



Original article

2022 American Society for Metabolic and Bariatric Surgery (ASMBS) and International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO): Indications for Metabolic and Bariatric Surgery

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Major updates to 1991 National Institutes of Health guidelines for bariatric surgery

- Metabolic and bariatric surgery (MBS) is recommended for individuals with a body mass index (BMI) ≥ 35 kg/m², regardless of presence, absence, or severity of co-morbidities.
- MBS should be considered for individuals with metabolic disease and BMI of 30–34.9 kg/m².
- BMI thresholds should be adjusted in the Asian population such that a BMI ≥ 25 kg/m² suggests clinical obesity, and individuals with BMI ≥ 27.5 kg/m² should be offered MBS.
- Long-term results of MBS consistently demonstrate safety and efficacy.
- Appropriately selected children and adolescents should be considered for MBS.

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Thirty years ago, the National Institutes of Health (NIH) convened a Consensus Development Conference that published a Statement on gastrointestinal surgery for severe obesity, reflecting expert assessment of the medical knowledge available at the time [1]. Specifically, it sought to address “the surgical treatments for severe obesity and the criteria for selection, the efficacy and risks of surgical treatments for severe obesity, and the need for future research on and epidemiological evaluation of these therapies,” and included specific recommendations for practice. Among these are that nonsurgical programs should be initial therapy for severe obesity; that patients should be carefully selected for surgery after evaluation by a multidisciplinary team; and that lifelong medical surveillance continue after surgery. The 1991 NIH Consensus Statement has been used by providers, hospitals, and insurers, as a standard for selection criteria for bariatric surgery. A body mass index (BMI) ≥ 40 kg/m², or BMI ≥ 35 kg/m² with co-morbidities, is a threshold for surgery that is applied universally.

Since its publication, hundreds of studies have been published on the worldwide obesity epidemic and global experience with metabolic and bariatric surgery (MBS), which has greatly enhanced the understanding of obesity and its treatment [2,3]. Now recognized as a chronic disease, obesity is associated with a chronic low-grade inflammatory state and immune dysfunction [4,5]. It is suspected that the prolonged state of inflammation leads to a disruption of homeostatic mechanisms and consequently to metabolic disorders commonly associated with obesity, mediated by incompletely elucidated pathways involving cytokine production, adipokines, hormones, and acute-phase reactants [5–8].

With an increasing global MBS experience, long-term studies have proven it an effective and durable treatment of severe obesity and its co-morbidities. Studies with long-term follow up, published in the decades following the 1991 NIH Consensus Statement, have consistently demonstrated that MBS produces superior weight loss outcomes

compared with nonoperative treatments [9–14]. After surgery, the significant improvement of metabolic disease, as well as the decrease in overall mortality, has been reported in multiple studies further supporting the importance of this treatment modality [15–19]. Concurrently, the safety of bariatric surgery has been studied and reported extensively [20–23]. Perioperative mortality is very low, ranging between .03% and .2% [24]. Thus, it is not surprising that MBS has become one of the most commonly performed operations in general surgery [25].

The operations commonly performed have evolved as well. Older surgical operations have been replaced with safer and more effective operations. The 1991 NIH Consensus Statement described the vertical banded gastroplasty (VBG) and Roux-en-Y gastric bypass (RYGB) as the dominant procedures in clinical practice at the time. Currently, the dominant procedures are sleeve gastrectomy and RYGB, together accounting for approximately 90% of all operations performed worldwide [26], and each has well-studied mid- and long-term outcomes. Other operations performed include adjustable gastric banding (AGB), biliopancreatic diversion with duodenal switch, and one-anastomosis gastric bypass. The VBG is of historical interest and no longer performed, and the popularity of the AGB has diminished significantly over the past decade. MBS is now preferably performed using minimally invasive surgical approaches (laparoscopic or robotic assisted).

In light of significant advances in the understanding of the disease of obesity, its management in general, and metabolic and bariatric surgery specifically, the leaderships of the American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) have convened to produce this joint statement on the current available scientific information on metabolic and bariatric surgery and its indications.

Criteria for surgery

BMI

Despite limitations of BMI to accurately risk stratify patients with obesity for their future health risk, it is the most feasible and widely used criteria to identify and classify patients with overweight or obesity. MBS is currently the most effective evidence-based treatment for obesity across all BMI classes.

BMI 30–34.9 kg/m². Class I obesity (BMI 30–34.9 kg/m²) is a well-defined disease that causes or exacerbates multiple medical and psychological co-morbidities, decreases longevity, and impairs quality of life. Prospective and large retrospective studies support the notion that MBS should be considered a treatment option for patients with class I obesity who do not achieve substantial or durable weight loss or co-morbidity improvement with nonsurgical methods, and early findings prompted international diabetes organizations to publish a joint statement supporting the consideration of MBS for patients with BMI <35 kg/m² and type 2 diabetes (T2D) [27]. Aminian et al. [28] summarize the available data from randomized controlled trials (RCT's), meta-analyses, and observational studies that also include individuals with BMI <35 kg/m². These data consistently demonstrate the weight loss and metabolic benefits of MBS in individuals with class I obesity [28]. Noun et al. [29] reported on >500 consecutive patients with BMI <35 kg/m² who had MBS and demonstrated significant weight loss at 5 years and improvement or remission of diabetes, hypertension, and dyslipidemia. In a cohort study of more than 1000 patients, MBS in individuals with BMI <35 kg/m² produced high rates of co-morbidity remission and was more likely than MBS in BMI ≥35 kg/m² to achieve BMI ≤25 kg/m² [30]. Ikramuddin et al. [31] and Schauer et al. [32] demonstrated superior diabetes improvement and weight loss following MBS in randomized controlled trials that include the subset of patients with BMI <35 kg/m². A 3-arm randomized controlled trial that had 43% of its subjects with class I obesity, demonstrated that MBS is superior to lifestyle intervention for remission of T2D, 3 years after surgery [33].

Furthermore, randomized trials designed specifically to study the population with BMI <35 kg/m² also demonstrate significant benefits of MBS in individuals with class I obesity compared with other treatment. O'Brien et al. [34], in a randomized controlled trial of 80 patients with BMI 30–35 kg/m² assigned to nonsurgical treatment or MBS, demonstrated that patients undergoing MBS had superior long-term weight reduction and improvement of metabolic disease. A short-term follow-up randomized trial examining patients with T2D demonstrated significantly improved remission of diabetes and weight loss in those individuals undergoing MBS compared with medical weight management [35]. In a study of 51 patients with class I

obesity diabetes randomized to either medical therapy or medical therapy plus MBS, the cohort who underwent surgery has superior diabetes control up to 2 years postoperatively [36].

Medical weight loss is considered to have greater durability in individuals with BMI <35 kg/m² than individuals with BMI ≥35 kg/m², and thus it is recommended that a trial of nonsurgical therapy is attempted before considering surgical treatment. However, if attempts at treating obesity and obesity-related co-morbidities such as T2D, hypertension, dyslipidemia, obstructive sleep apnea, cardiovascular disease (e.g., coronary artery disease, heart failure, atrial fibrillation), asthma, fatty liver disease and nonalcoholic steatohepatitis, chronic kidney disease, polycystic ovarian syndrome, infertility, gastroesophageal reflux disease, pseudotumor cerebri, and bone and joint diseases have not been effective, MBS should be considered for suitable individuals with class I obesity [27,28,37,38].

BMI ≥35 kg/m². Given the presence of high-quality scientific data on safety, efficacy, and cost-effectiveness of MBS in improving survival and quality of life in patients with BMI ≥35 kg/m², MBS should be strongly recommended in these patients regardless of presence or absence of evident obesity-related co-morbidities. Current nonsurgical treatment options for patients with BMI ≥35 kg/m² are ineffective in achieving a substantial and sustained weight reduction necessary to significantly improve their general health. Physical problems related to excess body weight, undiagnosed obesity-related co-morbidities, risk of developing obesity-related co-morbidities in the future, and impaired quality of life related to physical and mental consequences of obesity threaten the general health of individuals with moderate to severe obesity even in the absence of diagnosed obesity-related co-morbidities [27,28]. Thus, MBS is recommended in this population.

BMI thresholds in the Asian population

The World Health Organization defines the terms *overweight* and *obesity* based on BMI thresholds [39]. In its consensus panel statement of 1991, the NIH stated that the “risk for morbidity linked with obesity is proportional to the degree of overweight.” However, BMI does not account for an individual's sex, age, ethnicity, or fat distribution, and is recognized as only an approximation of adiposity. The health risk in a patient with BMI 30 kg/m² with visceral and ectopic fat accumulation and subsequent metabolic and cardiovascular disease would be significantly higher than a patient with BMI 40 kg/m² whose adipose tissue is mainly accumulated in the lower extremity. In the Asian population the prevalence of diabetes and cardiovascular disease is higher at a lower BMI than in the non-Asian population. Thus, BMI risk zones should be adjusted to define obesity at a BMI threshold of 25–27.5 kg/m² in this

population. Therefore, in certain populations access to MBS should not be denied solely based on traditional BMI thresholds [28,37,40–44].

Extremes of age

Older population

Coincident with the demonstrated safety of MBS, surgery has been performed successfully in increasingly older patients over the past few decades, including individuals >70 years of age [45,46]. In septuagenarians MBS is associated with slightly higher rates of postoperative complications compared with a younger population, but still provides substantial benefits of weight loss and remission of comorbid disease [46]. In fact, the presence of obesity comorbid disease and the choice of operation are more predictive of 30-day adverse outcomes than age alone [47]. Similar to other operations, the question of whether there should be an upper chronologic age limit is complex. The physiologic changes that occur with aging may have an impact on the efficacy of MBS, the incidence of postoperative complications, and the ability of older patients to recover from surgery. However, it appears that factors other than age, such as frailty, cognitive capacity, smoking status, and end-organ function have an important role [48].

Frailty, rather than age alone, is independently associated with higher rates of postoperative complications following MBS [49]. Furthermore, when considering MBS in older patients, the risk of surgery should be evaluated against the morbidity risk of obesity-related diseases. Thus, there is no evidence to support an age limit on patients seeking MBS, but careful selection that includes assessment of frailty is recommended.

Pediatrics and adolescents

Children and adolescents with obesity carry the burden of the disease and its co-morbidities into adulthood, increasing the individual risk for premature mortality and complications from obesity co-morbidities [50].

MBS is safe in the population younger than 18 years and produces durable weight loss and improvement in comorbid conditions. Adolescents with severe obesity undergoing RYGB have significantly greater weight loss and improvement of cardiovascular co-morbidities compared with adolescents undergoing medical management [51]. Furthermore, improvement in hypertension and dyslipidemia has been demonstrated up to 8 years after surgery [52]. Additional studies from the prospective Teen-Longitudinal Assessment of Bariatric Surgery database (Teen-LABS) demonstrated significant weight loss and durable improvement in cardiovascular risk factors and T2D in adolescents undergoing MBS. Furthermore, data suggest that the benefits of RYGB on T2D and hypertension are greater in adolescents than adults [52–55]. Prospective

data shows durable weight loss and maintained comorbidity remission in patients as young as 5 years old [56].

The American Academy of Pediatrics and the ASMBS recommend consideration of MBS in children/adolescents with BMI >120% of the 95th percentile (class II obesity) and major co-morbidity, or a BMI >140% of the 95th percentile (class III obesity) [57,58]. In addition, MBS does not negatively impact pubertal development or linear growth, and therefore a specific Tanner stage and bone age should not be considered a requirement for surgery [56]. Increasingly, syndromic obesity, developmental delay, autism spectrum, or history of trauma is not considered a contraindication to MBS in adolescents [59].

Bridge to other treatment

Joint arthroplasty

Poorer outcomes after total joint arthroplasty have been associated with obesity, such that some orthopedic surgical societies discourage hip and knee replacement in individuals with BMI >40 kg/m² [60–62]. In addition to the technical challenge of performing orthopedic surgery in individuals with severe obesity, patients with obesity undergoing joint arthroplasty are at increased risk of hospital readmission and surgical complications, such as wound infection and deep vein thrombosis [63–67].

There are reports to suggest that MBS may be effective as a bridge to total joint arthroplasty in individuals with class II/III obesity when performed ≥2 years prior to joint surgery [68,69]. A study of veterans with osteoarthritis demonstrated that an average of 35 months elapsed between MBS and joint arthroplasty or lumbar spine surgery in patients with known osteoarthritis [70]. MBS prior to total knee and hip arthroplasty has been shown to decrease operative time, hospital length-of-stay, and early postoperative complications [66,71,72]. Long-term joint-related complications rates were not significantly different.

In a randomized clinical trial on 82 patients with obesity and osteoarthritis, 41 were randomized to AGB 12-months prior to total knee arthroplasty (TKA) and 41 were randomized to receive usual nonoperative weight management prior to TKA. In a median follow-up of 2 years after TKA, 14.6% of patients in the MBS group incurred the primary outcome of composite complications, compared with 36.6% in the control (non-MBS) group (difference 22.0%, $P = .02$). Interestingly, TKA was declined by 29.3% of subjects in the MBS group because of symptom improvement following weight loss, compared with only 4.9% in the control group [73].

Abdominal wall hernia repair

Obesity is a risk factor for the development of ventral hernia. It increases the risk for impaired wound healing, local and systemic infections, and other complications following

hernia repair, and increases the risk for recurrence [74–76]. In addition to a larger volume of subcutaneous soft tissue, abdominal wall hernias in the population with obesity tend to be larger, adding to the complexity of repair in these patients. While the timing of MBS relative to hernia repair remains controversial, evidence suggests that patients with large, chronic abdominal wall hernia may benefit from significant weight loss initially as staged procedure to definitive hernia repair [75,77]. Thus, in patients with severe obesity and an abdominal wall hernia requiring elective repair, MBS should be considered first to induce significant weight loss, and consequently reduce the rate of complications associated with hernia repair and increase durability of the repair.

Organ transplantation

Class III obesity is associated with end-stage organ disease and may limit the access to transplantation of the patient with obesity, since it is a relative contraindication for solid organ transplantation and poses specific technical challenges during surgery. Conversely, MBS may be overlooked as an option in patients with severe end-stage organ disease. Nonetheless, MBS has been described in patients with end-stage organ disease as a way to improve their candidacy for transplantation. Patients with end-stage organ disease can achieve meaningful weight loss and improve their eligibility to receive an organ transplant [78]. Studies suggest that more than 50% of patients with end-stage renal disease (ESRD) and morbid obesity are able to be listed for kidney transplant within 5 years after MBS [79]. Similarly, MBS is shown to be safe and effective as a bridge to liver transplantation in selected patients who would otherwise be ineligible [80,81]. Heart transplant candidacy can also be improved by MBS, and reports in some patients demonstrate significant improvement in left ventricular ejection fraction after surgery to remove the requirement for transplantation [82,83]. MBS has been shown to be safe and effective in patients with heart failure and a left ventricular assist device (LVAD). McElderry et al. [84] demonstrated in a study of 2798 patients who underwent LVAD implantation that a history of prior MBS was associated with a 3-fold higher probability of heart transplantation in follow-up, compared with patients who did not have MBS. In addition, limited data suggest that patients with obesity and end-stage lung disease may lose sufficient weight after MBS to achieve listing for transplantation [85].

MBS in the high-risk patient

BMI >60 kg/m²

There is no consensus concerning the best procedure for individuals with especially high BMI, but the efficacy and safety of MBS have been demonstrated in this population

[86,87]. In general, mortality risk increases with increasing BMI, and BMI >50 kg/m² has been implicated in increasing surgical risk in older studies [88–90]. Individuals with BMI >60 kg/m² are considered to be at especially high risk for surgery since these patients have greater obesity-associated disease burden and more challenging surgical anatomy, resulting in longer operative times, higher rates of perioperative morbidity, and longer hospital lengths of stay in some studies [91,92]. Others, however, failed to demonstrate a significant difference in perioperative complications, length of stay, 30-day mortality, or long-term outcomes after MBS when individuals with BMI >60 kg/m² were compared with those with BMI <60 kg/m². Furthermore, studies have shown that MBS can be performed safely in patients with BMI >70 kg/m² [93]. Therefore, MBS should be considered as a preferred method to achieve clinically significant weight loss in patients with extreme BMI.

Cirrhosis

Obesity is a significant risk factor for nonalcoholic fatty liver disease (NAFLD), nonalcoholic steatohepatitis (NASH), and consequent cirrhosis. At the same time, obesity conveys a 3-fold increase in the risk of liver decompensation in patients with known cirrhosis [94]. In addition to inducing significant and durable weight loss, MBS has been associated with histologic improvement of NASH and regression of fibrosis in early cases, leading to a reduced risk of hepatocellular carcinoma [94,95]. Furthermore, MBS is associated with an 88% risk reduction of progression of NASH to cirrhosis [18].

The patient with obesity and compensated cirrhosis is at higher risk for perioperative mortality following MBS, but the risk remains small (<1%) and the benefits significant [94,96,97]. There is a paucity of data on surgical outcomes in patients with clinically significant portal hypertension [98]. Careful patient selection and consideration of choice of surgical procedure are important to ensure best outcomes.

Heart failure

There are increasing data to suggest that MBS can be a useful adjunct to treatment in patients with obesity and heart failure before heart transplantation or placement of a left ventricular assist device (LVAD), and performed with low morbidity and mortality [82,84,99]. The consequent improvement in obesity and associated co-morbidities improves overall health and can reduce the future risk associated with cardiac therapies. Furthermore, limited studies have shown that MBS in individuals with heart failure was associated with a significant improvement of left ventricular ejection fraction (LVEF), improvement of functional capacity, and higher chances for receiving heart transplantation [84,100–102].

Patient evaluation

The 1991 NIH Consensus Statement recommends that patients who are candidates for MBS should be evaluated by a “multidisciplinary team with access to medical, surgical, psychiatric, and nutritional expertise” [1]. The value of assessments by such a team has since been reiterated [103–105], reflecting the recognition of the complexity of the disease of obesity, and the ability to provide a comprehensive risk/benefit analysis when considering MBS. This may also facilitate the patient’s ability to comprehend the life-long changes that can be expected after surgery, benefitting from the expertise of different health-care providers [106]. Studies have suggested that the addition of a multidisciplinary team to the perioperative care of the patient may decrease rates of complications [107,108].

While there has been initial enthusiasm for weight loss prior to surgery, there are no data to support the practice of insurance-mandated preoperative weight loss; this practice is understood to be discriminatory, arbitrary, and scientifically unfounded, contributing to patient attrition, unnecessary delay of lifesaving treatment, and progression of life-threatening co-morbid conditions [109]. A multidisciplinary team can help assess and manage the patient’s modifiable risk factors with a goal of reducing risk of perioperative complications and improving outcomes; the decision for surgical readiness should be primarily determined by the surgeon.

The nutritional status of patients seeking MBS is important [104,110]. A nutritional assessment by a registered dietitian with expertise in MBS can help obtain a comprehensive weight history, identify maladaptive eating behaviors or patterns, and correct any micronutrient deficiencies prior to surgery. A registered dietitian can also provide preoperative nutrition education and prepare the patient for expected dietary changes after MBS [103,104]. In addition, a registered dietitian with expertise in MBS can assist in the management of postoperative patients who may be experiencing food intolerances, malabsorption issues and micronutrient deficiencies, and weight regain.

Mental health conditions such as depression and binge eating disorders, as well as substance abuse, are found at higher rates among candidates for MBS than in the general population. The pre-surgical evaluation process is designed to optimize surgical outcomes and implement interventions that can address disordered eating, severe uncontrolled mental illness, or active substance abuse. Licensed mental health providers with specialty knowledge and experience in MBS behavioral health are important to assess patients for psychopathology, and determine the candidate’s ability to cope with the adversity of surgery, changing body image, and life-style changes required after MBS. In addition, stressors that may affect long-term outcomes such as

financial, housing and food insecurity should be identified [104,111].

Outcomes

Weight loss and co-morbidity improvement

The ASMBS established standard guidelines for reporting on outcomes of MBS, including weight loss, comorbidity remission, surgical complications, and quality of life [112]. Mid- and long-term outcomes of MBS, confirming the safety, efficacy and durability of surgery are extensively studied and reported in the literature [24,113].

Overall weight loss outcomes for MBS that are durable for years after surgery are consistently reported at greater than 60% percent excess weight loss (%EWL), with some variation depending on the specific operation performed [14,114,115]. MBS is proven superior to diet, exercise, and other lifestyle interventions in attaining significant and durable weight loss, and improving obesity-related comorbid conditions in multiple observational and prospective studies [9,32,116]. Durability of weight loss at 5, 10, and 20 years after surgery has been consistently demonstrated in multiple studies [10,11,14,32,117].

Obesity is associated with diseases affecting nearly every organ system. They include the cardiovascular system (hypertension, dyslipidemia, coronary artery disease, heart failure, stroke), respiratory system (obstructive sleep apnea, asthma), digestive system (gastroesophageal reflux disease, gallbladder disease, pancreatitis), endocrine system (insulin resistance, T2D), reproductive system (polycystic ovary syndrome, infertility), liver (NAFLD, NASH), kidneys (nephrolithiasis, chronic kidney disease), musculoskeletal system (osteoarthritis) and mental health [118]. Nearly all of these conditions have demonstrated improvement, and in some cases remission, after weight loss associated with MBS. There is substantial evidence demonstrating the significant and durable clinical improvement of metabolic syndrome following surgery. In a large cohort study of >180,000 Medicare beneficiaries, patients who underwent MBS had significantly lower risk of new-onset heart failure, myocardial infarction, and stroke, compared with matched controls at 4 years after surgery [119]. The long-term reduction in cardiovascular risk after MBS has been shown by others, especially in individuals with concurrent T2D [19,120].

Greater weight loss and improvement in T2D, hypertension, and dyslipidemia has been demonstrated beyond 10 years after MBS, compared with nonsurgical controls [10,121]. Sustained weight loss of at least 15% is recognized as having a significant effect on inducing marked improvement of metabolic derangement in most patients, with individuals undergoing MBS demonstrating a consistent and durable benefit [122]. In the randomized controlled

STAMPEDE trial, medical therapy with RYGB or sleeve gastrectomy were shown to be superior to medical therapy alone in the long-term treatment of T2D [32]. Similarly, Mingrone et al. [123] demonstrated in a randomized controlled trial the superiority of MBS to medical therapy in the management of type 2 diabetes 5 years after surgery. Others have shown that microvascular complications of diabetes are decreased after MBS with up to 20 years follow up [116], and that the risk for, and markers of diabetic nephropathy improve after MBS in retrospective and randomized prospective studies [124–127].

Cancer risk

Obesity is associated with an elevated risk of multiple cancers, including esophagus, breast, colorectal, endometrial, gallbladder, stomach, kidney, ovary, pancreas, liver, thyroid, multiple myeloma, and meningioma [128–133]. There is evidence to suggest that MBS can lead to a significant reduction in incidence of obesity-associated cancer and cancer-related mortality, compared with obese individuals who did not undergo surgery. Multiple studies have shown that MBS reduces the risk of developing cancer in the population with class II/III obesity, ranging from 11% to 50% for all cancer types [130,134–137]. Benefits were also documented for the incidence of specific cancers, such as gastrointestinal and hepatobiliary cancers, genitourinary cancers, and gynecological cancers.

Furthermore, MBS may significantly reduce overall cancer mortality compared with nonsurgical obese controls [134,137]. There is some evidence to suggest that the risk-reduction attenuates as time from surgery increases, although it is unclear to what extent type of operation, type of cancer, health behaviors, and presence of comorbidities confound these findings [138]. Nonetheless, a recent retrospective cohort study of >30,000 patients with a median follow-up of 6 years found that adults with obesity who underwent MBS had a 32% lower risk of developing cancer and 48% lower risk of cancer-related death compared with a matched cohort who did not have surgery [137].

Mortality

Large prospective and retrospective studies have consistently reported the lower mortality and improved survival benefit of MBS. Representative studies include the Swedish Obese Subjects study demonstrated an adjusted decreased overall mortality by 30.7% in the group of 2010 surgical patients compared with nonsurgical controls, at an average of 10 years after surgery [17]. Similar results were demonstrated in a large retrospective study comparing 9949 individuals who had undergone RYGB compared with nonsurgical controls [139]. With a mean follow-up of 7 years, adjusted overall mortality decreased by 40% in the MBS group. In a retrospective cohort study of 2500 mostly male patients, all-cause mortality was significantly lower at

5–10 years after MBS compared to controls [16]. In a large meta-analysis with an overall >170,000 subjects, median life-expectancy was increased by 6.1 years after MBS compared with usual care [140]. In this study, the median life-expectancy is increased further in the population with diabetes. A study of Medicare beneficiaries comparing >94,000 individuals who had MBS to matched controls demonstrated a significantly lower risk of mortality [119]. Thus, the durable benefits of MBS for individuals with class II/III obesity are reflected in an overall lower mortality years after surgery in multiple populations.

Revisional surgery

With the rise in the number of metabolic and bariatric operations performed worldwide, and with the recognition of obesity as a chronic, relapsing, multifactorial disease, comes a rise in the need for revisional surgery. Indications for revisional MBS vary among individual patients, but may include weight regain, insufficient weight loss, insufficient improvement of co-morbidities, and managing complications (e.g., gastroesophageal reflux) [141–144].

Surgical revision can take the form of converting from one kind of MBS operation to another, enhancing the effect of a specific operation (e.g., distalization after RYGB), treating possible complications of the index operation, or restoring normal anatomy if possible [144,145]. Furthermore, with the understanding of severe obesity to be a chronic disease there has been a growing recognition of the requirement for long-term management of excess weight and obesity co-morbidities. This often takes the form of multimodal therapy that could include additional or “revisional” surgery, to achieve optimal outcomes. Thus, revisional surgery may also serve as escalation therapy for those individuals who are deemed poor responders to the initial operation.

The complexity of revisional surgery is higher than primary MBS, and is associated with increased hospital length of stay, and higher rates of complications [146]. Nonetheless, revisional MBS is effective in achieving additional weight loss and co-morbidity reduction after the primary operation in selected patients, with acceptable complication rates, and low mortality rates [145,147,148].

Conclusion

- Since the NIH published its statement on gastrointestinal surgery for severe obesity in 1991, the understanding of obesity and MBS has significantly grown based on a large body of clinical experience and research.
- Long-term data consistently demonstrate the safety, efficacy, and durability of MBS in the treatment of clinically severe obesity and its co-morbidities, with a resultant decreased mortality compared with nonoperative treatment methods.

- MBS is recommended for individuals with BMI ≥ 35 kg/m², regardless of presence, absence, or severity of co-morbidities.
- MBS is recommended in patients with T2D and BMI ≥ 30 kg/m².
- MBS should be considered in individuals with BMI of 30–34.9 kg/m² who do not achieve substantial or durable weight loss or co-morbidity improvement using nonsurgical methods.
- Obesity definitions using BMI thresholds do not apply similarly to all populations. Clinical obesity in the Asian population is recognized in individuals with BMI > 25 kg/m². Access to MBS should not be denied solely based on traditional BMI risk zones.
- There is no upper patient-age limit to MBS. Older individuals who could benefit from MBS should be considered for surgery after careful assessment of co-morbidities and frailty.
- Carefully selected individuals considered higher risk for general surgery may benefit from MBS.
- Children and adolescents with BMI $> 120\%$ of the 95th percentile and a major co-morbidity, or a BMI $> 140\%$ of the 95th percentile, should be considered for MBS after evaluation by a multidisciplinary team in a specialty center.
- MBS is an effective treatment of clinically severe obesity in patients who need other specialty surgery, such as joint arthroplasty, abdominal wall hernia repair, or organ transplantation.
- Consultation with a multidisciplinary team can help manage the patient's modifiable risk factors with a goal of reducing risk of perioperative complications and improving outcomes. The ultimate decision for surgical readiness should be determined by the surgeon.
- Severe obesity is a chronic disease requiring long-term management after primary MBS. This may include revisional surgery or other adjuvant therapy to achieve desired treatment effect.

References

- [1] Gastrointestinal surgery for severe obesity. Consensus Statement 1991;9(1):1–20.
- [2] Ogden CL, Carroll MD, Kit BK, Flegal KL. Prevalence of childhood and adult obesity in the United States 2011–12. *JAMA* 2014;311(8):806–14.
- [3] World Health Organization (WHO). [monograph on the Internet]. Geneva: World Health Organization; 2002. [cited 2022 Jul 1]. Available from: <https://www.who.int/publications/i/item/9241562072>.
- [4] Gossman H, Butsch WS, Jastreboff AM. Treating the chronic disease of obesity. *Med Clin N Am* 2021;105(6):983–1016.
- [5] Kawai T, Autieri MV, Scalia R. Adipose tissue inflammation and metabolic dysfunction in obesity. *Am J Physiol Cell Physiol* 2021;320(3):C375–91.
- [6] Hotamisligil GS. Inflammation and metabolic disorders. *Nature* 2006;444(7121):860–7.
- [7] Grosfeld A, Andre J, Hauguel-De Mouzon S, Berra E, Pousseguer J, Guerre-Millo M. Hypoxia-inducible factor 1 transactivates the human leptin gene promoter. *J Biol Chem* 2002;277(45):42953–7.
- [8] Chang SS, Eisenberg D, Zhao L, et al. Chemerin activation in human obesity. *Obesity (Silver Spring)* 2016;24(7):1522–9.
- [9] Gloy VL, Briel M, Bhatt DL, et al. Bariatric surgery versus non-surgical treatment of obesity: a systematic review and meta-analysis of randomised controlled trials. *BMJ* 2013;347:f5934.
- [10] Adams TD, Davidson LE, Litwin SE, et al. Weight and metabolic outcomes 12 years after gastric bypass. *N Engl J Med* 2017;377(12):1143–55.
- [11] Sjostrom L, Lindroos AK, Peltonen M, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. *N Engl J Med* 2004;351(26):2683–93.
- [12] Sjostrom L, Peltonen M, Jacobson P, et al. Bariatric surgery and long-term cardiovascular events. *JAMA* 2012;307(1):56–65.
- [13] Puzziferri N, Roshek III TB, Mayo HG, et al. Long-term follow-up after bariatric surgery: a systematic review. *JAMA* 2014;312(9):935–42.
- [14] Maciejewski ML, Arterburn DE, Van Scoyoc L, et al. Bariatric surgery and long-term durability of weight loss. *JAMA Surg* 2016;151(11):1046–55.
- [15] Schauer PR, Mingrone G, Ikramuddin S, Wolfe B. Clinical outcomes of metabolic surgery: efficacy of glycemic control, weight loss, and remission of diabetes. *Diabetes Care* 2016;39(6):902–11.
- [16] Arterburn DE, Olsen MK, Smith VA, et al. Association between bariatric surgery and long-term survival. *JAMA* 2015;313(1):62–70.
- [17] Sjostrom L, Narbro K, Sjostrom CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. *N Engl J Med* 2007;357(8):741–52.
- [18] Aminian A, Al-Kurd A, Wilson R, et al. Association of bariatric surgery with major adverse liver and cardiovascular outcomes in patients with biopsy-proven nonalcoholic steatohepatitis. *JAMA* 2021;26(20):2031–42.
- [19] Aminian A, Zajichek A, Arterburn DE, et al. Association of metabolic surgery with major adverse cardiovascular outcomes in patients with type 2 diabetes and obesity. *JAMA* 2019;322(13):1271–82.
- [20] Goldberg I, Yang J, Nie L, et al. Safety of bariatric surgery in patients older than 65 years. *Surg Obes Relat Dis* 2019;15(8):1380–7.
- [21] Phillips BT, Shikora SA. The history of metabolic and bariatric surgery: development of standards for patient safety and efficacy. *Metabolism* 2018;79:97–107.
- [22] The Longitudinal Assessment of Bariatric Surgery (LABS) Consortium. Perioperative safety in the longitudinal assessment of bariatric surgery. *N Engl J Med* 2009;361:445–54.
- [23] Buchwald H, Estok R, Fahrbach K, Banel D, Sledge I. Trends in mortality in bariatric surgery: a systematic review and meta-analysis. *Surgery* 2007;142(4):621–32.
- [24] Arterburn DE, Telem DA, Kushner RF, et al. Benefits and risks of bariatric surgery in adults: a review. *JAMA* 2020;324(9):879–87.
- [25] American Society for Metabolic and Bariatric Surgery (ASMBS) [Internet]. Newberry, FL: The Society [updated 2022 Jun; cited 2022 Jul 1]. Estimate of Bariatric Surgery Numbers, 2011–2020; [about 2 screens]. Available from: <https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers>.
- [26] International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO). 5th IFSO Global Registry Report [monograph on the Internet]. Naples, Italy: IFSO; 2019 [cited 2022 Jul 1]. Available from: <https://www.ifso.com/pdf/5th-ifso-global-registry-report-september-2019.pdf>.
- [27] Rubino F, Nathan DM, Eckel RH, et al. Metabolic surgery in the treatment algorithm for type 2 diabetes: a joint statement by international diabetes organizations. *Surg Obes Relat Dis* 2016;12(1):1144–62.

- [28] Aminian A, Chang J, Brethauer SA, et al. ASMBS updated position statement on bariatric surgery in class I obesity (BMI 30-35 kg/m²). *Surg Obes Relat Dis* 2018;14(8):1071–87.
- [29] Noun R, Slim R, Nasr M, et al. Results of laparoscopic sleeve gastrectomy in 541 consecutive patients with low baseline body mass index (30-35 kg/m²). *Obes Surg* 2016;26(12):2824–8.
- [30] Varban OA, Bonham AJ, Finks JF, Telem DA, Obeid NR, Ghaferi AA. Is it worth it? Determining the health benefits of sleeve gastrectomy in patients with a body mass index <35 kg/m². *Surg Obes Relat Dis* 2020;16(2):248–53.
- [31] Ikramuddin S, Komer J, Lee WJ, et al. Durability of addition of Roux-en-Y gastric bypass to lifestyle intervention and medical management in achieving primary treatment goals for uncontrolled type 2 diabetes in mild to moderate obesity: a randomized control trial. *Diabetes Care* 2016;39(9):1510–8.
- [32] Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes – 5-year outcomes. *N Engl J Med* 2017;376(7):641–51.
- [33] Courcoulas AP, Belle SH, Neiberg RH, et al. Three-year outcomes of bariatric surgery vs lifestyle intervention for type 2 diabetes mellitus treatment: a randomized clinical trial. *JAMA Surg* 2015;150(10):931–40.
- [34] O'Brien PE, Brennan L, Laurie C, Brown W. Intensive medical weight loss or laparoscopic adjustable gastric banding in the treatment of mild to moderate obesity: long-term follow-up of a prospective randomised trial. *Obes Surg* 2013;23(9):1345–53.
- [35] Parikh M, Chung M, Sheth S, et al. Randomized pilot trial of bariatric surgery versus intensive medical weight management on diabetes remission in type 2 diabetes patients who do NOT meet NIH criteria for surgery and the role of soluble RAGE as a novel biomarker of success. *Ann Surg* 2014;260(4):617–22.
- [36] Wentworth JM, Playfair J, Laurie C, et al. Multidisciplinary diabetes care with and without bariatric surgery in overweight people: a randomised controlled trial. *Lancet Diabetes Endocrinol* 2014;2(7):545–52.
- [37] Busetto L, Dixon J, De Luca M, Shikora S, Pories W, Angrisani L. Bariatric surgery in class I obesity: a position statement from the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO). *Obes Surg* 2014;24(4):487–519.
- [38] Rubino F, Cohen RV, Mingrone G, et al. Bariatric and metabolic surgery during and after the COVID-19 pandemic: DSS recommendations for management of surgical candidates and postoperative patients and prioritisation of access to surgery. *Lancet Diabetes Endocrinol* 2020;8(7):640–8.
- [39] World Health Organization (WHO) [Internet]. Geneva, Switzerland: The Organization; 2022 [cited 2022 Apr 27]. Obesity and overweight [about 6 screens]. Available from: www.who.int/westernpacific/health-topics/obesity.
- [40] Misra A. Ethnic-specific criteria for classification of body mass index: a perspective for Asian Indians and American Diabetes Association position statement. *Diabetes Technol Ther* 2015;17(9):667–71.
- [41] Hsu WC, Araneta MRG, Kanaya AM, Chiand JL, Fujimoto W. BMI cut points to identify at-risk Asian Americans for type 2 diabetes screening. *Diabetes Care* 2015;38(1):150–8.
- [42] Gill RS, Karmali S, Sharma AM. The potential role of the Edmonton obesity staging system in determining indications for bariatric surgery. *Obes Surg* 2011;21(12):1947–9.
- [43] Padwal RS, Pajewski NM, Allison DB, et al. Using the Edmonton obesity staging system to predict mortality in a population-representative cohort of people with overweight and obesity. *CMAJ* 2011;183(14):E1059–66.
- [44] Frattini F, Lavazza M, Rausei S, et al. BMI: the weakness of a milestone in obesity management and treatment. *Obes Surg* 2015;25(10):1940–1.
- [45] Al-Kurd A, Grinbaum R, Mordechay-Heyn T, et al. Outcomes of sleeve gastrectomy in septuagenarians. *Obes Surg* 2018;28(12):3895–901.
- [46] Smith ME, Bacal D, Bonham AJ, et al. Perioperative and 1-year outcomes of bariatric surgery in septuagenarians: implications for patient selection. *Surg Obes Relat Dis* 2019;15(10):1805–11.
- [47] Edwards MA, Mazzei M, Agarwal S, Rhodes L, Bruff A. Exploring perioperative outcomes in metabolic and bariatric surgery amongst the elderly: an analysis of the 2015–2017 MBSAQIP database. *Surg Obes Relat Dis* 2021;17(6):1096–106.
- [48] Watt J, Tricco AC, Talbot-Hamon C, et al. Identifying older adults at risk of harm following elective surgery: a systematic review and meta-analysis. *BMC Med* 2018;16(1):2.
- [49] Gondal AB, Hsu CH, Zeeshan M, Hamidi M, Joseph B, Ghaderi I. A frailty index and the impact of frailty on postoperative outcomes in older patients after bariatric surgery. *Surg Obes Relat Dis* 2019;15(9):1582–8.
- [50] Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes (Lond)* 2011;35(7):891–8.
- [51] Olbers T, Beamish AJ, Gronowitz E, et al. Laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity (AMOS): a prospective, 5-year, Swedish nationwide study. *Lancet Diabetes Endocrinol* 2017;5(3):174–83.
- [52] Inge TH, Jenkins TM, Xanthakos SA, et al. Long-term outcomes of bariatric surgery in adolescents with severe obesity (FABS-5+): a prospective follow-up analysis. *Lancet Diabetes Endocrinol* 2017;5(3):165–73.
- [53] Michalsky MP, Inge TH, Jenkins TM, et al., Teen-LABS consortium. Cardiovascular risk factors after adolescent bariatric surgery. *Pediatrics* 2018;141(2):e20172485.
- [54] Inge TH, Laffel LM, Jenkins TM, et al. Comparison of surgical and medical therapy for type 2 diabetes in severely obese adolescents. *JAMA Pediatr* 2018;172(5):452–60.
- [55] Inge TH, Courcoulas AP, Helmrath MA. Five-year outcomes of gastric bypass in adolescents as compared with adults. *N Engl J Med* 2019;380(22):2136–45.
- [56] Alqahtani AR, Elahmedi M, Abdurabu HY, Alqahtani S. Ten-year outcomes of children and adolescents who underwent sleeve gastrectomy: weight loss, comorbidity resolution, adverse events, and growth velocity. *J Am Coll Surg* 2021;233(6):657–64.
- [57] Pratt JSA, Browne A, Browne NT, et al. ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. *Surg Obes Relat Dis* 2018;14(7):882–901.
- [58] Armstrong SC, Bolling CF, Michalsky MP, et al. Pediatric metabolic and bariatric surgery: evidence, barriers, and best practices. *Pediatrics* 2019;144(6):e20193223.
- [59] Jones RE, Wood LSY, Matheson BE, et al. Pilot evaluation of a multidisciplinary strategy for laparoscopic sleeve gastrectomy in adolescents and young adults with obesity and intellectual disabilities. *Obes Surg* 2021;31(8):3883–7.
- [60] Khatod M, Cafri G, Namba RS, Inacio MCS, Paxton EW. Risk factors for total hip arthroplasty aseptic revision. *J Arthroplasty* 2014;29(7):1412–7.
- [61] Namba RS, Inacio MCS, Paxton EW. Risk factors associated with surgical site infection in 30,491 primary total hip replacements. *J Bone Joint Surg Br* 2012;94(10):1330–8.
- [62] Workgroup of the American Association of Hip and Knee Surgeons Evidence-Based Committee. Obesity and total joint arthroplasty: a literature-based review. *J Arthroplasty* 2013;28(5):714–21.
- [63] Arsoy D, Woodcock JA, Lewallen DG, Trousdale RT. Outcomes and complications following total hip arthroplasty in the super-obese patient, BMI>50. *J Arthroplasty* 2014;29(10):1899–905.

- [64] Issa K, Harwin SF, Malkani AL, Bonutti PM, Scillia A, Mont MA. Bariatric orthopaedics: total hip arthroplasty in super-obese patients (those with a BMI of >50 kg/m²). *Bone Joint Surg Am* 2016;98(3):180–5.
- [65] Rajagopal R, Martin R, Howard JL, et al. Outcomes and complications of total hip replacement in super-obese patients. *Bone Joint J* 2013;95-B(6):758–63.
- [66] McLawhorn AS, Levack AE, Lee YY, Ge Y, Do H, Dodwell ER. Bariatric surgery improves outcomes after lower extremity arthroplasty in the morbidly obese: a propensity score-matched analysis of a New York statewide database. *J Arthroplasty* 2018;33(7):2062–9.
- [67] Davis AM, Wood AM, Keenan ACM, Brenkel II, Ballantyne JA. Does body mass index affect clinical outcome post-operatively and at five years after primary unilateral total hip replacement performed for osteoarthritis? A multivariate analysis of prospective data. *J Bone Joint Surg Br* 2011;93(9):1178–82.
- [68] Inacio MC, Paxton EW, Fisher D, et al. Bariatric surgery prior to total joint arthroplasty may not provide dramatic improvements in post-arthroplasty surgical outcomes. *J Arthroplasty* 2014;29(7):1359–64.
- [69] Severson EP, Singh JA, Browne JA, et al. Total knee arthroplasty in morbidly obese patients treated with bariatric surgery: a comparative study. *J Arthroplasty* 2012;27(9):1696–700.
- [70] Kubat E, Giori NJ, Hwa K, Eisenberg D. Osteoarthritis in veterans undergoing bariatric surgery is associated with decreased excess weight loss: 5-year outcomes. *Surg Obes Relat Dis* 2016;12(7):1426–30.
- [71] Werner BC, Kurkis GM, Gwathmey FW, Browne JA. Bariatric surgery prior to total knee arthroplasty is associated with fewer postoperative complications. *J Arthroplasty* 2015;30(9):81–5.
- [72] Li S, Luo X, Sun H, et al. Does prior bariatric surgery improve outcomes following total joint arthroplasty in the morbidly obese? A meta-analysis. *J Arthroplasty* 2019;34(3):577–85.
- [73] Dowsey MM, Brown WA, Cochrane A, et al. Effect of bariatric surgery on risk of complications after total knee arthroplasty: A randomized clinical trial. *JAMA Netw Open* 2022;5(4):e226722.
- [74] Geletzke AK, Rinaldi JM, Phillips BE, et al. Prevalence of systemic inflammation and micronutrient imbalance in patients with complex abdominal hernias. *J Gastrointest Surg* 2014;18(4):646–55.
- [75] Veilleux E, Lufti R. Obesity and ventral hernia repair: is there success in staging? *J Laparoendosc Adv Surg Tech* 2020;30(8):896–9.
- [76] Novitsky YW, Orenstein SB. Effect of patient and hospital characteristics on outcomes of elective ventral hernia repair in the United States. *Hernia* 2013;17(5):639–45.
- [77] Menzo ML, Hinojosa M, Carbonell A, et al. American Society for Metabolic and Bariatric Surgery and American Hernia Society consensus guideline on bariatric surgery and hernia surgery. *Surg Obes Relat Dis* 2018;14(9):1221–32.
- [78] Yemini R, Neshet E, Carmeli I, et al. Bariatric surgery is efficacious and improves access to transplantation for morbidly obese renal transplant candidates. *Obes Surg* 2019;29(8):2373–80.
- [79] Al-Bahri S, Fakhry TK, Gonzalvo JP, Murr MM. Bariatric surgery as a bridge to renal transplantation in patients with end-stage renal disease. *Obes Surg* 2017;27(11):2951–5.
- [80] Lee Y, Tian C, Lovrics O, et al. Bariatric surgery before, during, and after liver transplantation: a systematic review and meta-analysis. *Surg Obes Relat Dis* 2020;16(9):1336–47.
- [81] Yemini R, Neshet E, Braun M, et al. Long-term outcomes of Roux-en-Y gastric bypass or sleeve gastrectomy in patients with cirrhosis: before, during or after liver transplantation: a single center's experience. *Clin Transplant* 2021;35(8):e14374.
- [82] Lee Y, Anvari S, Sam Soon M, et al. Bariatric surgery as a bridge to heart transplantation in morbidly obese patients. A systematic review and meta-analysis. *Cardiol Rev* 2022;30(8):1–7.
- [83] Lim CP, Fisher OM, Falkenback D, et al. Bariatric surgery provides a “bridge to transplant” for morbidly obese patients with advanced heart failure and may obviate the need for transplantation. *Obes Surg* 2016;26(3):486–93.
- [84] McElderry B, Alvarez P, Hanna M, et al. Outcomes of bariatric surgery in patients with left ventricular assist device. *J Heart Lung Transplant* 2022;41(7):914–8.
- [85] Orandi BJ, Purvis JW, Cannon RM, et al. Bariatric surgery to achieve transplant in end-stage organ disease patients: a systematic review and meta-analysis. *Am J Surg* 2020;220(3):566–79.
- [86] Laurenus A, Taha O, Maleckas A, Lönroth H, Olbers T. Laparoscopic biliopancreatic diversion/duodenal switch or laparoscopic Roux-en-Y gastric bypass for super-obesity-weight loss versus side effects. *Surg Obes Relat Dis* 2010;6(4):408–16.
- [87] Prachand VN, DaVee RT, Alverdy JC. Duodenal switch provides superior weight loss in the super-obese (BMI > 50 kg/m²) compared with the gastric bypass. *Ann Surg* 2006;244(4):611–9.
- [88] Whitlock G, Lewington S, Sherliker P, et al. Body mass index and cause-specific mortality in 900,000 adults: collaborative analyses of prospective studies. *Lancet* 2009;373(9669):1083–96.
- [89] Flum DR, Belle SH, King WC, et al. Perioperative safety in the longitudinal assessment of bariatric surgery. *N Engl J Med* 2009;361(5):445–54.
- [90] DeMaria EJ. Bariatric surgery for morbid obesity. *N Engl J Med* 2007;356(21):2176–83.
- [91] Wilkinson KH, Helm M, Lak K, et al. The risk of post-operative complications in super-superobesity compared to superobesity in accredited bariatric surgery centers. *Obes Surg* 2019;29(9):2964–71.
- [92] Stephens DJ, Saunders JK, Belsley S, et al. Short-term outcomes for super-super obese (BMI >60 kg/m²) patients undergoing weight loss surgery at a high-volume bariatric surgery center: laparoscopic adjustable gastric banding, laparoscopic gastric bypass, and open tubular gastric bypass. *Surg Obes Relat Dis* 2008;4(3):408–15.
- [93] Roland JC, Needleman BJ, Muscarella P, et al. Laparoscopic Roux-en-Y gastric bypass in patients with body mass index >70 kg/m². *Surg Obes Relat Dis* 2011;7(5):587–91.
- [94] Patton H, Heimbach J, McCullough A. AGA clinical practice update on bariatric surgery in cirrhosis: expert review. *Clin Gastroenterol Hepatol* 2021;19(3):436–45.
- [95] Lassailly G, Caiazzo R, Ntandja-Wandji LC, et al. Bariatric surgery provides long-term resolution of nonalcoholic steatohepatitis and regression of fibrosis. *Gastroenterology* 2020;159(4):1290–301.
- [96] Ahmed S, Pouwels S, Parmar C, et al. Global bariatric research collaborative. Outcomes of bariatric surgery in patients with liver cirrhosis: a systematic review. *Obes Surg* 2021;31(5):2255–67.
- [97] Mumtaz K, Lipshultz H, Jalil S, et al. Bariatric surgery in patients with cirrhosis: careful patient and surgery-type selection is key to improving outcomes. *Obes Surg* 2020;30(9):3444–52.
- [98] Hanipah ZN, Panchai S, McCullough A, et al. Bariatric surgery in patients with cirrhosis and portal hypertension. *Obes Surg* 2018;28(11):3431–8.
- [99] Hirji SA, Sabatino ME, Minhas AMK, et al. Contemporary nationwide heart transplantation and left ventricular assist device outcomes in patients with histories of bariatric surgery. *J Card Fail* 2022;28(2):330–3.
- [100] Yang TWW, Johari Y, Burton PR, et al. Bariatric surgery in patients with severe heart failure. *Obes Surg* 2020;30(8):2863–9.
- [101] McCloskey CA, Ramani GV, Mathier MA, et al. Bariatric surgery improves cardiac function in morbidly obese patients with severe cardiomyopathy. *Surg Obes Relat Dis* 2007;3(5):503–7.
- [102] Panchai S, Hanipah ZN, Sharm G, et al. Laparoscopic sleeve gastrectomy in heart failure patients with left ventricular assist device. *Obes Surg* 2019;29(4):1122–9.
- [103] Mechanick JL, Apovian C, Brethauer S, et al. Clinical practice guidelines for the perioperative nutrition, metabolic, and nonsurgical support of patients undergoing bariatric surgery-2019 update: co-sponsored by the American Association of Clinical

- Endocrinologists/American College of Endocrinology, The Obesity Society, American Society for Metabolic and Bariatric Surgery, and American Society of Anesthesiologists – executive summary. *Endoc Pract* 2019;25(12):1346–59.
- [104] Carter J, Chang J, Birriel J, et al. ASBMS position statement on preoperative patient optimization before metabolic and bariatric surgery. *Surg Obes Relat Dis* 2021;17(12):1956–76.
- [105] Eisenberg D, Lohnberg JA, Kubat EP, Bates CC, Greenberg LM, Frayne SM. Systems innovation model: an integrated interdisciplinary team approach pre- and post-bariatric surgery at a Veterans Affairs (VA) medical center. *Surg Obes Relat Dis* 2017;13(4):600–6.
- [106] Mechanick JL, Kushner RF, Sugerman HJ, et al. American Association of Clinical Endocrinologists, The Obesity Society, and the American Society for Metabolic and Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. *Obesity (Silver Spring)* 2009;17(Suppl 1):S1–70, v.
- [107] Rebibo L, Marechal V, De Lameth I, et al. Compliance with a multidisciplinary team meeting's decision prior to bariatric surgery protects against major postoperative complications. *Surg Obes Relat Dis* 2017;13(9):1537–43.
- [108] Bullen NL, Parmar J, Gilbert J, et al. How effective is the multidisciplinary team approach in bariatric surgery? *Obes Surg* 2019;29(10):3232–8.
- [109] Kim J, Rogers A, Ballem, et al. ASBMS updated position statement on insurance mandated preoperative weight loss requirements. *Surg Obes Relat Dis* 2016;12(5):955–9.
- [110] Andromalos L, Crowley N, Brown J, et al. Nutritional care in bariatric surgery: an Academy Evidence Analysis Center systematic review. *J Acad Nutr Diet* 2019;119(4):678–86.
- [111] Sogg S, Lauretti J, West-Smith L. Recommendations for the presurgical psychosocial evaluation of bariatric surgery patients. *Surg Obes Relat Dis* 2016;12(4):731–49.
- [112] Brethauer SA, Kim J, El Chaar M, et al. Standardized outcomes reporting in metabolic and bariatric surgery. *Surg Obes Relat Dis* 2015;11(3):489–506.
- [113] Salminen P, Grönroos S, Helmiö M, et al. Effect of laparoscopic sleeve gastrectomy vs Roux-en-Y gastric bypass on weight loss, comorbidities, and reflux at 10 years in adult patients with obesity: The SLEEVEPASS randomized clinical trial. *JAMA Surg* 2022;157(8):656–66.
- [114] Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004;292(14):1724–37.
- [115] Arterburn DE, Wellman R, Emiliano A, et al. Comparative effectiveness and safety of bariatric procedures for weight loss: a PCORnet cohort study. *Ann Intern Med* 2018;169(11):741–50.
- [116] Sjöström L, Peltonen M, Jacobson P, et al. Association of bariatric surgery with long-term remission of type 2 diabetes and with microvascular and macrovascular complications. *JAMA* 2014;311(22):2297–304.
- [117] O'Brien PE, Hindle A, Brennan L, et al. Long-term outcomes after bariatric surgery: a systematic review and meta-analysis of weight loss at 10 or more years for all bariatric procedures and a single-centre review of 20-year outcomes after adjustable gastric banding. *Obes Surg* 2019;29(1):3–14.
- [118] Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health* 2009;9:88.
- [119] Mentias A, Aminian A, Youssef D, et al. Long-term cardiovascular outcomes after bariatric surgery in the Medicare population. *J Am Coll Cardiol* 2022;79(15):1429–37.
- [120] Ke Z, Zhou X, Sun F, Li F, Tong W, Zhu Z. Effect of bariatric surgery versus medical therapy on long-term cardiovascular risk in low BMI Chinese patients with type 2 diabetes: a propensity score-matched analysis. *Surg Obes Relat Dis* 2022;18(4):475–83.
- [121] Colquitt JL, Pickett K, Loveman E, Frampton GK. Surgery for weight loss in adults. *Cochrane Database Syst Rev* 2014;2014(8):CD003641.
- [122] Sjöholm K, Sjöström E, Carlsson LMS, Peltonen M. Weight change-adjusted effects of gastric bypass surgery on glucose metabolism: 2- and 10-year results from the Swedish Obese Subjects (SOS) study. *Diabetes Care* 2016;39(4):625–31.
- [123] Mingrone G, Panunzi S, De Gaetano A, et al. Bariatric-metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single centre, randomised controlled trial. *Lancet* 2015;386(9997):964–73.
- [124] Docherty NG, le Roux CW. Bariatric surgery for the treatment of chronic kidney disease in obesity and type 2 diabetes mellitus. *Nature Rev Nephrol* 2020;16(12):709–20.
- [125] Morales E, Porrini E, Martin-Toboada M, et al. Renoprotective role of bariatric surgery in patients with established chronic kidney disease. *Clin Kidney J* 2020;14(9):2037–46.
- [126] Cohen RV, Pereira TV, Aboud CM, et al. Effect of gastric bypass vs best medical treatment on early-stage chronic kidney disease in patients with type 2 diabetes and obesity. A randomized clinical trial. *JAMA Surg* 2020;155(8):e200420.
- [127] Young L, Hanipah ZN, Brethauer SA, et al. Long-term impact of bariatric surgery in diabetic nephropathy. *Surg Endosc* 2019;33(5):1654–60.
- [128] Li H, Boakye D, Chen X, Hoffmeister M, Brenner H. Association of body mass index with risk of early-onset colorectal cancer: systematic review and meta-analysis. *Am J Gastroenterol* 2021;116(11):2173–83.
- [129] Lauby-Secretan B, Scoccianti C, Loomis D, et al. Body fatness and cancer-viewpoint of the IARC working group. *N Engl J Med* 2016;375(8):794–8.
- [130] Schauer DP, Feigelson HS, Koebnick C, et al. Bariatric surgery and the risk of cancer in a large multisite cohort. *Ann Surg* 2019;269(1):95–101.
- [131] Esposito K, Chiodini P, Colao A, et al. Metabolic syndrome and risk of cancer: a systematic review and meta-analysis. *Diabetes Care* 2012;35(11):2402–11.
- [132] Economides A, Giannakou K, Mamais I, Economides PA, Papageorgis P. Association between aggressive clinicopathologic features of papillary thyroid carcinoma and body mass index: A systematic review and meta-analysis. *Fron Endocrinol (Lausanne)* 2021;12:692879.
- [133] Shi J, Zhao L, Gao Y, et al. Associating the risk of three urinary cancers with obesity and overweight: an overview with evidence mapping of systematic reviews. *Syst Rev* 2021;10(1):58.
- [134] Adams TD, Hunt SC. Cancer and obesity: Effect of bariatric surgery. *World J Surg* 2009;33(10):2028–33.
- [135] Sjöström L, Gummesson A, Sjöström CD, et al. Effects of bariatric surgery on cancer incidence in obese patients in Sweden (Swedish Obese Subjects Study): a prospective, controlled intervention trial. *Lancet Oncol* 2009;10(7):653–62.
- [136] Anveden A, Taube M, Peltonen M, et al. Long-term incidence of female-specific cancer after bariatric surgery or usual care in the Swedish Obese Subjects Study. *Gynecol Oncol* 2017;145(2):224–9.
- [137] Aminian A, Wilson R, Al-Kurd A, et al. Association of bariatric surgery with cancer risk and mortality in adults with obesity. *JAMA* 2022;327(24):2423–33.
- [138] Tao W, Santoni G, von Euler-Chelpin M, et al. Cancer risk after bariatric surgery in a cohort study from the five Nordic countries. *Obes Surg* 2020;30(10):3761–7.
- [139] Adams TD, Gress RE, Smith SC, et al. Long-term mortality after gastric bypass surgery. *N Engl J Med* 2007;357(8):753–61.

- [140] Syn NL, Cummings DE, Wang LZ, et al. Association of metabolic-bariatric surgery with long-term survival in adults with and without diabetes: a one-stage meta-analysis of matched cohort and prospective controlled studies with 174772 participants. *Lancet* 2021;397(10287):1830–41.
- [141] Aleassa EM, Hassan M, Hayes K, et al. Effect of revisional bariatric surgery on type 2 diabetes mellitus. *Surg Endosc* 2019;33(8):2642–8.
- [142] McKenna D, Selzer D, Burchett M, Choi J, Mattar SG. Revisional bariatric surgery is more effective for improving obesity related comorbidities than it is for reinducing major weight loss. *Surg Obes Relat Dis* 2014;10(4):654–60.
- [143] Yan J, Cohen R, Aminian A. Reoperative bariatric surgery for treatment of type 2 diabetes mellitus. *Surg Obes Relat Dis* 2017;13(8):1412–21.
- [144] Ma P, Reddy S, Higa KD. Revisional bariatric/metabolic surgery: what dictates its indications? *Curr Atheroscler Rep* 2016;18(7):42.
- [145] Brethauer SA, Kothari S, Kallies K, et al. Systematic review on reoperative bariatric surgery: American Society for Metabolic and Bariatric Surgery Revision Task Force. *Surg Obes Relat Dis* 2014;10(5):952–72.
- [146] Lazzati A, Bechet S, Jouma S, et al. Revision surgery after sleeve gastrectomy: a nationwide study with 10 years of follow-up. *Surg Obes Relat Dis* 2020;16(10):1497–504.
- [147] Tran DD, Nwokeabia ID, Purnell S, et al. Revision of Roux-en-Y gastric bypass for weight regain: a systematic review of techniques and outcomes. *Obes Surg* 2016;26(7):1627–34.
- [148] Nevo N, Abu-Abeid S, Lahat G, Klausner J, Eldar SM. Converting a sleeve gastrectomy to a gastric bypass for weight loss failure – is it worth it? *Obes Surg* 2018;28(2):364–8.