# Best Practice Updates for Pediatric/Adolescent Weight Loss Surgery

Janey S.A. Pratt[1,2], Carine M. Lenders[3], Emily A. Dionne[2], Alison G. Hoppin[2], George L.K. Hsu[4], Thomas H. Inge[5], David F. Lawlor[1], Margaret F. Marino[3], Alan F. Meyers[3], Jennifer L. Rosenblum[2] and Vivian M. Sanchez[6]

**The objective of this study is to update evidence-based best practice guidelines for pediatric/adolescent weight loss surgery (WLS). We performed a systematic search of English-language literature on WLS and pediatric, adolescent, gastric bypass, laparoscopic gastric banding, and extreme obesity published between April 2004 and May 2007 in PubMed, MEDLINE, and the Cochrane Library. Keywords 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. In light of evidence on the natural history of obesity and on outcomes of WLS in adolescents, guidelines for surgical treatment of obesity in this age group need to be updated. We recommend modification of selection criteria to include adolescents with BMI ≥ 35 and specific obesity-related comorbidities for which there is clear evidence of important short-term morbidity (i.e., type 2 diabetes, severe steatohepatitis, pseudotumor cerebri, and moderate-to-severe obstructive sleep apnea). In addition, WLS should be considered for adolescents with extreme obesity (BMI ≥ 40) and other comorbidities associated with long-term risks. We identified >1,085 papers; 186 of the most relevant were reviewed in detail. Regular updates of evidence-based recommendations for best practices in pediatric/adolescent WLS are required to address advances in technology and the growing evidence base in pediatric WLS. Key considerations in patient safety include carefully designed criteria for patient selection, multidisciplinary evaluation, choice of appropriate procedure, thorough screening and management of comorbidities, optimization of long-term compliance, and age-appropriate fully informed consent.**

*Obesity* (2009) **17,** 901–910. doi:10.1038/oby.2008.577

## INTRODUCTION

Evidence-based best practice guidelines for pediatric/adolescent weight loss surgery (WLS) have been previously described (1). Earlier guidelines focused on patient safety, criteria for eligibility, informed consent, psychological maturity, and surgeon and program credentialing (2). This report covers key updates relating to pediatric/adolescent WLS.

Rapidly increasing prevalence of obesity among children and adolescents is associated with substantial medical and psychosocial morbidity (3,4). It is important that health professionals assess obesity and initiate action plans (5). Some WLS procedures may be indicated for carefully selected, extremely obese adolescents (5). Children with BMI >99th percentile become obese adults (BMI ≥ 30) (3) with more health complications and a higher mortality rate (6–9) than those who become obese in adulthood.

WLS in the mature adolescent may reduce the risk of morbidity and early mortality from obesity-related disease (10–12). To date, the current evidence base is not sufficient to determine which WLS procedures are optimal for adolescents. However, early evidence of safety and efficacy exists for two procedures (13–16). This report, which updates best practice guidelines in pediatric/adolescent WLS, focuses on prevention of early mortality and comorbidities from obesity, patient selection criteria, and long-term outcomes of WLS.

## METHODS AND PROCEDURES

We searched PubMed, MEDLINE, and the Cochrane Library for articles published between April 2004 and May 2007 on WLS and pediatrics, adolescents, gastric bypass, laparoscopic adjustable band, and extreme obesity. The system used to grade the quality of the evidence has already been described (2). More than 1,085 papers were identified; 186 of the most relevant were reviewed in detail. These included randomized controlled trials, prospective and retrospective cohort

[1]Department of Surgery, Massachusetts General Hospital, Boston, Massachusetts, USA; [2]MGH Weight Center, Massachusetts General Hospital, Boston, Massachusetts, USA; [3]Department of Pediatrics, Boston Medical Center, Boston, Massachusetts, USA; [4]Department of Psychiatry, Tufts-New England Medical Center, Boston, Massachusetts, USA; [5]Department of Pediatric Surgery, Cincinnati Children's Hospital, Cincinnati, Ohio, USA; [6]Department of Surgery, Beth Israel Deaconess Medical Center, Boston, Massachusetts, USA. Correspondence: Janey S.A. Pratt (jpratt@partners.org)

Received 26 June 2007; accepted 6 September 2007; published online 19 February 2009. doi:10.1038/oby.2008.577

studies, meta-analyses, case reports, prior systematic reviews, and expert opinion. The focus of the recommendations and the process used to develop them are described in our prior report (2).

## RESULTS

### Types of surgery

Data indicate that patient safety and weight loss outcomes for extremely obese adolescents who undergo WLS are comparable to, or better than, those seen in adults (13,15–18). Ten case series of WLS in adolescents have been published since 2004 (see **Table 1**) (17–26).

*Gastric bypass.* In the United States, Roux-en-Y gastric bypass (RYGB) for weight loss dates back to the 1960s for adults and the 1980s for adolescents (27,28). Only three new studies on RYGB

**Table 1 Summary of adolescent WLS studies January 2004–June 2007**

| Author, year, and location | Subjects age and gender | Initial mean BMI | Type of surgery | Results | Complications | Follow-up period | Type of study class |
|---|---|---|---|---|---|---|---|
| Angrisani *et al.* (23), 2005, Italy | 15–19 yo 47 F/11 M 58 Studied | 46.1 | AGB | 39.7–55.6% EWL 20% Had <25% EWL | 0 Mortality 10.3% Complications 10.3% Band removal | 7 Years | Case series Class C |
| Barnett *et al.* (24), 2005, United States | 13–17 yo 8 F/6 M 14 Studied | 55.1 | JIB RYGB VBG | 64% EWL Improved comorbidities | 0 Mortality 14% Major 14% Minor complication | Mean 6 years (1–21 years) | Retrospective Class C |
| Buchwald *et al.* (22), 2004, International | 16–64 yo 22,094 Points 72.6% F | 46.9 | RYGB, AGB, VBG, and BPD | EWL/DM resolve RYGB 61.6/83.8% AGB 47.5/47.8% VBG 68.2/68.2% BPD 70.1/97.9% | Mortality RYGB 0.5% AGB 0.1% BPD 1.1% | 2 Years | Meta-analysis Class B |
| Horgan *et al.* (25), 2005, United States | 17–19 yo 2 F/2 M 4 Studied | 51 | AGB | EWL 15–87% | 0 Mortality 1 CCY 6 month postoperatively | 4–30 Months | Case series Class C |
| Collins *et al.* (21), 2007, United States | 15–18 yo 7 F/4 M 11 Studied | 50.5 | RYGB | EWL 60.8% 70% Improvement comorbidities | 0 Mortality 27% Complications | 11.5 Months | Case series Class C |
| Lawson *et al.* (17), 2006, United States | 13–21 yo 30 Surgery (S) 12 Cohort (C) 42 Studied | 56.5 (S) 47.2 (C) | RYGB S Medical Weight Program (C) | BMI dropped to: 35.8 (S) 46 (C)—NS | 1/30 Late mortality from colitis 4/30 Serious complications 9/30 Minor complications 1/30 Weight regain | 1 Year | Cohort multicenter Class B |
| Nadler *et al.* (26), 2007, United States | 13–17 yo 41 F/12 M 53 Studied | 47.6 | AGB | EWL 37–63% | 0 Mortality 9.4% Morbidity 8% Reoperation | 6 Months to 2 years | Prospective case series Class B |
| Papadia *et al.* (19), 2007, Italy | 14–18 yo 52 F/16 M 68 Studied | 46 | BPD | EWL 78% 92% Resolution comorbidities | 2 Late mortality 2nd malnutrition 20% Reoperation 15% Malnutrition | 11 Years (2–23 years) | Case series Class C |
| Silberhumer *et al.* (18), 2006, Austria | 9–19 yo 31 F/19 M 50 Studied | 45.2 | AGB | EWL 62% 67% Resolution comorbidities 64% Improved QOL | 0 Mortality 6 to <25% EWL 2% Band slip | 35 Months (3.6–85.4) | Case series Class C |
| Tsai *et al.* (16), 2007, United States | 10–19 yo 78.5% F 566 Studied | NR | RYGB | NR | 0 Mortality 5.5% Complications (78% = resp comp) | In-hospital data only | Administrative data Class C |
| Yitzhak *et al.* (20), 2006, Israel | 9–18 yo 42 F/18 M 60 Studied | 43 | AGB | BMI decreased to 30 93% Improved QOL | 0 Mortality 10% Reoperation | ≥3 Years | Case series Class C |

AGB, adjustable gastric band; BPD, biliopancreatic diversion with or without duodenal switch; CCY, cholecystectomy; DM, diabetes mellitus; EWL, excess weight loss; F, female; JIB, jejeunoileal bypass; M, male; NR, not recorded; NS, nonsignificant; QOL, quality of life; Resp comp, respiratory complications; RYGB, Roux-en-Y gastric bypass; VBG, gastroplasty; WLS, weight loss surgery; yo, years old.

in adolescents have been published since our last review in 2004 (17,21,24). One of these (17) is a controlled multicenter study that compared laparoscopic RYGB (LRYGB) with a 1-year, family-based pediatric behavioral treatment program. In the LRYGB group, BMI decreased from 56.5 to 35.8, with significant resolution of comorbidities; there was no significant BMI change in the comparison group.

Perioperative morbidity was generally consistent with that seen in numerous adult studies and meta-analyses. In the three case series, no deaths occurred in the perioperative period. In Inge *et al.* (17), an 18-year-old adolescent with a BMI of 80 and multiple comorbidities died 9 months after RYGB from complications of *Clostridium difficile* colitis (17). Thus, based on current literature, RYGB (not mini-gastric bypass or loop gastric bypass) is recommended as a safe operation in adolescents, with outcomes similar to those observed in adults. However, every effort should be made to avoid vitamin deficiency (29) and to maximize postoperative compliance (30) because adolescence is a time of increased growth and development, and decreased compliance (28).

*Adjustable gastric band.* A number of new reports for adjustable gastric band (AGB) have been published in the past 4 years. Because of its relative safety, AGB offers an effective and attractive treatment option in carefully selected patients. It also has a lower risk of postoperative vitamin deficiencies compared with RYGB or biliopancreatic diversion (BPD). Between 2005 and 2007, five case series were reported in adolescents (18,20,23,25,26). The larger studies included 221 patients between the ages of 9 and 19. Patients had a mean preoperative BMI of 43–48, and they lost 37–63% of excess body weight during follow-up periods that ranged from 6 months to 7 years. However, caution must be used when interpreting reported excess weight loss. Few adolescent WLS studies indicate how data are calculated, and estimation of ideal weight for children differs considerably from adults.

Complication rates were 6–10%, with no deaths. Reoperation rates, including band removal, were 8–10% (20,23,25). Long-term weight loss outcomes and precise descriptions of changes in comorbidities following WLS are still lacking. In one study, at least 80% of adolescents had sustained weight loss 5 years after AGB, but their numbers were small, and the fraction lost to follow-up was not provided (20). Nonetheless, we can recommend AGB placement as safe, and more effective than behavioral interventions for a selected population of adolescents. However, we suggest limiting widespread use until more robust long-term safety and efficacy outcomes and the Food and Drug Administration trial results are available. Weight loss devices should only be used in pediatric populations in the setting of a controlled clinical trial after investigational device exemption and institutional review board approval.

*Other procedures.* Papadia *et al.* (19) describe a case series on BPD in adolescents. Outcomes suggest that risks outweigh potential benefits of greater weight loss with BPD, duodenal switch, and other procedures that cause significant malabsorption compared with RYGB or AGB. This is particularly true in light of well-described compliance issues that may increase risks for late protein malnutrition and nutritional complications surrounding pregnancy.

*Laparoscopic sleeve gastrectomy.* Laparoscopic sleeve gastrectomy is a new operation that produces significant initial weight loss with low operative risk in adults. Short-term data suggest that laparoscopic sleeve gastrectomy may be a safe alternative, with fewer nutritional risks than RYGB (20,31,32). Until techniques are standardized and proof of longer-term efficacy becomes available, we recommend that this operation be considered investigational and only be offered to adolescents within the context of a controlled prospective study.

### Recommendations

- RYGB is considered a safe and effective option for extremely obese adolescents as long as appropriate long-term follow-up is provided (category B).
- The AGB has not been approved by the Food and Drug Administration for use in adolescents, and therefore, should be considered investigational. Off-label use can be considered, if done in an institutional review board–approved study (category C).
- BPD and duodenal switch procedures cannot be recommended in adolescents. Current data suggest substantial risks of protein malnutrition, bone loss, and micronutrient deficiencies. These nutritional risks are of particular concern during pregnancy, and several late maternal deaths have been reported (category C).
- Sleeve gastrectomy should be considered investigational; existing data are not sufficient to recommend widespread and general use in adolescents (category D).

### Comorbidities

*Type 2 diabetes mellitus.* A steep rise in prevalence of type 2 diabetes is occurring worldwide in parallel with an increasing rate of obesity in children and adolescents (33). Children and adolescents with type 2 diabetes are at increased risk for obesity-related comorbidities, including hypertension (HTN), dyslipidemia, and nonalcoholic fatty liver disease. Moderately good evidence suggests that young patients with type 2 diabetes have rapidly progressive disease. Nephropathy, in particular, progresses rapidly; 30–40% of patients develop microalbuminuria within 5 years of diagnosis (34,35). Progressive retinopathy and atherosclerotic disease have also been documented within 5 years of diagnosis of type 2 diabetes in young adults (36). In this age group, glycemic control with medical treatment is often poor (37). Early data suggest that diabetes may completely reverse in adolescents who undergo LRYGB (T.H. Inge, unpublished data). Thus, established type 2 diabetes is a strong indication for WLS in adolescents (38).

*Obstructive sleep apnea.* Obstructive sleep apnea (OSA) and obesity hypoventilation syndrome are common among children with extreme obesity, cause substantial morbidity, and respond to WLS. Between 8 and 20% of children and adolescents with obesity have moderate-to-severe OSA, and ~15% have central sleep apnea, often associated with episodes of severe oxygen desaturation during sleep (<85%) (ref. 39). Adolescents presenting for WLS tend to have extreme obesity, and among this group, the prevalence of OSA is ~55% (ref. 39). Consequences of OSA include learning difficulties, hyperactivity, and cardiovascular abnormalities. In a small case series using pre- and postoperative polysomnography, OSA significantly improved or resolved in most adolescents after WLS (40). These findings are consistent with outcomes in adults after WLS. Thus, moderate or severe OSA (e.g., apnea–hypopnea index (AHI) >15) is a strong indication for early WLS in adolescents.

*Nonalcoholic fatty liver disease and nonalcoholic steatohepatitis (NASH).* Studies using histological diagnoses show that 38% of obese children and adolescents have steatosis compared with 5% of lean subjects; ~9% have NASH compared with 1% of the lean population (41). Although steatosis and NASH may progress to cirrhosis, the risk of disease progression is not well understood. There is good evidence that WLS can decrease the overall amount of steatosis (42) and many of the inflammatory markers associated with fatty liver disease (43). Dixon *et al*. (44) demonstrated regression in fibrosis with WLS at 2 years. Several drug trials are underway to treat pediatric nonalcoholic fatty liver disease, but weight loss is currently the only treatment option available for NASH in adolescents. Therefore, severe and progressive NASH (as opposed to steatosis alone or mild NASH) should be considered a strong indication for early WLS in adolescent patients.

*Pseudotumor cerebri.* WLS is considered the long-term procedure of choice among adults with pseudotumor cerebri (45,46). As with WLS in adults, symptoms of pseudotumor cerebri in adolescents improve several months after WLS (47,48). Thus, pseudotumor cerebri is a strong indication for early WLS in adolescents.

*Cardiovascular disease risks.* Childhood obesity (BMI at ages 4–17) is associated with left ventricular hypertrophy in young adults (ages 20–38) (ref. 49). Skinfold thickness and blood pressure measured in childhood and adolescence predict decreased carotid artery elasticity in adulthood (50). These factors likely predict long-term risk for cardiovascular disease (CVD), but evidence of short-term morbidity from these risk factors is lacking. WLS clearly improves these risk factors. Shargorodsky *et al*. (51) found that patients between 16 and 55 years old with AGB showed improvement in their metabolic milieu 4 months postoperatively, and high-risk patients (≥2 CVD risk factors) showed improvement in small artery elasticity (51). WLS improves HTN and significantly improves CVD risk factors in adults (22). In adolescents, CVD risk factors are not as strong indications for early WLS.

*Predictors of metabolic syndrome.* Indicators such as high waist circumference and triglycerides in childhood (9–10 years) predict the metabolic syndrome in young adulthood (18–19 years) (52). But unlike adults, metabolic syndrome in adolescents is ill-defined and unstable during this period of major physiologic changes, and the diagnosis may have less clinical utility than it does in adults (53). Buchwald *et al*. (22) found that WLS may result in improvement of metabolic and inflammatory parameters, including hyperinsulinemia, insulin resistance, and lipid metabolism. These conditions (i.e., hyperinsulinemia, insulin resistance, dyslipidemia, and HTN) are common among adolescents with obesity and are associated with long-term cardiovascular risk. Nonetheless, these indications are not strong enough to recommend early WLS in adolescents.

*Quality of life.* Research clearly shows that obesity has a negative impact on quality of life (QOL) for adolescents (54–58), and the degree of obesity is directly related to the perceived impairments in emotional, social, physical, and school functioning experienced by adolescents (55,57). Strauss and Pollack (56) demonstrated that teens with obesity are more likely to be socially marginalized than their normal-weight peers. Ball *et al*. (54)) found that being overweight as a young adult had a lasting impact on life satisfaction and aspirations. Research demonstrated improved psychosocial status in adults following WLS (59).

Several recent studies also suggest significant improvement in postoperative QOL after AGB and RYGB in adolescents (13,18,20). Behavioral interventions that focus on obese teens and their families generally have low success in achieving long-term weight loss (60). Based on this nascent data, WLS may bring important benefits to emotional health and QOL in extremely overweight adolescents.

*Depression.* There is a significant incidence of depression among overweight and obese adolescents. Studies consistently demonstrate that many obese adolescents seeking weight management treatment present with depression (58,60–62). For example, Zeller *et al*. (62) found that 53% of adolescents were mildly depressed, 30% self-reported clinically significant depressive symptoms, and 45% were clinically depressed based on their mothers' reports. In addition, only 21% of those seeking surgery were currently engaged in any form of psychological treatment (58). Available data indicate that preoperative depression does not adversely affect short-term (1–2 years) weight loss after WLS (63). Therefore, presence of depression is not an exclusion criterion for WLS.

*Eating disorder.* Binge eating and self-induced purging occur in 5–30% of obese adolescents seeking WLS. Such preoperative eating disturbances do not appear to affect weight loss outcome after WLS, at least in the short term. Therefore, presence of eating disturbances is not an exclusion criterion, but treatment must be initiated and the patient considered stable prior to surgery.

**Table 2 Selection criteria for WLS in adolescents**

| BMI (kg/m²) | Comorbidities |
|---|---|
| >35 | *Serious:* Type 2 diabetes mellitus, moderate or severe obstructive sleep apnea (AHI >15 events/h), pseudotumor cerebri, and severe steatohepatitis |
| >40 | *Other:* Mild obstructive sleep apnea (AHI ≥5 events/h), hypertension, insulin resistance, glucose intolerance, dyslipidemia, impaired quality of life or activities of daily living, among others |
| Eligibility criteria[a] | |
| Tanner stage | IV or V (unless severe comorbidities indicate WLS earlier) |
| Skeletal maturity | Completed at least 95% of estimated growth (only if planning a diversional or malabsorptive operation, including RYGB) |
| Lifestyle changes | Demonstrates ability to understand what dietary and physical activity changes will be required for optimal postoperative outcomes |
| Psychosocial | Evidence for mature decision making, with appropriate understanding of potential risks and benefits of surgery |
| | Evidence for appropriate social support without evidence of abuse or neglect |
| | If psychiatric condition (e.g., depression, anxiety, or binge eating disorder) is present, it is under treatment |
| | Evidence that family and patient have the ability and motivation to comply with recommended treatments pre- and postoperatively, including consistent use of micronutrient supplements. Evidence may include a history of reliable attendance at office visits for weight management and compliance with other medical needs |

AHI, apnea–hypopnea index; RYGB, Roux-en-Y gastric bypass; WLS, weight loss surgery.
[a]All of the eligibility criteria must be fulfilled.

#### Recommendations

- Strong indications for WLS in adolescents include established type 2 diabetes (category B), moderate-to-severe OSA, with AHI ≥15 (category C), severe and/or progressive NASH (category C), and pseudotumor cerebri (category C).
- Other indications for WLS in adolescents include mild OSA, mild NASH, HTN, dyslipidemia, and significantly impaired QOL (categories C and D).
- All adolescents with obesity should be formally assessed for depression; if found to be depressed, treatment should be initiated prior to WLS (category B).

The presence of eating disturbances is not an exclusion criterion for WLS, but adolescents with such disorders should be treated prior to surgery (category B).

#### Patient selection

Compared with lower levels of obesity, Freedman *et al.* (3) show increasing metabolic risks associated with higher BMI for age, especially ≥99th BMI percentile. They recommend more aggressive weight control strategies for this group. Using the Learning Management System database from the Centers for Disease Control (64), we calculated the BMI percentile values that correspond to BMI cut points recommended for use in adults (i.e., 35 and 40). A BMI of 35 between the ages 18 and 20 corresponds to a BMI percentile of 99.1–98.4 in men and 97.7–96.8 in women. In contrast to adults, a BMI of 35 at age 16 corresponds to a BMI percentile of 99.2 in boys and 98.4 in girls, although at age 12 it corresponds to a BMI percentile of 99.4 in boys and 99.3 in girls.

Because the average BMI increases with increasing age, a more conservative approach to younger patients is achieved by using a fixed BMI cut point. All adolescent boys, and most girls who are under age 18 and have a BMI of 35, are above the 99th BMI percentile (3). Therefore, BMI thresholds used for selecting adults for WLS also identify adolescents at substantially increased risk for short- and long-term medical comorbidities.

The benefits of WLS outweigh the risks in adolescents with extreme obesity and associated comorbidities. However, selection for surgery during adolescence should be closely linked to obesity-related comorbidities.

If short-term health consequences are likely to have a negative effect on long-term health, and if significant benefit is expected from WLS, we recommend WLS at a BMI cut point of ≥35. This is the case for patients with established type 2 diabetes mellitus, pseudotumor cerebri, moderate-to-severe sleep apnea (AHI > 15), and severe steatohepatitis. If adolescents have less severe comorbidities or risk factors for long-term disease, and if there is no proven disadvantage of waiting until adulthood, we recommend a BMI cut point ≥40 for WLS. Those comorbidities include, among others, HTN, milder forms of OSA, impaired QOL, insulin resistance, glucose intolerance, or dyslipidemia.

Considerations other than BMI and comorbidities must remain an important part of medical decision making for adolescents. These include, but are not limited to, physical and psychological maturity, treatment and stability of psychological comorbidities, adequacy of prior weight loss attempts, firm evidence of ability to comply with follow-up medical care, and the desire of the patient to have surgery. Table 2 provides a summary of updated recommendations on selection criteria for WLS in adolescents.

#### Recommendations

- When combination procedures are used in adolescents, physical maturity (completion of 95% of adult stature based on radiographic study) should be documented. In most cases, this criterion will limit surgery to children over age 12 (category D).
- Psychological maturity—demonstrated by understanding of the surgery, mature motivations for the operation, and compliance with preoperative therapy—should be assessed prior to WLS (category D).
- BMI cut points in children and adolescents who meet other criteria should be ≥35 with major comorbidities

(i.e., type 2 diabetes mellitus, moderate-to-severe sleep apnea (AHI > 15), pseudotumor cerebri, or severe NASH) and ≥40 with other comorbidities (e.g., HTN, insulin resistance, glucose intolerance, substantially impaired QOL or activities of daily living, dyslipidemia, sleep apnea with AHI ≥ 5) (categories B and C).

- Children and adolescents should demonstrate the ability to comply with treatment regimens and medical monitoring before WLS. In many cases, consistent attendance in a prolonged weight management program will provide important assurance of postoperative compliance (category D).
- Individuals with mental retardation vary in their capacity to demonstrate knowledge, motivation, and compliance; they should, therefore, be evaluated for WLS on a case-by-case basis. For these children, we suggest including an ethicist on the multidisciplinary evaluation team (category D).
- Patients with syndromic obesity, endocrine disorders, obesity that appears to be related to the use of weight-promoting medications, and those in whom obesity cannot be controlled through medical interventions and/or carefully designed environmental and behavioral management should be considered for surgery on a case-by-case basis (category D).

Patients with uncontrolled psychosis (presence of hallucinations and delusions), bipolar disorder (extreme mood lability), or substance use disorders can be considered for WLS on a case-by-case basis after they have been in remission for 1 year (category C).

### Team member qualifications

There is no empiric evidence supporting the establishment and use of a multidisciplinary team for adults or adolescents undergoing WLS, but this approach is rational and well-established as the standard of care (65–67). Experts agree that having a multidisciplinary team improves preoperative selection and education as well as postoperative outcomes. This is especially true in pediatric and adolescent programs. The ideal team would include a minimum of four or five professionals who are colocated and have at least one face-to-face meeting preoperatively to prepare a treatment plan for each patient. Primary team members should include a surgeon; pediatric specialist; registered dietitian; mental health specialist; and coordinator. Specialists in pediatric physical therapy, pulmonology, gynecology, endocrinology, infectious diseases, cardiology, sleep disorders, gastroenterology, radiology, psychiatry, and hematology should be available for consultation as needed.

Establishing a WLS program in a free-standing children's hospital entails significant expense (for extensive training and equipment that can accommodate extremely obese patients) (68). Low operative volume as well as surgeon and institutional inexperience with WLS may also pose significant risks (69,70). The volume of appropriate adolescent candidates for WLS is unlikely to be high enough in any one center to allow a pediatric surgeon to gain the experience required to minimize complications of WLS. Therefore, the pediatric/adolescent WLS program would ideally be colocated with an adult WLS program to allow for sharing of equipment (e.g., large computed tomography scanners, Hoyer lifts), and for an experienced weight loss surgeon to work with a pediatric surgeon in these complex, high-risk cases. Partnership with adult programs will also enable a seamless transition to support group and lifelong postoperative monitoring.

### Recommendations

- Although few hospitals have sufficient volume for a standalone pediatric surgical center, the ideal WLS team should include a minimum of four or five professionals who are colocated and have at least one preoperative face-to-face meeting to prepare a treatment plan for each patient (category D). Staff should include
- surgeon—experienced adult weight loss surgeon or pediatric surgeon with WLS fellowship or the equivalent experience;
- pediatric specialist—internist or pediatrician with adolescent and obesity training and experience;
- registered dietitian—with weight management certificate and experience in treating obesity and working with children and families;
- mental health professional—with specialty training in child, adolescent, and family treatment, and experience treating eating disorders and obesity;
- coordinator—registered nurse, social worker, or one of the other team members who has the responsibility of coordinating each child or adolescent's care and assuring compliance and follow-up.
- The ideal setting would be in an adult/pediatric hospital, with a pediatric program partnered with an adult program that has full access to pediatric specialists (category D).
- A comprehensive family-based evaluation should be provided to parents seeking surgery for their adolescent children (category D).

### Risks and outcomes

Patients with higher BMI and more significant medical illness are at increased risk during WLS. Access to WLS earlier in life may reduce the risk. Because younger patients will generally have fewer advanced comorbidities, early WLS may also decrease risk of perioperative mortality. One longitudinal study compared mortality among groups of extremely obese patients <40 years old. One group received WLS, the other did not. Among those treated with WLS, 3% died in the 13-year follow-up period compared with 13.8% of those who did not have surgery (71). This study suggests that surgery in early adulthood may reduce the risk of death from obesity. However, it does not directly show that WLS during adolescence confers additional benefit compared with WLS during early adulthood.

*Psychosocial risks.* Psychosocial outcomes after WLS have not been adequately studied, particularly in adolescents. Data suggest short-term improvements in depression, eating disturbances, and QOL after WLS (72). It is unknown whether these improvements are sustained long-term. Some long-term data in adults indicate that mood and eating disturbances may recur after initial improvement. It is therefore important that all adolescents undergoing WLS should receive careful follow-up, and that appropriate treatment be instituted should mood, eating, or substance use disorders occur after WLS (73).

*Nutritional risks.* The majority of patients undergoing WLS will develop some nutritional deficiency; therefore, strict preoperative (for those deficient in one or more nutrients) and postoperative adherence to multivitamin and mineral supplementation is critical for preventing severe complications (29,74,75). Noncompliance with medical regimens is particularly common among adolescents with chronic illnesses (76). Therefore, adolescents undergoing WLS should be carefully assessed for ability to comply with medical regimens and follow-up care. Consistent attendance and compliance with medical interventions is an important measure of whether a patient and family are likely to comply with postoperative care.

Low levels of iron, vitamin $B_{12}$, vitamin D, and calcium are common problems after RYGB (77). Adolescents may also be at particular risk for thiamine deficiency (29). Adolescence is a critical time for bone mass accumulation, with up to 50% of adult total bone mass achieved during this period. Calcium and vitamin D are vital for optimal bone mineral accrual in the developing skeleton (78,79).

*Pregnancy risks.* There are no randomized controlled trials on pregnancy before vs. after WLS, but some data show that pregnancy after RYGB and AGB is safe (80). In 1998, Wittgrove *et al.* (81) found less risk of gestational diabetes, macrosomia, and cesarean section post-RYGB than with pregnancy while obese (81). Dao *et al.* (82) reported no significant episodes of malnutrition, adverse fetal outcomes, or pregnancy complications within the first year after WLS. There are no studies on outcomes of pregnancy after WLS in the adolescent population, However, T.H. Inge (unpublished data) reported a twofold increase in teen pregnancy in his female LRYGB patients.

This unexpected finding suggests that there may be an increased risk of pregnancy in adolescents undergoing WLS. For this reason, we recommend that all female adolescents be informed preoperatively about increased fertility following weight loss, and the possible risks associated with pregnancy during the first 18 months after WLS. These patients should be counseled to avoid pregnancy during this period, and offered contraception.

**Recommendations**

- Early WLS may reduce obesity-related mortality and morbidity. However, early timing must be weighed against the patient's possible psychological immaturity, and the risk of decreased compliance and long-term follow-up (category C).
- All adolescents undergoing WLS should be included in prospective longitudinal data collection to improve the evidence base for evaluating the risks and benefits of WLS in this age group (category D).
- Emphasis on compliance strategies, careful monitoring of vitamin and mineral intake, and periodic laboratory surveillance to detect deficiencies is crucial (category D).
- Adolescent girls are particularly vulnerable to nutritional deficiencies; this group is at substantial risk of developing iron deficiency anemia and vitamin B deficiencies during menstruation and pregnancy (category C), and should receive special attention.
- Risk of getting pregnant increases after WLS. All female adolescents should be informed about increased fertility following weight loss, and possible risks associated with pregnancy during the first 18 months after surgery. These patients should be counseled to avoid pregnancy during this period, and offered contraception (category D).
- In addition to risks for deficiencies of iron, calcium, and vitamin $B_{12}$ after WLS, adolescents may also be at particular risk for osteopenia and thiamine deficiency (category C).

**Informed consent**

The process of informed consent in the adolescent who is referred for WLS is associated with certain medical, legal, and ethical issues. As part of a carefully considered risk–benefit decision, it is important for the care team, patient, and family to recognize and consider the specific risks of WLS, and particularly those relevant to the younger patient. The key facts to recognize and consider are a majority of adolescent obesity tracks into adulthood; risk factors for adult obesity are increasing age, higher BMI, and parental obesity (3); WLS is far more effective than behavior modification, and family-based therapy is generally more effective than unsupervised diet and exercise (17); some dieting behaviors and obesity both carry a risk of morbidity and mortality, and these long-term risks must be weighed against operative mortality and morbidity associated with WLS. Knowledge and understanding of these issues by patient and family alike should be formally assessed as part of the informed consent process.

Problems arise when the adolescent and the parents disagree about WLS. Parents and adolescents differ in their perceptions of the impact of obesity on their lives (55,57,60). Parents tend to more strongly endorse the negative medical and psychosocial impact that obesity is having on their children. One must be extremely careful to recognize when overt or subtle coercion is responsible for a child's assent to surgery. Without an empirically valid method of assessing an adolescent's capacity to make an informed decision about WLS, the clinical team must consider the adolescent's cognitive, social, and emotional development, and support his or her independent role in the decision-making process (83).

**Recommendations**

- Informed assent by the adolescent should be obtained separately from the parents to avoid coercion (as in other pediatric chronic illnesses that require surgical intervention) (category D).

- The patient's knowledge of the risks and benefits of the procedure and the importance of postoperative follow-up should be formally evaluated to ensure true informed assent (category C).
- The parental permission process should include discussion of the risks of adult obesity (category C), available medical treatments (category B), surgical alternatives, and the specific risks and outcomes of the proposed WLS in the proposed institution.

## DISCUSSION

Approximately 4% of US children suffer from extreme obesity (99th percentile of BMI for age) (3). There are currently no firmly established criteria for selecting adolescent patients who will benefit most from WLS. Patients who should undergo surgery are those who have the highest risk of continuing to suffer from obesity as adults, and those who have already developed comorbidities. The major risk factors for childhood obesity tracking into adult obesity include parental obesity, increasing age, and increasing BMI (3).

Our task group carefully considered several possible BMI-related selection criteria, and the available evidence for short- and long-term medical risks at a variety of BMI thresholds. We concluded that adult BMI criteria for WLS (≥35 with significant comorbidities or ≥40 with less serious comorbidities) are also appropriate for selecting adolescents who are most likely to benefit from WLS, provided that these thresholds are closely linked to established medical comorbidities and that all other selection criteria are rigorously met. This recommendation differs from that in our previous report (i.e., BMI cut points of 40 and 50) (ref. 14).

- During the past 3 years, the body of knowledge on adolescent WLS has experienced significant growth. Over 10 new studies adolescent WLS have been published (**Table 1**). These show
- clear evidence that RYGB is reasonably safe, and highly efficacious compared with dieting for the treatment of extreme obesity (category B);
- reasonably good safety and efficacy of the AGB in adolescents (except for a high rate of reoperation and few long-term data) (category C);
- risk of late protein malnutrition in adolescent patients undergoing BPD or duodenal switch (category C).

The evidence base on which these recommendations are made has limitations that need to be addressed by future research. Currently, little research effort focuses specifically on interventions that could treat or reverse extreme obesity for young people. However, federally sponsored multicenter studies have recently started (http://www.cincinnatichildrens.org/teen-labs). Recommendations are, therefore, largely based on cohort studies, nonrandomized clinical trials, case series or reports (i.e., categories B and C), and expert opinion (category D). All programs performing WLS in adolescents should participate in rigorous long-term data collection to improve the evidence base in this field.

## SUPPLEMENTARY MATERIAL

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

## ACKNOWLEDGMENTS

Dr Lenders and the Nutrition and Fitness for Life (CL, AM, MM) at the Boston Medical Center thank the American Society for Nutrition (Physician Nutrition Specialist Award), the Carl and Ruth Shapiro Family Foundation, and the New Balance Foundation for their clinical and educational activities support. We thank Frank Hu for advice in manuscript preparation, Leslie Kirle for administrative support, and Rita Buckley for research and editorial services. This report on WLS was prepared for the Betsy Lehman Center for Patient Safety and Medical Error Reduction (Commonwealth of Massachusetts, Boston, MA). Manuscript preparation was supported, in part, by the Boston Obesity Nutrition Research Center Grant P30-DK-46200 and the Center for Healthy Living, Division of Nutrition, Harvard Medical School.

## DISCLOSURE

The authors declared no conflict of interest.



## 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;13:206–226.
2. Apovian CM, Baker C, Ludwig DS *et al*. Best practice guidelines in pediatric/adolescent weight loss surgery. *Obes Res* 2005;13:274–282.
3. Freedman DS, Mei Z, Srinivasan SR, Berenson GS, Dietz WH. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *J Pediatr* 2007;150:12–17.e2.
4. Thompson DR, Obarzanek E, Franko DL *et al*. Childhood overweight and cardiovascular disease risk factors: the National Heart, Lung, and Blood Institute Growth and Health Study. *J Pediatr* 2007;150:18–25.
5. Whitlock EP, Williams SB, Gold R, Smith PR, Shipman SA. Screening and interventions for childhood overweight: a summary of evidence for the US Preventive Services Task Force. *Pediatrics* 2005;116:e125–e144.
6. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 1997;337:869–873.
7. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard Growth Study of 1922 to 1935. *N Engl J Med* 1992;327:1350–1355.
8. Sinaiko AR, Donahue RP, Jacobs DR Jr, Prineas RJ. Relation of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin, and lipids in young adults. The Minneapolis Children's Blood Pressure Study. *Circulation* 1999;99:1471–1476.
9. Vanhala M, Vanhala P, Kumpusalo E, Halonen P, Takala J. Relation between obesity from childhood to adulthood and the metabolic syndrome: population based study. *BMJ* 1998;317:319.
10. Inge TH. Bariatric surgery for morbidly obese adolescents: is there a rationale for early intervention? *Growth Horm IGF Res* 2006;16 (Suppl A):S15–S19.
11. Daniels SR, Arnett DK, Eckel RH *et al*. Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation* 2005;111:1999–2012.
12. Garcia VF, DeMaria EJ. Adolescent bariatric surgery: treatment delayed, treatment denied, a crisis invited. *Obes Surg* 2006;16:1–4.
13. Inge TH, Xanthakos SA, Zeller MH. Bariatric surgery for pediatric extreme obesity: now or later? *Int J Obes (Lond)* 2007;31:1–14.
14. Inge TH, Krebs NF, Garcia VF *et al*. Bariatric surgery for severely overweight adolescents: concerns and recommendations. *Pediatrics* 2004;114:217–223.

15. Inge TH, Zeller MH, Lawson ML, Daniels SR. A critical appraisal of evidence supporting a bariatric surgical approach to weight management for adolescents. *J Pediatr* 2005;147:10–19.
16. Tsai WS, Inge TH, Burd RS. Bariatric surgery in adolescents: recent national trends in use and in-hospital outcome. *Arch Pediatr Adolesc Med* 2007;161:217–221.
17. Lawson ML, Kirk S, Mitchell T *et al*. One-year outcomes of Roux-en-Y gastric bypass for morbidly obese adolescents: a multicenter study from the Pediatric Bariatric Study Group. *J Pediatr Surg* 2006;41:137–143; discussion 137–143.
18. Silberhumer GR, Miller K, Kriwanek S *et al*. Laparoscopic adjustable gastric banding in adolescents: the Austrian experience. *Obes Surg* 2006;16: 1062–1067.
19. Papadia FS, Adami GF, Marinari GM, Camerini G, Scopinaro N. Bariatric surgery in a dolescents: a long-term follow-up study. *Surg Obes Relat Dis* 2007;3:465–468.
20. Yitzhak A, Mizrahi S, Avinoach E. Laparoscopic gastric banding in adolescents. *Obes Surg* 2006;16:1318–1322.
21. Collins J, Mattar S, Qureshi F *et al*. Initial outcomes of laparoscopic Roux-en-Y gastric bypass in morbidly obese adolescents. *Surg Obes Relat Dis* 2007;3:147–152.
22. Buchwald H, Avidor Y, Braunwald E *et al*. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004;292:1724–1737.
23. Angrisani L, Favretti F, Furbetta F *et al*. Obese teenagers treated by Lap-Band System: the Italian experience. *Surgery* 2005;138:877–881.
24. Barnett SJ, Stanley C, Hanlon M *et al*. Long-term follow-up and the role of surgery in adolescents with morbid obesity. *Surg Obes Relat Dis* 2005;1:394–398.
25. Horgan S, Holterman MJ, Jacobsen GR *et al*. Laparoscopic adjustable gastric banding for the treatment of adolescent morbid obesity in the United States: a safe alternative to gastric bypass. *J Pediatr Surg* 2005;40:86–90; discussion 90–91.
26. Nadler EP, Youn HA, Ginsburg HB, Ren CJ, Fielding GA. Short-term results in 53 US obese pediatric patients treated with laparoscopic adjustable gastric banding. *J Pediatr Surg* 2007;42:137–141; discussion 141–142.
27. Sugerman HJ, Sugerman EL, DeMaria EJ *et al*. Bariatric surgery for severely obese adolescents. *J Gastrointest Surg* 2003;7:102–107; discussion 107–108.
28. Rand CS, Macgregor AM. Adolescents having obesity surgery: a 6-year follow-up. *South Med J* 1994;87:1208–1213.
29. Towbin A, Inge TH, Garcia VF *et al*. Beriberi after gastric bypass surgery in adolescence. *J Pediatr* 2004;145:263–267.
30. Xanthakos SA, Inge TH. Nutritional consequences of bariatric surgery. *Curr Opin Clin Nutr Metab Care* 2006;9:489–496.
31. Aggarwal S, Kini SU, Herron DM. Laparoscopic sleeve gastrectomy for morbid obesity: a review. *Surg Obes Relat Dis* 2007;3:189–194.
32. Cottam D, Qureshi FG, Mattar SG *et al*. Laparoscopic sleeve gastrectomy as an initial weight-loss procedure for high-risk patients with morbid obesity. *Surg Endosc* 2006;20:859–863.
33. Pinhas-Hamiel O, Zeitler P. The global spread of type 2 diabetes mellitus in children and adolescents. *J Pediatr* 2005;146:693–700.
34. Scott A, Toomath R, Bouchier D *et al*. First national audit of the outcomes of care in young people with diabetes in New Zealand: high prevalence of nephropathy in Maori and Pacific Islanders. *NZ Med J* 2006;119:U2015.
35. Scott A, Whitcombe S, Bouchier D, Dunn P. Diabetes in children and young adults in Waikato Province, New Zealand: outcomes of care. *NZ Med J* 2004;117:U1219.
36. Pinhas-Hamiel O, Zeitler P. Acute and chronic complications of type 2 diabetes mellitus in children and adolescents. *Lancet* 2007;369:1823–1831.
37. Dean H. Diagnostic criteria for non-insulin dependent diabetes in youth (NIDDM-Y). *Clin Pediatr (Phila)* 1998;37:67–71.
38. Xanthakos SA, Inge TH. Extreme pediatric obesity: weighing the health dangers. *J Pediatr* 2007;150:3–5.
39. Verhulst SL, Schrauwen N, Haentjens D *et al*. Sleep-disordered breathing in overweight and obese children and adolescents: prevalence, characteristics and the role of fat distribution. *Arch Dis Child* 2007;92:205–208.
40. Kalra M, Inge T, Garcia V *et al*. Obstructive sleep apnea in extremely overweight adolescents undergoing bariatric surgery. *Obes Res* 2005;13:1175–1179.
41. Schwimmer JB, Deutsch R, Kahen T *et al*. Prevalence of fatty liver in children and adolescents. *Pediatrics* 2006;118:1388–1393.
42. Mathurin P, Gonzalez F, Kerdraon O *et al*. The evolution of severe steatosis after bariatric surgery is related to insulin resistance. *Gastroenterology* 2006;130:1617–1624.
43. Klein S, Mittendorfer B, Eagon JC *et al*. Gastric bypass surgery improves metabolic and hepatic abnormalities associated with nonalcoholic fatty liver disease. *Gastroenterology* 2006;130:1564–1572.
44. Dixon JB, Bhathal PS, O'Brien PE. Weight loss and non-alcoholic fatty liver disease: falls in gamma-glutamyl transferase concentrations are associated with histologic improvement. *Obes Surg* 2006;16:1278–1286.
45. 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.
46. Sugerman HJ, Felton WL 3rd, Sismanis A *et al*. Gastric surgery for pseudotumor cerebri associated with severe obesity. *Ann Surg* 1999;229:634–640; discussion 640–642.
47. Chandra V, Dutta S, Albanese CT *et al*. Clinical resolution of severely symptomatic pseudotumor cerebri after gastric bypass in an adolescent. *Surg Obes Relat Dis* 2007;3:198–200.
48. Sugerman HJ. Multiple benefits of bariatric surgery. *Manag Care* 2005;14:16–21.
49. Li AM, Nelson EA, Wing YK. Obstructive sleep apnoea and obesity. *Hong Kong Med J* 2004;10:144.
50. Juonala M, Raitakari M, S A, Viikari J, Raitakari OT. Obesity in youth is not an independent predictor of carotid IMT in adulthood. The Cardiovascular Risk in Young Finns Study. *Atherosclerosis* 2006;185:388–393.
51. Shargorodsky M, Fleed A, Boaz M, Gavish D, Zimlichman R. The effect of a rapid weight loss induced by laparoscopic adjustable gastric banding on arterial stiffness, metabolic and inflammatory parameters in patients with morbid obesity. *Int J Obes (Lond)* 2006;30:1632–1638.
52. Morrison JA, Friedman LA, Harlan WR *et al*. Development of the metabolic syndrome in black and white adolescent girls: a longitudinal assessment. *Pediatrics* 2005;116:1178–1182.
53. Goodman E, Daniels SR, Meigs JB, Dolan LM. Instability in the diagnosis of metabolic syndrome in adolescents. *Circulation* 2007;115: 2316–2322.
54. Ball K, Crawford D, Kenardy J. Longitudinal relationships among overweight, life satisfaction, and aspirations in young women. *Obes Res* 2004;12: 1019–1030.
55. Fallon EM, Tanofsky-Kraff M, Norman AC *et al*. Health-related quality of life in overweight and nonoverweight black and white adolescents. *J Pediatr* 2005;147:443–450.
56. Strauss RS, Pollack HA. Social marginalization of overweight children. *Arch Pediatr Adolesc Med* 2003;157:746–752.
57. Zeller MH, Modi AC. Predictors of health-related quality of life in obese youth. *Obesity (Silver Spring)* 2006;14:122–130.
58. Zeller MH, Roehrig HR, Modi AC, Daniels SR, Inge TH. Health-related quality of life and depressive symptoms in adolescents with extreme obesity presenting for bariatric surgery. *Pediatrics* 2006;117:1155–1161.
59. Herpertz S, Kielmann R, Wolf AM *et al*. Does obesity surgery improve psychosocial functioning? A systematic review. *Int J Obes Relat Metab Disord* 2003;27:1300–1314.
60. Levine MD, Ringham RM, Kalarchian MA, Wisniewski L, Marcus MD. Is family-based behavioral weight control appropriate for severe pediatric obesity? *Int J Eat Disord* 2001;30:318–328.
61. Britz B, Siegfried W, Ziegler A *et al*. Rates of psychiatric disorders in a clinical study group of adolescents with extreme obesity and in obese adolescents ascertained via a population based study. *Int J Obes Relat Metab Disord* 2000;24:1707–1714.
62. Zeller MH, Saelens BE, Roehrig H, Kirk S, Daniels SR. Psychological adjustment of obese youth presenting for weight management treatment. *Obes Res* 2004;12:1576–1586.
63. Wolfe BL, Terry ML. Expectations and outcomes with gastric bypass surgery. *Obes Surg* 2006;16:1622–1629.
64. National Center for Health Statistics. CDC growth charts: United States. Percentile Datafile with LMS values <http://www.cdc.gov/growthcharts/> (2000). Accessed 22 August 2007.
65. Gastrointestinal surgery for severe obesity: National Institutes of Health Consensus Development Conference Statement. *Am J Clin Nutr* 1992;55:615S–619S..
66. Blackburn GL, Olbers T, Schneider BE *et al*. Surgical management of obesity and post-operative Care. In: Mantzoros CS (ed). *Nutrition and Metabolism*. Aristedes Daskalopoulos Foundation: Athens, Greece, 2007.

67. Fried M, Hainer V, Basdevant A *et al*. Inter-disciplinary European guidelines on surgery of severe obesity. *Int J Obes (Lond)* 2007;31:569–577.
68. Inge TH, Garcia V, Daniels S *et al*. A multidisciplinary approach to the adolescent bariatric surgical patient. *J Pediatr Surg* 2004;39:442–447; discussion 446–447.
69. Oliak D, Owens M, Schmidt HJ. Impact of fellowship training on the learning curve for laparoscopic gastric bypass. *Obes Surg* 2004;14:197–200.
70. Schirmer BD, Schauer PR, Flum DR, Ellsmere J, Jones DB. Bariatric surgery training: getting your ticket punched. *J Gastrointest Surg* 2007;11:807–812.
71. Belle SH, Berk PD, Courcoulas AP *et al*. Safety and efficacy of bariatric surgery: Longitudinal Assessment of Bariatric Surgery. *Surg Obes Relat Dis* 2007;3:116–126.
72. Herpertz S, Kielmann R, Wolf AM, Hebebrand J, Senf W. Do psychosocial variables predict weight loss or mental health after obesity surgery? A systematic review. *Obes Res* 2004;12:1554–1569.
73. Dutta S, Morton J, Shepard E *et al*. Methamphetamine use following bariatric surgery in an adolescent. *Obes Surg* 2006;16:780–782.
74. Coates PS, Fernstrom JD, Fernstrom MH, Schauer PR, Greenspan SL. Gastric bypass surgery for morbid obesity leads to an increase in bone turnover and a decrease in bone mass. *J Clin Endocrinol Metab* 2004;89:1061–1065.
75. Cominetti C, Garrido AB Jr, Cozzolino SM. Zinc nutritional status of morbidly obese patients before and after Roux-en-Y gastric bypass: a preliminary report. *Obes Surg* 2006;16:448–453.
76. Rianthavorn P, Ettenger RB. Medication non-adherence in the adolescent renal transplant recipient: a clinician's viewpoint. *Pediatr Transplant* 2005;9:398–407.
77. Alvarez-Leite JI. Nutrient deficiencies secondary to bariatric surgery. *Curr Opin Clin Nutr Metab Care* 2004;7:569–575.
78. Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: key roles for bone, body weight, glucose tolerance, and estrogen biosynthesis. *J Pediatr Adolesc Gynecol* 2005;18:305–311.
79. Harkness LS, Cromer BA. Vitamin D deficiency in adolescent females. *J Adolesc Health* 2005;37:75.
80. Woodard CB. Pregnancy following bariatric surgery. *J Perinat Neonatal Nurs* 2004;18:329–340.
81. Wittgrove AC, Jester L, Wittgrove P, Clark GW. Pregnancy following gastric bypass for morbid obesity. *Obes Surg* 1998;8:461–464; discussion 465–466.
82. Dao T, Kuhn J, Ehmer D, Fisher T, McCarty T. Pregnancy outcomes after gastric-bypass surgery. *Am J Surg* 2006;192:762–766.
83. Wilde ML. Bioethical and legal implications of pediatric gastric bypass. *Willamette Law Rev* 2004;40:575–625.