a mean BMI of 47.3 kg/m². Patients received, in random order, 3 months of an IGB and 3 months of sham. (Both groups underwent upper gastrointestinal endoscopy, but no device was placed in the sham group.) Patients who initially received the IGB had a mean BMI reduction of 5.8 kg/m² after 3 months; after crossover to sham, they had a mean additional BMI reduction of 1.1 kg/m². Patients initially in the sham group had an initial mean BMI reduction of 0.4 kg/m²; after crossover to an active device, they had a mean BMI reduction of 5.1 kg/m². The between-group difference in BMI reductions was statistically significant (p<0.001). Findings on other outcomes (mean percent EWL, mean weight loss) were similar.

Case Series
A case series of patients treated with an IGB with up to 60-month follow-up was published by Kotzampassi et al (2012). A total of 500 patients were treated with the BioEnterics IGB. Twenty-six patients did not complete the initial 6 months of treatment, and another 77 patients did not comply with dietary restrictions and did not have satisfactory weight loss at 6 months. Among 352 patients with data available, BMI was 44.5 kg/m² at baseline, 35.7 kg/m² at device removal, 38.8 kg/m² at 12 months after device removal, and 40.1 kg/m² at 24 months after device removal. Mean percent EWL was 43.9% at device removal, 27.7% at 12 months after device removal, and 17% at 24 months after device removal. Among the 195 patients with available 5-year data, mean baseline BMI was 43.3 kg/m², mean BMI at device removal was 33.8 kg/m², and mean BMI at 5 years was 40.1 kg/m². Mean percent EWL at 5 years was 13.0%. Overall, patients who initially complied with 6 months of IGB device use and lost weight slowly gained weight over time but weighed less at final follow-up than at baseline.

Section Summary: Intragastric Balloon Devices for Adults with Morbid Obesity
Evidence includes RCTs, a case series with long-term follow-up on 1 of the devices, and systematic reviews on various IGB devices. RCTs have found significantly better weight loss outcomes with IGB devices compared with sham treatment or LT alone. One RCT followed patients for an additional 6 months after IGB removal and found sustained weight loss. A large case series with follow-up up to 5 years has suggested that patients regain weight over time. Additional long-term follow-up data are needed. There are some adverse events, and in a minority of cases, these adverse events can be severe. The FDA wrote 2 letters in 2017 to health professionals to notify them about these cases.
care providers, 1 warning of spontaneous balloon inflation and pancreatitis and the other reporting 5 unanticipated deaths occurring in 2016-2017 following the IGB procedure. Health care providers are encouraged to monitor patients receiving IGBs.

Aspiration Therapy Device for Adults with Morbid Obesity

Clinical Context and Therapy Purpose

The purpose of the aspiration therapy (AT) device is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity.

The question addressed in this evidence review is: Does the AT device improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are adults with morbid obesity.

Interventions
The therapy being considered is the AT device.

Patients who are adults with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating AT device as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 2 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, 1 to 2 years of follow-up is considered necessary to demonstrate efficacy.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

c. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

d. Studies with duplicative or overlapping populations were excluded.

Randomized Controlled Trials
AT involves an FDA-approved device (AspireAssist) that allows patients to drain a portion of the stomach contents after meals via an implanted tube connected to an external skin port. One RCT has been published. The Pivotal Aspiration Therapy with Adjusted Lifestyle (PATHWAY) trial, by Thompson et al (2017), randomized 207 participants to 52 weeks of AspireAssist therapy plus lifestyle counseling (n=127) or lifestyle counseling alone (n=70). Participants were between 21 and 65 years of age, with a BMI ranging from 35 to 55 kg/m². Coprimary outcomes were mean EWL at 52 weeks and the proportion of patients with 25% or more EWL at 52 weeks. Investigators did a modified intention-to-treat analysis including all patients in the AspireAssist group who
attempted tube placement (n=111) and all patients in the lifestyle counseling group who attended at least 1 therapy session (n=60). Mean EWL at 52 weeks was 31.5% in the AspireAssist group and 9.8% in the lifestyle counseling group. The difference between groups was 21.7% (95% CI, 15.3% to 28.1%), which was greater than the 10% difference needed to meet the a priori definition of success. The proportion of patients with 25% or more EWL at 52 weeks was 58.6% in the AspireAssist group and 22% in the lifestyle counseling group (p<0.001). Bulimia or binge eating disorder were exclusion criteria and, during the study, there was no evidence that patients developed bulimia or that devices were overused (ie, used >3 times a day). Most of the adverse events (83.8%) in the AspireAssist group were associated with placement of a percutaneous endoscopic gastric tube. All 5 serious adverse events occurred in the AspireAssist group (mild peritonitis, severe abdominal pain and a case of product malfunction). Product malfunction was related to malfunction of the A-tube, typically occurring within the first week of implantation and seen in 90% of adverse events seen with the AspireAssist. The durability of a treatment effect beyond 1 year was not reported.

Thompson et al (2019) published 4-year outcomes from the PATHWAY trial. ATAT patients were permitted to continue the study beyond 1 year up to a maximum of 5 years provided they maintained at least 10% TWL from baseline at each year end. Out of 82 AT patients who completed year 1, 58 continued in the next phase, 43 completed year 2, 22 completed year 3, and 15 completed year 4 in the trial. Of 58 AT participants continuing in the study, 43 withdrew before completion of year 4, with 25/43 meeting their weight loss goal or losing >10% of their baseline weight. Forty of 58 patients (69%) achieved at least 10% TWL at 4 years or at time of study withdrawal. Out of 60 patients treated in the LT control group, only 31 completed the full initial study year. Two serious adverse events were reported in years 2-4. One patient developed a secondary fistula superior to the A-tube fistula, which resolved following A-tube removal. The second patient experienced an A-tube malfunction, which was replaced. A total of 57 adverse events, including the 2 serious adverse events, were recorded. The adverse events with the greatest frequency were peristomal irritation (12 events), persistent fistulas (12 events), and peristomal granulation tissue (8 events). A total of 27 A-tubes required replacement over the 4 years of the study. Reasons for replacement include tube defects (~50%) and tube leaks (~30%). According to the study survival analysis, one can expect 50% of A-tubes to be replaced within approximately 3.5 years postgastrostomy. No clinically significant metabolic disorders were observed. No evidence for the development of any eating disorders was noted. Study results are summarized in Table 12. Study relevance, design, and conduct limitations are summarized in Tables 13-14.

Table 12. Results of PATHWAY Trial

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<td>% TWL</td>
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<td></td>
<td>% (SD)</td>
<td>% (SD) [95% CI]</td>
<td></td>
</tr>
<tr>
<td>Year 1</td>
<td>82</td>
<td>68.3 (NR)</td>
<td>14.2 (9.8) [12.1 to 16.4]</td>
<td></td>
</tr>
<tr>
<td>Year 2</td>
<td>43</td>
<td>72.1 (NR)</td>
<td>15.3 (8.8) [12.6 to 18.0]</td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td>22</td>
<td>63.6 (NR)</td>
<td>16.6 (10.5) [12.0 to 21.3]</td>
<td></td>
</tr>
<tr>
<td>Year 4</td>
<td>15</td>
<td>73.3 (NR)</td>
<td>18.7 (11.7) [12.2 to 25.2]</td>
<td></td>
</tr>
</tbody>
</table>

AT: aspiration therapy; CI: confidence interval; EWL: excess weight loss; HbA1c: hemoglobin A1c; IWquality of life: Impact of Weight of Quality of Life survey; LT: lifestyle therapy; mITT: modified intent-to-treat; NR: not reported; PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle; PP: per protocol; SD: standard deviation; TWL: total weight loss.

1 Primary outcome measure.
2 Based on the modified intent-to-treat analysis.
3 Improvement in quality of life measures is reflected by increasing IWquality of life scores.
4 Treatment differences in individual IWquality of life component scores did not reach statistical significance.
5 Based on the per-protocol analysis.

Table 13. Relevance Limitations

<table>
<thead>
<tr>
<th>Study; Trial</th>
<th>Population a</th>
<th>Intervention b</th>
<th>Comparator c</th>
<th>Outcomes d</th>
<th>Follow-Up e</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thompson et al. (2017; 2019); PATHWAY⁹⁴,⁹⁵</td>
<td></td>
<td>2: No active comparator for years 2-4.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The study limitations stated in this table are those notable in the current review; this is not a comprehensive limitations assessment.

PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle.

a Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.
b Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.
c Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.
d Outcomes key: 1. Key health outcomes not addressed; 2. Physiologic measures, not validated surrogates; 3. No CONSORT reporting of harms; 4. Not establish and validated measurements; 5. Clinical significant difference not prespecified; 6. Clinical significant difference not supported.
e Follow-Up key: 1. Not sufficient duration for benefit; 2. Not sufficient duration for harms.

Table 14. Study Design and Conduct Limitations

<table>
<thead>
<tr>
<th>Study; Trial</th>
<th>Allocation a</th>
<th>Blinding b</th>
<th>Selective Reporting c</th>
<th>Data Completeness d</th>
<th>Power e</th>
<th>Statistical f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thompson et al (2019); PATHWAY⁹⁴,⁹⁵</td>
<td>2: Blinding to outcome assessment unclear. 3: Blinding and identity of</td>
<td>1: High loss to follow-up or missing data. High loss to pre- and post-enrollment withdrawals.</td>
<td>1: Study not powered beyond 1 y of follow-up. Study underpowered for completers at 1 y.</td>
<td>2: Not all sensitivity analyses are statistically significant for primary effectiveness outcome (at</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Outcome Assessors Unclear.**

2: Multiple strategies utilized for handling of missing data.
5: Inappropriate exclusion of patients with TWL <10% during years 2-4 from analysis.
6: Modified intent to treat analysis not carried through.
3: Rationale for clinically important difference not provided.

**least 50% of participants achieving at least 25% EWL; unclear if analysis is appropriate for multiple observations per patient or extent of missing data.**

The study limitations stated in this table are those notable in the current review; this is not a comprehensive limitations assessment.

EWL: excess weight loss; PATHWAY: Pivotal Aspiration Therapy with Adjusted Lifestyle; TWL: total weight loss.

d Data Completeness key: 1. High loss to follow-up or missing data; 2. Inadequate handling of missing data; 3. High number of crossovers; 4. Inadequate handling of crossovers; 5. Inappropriate exclusions; 6. No intent to treat analysis (per protocol for noninferiority trials).
e Power key: 1. Power calculations not reported; 2. Power not calculated for primary outcome; 3. Power not based on clinically important difference.
f Statistical key: 1. Analysis is not appropriate for outcome type: (a) continuous; (b) binary; (c) time to event; 2. Analysis is not appropriate for multiple observations per patient; 3. Confidence intervals and/or p values not reported; 4. Comparative treatment effects not calculated.

**Case Series**

In addition to the RCT, a case series by Noren and Forssell (2016) evaluated AspireAssist use by 25 obese patients.96 Patients had 1 year of AT and also participated in a cognitive-behavioral therapy weight loss program for the initial 3 months. Patients were instructed to aspirate 3 times a day after meals. Twenty (80%) patients completed the 1-year intervention period. Mean baseline weight was 107.4 kg. In a per-protocol analysis, the mean EWL was 54.5% at 12 months. Data on 15 (60%) patients were available at 24 months; mean EWL was 61.5%.

**Section Summary: Aspiration Therapy Device for Adults with Morbid Obesity**

The evidence consists of an RCT with 4 years of follow-up and a small case series with up to 2 years of follow-up. The RCT found significantly greater weight loss (measured several ways) with AT compared with LT at 1 year. Forty of 58 patients (69%) achieved at least 10% TWL at 4 years or at time of study withdrawal; however, only 15/111 initial AT patients completed the study through 4 years. In addition to a high degree of missing data, the PATHWAY study noted a potentially high degree of adverse events related to A-tube malfunction, an element of the therapy which is expected to require replacement within approximately 3.5 years post gastrostomy in 50% of cases. The impact of this on health outcomes compared to existing surgical approaches is unknown. The case series followed only 15 patients more than 1 year; at 2 years, study completers had not regained weight and instead had lost additional excess weight. The total amount of data on AT remains limited and additional studies need to be conducted before conclusions can be drawn about the long-term effects of treatment on weight loss, metabolism, safety, and nutrition.
Revision Bariatric Surgery for Adults with Morbid Obesity Who Failed Bariatric Surgery

Clinical Context and Therapy Purpose

The purpose of revision bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adults with morbid obesity and failed bariatric surgery.

The question addressed in this evidence review is: Does revision bariatric surgery improve the net health outcome in adults who are obese?

The following PICO was used to select literature to inform this review.

**Patients**
The relevant population of interest is individuals who are adults with morbid obesity and failed bariatric surgery.

**Interventions**
The therapy being considered is revision bariatric surgery.

Patients who are adults with morbid obesity and failed bariatric surgery are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**
Comparators of interest include standard medical care. Treatment for adults with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity.

The existing literature evaluating revision bariatric surgery as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

A number of studies have evaluated the efficacy of revision procedures after failed bariatric surgery and reported satisfactory weight loss and resolution of comorbidities with somewhat higher complication rates than with primary surgery.

Almalki et al (2018) published a retrospective analysis of patients diagnosed with failed restrictive procedure who underwent revision bariatric surgery. One hundred sixteen patients between 2001 and 2015 had revision RY gastric bypass (R-RYGB; n=35) or revision single-anastomosis (mini-) gastric bypass (R-SAGB; n=81); the primary indications for revisional procedures were weight regain (50.9%), inadequate weight loss (31%), and intolerance (18.1%). Major complications occurred in 12 (10%) patients without significant difference between groups (R-SAGB, n=9; R-
RYGB (n=3). At 1 year after revision surgery, the R-SAGB group (76.8% EWL) showed better weight loss than R-RYGB (32.9% EWL; p=0.001). In the 37.1% of patients available for follow-up at 5 years, R-SAGB had significantly lower hemoglobin levels than R-RYGB (8.2 ± 3.2 g/dl vs. 12.8 ± 0.5 g/dl; p=0.03). The study was limited by its retrospective nature, relatively short follow-up time, and lack of consideration of data related to patient compliance.

Sudan et al (2015) reported on safety and efficacy outcomes for reoperative bariatric surgeries using data from a national registry, the Bariatric Outcomes Longitudinal Database.98 The Bariatric Outcomes Longitudinal Database was a large, multi-institutional bariatric surgery-specific database to which data were submitted from 2007 through 2012 by 1029 surgeons and 709 hospitals participating in the Bariatric Surgery Centers of Excellence program. Surgeries were classified as primary or reoperative bariatric. Reoperations were further divided into corrective surgeries (when complications or incomplete treatment effect of a previous bariatric operation was addressed, but the initial operation was not changed) or conversions (when an index bariatric operation was changed to a different type of bariatric operation or a reversal restored original anatomy.) Of 449473 bariatric operations in the database, 420753 (93.6%) operations had no further reoperations (primary operations) while 28270 (6.3%) underwent reoperations. Of the reoperations, 19970 (69.5%) were corrective and 8750 (30.5%) were conversions. The primary bariatric operations were RYGB (n=204705 [49.1%]), LAGB (n=153142 [36.5%]), SG (n=42178 [10%]), and BPD-DS (n=4260 [1%]), with the rest classified as miscellaneous. LAGB was the most common primary surgery among conversions (57.5% of conversions; most often [63.5%] to RYGB). Compared with primary operations, mean hospital length of stay was longer for corrections (2.04 days vs. 1.8 days, p<0.001) and for conversions (2.86 days vs. 1.8 days, p<0.001). Mean percent EWL at 1 year was 43.5% after primary operation, 39.3% after conversions, and 35.9% after corrective operations (statistical comparison not reported). One-year mortality was higher for conversions (0.31%) than for primary surgeries (0.17% p<0.001), with no statistically significant difference for corrections (0.24%) compared with primary surgeries (0.17% p=NS). One-year serious adverse event rates were higher for conversions (3.61%) than for primary operations (1.87% p<0.001), with no statistically significant difference for corrections (1.9%) compared with primary operations (1.87% p=NS). The authors concluded that reoperation after primary bariatric surgery is relatively uncommon, but generally safe and efficacious when it occurs.

Brethauer et al (2014) conducted a systematic review of reoperations after primary bariatric surgery for the American Society for Metabolic and Bariatric Surgery that included 175 studies, most of which were single-center retrospective reviews.99 The review is primarily descriptive, but made the following conclusions:

“The current evidence regarding reoperative bariatric surgery includes a diverse group of patient populations and procedures. The majority of the studies are single institution case series reporting short- and medium-term outcomes after reoperative procedures. The reported outcomes after reoperative bariatric surgery are generally favorable and demonstrate that additional weight loss and co-morbidity reduction is achieved with additional therapy. The risks of reoperative bariatric surgery are higher than with primary bariatric surgery and the evidence highlights the need for careful patient selection and surgeon expertise.”

**Endoscopic Revision Procedures**

While bariatric surgery revision or correction can be conducted using standard surgical approaches, novel endoscopic procedures are being developed. Some procedures use devices also being evaluated for the endoscopic treatment of GERD (see evidence review 2.01.38). The published data on the use of these devices for treatment of regained weight is limited. Published case series have reported results using a number of devices and procedures (including sclerosing injections) as a treatment for this condition. The large series (2007) found involved 28 patients treated with a sclerosing agent (sodium morrhuate).100 Reported trials that used 1 of the suturing devices had fewer than 10 patients. For example, Herron et al (2008) reported on a feasibility study in animals.101 Thompson et al (2006) reported on a pilot study with changes in anastomotic diameter and weight loss in 8 patients who regained weight and had
dilated gastrojejunal anastomoses after RYGB. No comparative trials were identified; comparative trials are important because of the known association between an intervention and short-term weight loss.

The StomaphyX device, which has been used in this approach, was cleared by FDA through the 510(k) process. It was determined to be equivalent to the EndoCinch system, which has 510(k) marketing clearance for endoscopic suturing for gastrointestinal tract surgery. Eid et al (2014) reported on results from a single-center RCT that compared the StomaphyX device with a sham procedure for revisions in patients with prior weight loss after RYGB at least 2 years earlier. Enrollment was initially planned for 120 patients, but the trial was stopped prematurely after 1-year follow-up was completed by 45 patients in the StomaphyX group and 29 patients in the sham control group because preliminary analysis failed to achieve the primary efficacy endpoint in at least 50% of StomaphyX patients. The primary 12-month efficacy endpoint (reduction in pre-RYGB excess weight by ≥15%, excess BMI loss, and BMI <35 kg/m²) was achieved by 10 (22.2%) of 45 in the StomaphyX group and 1 (3.4%) of 29 in the sham control group (p<0.01).

A 2009 survey of American Society for Metabolic and Bariatric Surgery members (bariatric surgeons) indicated different risk tolerance and weight loss expectations for primary and revisional endoscopic procedures. They were “willing to accept less weight loss and more risk for revisional endoluminal procedures than for primary endoluminal procedures.” The durability of the procedures was a concern, and most surgeons were unwilling to consider the procedures until their efficacy has been proven. A 2013 systematic review of studies reporting outcomes after endoluminal revision of primary bariatric surgery conducted by American Society for Metabolic and Bariatric Surgery concluded: “The literature review shows the procedures on the whole to be well tolerated with limited efficacy. The majority of the literature is limited to small case series. Most of the reviewed devices are no longer commercially available.” Cohen et al (2019) conducted a systematic review evaluating the safety and efficacy of endoscopic gastroplasty for medically uncontrolled obesity. Nine observational studies and a single RCT was identified by the authors. Follow-up duration in the majority of studies was limited to 6-12 months with several studies reporting high rates of loss to follow-up. Percent total body weight loss ranged from -15.1% to 19.5%. Reduction in BMI ranged from -1.69 to -7.5 kg/m². Serious adverse events ranged from 2% to 10%. The quality of the current evidence was graded very low to moderate, with limited long-term data on weight loss durability and procedure safety.

Section Summary: Revision Bariatric Surgery for Adults with Morbid Obesity Who Failed Bariatric Surgery
For surgical revision of bariatric surgery after failed treatment, evidence from nonrandomized studies suggests that revisions are associated with improvements in a weight similar to those seen in primary surgery. However, the published scientific literature on the use of endoscopic devices and procedures in patients who regain weight after bariatric surgery is very limited.

Bariatric Surgery as a Treatment for T2D for Adults with Diabetes Who Are Not Morbidly Obese Clinical Context and Therapy Purpose
The purpose of gastric bypass, SG, BPD, and adjustable gastric banding is to provide treatment options that are alternatives to or improvements on existing therapies, such as standard medical care, in patients who are diabetic and not morbidly obese.

The question addressed in this evidence review is: Do various bariatric surgery procedures improve the net health outcome in those with diabetes who are not obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are diabetic and not morbidly obese.
Interventions
The therapy being considered is gastric bypass, SG, BPDn, and adjustable gastric banding. Patients who are diabetic and not morbidly obese are actively managed by endocrinologists and primary care providers in an outpatient clinical and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for patients who are diabetic include blood sugar regulation and insulin therapy.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating gastric bypass, SG, BPD, and adjustable gastric banding as a treatment for diabetes has varying lengths of follow-up, ranging from 1 to 5 years.

While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

Current indications for bariatric surgery view poorly or uncontrolled diabetes as a comorbidity whose presence supports the need for surgery in patients with a BMI of 35 to 40 kg/m². There also is growing interest in gastrointestinal surgery to treat patients with T2D in patients with lower BMI. This section focuses on RCTs and systematic reviews of RCTs comparing bariatric surgery with medical therapy.

T2D and BMI 30 to 34.9 kg/m²
Wu et al (2016) published a meta-analysis of studies comparing bariatric surgery with nonsurgical interventions for patients who had T2D. Eight RCTs with 619 patients were included. RCTs addressed RYGB (6 studies), LAGB (3 studies), LSG (1 study), and BPD (1 study). Mean BMI across studies was 29 kg/m² or higher; in 6 of 8 studies, mean BMI was 35 kg/m² or higher. One study had a 5-year follow-up, and the others had 1 to 3 years of follow-up. The study with a 5-year follow-up, by Mingrone et al (2015), was limited to patients with a BMI of at least 35 kg/m². All 8 studies reported remission of T2D as an efficacy endpoint. A pooled analysis found a significantly higher rate of T2D remission in the bariatric surgery versus the nonsurgical treatment group (RR, 5.76; 95% CI, 3.15 to 10.55; p<0.001). Another diabetes-related outcome (mean reduction in HbA1c levels) was significantly greater after bariatric surgery than nonsurgical treatment (MD = -1.29; 95% CI, -1.70 to -0.87). Also, there was a significantly greater reduction in BMI with bariatric surgery than with nonsurgical treatment (MD = -5.80; 95% CI, -6.95 to -4.64; p<0.001).

Since the publication of the Wu et al (2016) meta-analysis, 5-year follow-up has been reported for the Schauer et al (2017) RCT, which is shown in Table 15. When the Wu et al (2016) meta-analysis was published, only 3-year findings of the Schauer et al (2017) study were available. The study included patients with T2D who had BMI 27-43 kg/m². The RCTs evaluating bariatric surgery...
in patients with T2D, including the 5-year follow-up of the Schauer et al (2017) study, are summarized in Table 15.

Observational studies evaluating patients undergoing bariatric surgery in patients with T2D with a follow-up to 3 or more years are shown in Table 12.

Muller-Stich et al (2015) published a systematic review of RCTs and observational studies on bariatric surgery in patients with T2D and a BMI less than 35 kg/m².108 Eleven comparative trials of medical therapy versus bariatric surgery were included, with 5 RCTs and 6 nonrandomized comparative studies identified. Follow-up was between 1 and 3 years. The primary outcome reported was remission of diabetes. On combined analysis, bariatric surgery was associated with a higher remission rate than medical therapy (OR=14.1; 95% CI, 6.7 to 29.9; p<0.001). On secondary outcomes, surgery was associated with a greater decrease in BMI (MD = -5.5 kg/m²; 95% CI, -6.7 to -4.3 kg/m²; p=0.001), a lower HbA1c level (MD = -1.4%; 95% CI, -1.9% to -0.9%; p<0.001), lower rates of hypertension (OR=0.25; 95% CI, 0.12 to 0.50; p<0.001), and lower rates of dyslipidemia (OR=0.21; 95% CI, 0.10 to 0.44; p<0.001).

Also, Rao et al (2015) published a meta-analysis of short-term outcomes for patients with T2D and a BMI of 35 kg/m² or less who underwent RYGB.109 Nine articles were included (total N=343 patients). After 12 months, patients with T2D had a significant decrease in BMI (weighted MD, -7.42; 95% CI, -8.87 to -5.97; p<0.001) and improvements in HbA1c levels (weighted MD, -2.76; 95% CI, -3.41 to -2.11; p<0.000). Reviewers reported that longer term follow-up would be needed.

Previously, a 2012 TEC Assessment evaluated bariatric surgery in diabetic patients with a BMI less than 35 kg/m².110 The evidence consisted mainly of case series. The Assessment identified only observational studies. Based on the data, the Assessment concluded that gastric bypass met TEC criteria as a treatment for diabetes in patients with a BMI less than 35 kg/m² but that other procedures did not meet the TEC criteria for this indication:

- There were no randomized trials comparing bariatric surgery with medical treatment for diabetic subjects with a BMI less than 35 kg/m². There was only 1 randomized trial comparing 2 bariatric procedures. Therefore, studies were categorized by procedure type and presented as case series, regardless of the underlying study type.
- Nine studies reported diabetes remission rates and other outcomes in subjects undergoing gastric bypass. Diabetes remission rates varied between 48% and 100% at follow-up times of 1 year and beyond. One study was a randomized trial of gastric bypass versus SG; in it, diabetes remission associated with gastric bypass was 93% versus 47% for SG at 1 year.
- Two studies reported outcomes of SG. Diabetes remission rates were 55% and 47% at 1 year.
- One study reported outcomes of ileal interposition. The diabetes remission rate at a mean follow-up time of 39.1 months was 78.3%.
- Two studies reported outcomes of gastric banding. The outcomes reported were not considered to be rigorous, because the only measure of diabetes outcome was the withdrawal of diabetes medication. Reported remission rates were 27.5% and 50% at variable follow-up times.
- One study of BPD reported a remission rate of 67% for subjects with a BMI between 30 and 35 kg/m² and 27% for subjects with a BMI between 25 and 30 kg/m² at 12-month follow-up.
- One study reported outcomes of duodenojejunal exclusion. Subjects in this study had more severe diabetes than subjects enrolled in other studies; 100% were on insulin treatment, and the duration of diabetes was between 5 and 15 years. The diabetes remission rate was 17% at 6 months.

Summaries of various systematic reviews and meta-analyses on the use of bariatric or metabolic surgery in patients with a BMI <35 kg/m² are available, and report efficacy in achieving weight loss, glycemic control, T2D remission, and mitigation of various cardiovascular disease factors through 1-5 years of follow-up. 111,112 However, current studies are limited by heterogeneity in
applied surgical intervention and threshold definitions for T2D remission. Longer-term (>5 years) RCTs evaluating the use of metabolic surgery in lower-BMI patients for the treatment of T2D are pending (NCT02328599).

**Section Summary: Bariatric Surgery as a Treatment for T2D for Adults with Diabetes Who Are Not Morbidly Obese**

Systematic reviews of RCTs and observational studies have found that certain types of bariatric surgery are more efficacious than medical therapy as a treatment for T2D in obese patients, including those with a BMI between 30 and 34.9 kg/m². The greatest amount of evidence assesses gastric bypass, with some comparative studies on LAGB, LSG, and BPD. Systematic reviews have found significantly greater remission rates of diabetes, decrease in HbA1c levels, and decrease in BMI with bariatric surgery than with nonsurgical treatment. The efficacy of surgery is balanced against the short-term risks of the surgical procedure. Most RCTs in this population have 1 to 3 years of follow-up; 1 RCT, which included patients with BMI between 30 and 34.9 kg/m², had 5-year follow-up data.

**Table 15. RCTs of Bariatric Surgery Procedures Comparing Patients Who Had T2D With Controls**

<table>
<thead>
<tr>
<th>Study (Country)</th>
<th>N</th>
<th>BMI Range, kg/m²</th>
<th>Patients With BMI ≤35 kg/m²</th>
<th>Length of FU, years</th>
<th>Definition of Diabetes Remission</th>
<th>Diabetes Remission Rate, n/N (%)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dixon et al (2008)⁴⁴ (US)</td>
<td>60</td>
<td>30-40</td>
<td>22%</td>
<td>2</td>
<td>Surgery (LAGB)</td>
<td>22/30 (93%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Control (ILI/A1C-R)</td>
<td>4/30 (13%)</td>
<td></td>
</tr>
<tr>
<td>Ikramuddin et al (2015)⁴¹, (U.S.)</td>
<td>12</td>
<td>30-40</td>
<td>59%</td>
<td>2</td>
<td>Surgery (RYGB)</td>
<td>26/60 (43%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Control (HILI/A1C-R)</td>
<td>8/59 (14%)</td>
<td></td>
</tr>
<tr>
<td>Liang et al (2013)⁴¹, (China)</td>
<td>10</td>
<td>&gt;28g</td>
<td>1</td>
<td>T2D remission b</td>
<td>Surgery (RYGB)</td>
<td>28/31 (90%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Surgery (LAGB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Control (HILI/A1C-S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>RCTs</td>
<td>BMI Range</td>
<td>CGI</td>
<td>Surgery 1</td>
<td>Surgery 2</td>
<td>Control 1</td>
<td>Control 2</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------</td>
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<td>-----</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Courcoulas et al (2015)</td>
<td>61</td>
<td>30-40</td>
<td>43%</td>
<td>3</td>
<td>8/20</td>
<td>6/21</td>
<td>0%</td>
</tr>
<tr>
<td>Partial: HbA1c &lt;6.5%</td>
<td></td>
<td></td>
<td></td>
<td>Full:</td>
<td>HbA1c &lt;5.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full: HbA1c &lt;5.7% (off meds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schauer et al (2017)</td>
<td>15</td>
<td>27-43</td>
<td>37%</td>
<td>5h</td>
<td>14/49</td>
<td>11/49</td>
<td>2/38</td>
</tr>
<tr>
<td>% HbA1c &lt;6.0% (meds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention-to-Treat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (RYGB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (LSG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (ILI/A1C-S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mingrone et al (2015)</td>
<td>60</td>
<td>35+</td>
<td>0%</td>
<td>5h</td>
<td>8/19</td>
<td>13/19</td>
<td>0%</td>
</tr>
<tr>
<td>% HbA1c ≤6.5% (% meds x1y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (LAGB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (BPD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (GCP/A1C-S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wentworth et al (2014)</td>
<td>51</td>
<td>25-30</td>
<td>100%</td>
<td>2</td>
<td>&lt;125 mg/dL</td>
<td>12/23</td>
<td>2/25</td>
</tr>
<tr>
<td>&lt;200 mg/dL or 200 mg/dL 2-h OGTT (off meds x2d)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (RYGB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery (HILI/A1C-S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halperin et al (2014)</td>
<td>43</td>
<td>30-42</td>
<td>30%</td>
<td>1</td>
<td>11/19</td>
<td>3/19</td>
<td>0.03</td>
</tr>
<tr>
<td>% HbA1c &lt;6.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


^ All RCTs in this table are in the Wu et al (2016) meta-analysis; 7 of the 8 (except Mingrone et al) are in the Muller-Stich et al (2015) meta-analysis; the Rao et al (2015) meta-analysis and the TEC Assessment did not include RCTs.

^ No additional RCTs comparing bariatric surgery with nonsurgical treatment in patients who had T2D were identified.
b Used as a secondary outcome. Primary outcome was change in left ventricular mass index.

c Unadjusted (RYGB vs. control).

d Unadjusted (LSG vs. control).

e RYGB vs. control.

f LSG vs. control.

g WHO Asia-Pacific Obesity Classification.

h Through February 2017.

Table 16. Observational Studies Assessing Bariatric Surgery in Patients With Type 2 Diabetes With Follow-Up ≥3 Years

<table>
<thead>
<tr>
<th>Study (Country)</th>
<th>N</th>
<th>BMI Range, kg/m²</th>
<th>Patients With BMI ≤35 kg/m²</th>
<th>Length of FU</th>
<th>Interv</th>
<th>Mean HbA1c</th>
<th>Mean BMI, kg/m²</th>
<th>Diabetes Remission Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scopinaro et al (2014) (Italy)</td>
<td>20 treated; 27 matched diabetic controls</td>
<td>30-34.9</td>
<td>100%</td>
<td>3 y</td>
<td>RYGB</td>
<td>9.5%</td>
<td>7.0%</td>
<td>a</td>
</tr>
<tr>
<td>Lanzarini et al (2013) (Chile)</td>
<td>31</td>
<td>30-35</td>
<td>100%</td>
<td>30 mo</td>
<td>RYGB</td>
<td>7.9%</td>
<td>5.5%</td>
<td>a</td>
</tr>
<tr>
<td>Boza et al (2011) (Chile)</td>
<td>30</td>
<td>&lt;35</td>
<td>100%</td>
<td>2 y</td>
<td>RYGB</td>
<td>8.1%</td>
<td>=6.2%a,b</td>
<td>33.5</td>
</tr>
<tr>
<td>DePaula et al (2012) (Brazil)</td>
<td>202</td>
<td>&lt;35</td>
<td>100%</td>
<td>39 mo</td>
<td>SG</td>
<td>8.7%</td>
<td>6.1%</td>
<td>a</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lee et al (2008)35 and (202) (Taiwan)</td>
<td>544 bypass</td>
<td>32-77</td>
<td>Not reported</td>
<td>3 y</td>
<td>Bypass</td>
<td>6.2%</td>
<td>4.8%</td>
<td>41.3</td>
</tr>
<tr>
<td></td>
<td>116 LAGB</td>
<td>Not reported</td>
<td>LAGB</td>
<td>5.9%</td>
<td>5.2%</td>
<td>41.9</td>
<td>32.7</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

Group 1 is defined as poor control optimal medical management (may include insulin). Group 2 is defined as adequate control with medication (may include insulin).


a p < 0.05 (follow-up vs baseline).

b Estimated from figure.

c Mean.

Bariatric Surgery in Nondiabetic Patients With a Body Mass Index Less Than 35 kg/m²

Clinical Context and Test Purpose

The purpose of any bariatric surgery procedure is to provide a treatment option that is an alternative to or improvement on existing therapies, such as standard medical care, in patients who are not diabetic and not morbidly obese.

The question addressed in this evidence review is: Do various bariatric surgery procedures improve the net health outcome in those without diabetes who are not obese?

Patients

The relevant population of interest is individuals who are not diabetic and not morbidly obese.
Interventions
The therapy being considered is any bariatric surgery procedure. Patients who are diabetic and not morbidly obese are actively managed by endocrinologists and primary care providers in an outpatient clinical and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for patients who are diabetic include blood sugar regulation and insulin therapy.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating any bariatric surgery procedure as a treatment for diabetes has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
c. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
d. Studies with duplicative or overlapping populations were excluded.

Systematic Reviews
A 2012 TEC Assessment evaluated LAGB in individuals without diabetes who had a BMI less than 35 kg/m². This Assessment was prompted by FDA approval of LAP-BAND for this indication in 2011. The TEC Assessment concluded that LAGB did not meet TEC criteria in these patients and made the following summary statements:

- The evidence on LAGB for patients with lower BMIs is limited both in quantity and quality. There was only 1 small RCT, which had methodologic limitations, a nonrandomized comparative study based on registry data, and several case series. Using the GRADE evaluation, the quality of evidence on the comorbidity outcomes was judged to be low, and the quality of the evidence on the weight loss outcomes was judged to be moderate.
- The evidence was sufficient to determine that weight loss following LAGB is greater than with nonsurgical therapy.
- Direct data on improvement in weight-related comorbidities was lacking. The limited evidence was not sufficient to conclude that the amount of weight loss is large enough that improvements in weight-related comorbidities could be assumed.
- There were very few data on quality of life in this population of patients.
- The frequency and impact of long-term complications following LAGB were uncertain, and this uncertainty has been one of the main reasons why it is difficult to determine whether the benefit of LAGB outweighs the risk for this population. While the short-term safety of LAGB has been well-established, the long-term adverse events occur at a higher rate and are less well-defined.

Systematic reviews and meta-analyses on the use of bariatric or metabolic surgery in patients with a BMI <35 kg/m² are available, and report efficacy in achieving weight loss, glycemic control, T2D remission, and various cardiovascular disease factors through 1-5 years of follow-up.
Current studies are limited by heterogeneity in establishing definitions for T2D remission and surgical intervention. Longer-term (>5 years) RCTs evaluating the use of metabolic surgery in lower-BMI patients for the treatment of T2Ds are pending (NCT02328599).

**Section Summary: Bariatric Surgery in Nondiabetic Patients With a Body Mass Index Less Than 35 kg/m²**

There is limited evidence for bariatric surgery in patients who are not diabetic or morbidly obese. A few small RCTs and case series have reported a loss of weight and improvements in comorbidities for this population. However, the evidence does not permit conclusions on the long-term risk-benefit ratio of bariatric surgery in this population.

**Bariatric Surgery in Morbidly Obese Adolescent Children**

**Clinical Context and Therapy Purpose**

The purpose of gastric bypass, LAGB, or SG is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are adolescent children with morbid obesity.

The question addressed in this evidence review is: Do various bariatric surgery procedures improve the net health outcome in adolescents who are obese?

The following PICO was used to select literature to inform this review.

**Patients**

The relevant population of interest is individuals who are adolescent children with morbid obesity. While guidelines for bariatric surgery in adolescents are not uniform, most use weight-based criteria that parallel those for adults.

**Interventions**

The therapy being considered is gastric bypass, LAGB, or SG. Patients who are adolescent children with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Comparators**

Comparators of interest include standard medical care. Treatment for adolescent children with morbid obesity includes physical exercise, low carbohydrate dieting, and low-fat dieting.

**Outcomes**

The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating gastric bypass, LAGB, or SG as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 6 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

**Study Selection Criteria**

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.
Bariatric Surgery Techniques
Systematic Reviews
Qi et al (2017) published a systematic review and meta-analysis on the use of bariatric surgery for the treatment of adolescents with obesity (see Table 17). In a literature search conducted through July 2017, 49 studies were identified for inclusion. Study quality was assessed using the Newcastle-Ottawa Scale. Age of patients ranged from 14 to 20 years. BMI ranged from 34 to 63 kg/m². Overall results showed significant improvements in BMI as well as glycemic and lipid control with various bariatric surgery techniques (see Table 17). RYGP showed the largest improvements compared with other procedures, with LAGB and SG also showing improvements in this population.

In a systematic review of 23 studies, Black et al (2013) concluded that the available literature demonstrated a high rate of significant short-term weight loss after bariatric surgery (see Table 18). The literature search was conducted through January 2013. Quality assessment of the included studies was not discussed. Ages of patients at the time of surgery ranged from 5 to 23 years. A meta-analysis showed significant reductions in BMI (see Table 18). Meta-analyses were not conducted on the resolution of comorbidities due to heterogeneity in reporting. However, most cases of hypertension, OSA, T2D, and dyslipidemia were reported to have resolved at 1-year follow-up. Reviewers noted that complication and comorbidity rates were not well-defined.

Treadwell et al (2008) conducted a systematic review and meta-analysis of the published evidence on bariatric surgery in adolescents (see Table 18). Their analysis included English-language articles on currently performed procedures when data were separated by procedure, and there was a minimum 1-year follow-up for weight and BMI. Studies must have reported outcomes data for 3 or more patients ages 21 years or younger, representing at least 50% of pediatric patients enrolled at that center. Nineteen studies reported on between 11 and 68 patients who were 21 years or younger. Eight studies of LAGB (mean BMI, 45.8 kg/m²; median age range, 15.6-20 years); 6 studies on RYGB (mean BMI, 51.8 kg/m²; median age range, 16-17.6 years); 5 studies of other procedures (mean BMI, 48.8 kg/m²; median age range, 15.7-21 years) were included.

Meta-analyses of BMI at longest follow-up indicated sustained and clinically significant reductions for both LAGB and RYGB (see Table 18). Comorbidity resolution was sparsely reported, but surgery appeared to resolve some medical conditions, including diabetes and hypertension; 2 studies of LAGB showed large rates of diabetes resolution but low patient enrollment, and only 1 study of RYGB reported relevant data. No in-hospital or postoperative deaths were reported in any LAGB study. The most frequently reported complications for LAGB were band slippage and micronutrient deficiency with sporadic cases of band erosion, port/tube dysfunction, hiatal hernia, wound infection, and pouch dilation. More severe complications were reported for RYGB, such as pulmonary embolism, shock, intestinal obstruction, postoperative bleeding, staple line leak, and severe malnutrition. No in-hospital deaths were reported; however, 1 patient died 9 months after the study with severe Clostridium difficile colitis; 3 others died of causes not likely to have been directly related to the bariatric surgeries. No LAGB studies reported data on the impact of surgery on growth and development. One study of RYGB reported pre- and postoperative heights and concluded that there was no evidence of growth retardation at an average follow-up of 6 years, but it could not be determined from the data whether expected growth was achieved.

<table>
<thead>
<tr>
<th>Study</th>
<th>Dates</th>
<th>Studies</th>
<th>Participants</th>
<th>Design</th>
<th>Duration</th>
</tr>
</thead>
</table>
LAGB: 1028
LSG: 665
Other: 98 | 1 RCT
22 prospective
26 retrospective | 12-120 mo |
LAGB: 271 | 1 controlled
22 uncontrolled | 6-120 mo |

Table 18. Systematic Review Results for Bariatric Surgery for Adolescents With Obesity

<table>
<thead>
<tr>
<th>Study</th>
<th>BMI Reduction Mean Difference (95% CI)</th>
<th>Fasting Blood Insulin, mlU/L Mean Difference (95% CI)</th>
<th>Total Cholesterol, mg/dL Mean Difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qi et al (2017)</td>
<td>18.5 (16.4 to 20.7)</td>
<td>24.8 (10.0 to 30.7)</td>
<td>29.4 (18.1 to 40.7)</td>
</tr>
<tr>
<td>RYGB</td>
<td>12.1 (11.0 to 13.3)</td>
<td>20.5 (16.4 to 24.6)</td>
<td>2.2 (-10.0 to 14.4)</td>
</tr>
<tr>
<td>LAGB</td>
<td>16.0 (13.2 to 20.7)</td>
<td>18.4 (11.4 to 25.3)</td>
<td>13.6 (2.9 to 24.2)</td>
</tr>
<tr>
<td>LSG</td>
<td>23.2 (15.6 to 30.7)</td>
<td>28.3 (5.7 to 50.9)</td>
<td>49.5 (29.9 to 69.2)</td>
</tr>
<tr>
<td>Other</td>
<td>14.5 (11.7 to 17.3)</td>
<td>15.4 (9.1 to 21.8)</td>
<td>16.3 (9.1 to 23.5)</td>
</tr>
</tbody>
</table>

BMI: body mass index; CI: confidence interval; LAGB: laparoscopic adjustable gastric banding; LSG: laparoscopic sleeve gastrectomy; NR: not reported; RYGP: Roux-en-Y gastric bypass; a No point estimate provided, only 95% CIs given.

Observational Studies

Dumont et al (2018) published a retrospective study of obese adolescents who underwent LAGB. Between 2006 and 2015, 97 consecutive teenagers (average age at surgery 17.2 ± 0.7 years; mean BMI of 44.9 ± 6.1 kg/m²) who had achieved full growth and sexual maturity and had previously failed a medical nutritional and dietary management program for at least 1 year were enrolled in the study. After a mean follow-up time of 56.0 ± 22.0 months, mean total weight loss was 20.0 ± 16.6% and mean excess weight loss was 46.6 ± 39.5%. Nineteen patients underwent band removal (mean 43.0 ± 28.0 months). No limitations to the study were reported.

One of the larger observational studies included in the systematic reviews was by Inge et al (2014), who reported results from the Teen-Longitudinal Assessment of Bariatric Surgery study, a prospective, multicenter observational study of bariatric surgery in patients ages 19 or younger. The study enrolled 242 patients, with a mean age 17.1 years and median BMI of 50.5 kg/m² (IQR, 45.2-58.2 kg/m²) at the time of surgery. All patients had at least 1 obesity-related comorbidity, most commonly dyslipidemia (74%), followed by OSA (57%), back and joint pain (46%), hypertension (45%), and fatty liver disease (37%). Gastric bypass, LAGB, and vertical SG were performed in 66.5%, 5.8%, and 27.7% of patients, respectively. Within 30 days of surgery, 20 major complications occurred in 19 (7.9%) patients, most of which were perioperative. The cohort is being followed to assess longer term outcomes.

Gastric Bypass

Comparative Studies

Olbers et al (2017) published results from the Adolescent Morbid Obesity Surgery (AMOS) study. AMOS is a prospective, nonrandomized study of patients ages 13 to 18 years with severe obesity. Enrolled patients underwent RYGB (n=81) and were compared with 80 matched adolescent controls undergoing conservative treatment and 81 matched adult controls.
undergoing RYGB. The primary outcome was change in BMI after 5 years. Adolescents undergoing RYGB had a mean age of 16.5 years and mean BMI of 45.5 kg/m². At 5-year follow-up, adolescents receiving RYGB experienced a mean reduction in BMI of 13.1 kg/m² (95% CI, 11.8 to 14.5 kg/m²). Adolescents receiving conservative treatment experienced a mean increase in BMI of 3.3 kg/m² (95% CI, 1.1 to 4.8 kg/m²). Adult controls receiving RYGB experienced a reduction in BMI similar to the adolescents undergoing RYGB, 12.3 kg/m² (95% CI, 10.9 to 13.7 kg/m²). Adolescents undergoing RYGB also experienced significant improvements in glucose, insulin, cholesterol, and blood pressure levels compared with adolescents in the control group.

Laparoscopic Adjustable Gastric Banding

Systematic Reviews

Willcox and Brennan (2014) conducted a systematic review focusing on studies reporting biopsychosocial outcomes following LAGB in adolescents with obesity. The literature search, conducted through May 2013, identified 11 studies for inclusion. Significant weight loss was reported in all studies. Resolution of comorbidities was also reported, though the evidence was poor quality due to a limited discussion of comorbidity assessment criteria. Reporting of psychosocial outcomes was considered limited, with reviewers concluding that further research is needed to better understand the behavioral, emotional, and social factors experienced by adolescents undergoing LAGB.

Randomized Controlled Trials

In the only RCT identified in the systematic reviews, O’Brien et al (2010) reported on 50 adolescents between the ages of 14 and 18 years with a BMI 35 kg/m² or higher who received either a lifestyle intervention or LAGB. Follow-up was 2 years. Twenty-four of 25 patients in the gastric banding group and 18 of 25 in the lifestyle group completed the study. Twenty-one (84%) in the gastric banding group and 3 (12%) in the lifestyle group lost more than 50% of excess weight. Overall, mean weight loss in the gastric banding group was 34.6 kg (95% CI, 30.2 to 39.0 kg), representing an EWL of 78.8% (95% CI, 66.6% to 91.0%). Mean losses in the lifestyle group were 3.0 kg (95% CI, 2.1 to 8.1 kg), representing an EWL of 13.2% (95% CI, 2.6% to 21.0%). The gastric banding group experienced improved quality of life with no perioperative adverse events; however, 8 (33%) surgeries were required in 7 patients for revisional procedures, either for proximal pouch dilatation or tubing injury during follow-up.

Case Series

There are many case series of bariatric surgery in adolescents, and they have generally reported weight loss in the same range reported for adults. For example, Nadler et al (2008) reported on 73 patients ages 13 to 17 years who had undergone LAGB since 2001 at the authors’ institution. Mean preoperative BMI was 48 kg/m². EWL at 6 months, 1 year, and 2 years postoperatively was 35%, 57%, and 61%, respectively. Six patients developed band slippage, and 3 developed symptomatic hiatal hernias. Nutritional complications included an asymptomatic iron deficiency in 13 patients, asymptomatic vitamin D deficiency in 4 patients, and mild subjective hair loss in 14. In the 21 patients who entered the authors’ FDA-approved study and had reached 1-year follow-up, 51 comorbid conditions were identified, 35 of which completely resolved, 9 were improved, 5 were unchanged, and 2 were aggravated after 1 year.

Sleeve Gastrectomy

Manco et al (2017) published results from contemporaneous cohorts of adolescent patients with BMI of 35 kg/m² or more and nonalcoholic steatohepatitis who chose between 3 treatment options. Twenty patients chose to undergo LSG, 20 patients opted to ingest intragastric weight loss devices (IGWLD, either the BioEnterics Intragastric Balloon System or Obalon Gastric Balloon) plus lifestyle interventions, and 53 patients chose lifestyle interventions alone. All patients in the LSG and IGWLD groups completed the study; 22 of the 53 in the lifestyle intervention group completed the study. After 1-year follow-up: patients undergoing LSG lost 21% body weight; patients treated with IGWLD lost 3% body weight, and patients receiving lifestyle interventions...
only gained 2% body weight. Nonalcoholic steatohepatitis reverted in 100% of patients receiving LSG and in 24% receiving IGWLD. Patients receiving lifestyle interventions alone did not improve significantly.

Section Summary: Bariatric Surgery in Morbidly Obese Adolescent Children
Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy
Several systematic reviews and meta-analyses have been conducted on observational studies evaluating the use of bariatric surgery for the treatment of adolescents with obesity. There is an overlap of studies among the systematic reviews. The majority of evidence assesses the use of gastric bypass, SG, or LAGB. Two nonrandomized comparative studies were published after the systematic reviews. One compared RYGB with conservative treatment and with adults undergoing RYGB, and 1 compared LSG with gastric balloons and lifestyle interventions. The evidence on bariatric surgery in adolescents indicates that the percent EWL and change in BMI are approximately the same as that in adults. There are greater concerns for developmental maturity, psychosocial status, and informed consent in adolescents.

Bariatric Surgery Other Than Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy
There is less evidence for the use of bariatric techniques other than gastric bypass, LAGB, and SG. Sample sizes are small for these other techniques and meta-analyses have shown wide CIs in the estimates.

Guideline recommendations for bariatric surgery in adolescents lack uniformity but generally correspond to the clinical selection criteria for adults and supplement these clinical selection criteria with greater attention to issues of maturity and psychosocial status.

Bariatric Surgery in Morbidly Obese PreAdolescent Children
Clinical Context and Therapy Purpose
The purpose of bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients who are preadolescent children with morbid obesity.

The question addressed in this evidence review is: Do various bariatric surgery procedures improve the net health outcome in preadolescents who are obese?

The following PICO was used to select literature to inform this review.

Patients
The relevant population of interest is individuals who are preadolescent children with morbid obesity.

Interventions
The therapy being considered is bariatric surgery.

Patients who are adolescent children with morbid obesity are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

Comparators
Comparators of interest include standard medical care. Treatment for preadolescent children with morbid obesity includes low carbohydrate dieting and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity.
The existing literature evaluating bariatric surgery as a treatment for morbid obesity has varying lengths of follow-up, ranging from 1 to 5 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
c. To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
d. Studies with duplicative or overlapping populations were excluded.

Black et al (2013; described above) published a systematic review of 23 studies on bariatric surgery in children and adolescents.125

Clinical practice guidelines (eg, from the Endocrine Society [2008]1, and the Institute for Clinical Systems Improvement [2013]2, ) have recommended against bariatric surgery in preadolescent children.

**Section Summary: Bariatric Surgery in Morbidly Obese Preadolescent Children**
There are few published data, and no studies were identified that focused on bariatric surgery in preadolescent children. Clinical guidelines have recommended against bariatric surgery in preadolescent children.

**Hiatal Hernia Repair in Conjunction With Bariatric Surgery for Adults with Morbid Obesity and a Preoperative Diagnosis of Hiatal Hernia**

**Clinical Context and Therapy Purpose**
The purpose of hiatal hernia repair with bariatric surgery is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as standard medical care, in patients with morbid obesity and a preoperative diagnosis of hiatal hernia.

The question addressed in this evidence review is: Do various bariatric surgery procedures improve the net health outcome in adults who are obese with a preoperative diagnosis of hiatal hernia?

The following PICO was used to select literature to inform this review.

**Patients**
The relevant population of interest is individuals with morbid obesity and a preoperative diagnosis of hiatal hernia.

Patients with morbid obesity and a preoperative diagnosis of hiatal hernia are actively managed by nutritionists and primary care providers in an outpatient clinical setting and bariatric surgeons for the provision of surgical intervention.

**Interventions**
The therapy being considered is hiatal hernia repair with bariatric surgery.
Comparators
Comparators of interest include standard medical care. Treatment for patients with morbid obesity and a preoperative diagnosis of hiatal hernia includes physical exercise, low carbohydrate dieting, and low-fat dieting.

Outcomes
The general outcomes of interest are OS, change in disease status, functional outcomes, health status measures, quality of life, treatment-related mortality, and treatment-related morbidity. The existing literature evaluating hiatal hernia repair with bariatric surgery as a treatment for morbid obesity and a preoperative diagnosis of hiatal hernia has varying lengths of follow-up, ranging from 1 to 3 years. While studies described below all reported at least 1 outcome of interest, longer follow-up was necessary to fully observe outcomes. One-year follow-up is necessary to demonstrate weight loss efficacy. Longer follow-up to 5-10 years is desirable to assess maintenance of weight loss, impact on co-occurring conditions and appearance of long-term complications.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess longer term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Studies with duplicative or overlapping populations were excluded.

Hiatal hernia is associated with obesity, and existing hiatal hernias may be worsened with bariatric surgery. In some studies, the presence of a hiatal hernia has been associated with complications after LAGB, although other studies have reported no differences in perioperative complications after LAGB in patients with GERD and/or a hiatal hernia or those without GERD and/or hiatal hernia. Hiatal hernias, either incidentally found at surgery or diagnosed preoperatively, are often repaired at the time of bariatric surgery. In 2013, the Society of American Gastrointestinal and Endoscopic Surgeons published guidelines on the management of hiatal hernia, recommending that, during RYGB, SG, and the placement of LAGBs, all detected hiatal hernias should be repaired (grade of recommendation: weak; evidence quality moderate).

There is limited evidence whether repair of hiatal hernias at the time of bariatric surgery improves outcomes after surgery; it consists primarily of cohort studies comparing outcomes for patients who had a hiatal hernia and underwent repair during bariatric surgery with patients without a hiatal hernia.

Gulkarov et al (2008) reported on results of a prospective cohort study comparing outcomes for patients who underwent LAGB with or without concurrent hiatal hernia repair (n=1298 with LAGB alone; n=520 with concurrent hiatal hernia repair). The authors reported that, initially, hiatal hernias were diagnosed based on preoperative esophagram and upper endoscopy, but this was discontinued after these studies were shown to have poor predictive value for small-to-medium size hernias; subsequent patients were diagnosed at the time of surgery. It was not specified how many patients were diagnosed with each method or how many of those had symptoms before gastric banding. Fewer patients who underwent concurrent hiatal hernia repair required reoperation for a complication (3.5% vs. 7.9% in the LAGB alone group; p<0.001). Hiatal hernia repair added an average of 14 minutes to surgical time. Weight loss outcomes did not differ significantly between groups.

Santonicola et al (2014) evaluated the effects of LSG with or without hiatal hernia repair on GERD in obese patients. The study included 78 patients who underwent SG with concomitant...
Reynoso et al (2011) reported on outcomes after primary and revisional LAGB in patients with a hiatal hernia treated at a single hospital system.137 Of 1637 patients with a hiatal hernia undergoing primary gastric banding, 190 (11.6%) underwent concurrent hiatal hernia repair; of 181 patients undergoing revision gastric banding, 15 (8.3%) underwent concurrent hiatal hernia repair. For primary procedures, there were no significant differences in mortality, morbidity, length of stay, and 30-day readmission rates for patients who underwent LAGB with and without hiatal hernia repair. However, this compares patients with a hiatal hernia undergoing repair to patients without a hiatal hernia. The more relevant comparison would be comparing repair to no repair in patients who have a hiatal hernia.

Ardestani et al (2014) analyzed data from the Bariatric Outcomes Longitudinal Database registry to compare outcomes for patients with and without hiatal hernia repair at the time of LAGB.138 Of 41611 patients who had LAGB from 2007 to 2010, 8120 (19.5%) had a concomitant hiatal hernia repair. Those with hiatal hernia repair were more likely to have GERD preoperatively (49% vs. 40% in the non–hiatal hernia repair group; p<0.001). Perioperative outcomes were similar between groups. Of those with GERD preoperatively, rates of improvement in GERD symptoms did not differ significantly at 1 year, postsurgery (53% for hiatal hernia repair vs. 52% for non–hiatal hernia repair; p=0.4). Although the hiatal hernia repair added minimal time (mean, 4 minutes) to surgery, the authors concluded that many repairs would have involved small hernias with limited clinical effect.

In general, studies have reported that the addition of hiatal hernia repair at the time of bariatric surgery is safe and feasible. In a small case series of 21 patients, Frezza et al (2008) described the feasibility of crural repair at the time of LAGB for patients with a hiatal hernia.139 Al-Haddad et al (2014) used data from the U.S. Nationwide Inpatient Sample to evaluate the surgical risk associated with hiatal hernia repair at the time of bariatric surgery.140 For laparoscopic RYGB, there were 206559 and 9060 patients who underwent the procedure alone or with concomitant hiatal hernia repair, respectively. For LAGB, 52901 and 9893 patients, respectively, underwent the procedure alone or with hiatal hernia repair. The authors reported no evidence of increased risk of perioperative adverse events associated with the concomitant hiatal hernia repair. However, patients who underwent a concomitant hiatal hernia repair were less likely to have prolonged length of stay, with an average treatment effect on the treated of hiatal hernia repair of -0.124 (95% CI, -0.15 to -0.088) for prolonged length of stay for patients who underwent RYGB and an average treatment effect on the treated of hiatal hernia repair of -0.107 (95% CI, -0.159 to -0.0552) for prolonged length of stay for patients who underwent LAGB.

**Section Summary: Hiatal Hernia Repair in Conjunction With Bariatric Surgery for Adults with Morbid Obesity and a Preoperative Diagnosis of Hiatal Hernia**

Hiatal hernia repair is frequently undertaken at the time of bariatric surgery. The evidence related to whether hiatal hernia repair improves outcomes after bariatric surgery is limited, particularly for hiatal hernias that are incidentally diagnosed at the time of surgery. No studies were identified that compared outcomes after bariatric surgery with or without hiatal hernia repair in a population of patients with a known hiatal hernia. For patients with a preoperative diagnosis of a hiatal hernia, symptoms related to a hernia, and indications for surgical repair, it is reasonable to undertake this procedure at the time of bariatric surgery. For other patients, it is uncertain whether repair of a hiatal hernia at the time of bariatric surgery improves outcomes.
Summary of Evidence
Adults with Morbid Obesity
For individuals who are adults with morbid obesity who receive gastric bypass, the evidence includes RCTs, observational studies, and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. TEC Assessments and other systematic reviews of RCTs and observational studies found that gastric bypass improves health outcomes, including weight loss and remission of T2D. A TEC Assessment found similar weight loss with open and laparoscopic gastric bypass. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who are adults with morbid obesity who receive LAGB, the evidence includes RCTs, observational studies, and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Systematic reviews of RCTs and observational studies have found that LAGB is a reasonable alternative to gastric bypass. There is less weight loss with LAGB than with gastric bypass, but LAGB is less invasive and is associated with fewer serious adverse events. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who are adults with morbid obesity who receive SG, the evidence includes RCTs, observational studies (evaluating SG alone and comparing SG with gastric bypass), as well as systematic reviews. Relevant outcomes are OS, survival, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Systematic reviews of RCTs and observational studies have found that SG results in substantial weight loss and that this weight loss is durable for at least 5 years. A meta-analysis found that short-term weight loss was similar after SG compared with gastric bypass. Long-term weight loss was greater after gastric bypass, but SG is associated with fewer adverse events. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who are adults with morbid obesity who receive BPD-DS, the evidence includes nonrandomized comparative studies, observational studies, and a systematic review. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Nonrandomized comparative studies have found significantly higher weight loss after BPD-DS compared with gastric bypass at 1 year. A large case series found sustained weight loss after 7 years. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome. For individuals who are adults with morbid obesity who receive BPD without DS, the evidence includes observational studies and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. A TEC Assessment reviewed the available observational studies and concluded that weight loss was similar after BPD without a DS or gastric bypass. However, concerns have been raised about complications associated with BPD without DS, especially long-term nutritional and vitamin deficiencies. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive VBG, the evidence includes observational studies and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. A TEC Assessment identified 8 nonrandomized comparative studies evaluating VBG, and these studies found that weight loss was significantly greater with open gastric bypass. Moreover, VBG has relatively high rates of complications, revisions, and reoperations. The evidence is insufficient to determine the effects of the technology on health outcomes.
For individuals who are adults with morbid obesity who receive 2-stage bariatric surgery procedures, the evidence includes a small RCT and observational studies. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. There is a lack of evidence that 2-stage bariatric procedures improve outcomes compared with 1-stage procedures. The small RCT compared IGB plus gastric bypass with the standard of care plus gastric bypass and did not detect a difference in weight loss at 6 months post-surgery. Case series have shown relatively high complication rates in 2-stage procedures, and patients are at risk of complications in both stages. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive laparoscopic gastric plication, the evidence includes 2 RCTs, observational studies, and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. A 2014 systematic review only identified a small non-randomized comparative study comparing laparoscopic gastric plication with other bariatric surgery procedures. Since the systematic review, 2 RCTs have been published, 1 comparing laparoscopic gastric plication with a sham procedure and another comparing laparoscopic gastric plication with SG. Laparoscopic gastric plication was more effective than sham at 1-year follow-up and equally effective as SG at 2-year follow-up. Additional comparative studies and RCTs with longer follow-up are needed to permit conclusions about the safety and efficacy of laparoscopic gastric plication. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive SADI-S, the evidence includes observational studies. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. No controlled trials have evaluated SADI-S. There are a few case series, the largest of which had fewer than 100 patients. A retrospective chart review of patients receiving gastric bypass, BPD, and SADI-S, reported that among patients without diabetes, SADI-S was more effective in weight loss and cholesterol outcomes than gastric bypass. Among patients with diabetes, SADI-S and BDP had higher remission rates than gastric bypass. Comparative studies and especially RCTs are needed to permit conclusions about safety and efficacy of SADI-S. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive duodenojejunal sleeve, the evidence includes RCTs and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. A systematic review of duodenojejunal sleeves included 5 RCTs and found significantly greater short-term weight loss (12-24 weeks) with the sleeves compared with medical therapy. There was no significant difference in symptoms associated with diabetes. All RCTs were small and judged by systematic reviewers to be at high-risk of bias. High-quality comparative studies are needed to permit conclusions on the safety and efficacy of the procedure. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive IGB devices, the evidence includes RCTs, systematic reviews, and case series. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. RCTs assessing the 2 IGB devices approved by the FDA have found significantly greater weight loss with IGB than with sham treatment or LT alone after 6 months (maximum length of device use). Some adverse events were reported, mainly related to accommodation of the balloon in the stomach; in a minority of cases, these adverse events were severe. One RCT followed patients for an additional 6 months after IGB removal and found sustained weight loss. There are limited data on the durability of weight loss in the long-term. Comparative data are lacking. A large case series found that patients gradually regained
weight over time. Moreover, it is unclear how 6 months of IGB use would fit into a long-term weight loss and maintenance intervention. The evidence is insufficient to determine the effects of the technology on health outcomes.

For individuals who are adults with morbid obesity who receive an AT device, the evidence includes an RCT and case series. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. The RCT found significantly greater weight loss with AT than LT at 1 year. Forty of 58 patients (69%) achieved at least 10% TWL at 4 years or at time of study withdrawal; however, only 15/111 initial AT patients completed the study through 4 years. In addition to a high degree of missing data, the PATHWAY study noted a potentially large number of adverse events related to A-tube malfunction, an element of the therapy which is expected to require replacement within approximately 3.5 years postgastrostomy in 50% of cases. The impact of this on health outcomes compared to existing surgical approaches is unknown. One small case series reported on 15 patients at 2 years. The total amount of data on AT remains limited and additional studies are needed before conclusions can be drawn about the effects of treatment on weight loss, metabolism, safety, nutrition, and long-term durability of treatment. The evidence is insufficient to determine the effects of the technology on health outcomes.

Revision Bariatric Surgery

For individuals who are adults with morbid obesity and failed bariatric surgery who receive revision bariatric surgery, the evidence includes case series and registry data. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Case series have shown that patients receiving revision bariatric surgery experienced satisfactory weight loss. Data from a multinational bariatric surgery database has found that corrective procedures following primary bariatric surgery are relatively uncommon but generally safe and efficacious. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

Adults with Type 2 Diabetes

For individuals who are diabetic and not morbidly obese who receive gastric bypass, SG, BPD, or LAGB, the evidence includes RCTs, nonrandomized comparative studies, and case series. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Systematic reviews of RCTs and observational studies have found that certain types of bariatric surgery are more efficacious than medical therapy as a treatment for T2D in obese patients, including those with a BMI between 30 and 34.9 kg/m². The greatest amount of evidence is on gastric bypass. Systematic reviews have found significantly greater remission rates of diabetes, decrease in HbA1c levels, and decrease in BMI with bariatric surgery than with nonsurgical treatment. The efficacy of surgery is balanced against the short-term risks of the surgical procedure. Most RCTs in this population have 1 to 3 years of follow-up; 1 RCT that included patients with BMI between 30 and 34.9 kg/m² had 5-year follow-up data. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

Nondiabetic and Nonobese Adults

For individuals who are not diabetic and not morbidly obese who receive any bariatric surgery procedure, the evidence includes RCTs, nonrandomized comparative studies, and case series. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. There is limited evidence for bariatric surgery in patients who are not diabetic or morbidly obese. A few small RCTs and case series have reported a loss of weight and improvements in comorbidities for this population. However, the evidence does not permit conclusions on the long-term risk-benefit ratio of bariatric surgery in this population. The evidence is insufficient to determine the effects of the technology on health outcomes.
Adolescent Children with Morbid Obesity

Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy
For individuals who are adolescent children with morbid obesity who receive gastric bypass, or LAGB, or SG, the evidence includes RCTs, observational studies, and systematic reviews. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Systematic reviews of studies on bariatric surgery in adolescents, who mainly received gastric bypass or LAGB or SG, found significant weight loss and reductions in comorbidity outcomes with bariatric surgery. For bariatric surgery in the adolescent population, although data are limited on some procedures, studies have generally reported that weight loss and reduction in risk factors for adolescents are similar to that for adults. Most experts and clinical practice guidelines have recommended that bariatric surgery in adolescents be reserved for individuals with severe comorbidities, or for individuals with a BMI greater than 50 kg/m². Also, greater consideration should be placed on the patient developmental stage, on the psychosocial aspects of obesity and surgery, and on ensuring that the patient can provide fully informed consent. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

Bariatric Surgery Other Than Gastric Bypass, Laparoscopic Adjustable Gastric Banding, or Sleeve Gastrectomy
For individuals who are adolescent children with morbid obesity who receive bariatric surgery other than gastric bypass, or LAGB, or SG, the evidence includes systematic reviews and a cohort study. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Studies using bariatric surgery other than gastric bypass, LAGB, or SG, have small sample sizes. Results from a meta-analysis including patients using other procedures have shown significant improvements in BMI reduction, fasting blood insulin, and total cholesterol, although the estimates have wide confidence intervals, limiting interpretation. The evidence is insufficient to determine the effects of the technology on health outcomes.

Preadolescent Children with Morbid Obesity
For individuals who are preadolescent children with morbid obesity who receive bariatric surgery, the evidence includes no studies focused on this population. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Several studies of bariatric surgery in adolescents have also included children younger than 12 years old, but findings were not reported separately for preadolescent children. Moreover, clinical practice guidelines have recommended against bariatric surgery for preadolescent children. The evidence is insufficient to determine the effects of the technology on health outcomes.

Hiatal Hernia Repair with Bariatric Surgery
For individuals with morbid obesity and a preoperative diagnosis of a hiatal hernia who receive hiatal hernia repair with bariatric surgery, the evidence includes cohort studies and case series. Relevant outcomes are OS, change in disease status, functional outcomes, health status measures, quality of life, and treatment-related mortality and morbidity. Results from the cohort studies and case series have shown that, when a preoperative diagnosis of a hiatal hernia has been present, repairing the hiatal hernia during bariatric surgery resulted in fewer complications. However, the results are limited to individuals with a preoperative diagnosis. There was no evidence on the use of hiatal hernia repair when the hiatal hernia diagnosis is incidental. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

Supplemental Information
Clinical Input From Physician Specialty Societies and Academic Medical Centers
While the various physician specialty societies and academic medical centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the physician specialty societies or academic medical centers, unless otherwise noted.
In response to the requests from Blue Cross Blue Shield Association, input was received from 1 physician specialty society and 2 academic medical centers on the use of the REALIZE band in 2008. All 3 responses supported the use of the REALIZE band as a surgical option for patients, as adopted into the policy in 2008.

In response to the requests from Blue Cross Blue Shield Association, input was also received from 2 academic medical centers on the use of the new endoscopic placement of devices to remedy weight gain that occurs after bariatric surgery in 2008. Input from both centers agreed that this approach is considered investigational, as adopted in the policy in 2008.

**Practice Guidelines and Position Statements**

American Association of Clinical Endocrinologists et al.

In 2017, the American Association of Clinical Endocrinologists (AACE) and the American College of Endocrinology jointly published a comprehensive diabetes type 2 management algorithm. The document stated: “Bariatric surgery should be considered for adult patients with a BMI [body mass index] of 35 kg/m² or more and comorbidities, especially if therapeutic goals have not been reached using other modalities.”

In 2016, the AACE and the American College of Endocrinology jointly published comprehensive clinical guidelines on the medical care of patients with obesity. The guidelines addressed 9 broad clinical questions with 123 recommendations. It was noted that the 2013 guidelines specifically on bariatric surgery (see below) were considered adequate in the current form. With regard to bariatric surgery for these guidelines, the following recommendations were added to those in the 2013 guideline (see Table 19).

<table>
<thead>
<tr>
<th>No.</th>
<th>Recommendation</th>
<th>GOE</th>
<th>BEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Patients with obesity (BMI ≥30 kg/m²) and diabetes who have failed to achieve targeted clinical outcomes following treatment with lifestyle therapy and weight-loss medications may be considered for bariatric surgery, preferably Roux-en-Y gastric bypass, sleeve gastrectomy, or biliopancreatic diversion.”</td>
<td>B</td>
<td>1a</td>
</tr>
</tbody>
</table>
| 121 | “Patients with a BMI of ≥35 kg/m² and 1 or more severe obesity-related complications, including type 2 diabetes, hypertension, obstructive sleep apnea, obesity-hypoventilation syndrome, Pickwickian syndrome, nonalcoholic fatty liver disease or nonalcoholic steatohepatitis, pseudotumor cerebri, gastroesophageal reflux disease, asthma, venous stasis disease, severe urinary incontinence, debilitating arthritis, or considerably impaired quality of life may also be considered for a bariatric surgery procedure. Patients with BMI of 30 to 34.9 kg/m² with diabetes or metabolic syndrome may also be considered for a bariatric procedure, although current evidence is limited by the number of patients studied and lack of long-term data demonstrating net benefit.  
  - BMI ≥35 kg/m² and therapeutic target of weight control and improved biochemical markers of CVD risk.”  
  - “BMI ≥30 kg/m² and therapeutic target of weight control and improved biochemical markers of CVD risk.  
  - BMI ≥30 kg/m² and therapeutic target of glycemic control in type 2 diabetes and improved biochemical markers of CVD risk.” | A   | 1   |
|     | “Independent of BMI criteria, there is insufficient evidence for recommending a bariatric surgical procedure specifically for glycemic control alone, lipid lowering alone, or CVD risk reduction alone.” | B   | 2   |
| 122 | “Roux-en-Y gastric bypass should be considered as the bariatric surgery procedure of choice for patients with obesity and moderate to severe gastroesophageal reflux symptoms, hiatal hernia, esophagitis, or Barrett’s esophagus.”  
  “Intragastric balloon for weight loss may increase gastroesophageal reflux symptoms and should not be used for weight loss in patients with established gastroesophageal reflux.” | C   | 3   |
| 62  |                                                   | D   |     |

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a Downgraded due to study limitations.

In 2013, joint guidelines on support for bariatric surgery patients were published by the AACE, the Obesity Society, and the American Society for Metabolic and Bariatric Surgery (ASMBS).143. Recommendations on the following questions are summarized below.

- "Which patients should be offered bariatric surgery?"
- "Patients with a BMI≥40 kg/m² without coexisting medical problems and for whom bariatric surgery would not be associated with excessive risk should be eligible for 1 of the procedures."
- "Patients with a BMI≥35 kg/m² and 1 or more severe obesity-related comorbidities...."
- "Patients with BMI of 30-34.9 kg/m² with diabetes or metabolic syndrome may also be offered a bariatric procedure although current evidence is limited by the number of subjects studied and lack of long-term data demonstrating net benefit."
- "There is insufficient evidence for recommending a bariatric surgical procedure specifically for glycemic control alone, lipid lowering alone, or cardiovascular disease risk reduction alone, independent of BMI criteria."
- "Which bariatric surgical procedure should be offered?"
- "The best choice for any bariatric procedure (type of procedure and type of approach) depends on the individualized goals of therapy (e.g., weight loss and/or metabolic [glycemic] control), available local-regional expertise (surgeon and institution), patient preferences, and personalized risk stratification.... At this time, there is still insufficient evidence to generalize in favor of one bariatric surgical procedure for the severely obese population."

American College of Cardiology et al.

In 2013, the American College of Cardiology, American Heart Association, and the Obesity Society published joint guidelines on the management of obesity and overweight in adults. The guidelines made the following recommendations related to bariatric surgery:

- "Advise adults with a BMI 40kg/m² or BMI 35 kg/m² with obesity-related comorbid conditions who are motivated to lose weight and who have not responded to behavioral treatment with or without pharmacotherapy with sufficient weight loss to achieve targeted health outcome goals that bariatric surgery may be an appropriate option to improve health and offer referral to an experienced bariatric surgeon for consultation and evaluation. NHLBI Grade A (Strong); AHA/ACC COR [class of recommendation]: Ila; AHA/ACC LOE [level of evidence]: A"
- "For individuals with a BMI <35 kg/m², there is insufficient evidence to recommend for or against undergoing bariatric surgical procedures. NHLBI Grade N (No Recommendation)"

American Society for Metabolic and Bariatric Surgery

In 2016, the ASMBS published a position statement on intragastric balloon therapy (the statement was also endorsed by the Society of American Gastrointestinal and Endoscopic Surgeons).144. The statement did not include specific recommendations for or against using these devices. A summary of key recommendations is as follows:

There is level 1 data from RCTs [randomized controlled trials] on the “efficacy [and] safety of intragastric balloon therapy for obesity ... [and] lower-level evidence [suggesting] that weight loss can be maintained ... for some finite time into the future.”

It is difficult to separate the effect from the intragastric “balloon alone from those of supervised diet and lifestyle changes....” This has been addressed in recent FDA [Food and Drug Administration] pivotal trials. “In general, any obesity treatment, including intragastric balloon therapy, would benefit from a multidisciplinary team....”

“...serious complications are rare. Early postoperative tolerance challenges ... can be managed with pharmacotherapy in the majority of patients...."
In 2012, the ASMBS published a position statement on sleeve gastrectomy. This updated statement provided the following conclusions:

- “Substantial comparative and long-term data have now been published in the peer-reviewed studies demonstrating durable weight loss, improved medical co-morbidities, long-term patient satisfaction, and improved quality of life after SG [sleeve gastrectomy].
- The ASMBS therefore recognizes SG as an acceptable option as a primary bariatric procedure and as a first-stage procedure in high-risk patients as part of a planned staged approach.
- From the current published data, SG has a risk/benefit profile that lies between LAGB [laparoscopic adjustable gastric banding] and the laparoscopic RYGB [Roux-en-Y gastric bypass]. As with any bariatric procedure, long-term weight regain can occur and, in the case of SG, this could be managed effectively with reintervention. Informed consent for SG used as a primary procedure should be consistent with consent provided for other bariatric procedures and should include the risk of long-term weight gain.

Surgeons performing SG are encouraged to continue to prospectively collect and report outcome data in the peer-reviewed scientific literature.”

**Society of American Gastrointestinal and Endoscopic Surgeons**

In 2013, the Society of American Gastrointestinal and Endoscopic Surgeons issued evidence-based guidelines on the management of a hiatal hernia, which included a recommendation about the repair of hiatal hernias incidentally detected at the time of bariatric surgery. These guidelines stated: “During operations for Roux-en-Y gastric bypass, sleeve gastrectomy and the placement of adjustable gastric bands, all detected hiatal hernias should be repaired” (moderate quality evidence, weak recommendation).

**International Federation for the Surgery of Obesity and Metabolic Disorders**

In 2019, members of societies affiliated with the International Federation for the Surgery of Obesity and Metabolic Disorders established an expert consensus statement on revisional bariatric surgery (RBS). Consensus agreement was established for the following recommendation statements:

- "RYGB is an acceptable RBS option after gastric banding."
- "OAGB is an acceptable RBS option after gastric banding."
- "SADI-S is an acceptable RBS option after gastric banding."a
- "RBS after gastric banding can be carried out in either 1 or 2-stage."
- "OAGB is an acceptable RBS option after SG."
- "BPD-DS is an acceptable RBS option after SG."
- "SADI-S is an acceptable RBS option after SG."
- "Prolongation of bili-pancreatic limb is an acceptable RBS option after RYGB."
- "Prolongation of bili-pancreatic limb is an acceptable RBS option after OAGB."a


a Consensus achieved in second round of voting.

**Guidelines for Children and Adolescents**

Childerhose et al (2017) conducted a systematic review of adolescent bariatric surgery recommendation documents published in the United States and provided recommendations based on their review. The literature search was conducted from 1999 through 2013 and identified 16 recommendations for inclusion: 10 clinical practice guidelines, 4 position statements, and 2 consensus statements. Fifteen of the 16 publications recommended bariatric surgery for adolescents. The main reasons for recommending bariatric surgery for adolescents included: (1) surgery is effective in producing short- and long-term weight loss; (2) surgery is appropriate when the patient does not respond to behavioral or medical interventions; (3) surgery is appropriate when serious comorbidities threaten the health of the patient; and (4)
surgery can improve long-term health and/or emotional problems. Body mass index thresholds ranged from 35 kg/m² or more to 50 kg/m² or more, with lower thresholds usually requiring the presence of at least 1 serious comorbidity. The minimum age was specified in 10 publications, with most using physiologic maturity (Tanner stage IV and/or 95% of adult height based on bone age, corresponding to ≥13 years for females and to ≥15 years for males) rather than years.

**American Society for Metabolic and Bariatric Surgery**

In 2012, the ASMBS best practice guidelines found that current evidence was insufficient to discriminate among specific bariatric procedures, but allowed that there was an increasing body of data showing safety and efficacy of Roux-en-Y gastric bypass and adjustable gastric band for the pediatric population. Bariatric surgery was recommended for pediatric patients with morbid obesity and the following comorbidities:

**Strong indications:**
- Type 2 diabetes
- Moderate or severe obstructive sleep apnea (apnea-hypopnea index >15)
- Nonalcoholic steatohepatitis
- Pseudotumor cerebri.

**Less strong indications:**
- Cardiovascular disease
- Metabolic syndrome.

The guidelines stated that depression and eating disorders should not be considered exclusion criteria for bariatric surgery. The guidelines also noted that depression should be monitored following the procedure and that eating disorders should be treated and the patient stabilized before the procedure.

**European Society for Gastroenterology, Hepatology and Nutrition et al.**

In 2015, a joint position paper published by the European Society for Gastroenterology, Hepatology and Nutrition and the North American Society for Gastroenterology, Hepatology and Nutrition made the following recommendations on indications for bariatric surgery in adolescents:

- **BMI > 40 kg/m² with severe comorbidities**
  - Type 2 diabetes mellitus
  - Moderate-to-severe sleep apnea
  - Pseudotumor cerebri
  - NASH [nonalcoholic steatohepatitis] with advanced fibrosis (ISHAK score > 1)
  - BMI > 50 kg/m² with mild comorbidities
  - Hypertension
  - Dyslipidemia
  - Mild obstructive sleep apnea
  - Chronic venous insufficiency
  - Panniculitis
  - Urinary incontinence
  - Impairment in activities of daily living
  - NASH
  - Gastroesophageal reflux disease
  - Severe psychological distress
  - Arthropathies related to weight.”

Additional criteria included:
- “Have attained 95% of adult stature
- Have failed to attain a healthy weight with previously organized behavioral/medical treatments
- Demonstrate commitment to psychological evaluation perioperatively
- Avoid pregnancy for 1 year after surgery...
- Have decisional capacity and will provide informed assent/consent, as age appropriate.”
Endocrine Society
In 2008, the Endocrine Society published recommendations on the prevention and treatment of pediatric obesity. In 2017, the Society sponsored an update of these guidelines by the Pediatric Endocrine Society and the European Society of Endocrinology. These guidelines recommended the following:

“We suggest that bariatric surgery be considered only under the following conditions:

- The child has attained Tanner 4 or 5 pubertal development and final or near-final adult height.
- The child has a BMI > 40 kg/m² or has BMI above 35 kg/m² and significant, extreme comorbidities.
- Extreme obesity and comorbidities persist, despite compliance with a formal program of lifestyle modification, with or without a trial of pharmacotherapy.
- Psychological evaluation confirms the stability and competence of the family unit.
- There is access to an experienced surgeon in a pediatric bariatric surgery center of excellence that provides the necessary infrastructure for patient care, including a team capable of long-term follow-up of the metabolic and psychosocial needs of the patient and family.
- The patient demonstrates the ability to adhere to the principles of healthy dietary and activity habits.

We recommend against bariatric surgery for preadolescent children, for pregnant or breastfeeding adolescents (and those planning to become pregnant within 2 yr of surgery) and in any patient who has not mastered the principles of healthy dietary and activity habits and/or has an unresolved substance abuse, eating disorder, or untreated psychiatric disorder.”

U.S. Preventive Services Task Force Recommendations
Not applicable.

Medicare National Coverage
The Centers for Medicare & Medicaid Services have published a national coverage decision on bariatric surgery. The Centers determined that:

“...the evidence is adequate to conclude that open and laparoscopic Roux-en-Y gastric bypass (RYGBP), laparoscopic adjustable gastric banding (LAGB), and open and laparoscopic biliopancreatic diversion with duodenal switch (BPD/DS), are reasonable and necessary for Medicare beneficiaries who have a body mass index (BMI) ≥35, have at least one co-morbidity related to obesity, and have been previously unsuccessful with medical treatment for obesity.”

Ongoing and Unpublished Clinical Trials
Some currently unpublished trials that might influence this review are listed in Table 20.

<table>
<thead>
<tr>
<th>NCTNo.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
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<tr>
<td>Ongoing</td>
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<tr>
<td><a href="#">NCT02881684</a></td>
<td>Weight Reduction by Aspiration Therapy in Asian Patients with Morbid Obesity</td>
<td>15</td>
<td>Dec 2018 (recruiting)</td>
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<td><a href="#">NCT02142257</a></td>
<td>Gastric Bypass Procedure and AspireAssist Aspiration Therapy System for the Treatment of Morbid Obesity, Observational Study over 5 Years</td>
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<td>May 2020 (ongoing)</td>
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<tr>
<td><a href="#">NCT03493620</a></td>
<td>Multicenter Randomized Prospective Study With Sham Group to Evaluate the Efficacy and Results of Endoscopic Gastroplasty Using Overstitch in Patients With Class I and II Obesity</td>
<td>60</td>
<td>Aug 2020 (ongoing)</td>
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<tr>
<td><a href="#">NCT03102697</a></td>
<td>Optimization and Follow-Up of the Consecutive Use of Two Intragastric Balloons in the Treatment of Obesity</td>
<td>30</td>
<td>Dec 2020 (recruiting)</td>
</tr>
</tbody>
</table>
The BASIC Trial: Morbid Obesity in Children and Adolescents: A Prospective Randomised Trial of Conservative Treatment Versus Surgery

Metabolic Surgery for Patients with Type 2 DM and Grade 1 Obesity with Bad Metabolic Control (MSO1CT)

A Prospective Consortium Evaluating the Long-term Follow-up of Patients With Type 2 Diabetes Enrolled In a Randomized Controlled Trial Comparing Bariatric Surgery Versus Medical Management (ARMMS-T2D)

Prospective Multicentric Randomized Trial Comparing the Efficacy and Safety of Single-anastomosis Duodeno ileal Bypass With Sleeve Gastrectomy (SADI-S) Versus Roux-en-Y Gastric Bypass (RYGB) (SADISLEEVE)

Prospective Multicentric, Open Label, Randomized Clinical Trial of Superiority, With Two Arms, Comparing Bariatric Surgery to the Recommended Medical Treatment for NASH (NASHSURG)

Single Anastomosis Duodeno-ileal Bypass with Sleeve Gastrectomy (SADI-S): a Prospective Cohort Study

Surgical or Medical Treatment for Pediatric Type 2 Diabetes

Laparoscopic Roux-en-Y Gastric Bypass Versus Single Anastomosis Gastric Bypass (MGB vs LGBP)

Laparoscopic Single-Anastomosis Duodenal-Ileal Bypass With Sleeve Gastrectomy vs Laparoscopic Duodenal Switch as a Primary Bariatric Procedure. 5 Year Patient Follow

Single Anastomosis Duodenal ileal Bypass (SADI) as a Second Stage for Sleeve Gastrectomy Weight Loss Failure

NCT: national clinical trial.

a Denotes industry-sponsored or cosponsored trial.

References


51. Skogar ML, Sundbom M. Duodenal switch is superior to gastric bypass in patients with super obesity when evaluated with the Bariatric Analysis and Reporting Outcome System (BAROS). Obes Surg. Sep 2017;27(9):2308-2316. PMID 28439748
53. Prachand VN, Davee RT, Alveryd J C. Duodenal switch provides superior weight loss in the super-obese (BMI > or =50 kg/m2) compared with gastric bypass. Ann Surg. Oct 2006;244(4):611-619. PMID 16998370
54. Skogar ML, Sundbom M. Duodenal switch is superior to gastric bypass in patients with super obesity when evaluated with the Bariatric Analysis and Reporting Outcome System (BAROS). Obes Surg. Sep 2017;27(9):2308-2316. PMID 28155056


121. Willcox K, Brennan L. Biopsychosocial outcomes of laparoscopic adjustable gastric banding in adolescents with body mass index less than 35 kg/m2 with weight-related comorbidity. JAMA Pediatr. Jan 2014;168(1):47-53. PMID 24189578


**Documentation for Clinical Review**

**Please provide the following documentation (if/when requested):**

**Initial Bariatric Procedure in Adults with Morbid Obesity:**
- History and physical and/or consultation notes including prior weight loss attempts and responses, and comorbidities (if needed):
  - A body mass index (BMI) greater than 40.0 kg/m²
  - OR
  - If BMI is greater than or equal to 35.0 kg/m² and less than 40.0 kg/m², documentation of **at least one** of the following comorbidities, including, but not limited to:
    - **Coronary artery disease:** Submit documentation of **at least one** of the following:
      - Stress study
      - Coronary angiography
      - Heart failure
      - History of prior myocardial infarction
      - Prior coronary artery bypass
      - Prior percutaneous coronary intervention
    - **Diabetes:** Submit documentation from primary care provider or endocrinologist of the diagnosis and treatment

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Hypertension: Submit documentation showing a blood pressure of greater than 140 mm Hg systolic and/or 90 mmHg diastolic in spite of concurrent use of at least 3 anti-hypertensive drugs, one of which may be a diuretic.

Obstructive sleep apnea (OSA): Submit documentation of clinically significant OSA such as an official sleep study report interpreted by a sleep disorders specialist MD or Doctor of Osteopathic (DO) medicine showing an Apnea Hypopnea Index (AHI) of at least 15 events per hour, or at least 5 events per hour in addition to excessive daytime sleepiness or hypertension; or obesity hypoventilation syndrome as shown by an awake arterial blood gas or serum bicarbonate level.

Osteoarthritis: Submit documentation that includes radiographic reports confirming the diagnosis.

Hyperlipidemia: Submit documentation of an LDL cholesterol of 160 mg/dl or higher despite dieting and medical treatment.

GastroEsophageal Reflux Disease (GERD): Submit documentation showing endoscopic findings or an ambulatory pH monitoring report that supports the diagnosis and failure of maximal medical therapy.

- Description of medically supervised non-surgical weight-reduction program, initial weight, end weight, duration (start and end dates)
- Documented failure of weight reduction to a BMI less than 35 kg/m² by conservative measures for 3 of the past 6 months
- Medical records that include current height, weight, and body mass index (BMI), surgery requested, and any other recommendations
- Documented educational counseling/class
- Completed Bariatric Surgery Decision Aid signed by the patient
- Completed CollaborATE survey signed by the patient
- Signed Psychosocial-behavioral checklist
- Signed Pre-operative checklist

Revision Bariatric Surgical Requests for Complications:
- Documentation of the problem needing correction (history and physical and/or consultation notes including: prior surgery and complications as applicable, indication for surgery, and treatment plan), which may include, but are not limited to:
  - Staple-line failure or leakage
  - Obstruction, stricture, erosion, or fistula
  - Gastroesophageal reflux disease (GERD), based on ambulatory pH probe monitoring, or endoscopic findings of ulcer, strictures, Barrett’s esophagus, or esophagitis and failing maximal medical therapy
  - Symptomatic pouch enlargement (recurrent vomiting or nausea)
  - Nonabsorption resulting in hypoglycemia or malnutrition
  - Weight loss of 20% or more below ideal body weight
  - Band slippage or hemiation that cannot be corrected with manipulation or adjustment

Revision Bariatric Surgical Requests for Inadequate Weight Loss:
- Documentation requested for Initial Bariatric Procedure in Adults with Morbid Obesity
- Post-surgical weight loss history (including pre- and post-surgical BMI), nutrition and exercise compliance
- Operative report(s) (if applicable)
- Documentation at least 2 years have passed since the initial procedure
- Inadequate weight loss resulted from initial procedure; less than 50% expected weight loss and/or weight remains greater than 40% over ideal body weight (normal body weight BMI parameter = 18.5-24.9)

Bariatric Surgery in Adolescents:
- Documentation requested for Initial Bariatric Procedure in Adults with Morbid Obesity
• Documentation of psychological counseling
• Documentation of informed consent
• Documentation that any device used for bariatric surgery is in accordance with the FDA-approved indication for use

**Concomitant Hiatal Hernia Repair:**

• Documentation of preoperatively-diagnosed hiatal hernia with indications for surgical repair

**Coding**

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy. Inclusion or exclusion of codes does not constitute or imply member coverage or provider reimbursement.

**MN/IE**

The following services may be considered medically necessary in certain instances and investigational in others. Services may be considered medically necessary when policy criteria are met. Services may be considered investigational when the policy criteria are not met or when the code describes application of a product in the position statement that is investigational.

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Description</th>
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<td>CPT®</td>
<td>43632</td>
<td>Gastrectomy, partial, distal; with gastrojejunostomy</td>
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<td>43644</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and Roux-en-Y gastroenterostomy (Roux limb 150 cm or less)</td>
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<td>43645</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; with gastric bypass and small intestine reconstruction to limit absorption</td>
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<td>43659</td>
<td>Unlisted laparoscopy procedure, stomach</td>
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<td>Laparoscopy, surgical, gastric restrictive procedure; placement of adjustable gastric restrictive device (e.g., gastric band and subcutaneous port components)</td>
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<td>Laparoscopy, surgical, gastric restrictive procedure; revision of adjustable gastric restrictive device component only</td>
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<td>43772</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; removal of adjustable gastric restrictive device component only</td>
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<td>43773</td>
<td>Laparoscopy, surgical, gastric restrictive procedure; removal and replacement of adjustable gastric restrictive device component only</td>
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<td>43843</td>
<td>Gastric restrictive procedure, without gastric bypass, for morbid obesity; other than vertical-banded gastroplasty</td>
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<td>Gastric restrictive procedure with partial gastrectomy, pylorus-preserving duodenileostomy and ileileostomy (50 to 100 cm common channel) to limit absorption (biliopancreatic diversion with duodenal switch)</td>
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<td>Gastric restrictive procedure, with gastric bypass for morbid obesity; with short limb (150 cm or less) Roux-en-Y gastroenterostomy</td>
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<td>Gastric restrictive procedure, with gastric bypass for morbid obesity; with small intestine reconstruction to limit absorption</td>
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<td>Revision, open, of gastric restrictive procedure for morbid obesity, other than adjustable gastric restrictive device (separate procedure)</td>
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<td>Adjustment of gastric band diameter via subcutaneous port by injection or aspiration of saline</td>
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<td>S2900</td>
<td>Surgical techniques requiring use of robotic surgical system (list separately in addition to code for primary procedure)</td>
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### Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

<table>
<thead>
<tr>
<th>Effective Date</th>
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<tr>
<td>04/14/1970</td>
<td>New Policy Adoption</td>
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<td>11/10/1999</td>
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<td>02/13/2002</td>
<td>BCBSA Medical Policy adoption</td>
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<td>08/01/2002</td>
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### Effective Date | Action
---|---
06/01/2004 | Policy Revision  
Coding update  
Laparoscopic Gastric Banding  
CTAF update
01/01/2005 | Policy Revision  
Coding update
09/01/2005 | Policy Revision  
External review and recommendations for revision to policy statement:  
Duodenal Switch
12/01/2005 | Policy Statement Revision
03/01/2006 | Policy Revision  
Policy Statement Revision for Duodenal Switch and Lap Gastric Bypass  
Coding update
06/01/2006 | Policy Name Change
12/07/2006 | BCBSA Medical Policy adoption
03/12/2007 | Policy Review  
CTAF review
03/24/2008 | Coding Update
07/08/2008 | Policy Revision  
Added lap banding adjustment, rationale, references  
Coding update
09/25/2009 | Policy Title Revision  
Criteria revised
02/05/2010 | Policy revision with position change  
Coding update
08/06/2010 | Policy revision with position change
09/13/2010 | Documentation required for clinical review update
11/04/2010 | Policy revision for clarification of criteria
11/12/2010 | Policy revision for clarification of criteria
04/01/2011 | Policy revision for clarification of criteria
06/28/2013 | Coding update
04/30/2015 | Policy revision with position change effective 6/30/2015
06/30/2015 | Policy revision with position change
07/31/2015 | Policy clarification update
06/01/2016 | Policy revision without position change
05/01/2017 | Policy revision without position change
12/01/2017 | Policy revision without position change
04/01/2018 | Policy revision without position change
11/01/2018 | Policy statement clarification
04/01/2019 | Policy revision without position change
05/01/2020 | Annual Review. Policy statement, guidelines and literature updated.

### Definitions of Decision Determinations

**Medically Necessary:** Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member's illness, injury, or disease.
**Investigational/Experimental:** A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

**Split Evaluation:** Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

**Prior Authorization Requirements (as applicable to your plan)**

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at www.blueshieldca.com/provider.

**Disclaimer:** This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.