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Best Practice Updates for Multidisciplinary Care in Weight Loss Surgery

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Abstract

The objective of this study is to update evidence-based best practice guidelines for multidisciplinary care of weight loss surgery (WLS) patients. We performed systematic search of English-language literature on WLS, patient selection, and medical, multidisciplinary, and nutritional care published between April 2004 and May 2007 in MEDLINE and the Cochrane Library. Key words were used to narrow the search for a selective review of abstracts, retrieval of full articles, and grading of evidence according to systems used in established evidence-based models. A total of 150 papers were retrieved from the literature search and 112 were reviewed in detail. We made evidence-based best practice recommendations from the most recent literature on multidisciplinary care of WLS patients. New recommendations were developed in the areas of patient selection, medical evaluation, and treatment. Regular updates of evidence-based recommendations for best practices in multidisciplinary care are required to address changes in patient demographics and levels of obesity. Key factors in patient safety include comprehensive preoperative medical evaluation, patient education, appropriate perioperative care, and long-term follow-up.

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SUPPLEMENTARY MATERIAL

To review task group appendices, go to www.mass.gov/dph and search "Weight Loss Surgery."

DISCLOSURE

The authors declared no conflict of interest.

INTRODUCTION

Evidence-based best practice guidelines for multidisciplinary care in weight loss surgery (WLS) have been previously described (1). Earlier recommendations focused on patient selection/screening, operative risk, medical evaluation, nutrition counseling, and postoperative care (2). This report covers key updates in these and other areas.

Because extreme obesity can potentially affect all organ systems and psychological health (3), optimal surgical treatment of WLS requires communication and collaboration among a multidisciplinary team of caregivers. This article establishes the most current best practice guidelines for multidisciplinary care, with a focus on long-term outcomes and patient safety.

METHODS AND PROCEDURES

We searched MEDLINE and the Cochrane Library for articles published on WLS and patient selection, medical, multidisciplinary, and nutritional care published between April 2004 and April 2007. The system used to grade the quality of the evidence has already been described (1). We identified >150 papers; the 112 most relevant were reviewed in detail. These included randomized controlled trials, prospective and retrospective cohort studies, meta-analyses, case reports, prior systematic reviews, and expert opinion. The focus of the recommendations and the process used to develop them are reported elsewhere (1).

RESULTS

Multidisciplinary care

In February 2006, the Centers for Medicare and Medicaid Services decided to cover WLS performed at accredited facilities, such as Centers of Excellence (4). These are defined as facilities that meet standards of multidisciplinary care set by the American Society for Metabolic and Bariatric Surgery (4) and the American College of Surgeons (5).

However, existing guidelines on multidisciplinary care are vague. The 1991 National Institutes of Health consensus report on *Gastrointestinal Surgery for Severe Obesity* recommended multidisciplinary teams with medical, surgical, psychiatric, and nutritional expertise (6). Based on results from a national survey, 93% of respondents used a multidisciplinary approach to treat WLS patients, but only 53% had the National Institutes of Health–recommended team, and only 47% required the National Institutes of Health–recommended evaluations (7).

Recommendations

- Development of uniform minimum standards of multidisciplinary care for WLS patients (category D).
- Further research on the effectiveness of general medical, surgical, anesthetic, nutritional, and psychological programs for WLS patients (category D).

Preoperative education and patient selection

Many patients pursue WLS without understanding the procedures or their implications. Giusti *et al*. (8) found that many applicants for gastric banding did not know that the aim of the band was to sharply reduce food consumption. Preoperative education on eating, psychological implications, and risks and disadvantages of WLS led 9% of patients to opt out of WLS; it clarified doubts and defined expectations in 99% of them; and objective comparisons of procedures prompted 15% to change from one type of surgery to another (8). These data indicate that preoperative teaching by a multidisciplinary team improves patient

selection, and enables patients to choose the surgical procedure most appropriate for them, thus, leading to more successful outcomes. Registered dietitians can help patients make informed decisions (9).

Recommendations

Use preoperative education to

- Dispel misperceptions and unrealistic expectations, and clarify issues related to comorbid conditions, differences between surgical procedures, and required lifestyle changes after WLS (category D).

Patient selection

Operative risk—Higher BMI and medical comorbidities (e.g., coronary heart disease (CHD) risk factors and obstructive sleep apnea) increase operative risk and postoperative complications. Such complications as leak, infection, thromboembolism, cardiovascular events, and pneumonia occur in 6–20% of patients. Risk factors for perioperative morbidity and mortality include CHD, open procedure, male gender, age >50, smoking, and BMI >59. Recently published data include a meta-analysis showing average surgical mortality of 0.5%, with figures ranging from 0 to 1.5% (refs. 10–17).

Recommendations

- Individual assessment of risk factors relative to potential reduction in long-term disease risk and burden (category C).

Preoperative weight loss—Studies show that a preoperative weight loss of ≥5% is associated with decreased operative time, with potential reduction of surgical risk (18–20). A prospective study by Colles *et al*. (20) also found that patients who followed a very low–energy diet had a significant decrease in liver volume. A reduction in liver size prior to WLS has been recommended to decrease surgical difficulty and help prevent conversions from laparoscopic to open procedures (21,22).

Alami *et al*. (18) and Alvarado *et al*. (19) found no association between preoperative weight loss and reduction in major postoperative complications. More prospective randomized controlled studies are needed to establish evidence-based guidelines regarding preoperative weight loss and improved postoperative resolution of comorbidities.

Recommendations

- Preoperative weight loss of 5–10% of initial body weight, especially for patients with a BMI ≥50 (category C).
- More prospective randomized controlled studies to determine optimal preoperative weight loss and improve supervision of preoperative weight reduction and WLS education programs (category C).

Medical evaluation

Coronary artery disease—Many individuals with severe obesity have one or more risk factors for CHD, but there are few data on strategies for reducing perioperative cardiovascular risk in WLS patients. Current standards of care include preoperative stabilization and optimization of risk factors, e.g., blood pressure, dyslipidemia, and glucose control. Perioperative β blockers should be considered for individuals with substantial CHD risk or prior diagnosis of CHD (23). Obesity-related cardiovascular risk factors reverse

significantly after weight reduction from WLS (24–26). In virtually all individuals, CHD risk factors improve significantly after reductions in visceral fat burden.

Recommendations

- Preoperative assessment of cardiovascular conditions as indicated in patients with a history of coronary artery disease (category C).
- Perioperative β blockers in patients with stable or suspected coronary artery disease, unless contraindicated (category C).

Abnormal liver function—Nonalcoholic fatty liver disease is the most common cause of abnormal liver function in WLS patients (27). Patients with nonalcoholic steatohepatitis (NASH) are often insulin resistant and may have hypertension, hypertriglyceridemia, and diabetes mellitus. Cirrhotic liver disease with portal hypertension is usually considered a contraindication to WLS (28,29).

However, weight loss after gastric bypass surgery in those with NASH results in significant improvement in glucose, HbA_{1c}, and lipid profiles. Further, surgery leads to significant improvement in the histological features of NASH, with resolution of disease in a majority of patients (27,30,31). When liver function studies show elevated levels, imaging of the liver with either ultrasonography or computed tomography can detect the presence of NASH in obese patients, and may aid in the selection of patients for closer follow-up after surgery or for liver biopsy prior to surgery (32).

Recommendations

- Evaluation of patients with known or suspected liver disease to assess severity of cirrhosis and/or portal hypertension (category B).
- Interoperative liver biopsy at the time of surgery for diagnosis and assessment of liver disease (category C).
- WLS is not recommended in patients with child's class C cirrhosis (category B).

Deep vein thrombosis and pulmonary embolism—Prudent prophylaxis for thromboembolic complications includes use of sequential alternating compressive devices on the lower extremities in addition to some form of heparin, usually low-molecular-weight heparin. However, the optimal form and duration of heparin-type prophylaxis in the patient with severe obesity is unknown (33). Data suggest that weight-based dose adjustments and extended prophylaxis may be beneficial (34).

Recommendations

- Use of perioperative anticoagulants and sequential compression devices to reduce risk of deep vein thrombosis and pulmonary embolism, unless clinically contraindicated (category B).
- Consideration of extended prophylaxis in patients with increased risk of deep vein thrombosis and pulmonary embolism (category D).

Smoking—In addition to superobesity (weight >350 lb), smoking has been identified as a preoperative risk factor associated with postoperative complications, e.g., thromboembolic and pulmonary complications (32,35). A >20-pack-year history of smoking is associated with difficulty in postoperative weaning from a ventilator (12). Smoking also significantly increases the risk of postoperative marginal ulceration (36).

Recommendations

- Strong encouragement of smokers to stop smoking prior to WLS (category B).
- Availability of smoking cessation advice and treatment at the institution or through the WLS program (category D).

Preoperative metabolic evaluation

Hypoglycemia—Endocrinological and metabolic effects of WLS have received greater attention recently. One condition, severe postprandial hypoglycemia, can be life-threatening (with loss of consciousness, motor vehicle accidents, and seizures) and is often refractory to medical nutrition therapy (37,38). Although the overall incidence is unknown, recognition of this complication is increasing. Some individuals evaluated for the condition postoperatively report symptoms consistent with hypoglycemia preoperatively, suggesting that the hypoglycemia may have predated obesity surgery (39).

Thus, medical history should include determination of personal or family history of hypoglycemia during neonatal or adult life, and assessment for potential symptoms of hypoglycemia, including exercise- or meal-related shakiness, sweating, palpitations, blurred vision, difficulty concentrating, unexplained near-syncope or syncope, or seizures. If these symptoms are noted during the preoperative evaluation, consideration should be given to endocrinology evaluation for hyperinsulinemic hypoglycemia; if present, purely restrictive surgical approaches (which would not be expected to further enhance incretin secretion and hyperinsulinemia) should be considered.

Recommendations

- Endocrinology evaluation prior to WLS, and consideration of purely restrictive procedures for patients with a documented history of hypoglycemia (category D).

Preoperative gastrointestinal and liver assessment

A number of gastrointestinal conditions may be present in the preoperative WLS patient and should be considered on a case-by-base basis. Two common conditions warrant assessment: fatty liver and NASH. First is the presence of fatty liver disease as evidenced clinically or by elevations in hepatic transaminases, alkaline phosphatase, or bilirubin concentrations.

Laboratory or radiographic evidence of liver dysfunction is common in preoperative WLS patients. Nonalcoholic fatty liver disease describes a spectrum of fatty liver from hepatic steatosis to NASH to cirrhosis, and has been reported to be the most common cause of abnormal liver function in WLS patients (25). Patients with NASH are often insulin resistant and may have hypertension, hypertriglyceridemia, and diabetes mellitus, diseases comprising the metabolic syndrome. Although the pathophysiologic role of these conditions in the progression NASH is unclear, weight loss after gastric bypass results in significant improvement in associated conditions and the histological features of NASH. In a majority of patients, the disease resolves (25–27).

NASH cannot be accurately differentiated from the more benign steatosis by clinical or biochemical abnormalities; liver biopsy remains the gold standard diagnostic tool. In a study of WLS patients with abnormal liver blood tests, imaging of the liver by ultrasonography or computed tomography suggested the presence of NASH; hence, preoperative imaging may aid in the selection of patients for postoperative monitoring or for liver biopsy prior to surgery (28). However, the additional predictive utility of imaging vs. usual biochemical and histologic assessment needs to be confirmed in additional studies.

Chronic renal disease

Chronic renal disease as a consequence of obesity is often overlooked in WLS patients. Few studies suggest that gastric bypass surgery is an effective and safe means for achieving significant weight loss in transplant patients and those with renal failure (40). Increased fluid volume in WLS patients with chronic renal disease, especially those on dialysis, may make it difficult to assess weight changes. This population also has increased risk of infection, especially with gastric banding (41). In addition, Roux-en-Y gastric bypass and other malabsorptive procedures may impede maintenance of therapeutic levels of immunosuppressive agents.

Recommendations

- Pre- and postoperative monitoring of renal function in patients with diabetes and hypertension (categories A and B).
- Evaluation by a nephrologist prior to WLS for patients with significant renal disease (category D).
- Special consideration to pre- and postoperative monitoring of fluid and intravascular volume (category A).

HIV infection

Literature on WLS in patients with HIV is scarce. Only one paper to date has examined WLS in patients with HIV; it found that Roux-en-Y gastric bypass could be safely performed in this population (1). There is a need for further research on HIV-infection and WLS.

Recommendations

- Patients with HIV should be evaluated by an infectious disease specialist prior to WLS (category D).
- Special consideration should be given to preoperative assessment of viral loads, CD4 counts (category D) and weight gain from antiretroviral medications (category D).

Nutrition

Pre- and postoperative micronutrients—Flancbaum *et al*. (42) retrospectively analyzed preoperative values of serum albumin, calcium, 25-OH-vitamin D, iron, ferritin, hemoglobin, vitamin B_{12}, and thiamine in 379 patients undergoing WLS. The data suggested that nutritional deficiencies should be detected and corrected preoperatively. Madan *et al*. (43) examined preoperative and 1-year postoperative levels of vitamin A, vitamin B_{12}, vitamin D-25, zinc, iron, ferritin, selenium, and folate in patients undergoing laparoscopic Roux-en-Y gastric bypass (RYGB). They concluded that low vitamin and trace mineral values are common pre- and postoperatively.

Patients with obesity are at high risk of vitamin D deficiency, a major public health problem in the United States (44). Flancbaum *et al*. demonstrated high incidence of thiamine deficiency preoperatively, especially among African Americans and Hispanics. A review of nutritional consequences of WLS by Xanthakos and Inge (45) includes summaries of recent advances and guidelines for nutritional screening. Long-term follow-up is essential for WLS patients (46).

Recommendations

- Pre- and postoperative monitoring for deficiencies in vitamin D, thiamin, calcium (including parathyroid hormone), iron, vitamin B_{12}, and folic acid, with repletion as indicated (categories A, B, and C).

Vitamin D—At 36-month follow-up, Ybarra *et al*. found that no RYGB patients were taking vitamin D supplements, and 43% were deficient in vitamin D (44). At 1- and 2-year follow-up, Clements *et al*. found 7–8% vitamin D deficiency in patients who reported compliance with recommended supplementation (46). Black patients experienced significantly more vitamin D deficiency than whites. It is not known whether 400 IU of vitamin D in a standard multivitamin is sufficient to prevent deficiencies in the long term.

Calcium—Calcium deficiency in RYGB patients is not always apparent because serum calcium is protected by the release of calcium from the bone (47). Biomarkers of postoperative metabolic bone disease include increased serum and urine markers of bone turnover, including elevated alkaline phosphatase and parathyroid hormone (48,49). Riedt *et al*. found 800 mg of calcium for premenopausal women and 1,500 mg/day for post-menopausal women sufficient to achieve calcium balance after RYGB surgery (49). Most centers recommend 1,200–1,500 mg/day of calcium and 400 IU/day of vitamin D supplements (50–52). In achlorhydric patients, the bioavailability of calcium carbonate and calcium citrate is 4 and 45%, respectively (50,51,53–56).

Iron—Recommendations for iron supplementation include a daily multivitamin with iron and prophalactically, two 325 mg of ferrous sulfate (65 mg elemental per tablet) in menstruating women (51). Replacement doses for iron deficiency are not clearly established, however. Shikora *et al*. recommend supplementation with iron sulfate 325 mg plus 250 mg vitamin C daily, increased to three times daily as tolerated if iron saturation is <10% and serum ferritin level is <10 mg/ml, or iron saturation is <7% regardless of ferritin level (55). Due to the bypass of the lower stomach, it may be difficult for iron-deficient patients to absorb oral iron, and intravenous iron may be required several times a year (57).

Vitamin B_{12}—There is some passive absorption of vitamin B_{12} in RYGB patients. Normal serum cobalamin is >200 pg/ml; however, consider repletion doses with a cobalamin level of <250 pg/ml.

Folic acid—Folic acid deficiency can usually be prevented with a daily multivitamin. Low levels can be treated with 1 mg of folic acid daily. Studies of folate deficiency after placement of adjustable gastric banding are inconclusive (58).

Thiamine—Thiamine deficiency has a wide range of clinical symptoms that vary from cardiac beriberi (wet beriberi) to neurological beriberi (dry beriberi) (52). Dry beriberi can have both peripheral and central neurological symptoms (52,59). Thiamine deficiency is most common in the first few weeks after WLS (60). Predisposing factors include IV glucose, parenteral nutrition, steroid ingestions, diuretic use, malabsorption, and noncompliance with vitamin supplementation after WLS (52,60). Patients are not necessarily at risk from other deficiencies in micronutrients (61,62). Persistent vomiting should be of concern after placement of an adjustable gastric band.

Macronutrients—Reported caloric intake after RYGB varies widely and more research is needed to determine the optimal composition of a post-RYGB diet that produces weight loss while minimizing short- and long-term nutritional complications (59,63). Carbohydrates are a major source of energy for body metabolism and the sole energy source for the brain and

red blood cells (64). RYGB alters carbohydrate digestion and absorption (65), thereby putting patients at risk for dumping syndrome.

The prevalence of protein-calorie malnutrition is not well documented, but reportedly low (59,64). In obese populations, 1.2 g protein/kg calculated body weight (or 2.0–2.1 g protein/kg ideal body weight) (per kg serving is calculated as 1/3 of weight above ideal body weight) will sufficiently aliment obese patients without renal complications or extraordinary medical complications (66).

Exercise and physical activity

Postsurgical weight loss and maintenance—After WLS, patients experience a rapid loss of body weight, 14.1–48.5% of which may include lean body mass (67). Loss of lean body mass is due in part to the surgical procedure, with a greater loss seen with malabsorptive surgeries compared with gastric banding (67). In a prospective cohort study of WLS patients and self-reported exercise, Metcalf *et al*. found that exercisers lost 28% more fat mass and retained 8% more lean body mass compared with those who did not exercise (68).

Fitness improvements—WLS patients typically have low exercise tolerance (ET) and measured functional capacity (e.g., peak VO_2) rivaling patients with chronic heart failure (69). Several studies have documented improvements in cardiovascular fitness and related changes in self-reported measures (e.g., dyspnea) within months after undergoing WLS (70,71). Objectively measured changes postoperatively include increased VO_2 peak and improved hemodynamic and ventilatory response at both maximal and submaximal exercise (71). Fitness improvements are not wholly explained by changes in BMI or excess weight and suggest that exercise may improve ET and peak VO_2 independent of weight loss (71).

Post-WLS complications—Although WLS improves ET and fitness, patients with relatively low fitness and ET may be at greater risk for operative and postoperative complications than WLS patients with better fitness (69). Patients with relatively low graded exercise test–derived peak VO_2 (<16 ml/kg/min) have been found more likely to experience (odds ratio: 1.61) postoperative complications than patients with higher peak VO_2, indicating a possible role for submaximal exercise evaluation in WLS candidates. One small prospective study in laparoscopic adjustable gastric band patients has validated the six-minute walk test, a simple submaximal index of functional capacity (69).

Exercise training pre- and post-WLS—Presurgical exercise reduces perioperative complications and facilitates recovery in other surgical groups with comorbid conditions common to WLS candidates (72–74). Recent self-report data suggest that WLS patients are more physically active after surgery (69). However, many patients do not adhere to exercise recommendations. Elkins *et al*. (75) found that behavioral noncompliance was pervasive at 12-month post-RYGB surgery.

Recommendations

- Encouragement of WLS patients to increase pre- and postoperative physical activity and low-to-moderate intensity exercise (categories A and D).
- Guidance and periodic monitoring to help WLS patients remain physically active (category D).

Pregnancy

Pregnancy after WLS is safe with proper monitoring and counseling (76). Studies show that previous WLS is not associated with adverse perinatal outcomes (77,78). However, it is recommended that women avoid pregnancy for at least 12–18 months postoperatively (79–83). This is due to concern that the patient or baby may become unhealthy or malnourished in the relative starvation state (76,79). There is also the potential for iron, vitamin B_{12}, folate, and calcium deficiencies, especially after malabsorptive surgeries (84). Women are routinely tested at 28 weeks for gestational diabetes with a glucose tolerance test using a 50–100-g oral glucose load. As an alternative, they may wear a continuous glucose sensor for a period of 3 days (80).

Women with a history of gastric bypass surgery may be at risk for gastrointestinal complications during the antepartum period (78). Case reports have described bowel obstruction during pregnancy after laparoscopic RYGB (85). The obstruction is most commonly caused by adhesions; however, it may also be a result of internal herniation (78). The incidence of these hernias has ranged between 1.5 and 5% in gastric bypass patients (78,81). Signs and symptoms tend to be nonspecific and patients may present with a spectrum of complaints that range from mild intermittent abdominal pain to vomiting (78). Computed tomography scanning poses a minimal risk to a fetus and is recommended in these patients (86) (Table 1).

Recommendations

- WLS should not be performed in patients who are known to be pregnant; preoperative testing for women of child-bearing age is strongly recommended (category C).
- Patients should be strongly counseled to not get pregnant for at least 18 months after WLS (category C).

Post-WLS body contouring

Introduction—Body contouring procedures have only been performed in large numbers in the United States in the last few years. Thus, the literature in this field is very limited. We identified and reviewed in detail a total of 80 relevant articles, ranging from case reports and expert opinions to prospective randomized trials.

Results/recommendations

Insurance coverage—Third-party payers have developed a variety of criteria for coverage of panniculectomy in the massive weight loss patient. These vary from one insurer to the next.

Pre-body contouring operative evaluation

Timing of surgery—Body contouring surgery should only be considered after the patient has achieved a stable weight for ≥3 months (83). This generally occurs, at a minimum, 15–18 months after WLS, but can take longer.

Risk stratification

Nicotine—Body contouring surgery in nicotine users should be performed with great caution, or in some cases, not at all (87). Some centers use urine cotinine tests to assure that patients are nicotine-free at the time of surgery.

BMI—There is no accepted consensus on BMI criteria for body contouring surgery (84,88,89).

Informed consent and psychological considerations for body contouring surgery

Ensuring realistic expectations of esthetic outcome is a key component of the informed consent process. Care must be taken to screen for body dysmorphic disorder, depression, and other psychosocial factors that may need additional attention prior to surgery. Generally, body contouring surgery is known to have a very positive psychiatric effect on the massive weight loss patient (90,91).

Body contouring: perioperative considerations

Facility and surgeon criteria—Body contouring surgery should be performed in a well-equipped, fully accredited in-patient or out-patient facility. Use of a nurse–anesthetist or anesthesiologist experienced in body contouring surgery and management of obese and massive weight loss patients is essential. Close proximity to intensive care facilities is necessary for patient safety. Only surgeons with proper training and experience in contouring procedures should undertake this type of specialized surgery.

Avoiding hypothermia—Various techniques have been developed to minimize the risk of hypothermia, including use of forced-air heating blankets pre-, peri-, and postoperatively (85,86).

Post-WLS body contouring recommendations

- Body contouring should be reserved until a patient has achieved a stable weight which is generally 18 months (or more) after WLS (category D).
- There are no widely accepted guidelines for insurance coverage of body contouring after substantial weight loss; we recommend third-party coverage of excess skin excision, if medically indicated (category D).
- Body contouring should only be performed by board-eligible or board-certified surgeons with training and experience in the relevant procedures (category D).

DISCUSSION

This study of evidence-based best practice guidelines shows growing recognition of the need for a multidisciplinary approach to WLS, and refinements in preoperative assessment and postoperative care. With increasing obesity and greater acceptance of the field of WLS, it has become more crucial than ever to carefully screen for and manage pre- and postoperative risk factors. Nonetheless, there are few definitive studies to establish specific standards for components of multidisciplinary care, e.g., preoperative weight loss.

There are ethical concerns about the design of randomized control trials in the area of multidisciplinary care, yet data are needed to develop new policies that detail minimum standards for the multidisciplinary evaluation of WLS patients (7). For example, there are no nationally recognized pregastric or postgastric bypass protocols for nutrition assessment and therapy. Outcome studies, including those on nutrition and eating behavior related to various operations are also needed (4,5). To date, patterns of multidisciplinary care are inconsistent and unpredictable. Further research should explore the impact of different methods on outcomes (7).

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REFERENCES

1. Lehman Center Weight Loss Surgery Expert Panel. Commonwealth of Massachusetts Betsy Lehman Center for Patient Safety and Medical Error Reduction Expert Panel on Weight Loss Surgery: executive report. Obes Res 2005;13:205–226. [PubMed: 15800277]
2. Saltzman E, Anderson W, Apovian CM, et al. Criteria for patient selection and multidisciplinary evaluation and treatment of the weight loss surgery patient. Obes Res 2005;13:234–243. [PubMed: 15800279]
3. Greenberg I, Perna F, Kaplan M, Sullivan MA. Behavioral and psychological factors in the assessment and treatment of obesity surgery patients. Obes Res 2005;13:244–249. [PubMed: 15800280]
4. Bariatric Surgery Centers of Excellence. Surgical Review Corporation. 2007 [Accessed 11 December 2008]. <http://www.surgicalreview.org/pcoe/tertiary/tertiary_requirements.aspx>
5. American College of Surgeons. Continuing Quality Improvement. Bariatric Surgery Center Network Program. 2008 [Accessed 11 December 2008]. <http://www.facs.org/cqi/bscn/index.html>
6. Gastrointestinal Surgery for Severe Obesity. NIH Consensus Statement. 1991 [Accessed 15 August 2007]. Online, 25–27 March 1991 <http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=hstat4.chapter.9282>
7. Santry HP, Chin MH, Cagney KA, Alverdy JC, Lauderdale DS. The use of multidisciplinary teams to evaluate bariatric surgery patients: results from a national survey in the USA. Obes Surg 2006;16:59–66. [PubMed: 16417760]
8. Giusti V, De Lucia A, Di Vetta V, et al. Impact of preoperative teaching on surgical option of patients qualifying for bariatric surgery. Obes Surg 2004;14:1241–1246. [PubMed: 15527642]
9. Cunningham E. What is the registered dietitian's role in the preoperative assessment of a client contemplating bariatric surgery? J Am Diet Assoc 2006;106:163. [PubMed: 16390679]
10. Manterola C, Pineda V, Vial M, Losada H, Munoz S. Surgery for morbid obesity: selection of operation based on evidence from literature review. Obes Surg 2005;15:106–113. [PubMed: 15760508]
11. Benotti P, Wood GC, Still C, Petrick A, Strodel W. Obesity disease burden and surgical risk. Surg Obes Relat Dis 2006;2:600–606. [PubMed: 16996319]
12. Livingston EH, Langert J. The impact of age and Medicare status on bariatric surgical outcomes. Arch Surg 2006;141:1115–1120. [PubMed: 17116805]
13. Varela JE, Wilson SE, Nguyen NT. Outcomes of bariatric surgery in the elderly. Am Surg 2006;72:865–869. [PubMed: 17058723]
14. Poulose BK, Griffin MR, Moore DE, et al. Risk factors for post-operative mortality in bariatric surgery. J Surg Res 2005;127:1–7. [PubMed: 15964300]
15. Benotti PN, Wood GC, Rodriguez H, Carnevale N, Liriano E. Perioperative outcomes and risk factors in gastric surgery for morbid obesity: a 9-year experience. Surgery 2006;139:340–346. [PubMed: 16546498]
16. Taylor JD, Leitman IM, Hon P, Horowitz M, Panagopoulos G. Outcome and complications of gastric bypass in super-super obesity versus morbid obesity. Obes Surg 2006;16:16–18. [PubMed: 16417751]
17. Jamal MK, DeMaria EJ, Johnson JM, et al. Impact of major co-morbidities on mortality and complications after gastric bypass. Surg Obes Relat Dis 2005;1:511–516. [PubMed: 16925280]
18. Alami RS, Morton JM, Schuster R, et al. Is there a benefit to preoperative weight loss in gastric bypass patients? A prospective randomized trial. Surg Obes Relat Dis 2007;3:141–145. [PubMed: 17331803]

19. Alvarado R, Alami RS, Hsu G, et al. The impact of preoperative weight loss in patients undergoing laparoscopic Roux-en-Y gastric bypass. Obes Surg 2005;15:1282–1286. [PubMed: 16259888]
20. Colles SL, Dixon JB, Marks P, Strauss BJ, O'Brien PE. Preoperative weight loss with a very-low-energy diet: quantitation of changes in liver and abdominal fat by serial imaging. Am J Clin Nutr 2006;84:304–311. [PubMed: 16895876]
21. Schwartz ML, Drew RL, Chazin-Caldie M. Laparoscopic Roux-en-Y gastric bypass: preoperative determinants of prolonged operative times, conversion to open gastric bypasses, and postoperative complications. Obes Surg 2003;13:734–738. [PubMed: 14627468]
22. Fris RJ. Preoperative low energy diet diminishes liver size. Obes Surg 2004;14:1165–1170. [PubMed: 15527628]
23. Fleisher LA, Beckman JA, Brown KA, et al. ACC/AHA 2006 guideline update on perioperative cardiovascular evaluation for noncardiac surgery: focused update on perioperative beta-blocker therapy—a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Update the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery). J Am Coll Cardiol 2006;47:2343–2355. [PubMed: 16750714]
24. Vogel JA, Franklin BA, Zalesin KC, et al. Reduction in predicted coronary heart disease risk after substantial weight reduction after bariatric surgery. Am J Cardiol 2007;99:222–226. [PubMed: 17223422]
25. Sampalis JS, Sampalis F, Christou N. Impact of bariatric surgery on cardiovascular and musculoskeletal morbidity. Surg Obes Relat Dis 2006;2:587–591. [PubMed: 16996318]
26. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. JAMA 2004;292:1724–1737. [PubMed: 15479938]
27. Barker KB, Palekar NA, Bowers SP, et al. Non-alcoholic steatohepatitis: effect of Roux-en-Y gastric bypass surgery. Am J Gastroenterol 2006;101:368–373. [PubMed: 16454845]
28. Baltasar A. Liver cirrhosis and bariatric operations. Surg Obes Relat Dis 2006;2:580. [PubMed: 17015221]
29. Sarr MG. Is a bariatric procedure appropriate in patients with portal hypertension secondary to cirrhosis? Surg Obes Relat Dis 2006;2:405–406. [PubMed: 16925365]
30. deAlmeida SR, Rocha PR, Sanches MD, et al. Roux-en-Y gastric bypass improves the nonalcoholic steatohepatitis (NASH) of morbid obesity. Obes Surg 2006;16:270–278. [PubMed: 16545157]
31. Jaskkiewicz K, Raczynska S, Rzepko R, Sledzinski Z. Nonalcoholic fatty liver disease treated by gastroplasty. Dig Dis Sci 2006;51:21–26. [PubMed: 16416204]
32. Zhang W, Mason EE, Renquist KE, Zimmerman MB. IBSR Contributors. Factors influencing survival following surgical treatment of obesity. Obes Surg 2005;15:43–50. [PubMed: 16013115]
33. Gugliotti, DV. What is the optimal venous thromboembolism prophylaxis for patients undergoing bariatric surgery? IMPACT consults. Cleve Clin J Med; Proceedings of the 2nd Annual Cleveland Clinic Perioperative Medicine Summit; 2006. p. S17-S18.
34. Hamad GG, Choban PS. Enoxaparin for thromboprophylaxis in morbidly obese patients undergoing bariatric surgery: findings of the prophylaxis against VTE outcomes in bariatric surgery patients receiving enoxaparin (PROBE) study. Obes Surg 2005;15:1368–1374. [PubMed: 16354513]
35. Gonzalez R, Haines K, Nelson LG, Gallagher SF, Murr MM. Predictive factors of thromboembolic events in patients undergoing Roux-en-Y gastric bypass. Surg Obes Relat Dis 2006;2:30–35. [PubMed: 16925311]
36. Wilson JA, Romagnuolo J, Byrne TK, Morgan K, Wilson FA. Predictors of endoscopic findings after Roux-en-Y gastric bypass. Am J Gastroenterol 2006;101:2194–2199. [PubMed: 17032183]
37. Patti ME, McMahon G, Mun EC, et al. Severe hypoglycaemia post-gastric bypass requiring partial pancreatectomy: evidence for inappropriate insulin secretion and pancreatic islet hyperplasia. Diabetologia 2005;48:2236–2240. [PubMed: 16195867]
38. Service GJ, Thompson GB, Service FJ, et al. Hyperinsulinemic hypoglycemia with nesidioblastosis after gastric-bypass surgery. N Engl J Med 2005;353:249–254. [PubMed: 16034010]

39. Goldfine AB, Mun EC, Patti ME. Hyperinsulinemic hypoglycaemia following gastric bypass surgery for obesity. Curr Opin Endocrinol Diabetes 2006;13:419–424.
40. Alexander JW, Goodman H. Gastric bypass in chronic renal failure and renal transplant. Nutr Clin Pract 2007;22:16–21. [PubMed: 17242450]
41. Zalesin KC, McCullough PA. Bariatric surgery for morbid obesity: risks and benefits in chronic kidney disease patients. Adv Chronic Kidney Dis 2006;13:403–417. [PubMed: 17045226]
42. Flancbaum L, Belsley S, Drake V, Colarusso T, Tayler E. Preoperative nutritional status of patients undergoing Roux-en-Y gastric bypass for morbid obesity. J Gastrointest Surg 2006;10:1033–1037. [PubMed: 16843874]
43. Madan AK, Whitney SO, Tichansky DS, Ternovits CA. Vitamin and trace mineral levels after laparoscopic gastric bypass. Obes Surg 2006;16:603–606. [PubMed: 16687029]
44. Ybarra J, Sanchez-Hernandez J, Gich I, et al. Unchanged hypovitaminosis D and secondary hyperparathyroidism in morbid obesity after bariatric surgery. Obes Surg 2005;15:330–335. [PubMed: 15826464]
45. Xanthakos SA, Inge TH. Nutritional consequences of bariatric surgery. Curr Opin Clin Nutr Metab Care 2006;9:489–496. [PubMed: 16778582]
46. Clements RH, Katasani VG, Palepu R, et al. Incidence of vitamin deficiency after laparoscopic Roux-en-Y gastric bypass in a university hospital setting. Am Surg 2006;72:1196–1202. [PubMed: 17216818]
47. Shah M, Simha V, Garg A. Review: long-term impact of bariatric surgery on body weight, comorbidities, and nutritional status. J Clin Endocrinol Metab 2006;91:4223–4321. [PubMed: 16954156]
48. Bloomberg RD, Fleishman A, Nalle JE, Herron DM, Kini S. Nutritional deficiencies following bariatric surgery: what have we learned? Obes Surg 2005;15:145–154. [PubMed: 15802055]
49. Riedt CS, Brolin RE, Sherrell RM, Field MP, Shapses SA. True fractional calcium absorption is decreased after Roux-en-Y gastric bypass surgery. Obesity (Silver Spring) 2006;14:1940–1948. [PubMed: 17135609]
50. Miller AD, Smith KM. Medication and nutrient administration considerations after bariatric surgery. Am J Health Syst Pharm 2006;63:1852–1857. [PubMed: 16990631]
51. Brolin RE, Gorman JH, Gorman RC, et al. Prophylactic iron supplementation after Roux-en-Y gastric bypass: a prospective, double-blind, randomized study. Arch Surg 1998;133:740–744. [PubMed: 9688002]
52. Angstadt JD, Bodziner RA. Peripheral polyneuropathy from thiamine deficiency following laparoscopic Roux-en-Y gastric bypass. Obes Surg 2005;15:890–892. [PubMed: 15978166]
53. Recker RR. Calcium absorption and achlorhydria. N Engl J Med 1985;313:70–73. [PubMed: 4000241]
54. Skroubis G, Anesidis S, Kehagias I, et al. Roux-en-Y gastric bypass versus a variant of biliopancreatic diversion in a non-superobese population: prospective comparison of the efficacy and the incidence of metabolic deficiencies. Obes Surg 2006;16:488–495. [PubMed: 16608616]
55. Shikora SA, Kim JJ, Tarnoff ME. Nutrition and gastrointestinal complications of bariatric surgery. Nutr Clin Pract 2007;22:29–40. [PubMed: 17242452]
56. Miller AD, Smith KM. Medication and nutrient administration considerations after bariatric surgery. Am J Health Syst Pharm 2006;63:1852–1857. [PubMed: 16990631]
57. Fugioka K. Follow-up of nutritional and metabolic problems after bariatric surgery. Diabetes Care 2005;28:481–484. [PubMed: 15677821]
58. Gasteyger C, Suter M, Calmes JM, Gaillard RC, Giusti V. Changes in body composition, metabolic profile and nutritional status 24 months after gastric banding. Obes Surg 2006;16:243–250. [PubMed: 16545153]
59. Shuster MH, Vázquez JA. Nutritional concerns related to Roux-en-Y gastric bypass: what every clinician needs to know. Crit Care Nurs Q 2005;28:227–260. [PubMed: 16041224]
60. Singh S, Kumar A. Wernicki encephalopathy after obesity surgery: a systematic review. Neurology 2007;68:807–811. [PubMed: 17353468]

61. Guisti V, Suter M, Heraief E, Gaillard RC, Burckhardt P. Effects of laparoscopic gastric banding on body composition, metabolic profile and nutritional status of obese women: 12-months follow-up. Obes Surg 2004;14:239–245. [PubMed: 15018754]
62. Ledoux S, Msika S, Moussa F, et al. Comparison of nutritional consequences of conventional therapy of obesity, adjustable gastric banding, and gastric bypass. Obes Surg 2006;16:1041–1049. [PubMed: 16901358]
63. Wardé-Kamar J, Rogers M, Flancbaum L, Laferrere B. Calorie intake and meal patterns up to 4 years after Roux-en-Y gastric bypass surgery. Obes Surg 2004;14:1070–1079. [PubMed: 15479596]
64. Ponsky TA, Brody F, Pucci E. Alterations in gastrointestinal physiology after Roux-en-Y gastric bypass. J Am Coll Surg 2005;201:125–131. [PubMed: 15978453]
65. DeMaria E. Bariatric surgery for morbid obesity. N Engl J Med 2007;356:2176–2183. [PubMed: 17522401]
66. Rinaldi Schinkel E, Pettine SM, Adams E, Harris M. Impact of varying levels of protein intake on protein status indicators after gastric bypass in patients with multiple complications requiring nutritional support. Obes Surg 2006;16:24–30. [PubMed: 16417753]
67. Chaston TB, Dixon JB, O'Brien PE. Changes in fat-free mass during significant weight loss: a systematic review. Int J Obes (Lond) 2007;31:743–750. [PubMed: 17075583]
68. Metcalf B, Rabkin RA, Rabkin JM, Metcalf LJ, Lehman-Becker LB. Weight loss composition: the effects of exercise following obesity surgery as measured by bioelectrical impedance analysis. Obes Surg 2005;15:183–186. [PubMed: 15802058]
69. McCullough PA, Gallagher MJ, Dejong AT, et al. Cardiorespiratory fitness and short-term complications after bariatric surgery. Chest 2006;130:517–525. [PubMed: 16899853]
70. Maniscalco M, Zedda A, Giardiello C, et al. Effect of bariatric surgery on the six-minute walk test in severe uncomplicated obesity. Obes Surg 2006;16:836–841. [PubMed: 16839479]
71. Serés L, Lopez-Ayerbe J, Coll R, et al. Increased exercise capacity after surgically induced weight loss in morbid obesity. Obesity (Silver Spring) 2006;14:273–279. [PubMed: 16571853]
72. Rooks DS, Huang J, Bierbaum BE, et al. Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. Arthritis Rheum 2006;55:700–708. [PubMed: 17013852]
73. Bond DS, Evans RK, DeMaria E, et al. Physical activity and quality of life improvements before obesity surgery. Am J Health Behav 2006;30:422–434. [PubMed: 16787132]
74. Boan J, Kolotkin RL, Westman EC, McMahon RL, Grant JP. Binge eating, quality of life and physical activity improve after Roux-en-Y gastric bypass for morbid obesity. Obes Surg 2004;14:341–348. [PubMed: 15072655]
75. Elkins G, Whitfield P, Marcus J, et al. Noncompliance with behavioral recommendations following bariatric surgery. Obes Surg 2005;15:546–551. [PubMed: 15946436]
76. Dao T, Kuhn J, Ehmer D, Fisher T, McCarty T. Pregnancy outcomes after gastric-bypass surgery. Am J Surg 2006;192:762–766. [PubMed: 17161090]
77. Sheiner E, Levy A, Silverberg D, et al. Pregnancy after bariatric surgery is not associated with adverse perinatal outcome. Am J Obstet Gynecol 2004;190:1335–1340. [PubMed: 15167839]
78. Kakarla N, Dailey C, Marino T, Shikora SA, Chelmow D. Pregnancy after gastric bypass surgery and internal hernia formation. Obstet Gynecol 2005;105(5 Pt 2):1195–1198. [PubMed: 15863579]
79. Marceau P, Kaufman D, Biron S, et al. Outcome of pregnancies after biliopancreatic diversion. Obes Surg 2004;14:318–324. [PubMed: 15072650]
80. Woodard CB. Pregnancy following bariatric surgery. J Perinat Neonatal Nurs 2004;18:329–340. [PubMed: 15646304]
81. Ahmed AR, O'Malley W. Internal hernia with Roux loop obstruction during pregnancy after gastric bypass surgery. Obes Surg 2006;16:1246–1248. [PubMed: 16989713]
82. Moore KA, Ouyang DW, Whang EE. Maternal and fetal deaths after gastric bypass surgery for morbid obesity. N Engl J Med 2004;351:721–722. [PubMed: 15306679]
83. Hurwitz DJ. Single-staged total body lift after massive weight loss. Ann Plast Surg 2004;52:435–441. [PubMed: 15096919]

84. Arthurs ZM, Cuadrado D, Sohn V, et al. Post-bariatric panniculectomy: pre-panniculectomy body mass index impacts the complication profile. Am J Surg 2007;193:567–570. [PubMed: 17434356]
85. Ng V, Lai A, Ho V. Comparison of forced-air warming and electric heating pad for maintenance of body temperature during total knee replacement. Anaesthesia 2006;61:1100–1104. [PubMed: 17042850]
86. Wong PF, Kumar S, Bohra A, Whetter D, Leaper DJ. Randomized clinical trial of perioperative systemic warming in major elective abdominal surgery. Br J Surg 2007;94:421–426. [PubMed: 17380549]
87. Payne CE, Southern SJ. Urinary point-of-care test for smoking in the preoperative assessment of patients undergoing elective plastic surgery. J Plast Reconstr Aesthet Surg 2006;59:1156–1161. [PubMed: 17046624]
88. Borud LJ, Warren AG. Modified vertical abdominoplasty in the massive weight loss patient. Plast Reconstr Surg 2007;119:1911–1921. [PubMed: 17440374]
89. Shermak MA, Chang DC, Heller J. Factors impacting thromboembolism after bariatric body contouring surgery. Plast Reconstr Surg 2007;119:1590–1596. [PubMed: 17415254]
90. Song AY, Rubin JP, Thomas V, et al. Body image and quality of life in post massive weight loss body contouring patients. Obesity (Silver Spring) 2006;14:1626–1636. [PubMed: 17030974]
91. Pecori L, Serra Cervetti GG, Marinari GM, Migliori F, Adami GF. Attitudes of morbidly obese patients to weight loss and body image following bariatric surgery and body contouring. Obes Surg 2007;17:68–73. [PubMed: 17355771]
92. Martin LF, Finigan KM, Nolan TE. Pregnancy after adjustable gastric banding. Obstet Gynecol 2000;95:927–930. (Category A). [PubMed: 10831994]
93. Wittgrove AC, Jester L, Wittgrove P, Clark GW. Pregnancy following gastric bypass for morbid obesity. Obes Surg 1998;8:461–464. (Category C). [PubMed: 9731683]
94. Deitel M. Pregnancy after bariatric surgery. Obes Surg 1998;8:465–466. (Category C).
95. Dixon JB, Dixon ME, O'Brien PE. Pregnancy after Lap Band surgery: management of the band to achieve healthy weight outcomes. Obes Surg 2001;11:59–65. (Category B). [PubMed: 11361170]
96. Goldner WS, O'Dorisio TM, Dillon JS, Mason EE. Severe metabolic bone disease as a long-term complication of obesity surgery. Obes Surg 2002;12:685–692. (Category C). [PubMed: 12448393]

Table 1

Pregnancy issues with gastric bypass and LapBand

	Gastric bypass	LapBand
Contraception	Recommend for fertile and infertile women 12–18 months postoperatively (79)	Recommend for fertile and infertile women 12–18 months postoperatively (79)
Pregnancy	Avoid for 12–18 months (76,78,92,93)	Avoid for 12–18 months (76,78,92,93)
Prenatal team	Multidisciplinary approach (OB/Gyn, surgeon, dietitian) (93)	Multidisciplinary approach (OB/Gyn, surgeon, dietitian) (93)
Prenatal goals	Early prenatal care (93)	Early prenatal care (93)
	Adequate fetal weight gain (94)	Adequate fetal weight gain (94)
	Correct or prevent vitamin deficiencies (93)	Correct or prevent vitamin deficiencies (93)
GI considerations	Bowel obstruction (adhesions) (81)	Bowel obstruction (adhesions) (81)
	Internal herniation (signs and symptoms are nonspecific)	Internal herniation (signs and symptoms are nonspecific)
Dietary considerations	High protein meals and avoid constant snacking (93)	High protein meals and avoid constant snacking (93)
Vitamin and minerals	Chewable/liquid prenatal vitamin supplementation should be taken in addition to usually prescribed vitamin supplementation (93,94)	Chewable/liquid prenatal vitamin supplementation should be taken in addition to usually prescribed vitamin supplementation (93,94)
	Vitamin A: <5,000 IU/day (95)	Vitamin A: <5,000 IU/day (95)
	Folic acid: 400 μg/day (95)	Folic acid: 400 μg/day (95)
	Calcium: 1,200–1,500 mg/day (96)	Calcium: 1,200–1,500 mg/day (96)
	Vitamin D: 800 IU/day (96)	Vitamin D: 800 IU/day (96)
Glucose tolerance test	OGTT may produce dumping syndrome	May not be able to consume OGTT volume
	May not be able to consume OGTT volume	Fasting glucose level (9)
	Fasting glucose level (9)	2-h postprandial glucose level (9)
	2-h postprandial glucose level (9)	HbA_{1c} (9)
	HbA_{1c} (9)	

GI, gastrointestinal; OGTT, oral glucose tolerance test.