# GUIDELINES FOR THE NUTRITIONAL MANAGEMENT OF BARIATRIC SURGERY PATIENTS: PRE- AND POST-OPERATIVELY


by

**Rachel Leigh Kreider**

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this thesis was presented

by

Rachel Leigh Kreider

It was defended on

July 30, 2010

and approved by

Melissa A. Kalarchian, PhD,
Associate Professor of Psychiatry and Psychology, School of Medicine, University of Pittsburgh

Lora E. Burke, PhD, MPH, FAHA, FAAN
Professor of Health and Community Systems, School of Nursing, University of Pittsburgh

Diane L. Helsel, PhD, RD, CSSD
Assistant Professor of Sports Medicine and Nutrition, School of Health and Rehabilitation Sciences, University of Pittsburgh

**Thesis Chair**: Jessica G. Burke, PhD, MHS
Assistant Professor of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

**GUIDELINES FOR THE NUTRITIONAL MANAGEMENT OF BARIATRIC SURGERY PATIENTS: PRE- AND POST-OPERATIVELY**

Rachel L. Kreider, MPH

University of Pittsburgh, 2010

**Objective**: The purpose of this thesis was to explore the nutritional management of bariatric surgery patients. This thesis utilized a literature review to locate the guidelines which address the nutritional management of bariatric surgery patients. To this end, a literature search was completed to find the guidelines. Many components of the nutritional guidelines reviewed were based on limited research, and mostly on expert opinion. The guidelines for the nutritional management of bariatric surgery are categorized by preoperative assessment/education, post-operative diet progression, supplement use and long-term follow-up. Another aim was to find out if these guidelines are used in practice and followed by individuals who have had bariatric surgery. After the guidelines were reviewed and summarized, another literature search was undertaken to find empirical research regarding the diet quality of individuals who have had bariatric surgery. Finally, the available research is critiqued and recommendations are made for directions of future research.

**Method**: PubMed searches were the primary source of literature to be used for this review.

**Conclusion**: The nutritional management of individuals who have had bariatric surgery is complex and must be carried out for the long-term. Deficiencies of vitamins, minerals and protein were reported with some frequency, but other concerns relate to inadequate weight loss to achieve clinical significance. More work needs to be done to understand how patients can maximize their weight loss after surgery while maintaining adequate nutritional status. Results of the research reviewed were highly variable, but many studies were conducted using convenience

samples. The public health significance of this paper lies in the fact that as the obesity epidemic persists in the United States; more and more patients are turning to bariatric surgery as a treatment for obesity. Well-researched guidelines are imperative to the care of these individuals and to ensure that the health care dollars spent on the surgery are being used effectively.

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# PREFACE

I would like to thank my committee members, for providing the guidance and expertise to help me navigate through the process of writing a thesis. I believe that I had the perfect combination of committee members, with your expertise in nutrition, bariatric surgery, weight loss and social sciences research; you were able to help me to find the best research available and help me to polish my ideas and writing.

# 1.0 INTRODUCTION

The obesity epidemic in the United States, and worldwide, has lead to a search for more effective methods of long term weight loss. While diet, exercise and more recently, pharmaceutical treatments are well-known options for weight loss, surgical weight loss has become an increasingly accepted option. In the past 20 years, weight loss surgery, also known as bariatric surgery, has become a more common procedure (Saber, Elgamal, & McLeod, 2008). Bariatric surgery involves decreasing the size of a patient's stomach, bypassing a portion of the small intestine to decrease the amount of calories absorbed, or a combination of the two (Buchwald et al., 2004).

Bariatric surgery poses a monumental change in the lives of those who choose to undergo the procedure. These patients must drastically change their eating habits in order to ensure a successful result from the surgery (Nagle, 2010; Wulkan & Durham, 2005); consequently, bariatric surgery is a tool that is intended to help the individual make the behavior changes necessary for weight loss to occur. The management of patients who have had bariatric surgery may be categorized into two phases; the pre-operative period and the post-operative period. Each phase comes with its own set of challenges. Several organizations (Aills, Blankenship, Buffington, Furtado, & Parrott, 2008; Jeffrey I. Mechanick et al., 2008; Sauerland et al., 2005) have provided guidelines on the most effective management of individuals who have had bariatric surgery. It is assumed that the goal of such guidelines is to maximize the quality of care that these patients receive.

Though there are several sets of guidelines for the pre-operative assessment and care of surgical candidates, and for the postoperative period, there is lack of true consensus regarding the "best" practice guidelines (Aills et al., 2008). Moreover, there are many components to these guidelines, which include the preoperative assessment methods used in determining surgical eligibility, surgical methods used, diet recommendations in the immediate post-operative period, and recommendations regarding follow-up appointments for long-term care of post-surgical patients.

The preoperative period is easier to regulate, as the surgery will not be approved for payment if the patient is non-compliant with the process as set forth by his or her insurance company and the requirements of the surgeon. The post-operative period remains a challenge, as mandating follow-up is difficult after the surgical intervention has been completed (Toussi, Fujioka, & Coleman, 2009). This makes it more difficult to study the type of postoperative dietary changes that are associated with long-term success following bariatric surgery.

Patients having bariatric surgery require surgical intervention because they have been unable to sustain a significant weight-loss for an extended period of time; however, the health risks of being overweight should be greater than undergoing surgery (Kulick, Hark, & Deen, 2010). There are several surgical methods used, including laparoscopic adjustable gastric banding (LAGB), roux-en-y gastric bypass (RYGB), biliopancreatic diversion (BPD), or biliopancreatic diversion with duodenal switch (BPD/DS). The purpose of LAGB is to reduce the size of the stomach in order to decrease the amount of food consumed, in turn decreasing calorie intake (Buchwald et al., 2004). RYGB involves reduction of the stomach size and bypass of the first portion of the small intestine. The smaller size of the stomach (gastric pouch) limits the amount of food that the patient can eat in one sitting, while the bypass of the intestine causes malabsorption, which means that the individual does not absorb the normal amount of calories and other nutrients from food passing through the gastrointestinal (GI) tract (Buchwald et al., 2004). BPD involves altering the time that the digestive enzymes have to interact with food in the GI tract, which inhibits proper absorption of calories and nutrients (Saber et al., 2008). BPD/DS was a modified version of BPD which was developed to add a component of gastric restriction and to reduce the risk of developing ulcers (Saber et al., 2008). The malabsorptive component of surgery can be somewhat problematic, because it not only reduces the calories absorbed from food, it also decreases the absorption of key nutrients (Saber et al., 2008).

Although there have been some reports of overall caloric intake postoperatively, the types and quantities of food that post-surgical individuals eat have not been not well documented (Thomas, Gizis, & Marcus, 2010). It might be assumed that those who are unsuccessful following bariatric surgery consume excessive calories (tipping energy balance equation toward weight gain), however, few studies have closely examined the diet quality of individuals post-surgery via well-controlled studies. In fact, little is known about what the post-operative diet of individuals who have had bariatric surgery (Thomas et al., 2010). Compliance with dietary recommendations is particularly important as the patient transitions from a period of rapid weight loss during the first year, to a period of longer-term weight stabilization, and possible weight regain.

This thesis will provide a review of the current dietary and nutritional guidelines and recommendations for individuals who have undergone bariatric surgery. The literature review methods section provides a summary of the guidelines that will be reviewed. This review will be followed by a summary of the existing literature on postoperative diets and eating behaviors among bariatric surgery patients. The intent of this review is to learn if the guidelines are being followed, and determine if patients are encountering any nutritional issues post surgery that have not been addressed in the guidelines. Finally, gaps in the research and literature will be identified and recommendations will be made for areas in need of future research.

## 1.1 OBESITY DEFINED

The definition and classification of obesity is based primarily on the body mass index (BMI), which is calculated by dividing weight in kilograms (kg) by the square of height in meters (m). BMI assessment is a method for stratifying health risk based on a person's height and weight. Use of BMI has limitations, for example, a very muscular person can have a high BMI, but very low percentage of body fat. However, in the general population, BMI is a good proxy for health risks (World Health Organization, 2000). Other limitations include differences in BMI based on racial background and, during weight loss, BMI is not a good indicator of fat loss (Prentice & Jebb, 2001). A summary of the BMI classification system can be found in Table 1 (Flegal, Carroll, Ogden, & Curtin, 2010).

Individuals with Class III obesity are at the highest health risk compared to less obese individuals (Flegal et al., 2010). Analysis of data from 1999-2004 showed that almost 5% of adults in the United States (U.S.) are now classified as having Class III, or extreme obesity. More than 10% of African-American adults in the U.S. now fall into this category. (Ogden et al., 2006). More recent data (1999-2008) showed 5.7% prevalence of obesity in U.S. adults (Flegal et al., 2010). Some evidence indicates that the obesity epidemic is leveling off, predominantly in women, and possibly men; but declines in the prevalence of obesity have not yet been noted (Flegal et al., 2010). The prevalence of obesity in the United States has brought national attention to the matter, and many public prevention programs are being put into place to quell the epidemic. Though the perception of some may be that obesity is a disease caused by personal lack of self-control or will-power, the truth is that obesity is a complex, multi-factorial chronic disease that results from an interaction of genotype and the environment (Lee, 2009). The complexity of the disease necessitates interventions at various levels, from the individual to that of society.

Obesity impacts all organ systems, placing obese individuals at increased risk for a variety of comorbid conditions, including diabetes, hypertension, dyslipidemia, heart disease, sleep apnea, some types of cancer, nonalcoholic fatty liver disease and osteoarthritis, among others (Buchwald, 2004; National Institutes of Health, 1992). Additionally, there are social and economic hindrances of obesity that cannot be ignored (National Institutes of Health, 1992).

**Table 1. BMI Classifications**

| | **BMI ($kg/m^2$)** | **Obesity Class** |
|---|---|---|
| Underweight | ≤18.5 | |
| Normal Weight | 18.5-24.9 | |
| Overweight | 25-29.9 | |
| Obesity | 30-34.9 | I |
| | 35-39.9 | II |
| Extreme Obesity | ≥40 | III |

## 1.2 OBESITY EPIDEMIC

The prevalence of obesity has increased dramatically in the United States during the past three decades (Ogden et al., 2006; Wang & Beydoun, 2007). Trends also show that the prevalence of obesity is spread disproportionately among certain subgroups of the population, such as non-Hispanic Blacks (76.1%) and Mexican Americans (75.8%), compared to 64.2% of Whites (Wang & Beydoun, 2007). The National Health and Nutrition Examination Survey (NHANES), Behavioral Risk Factors Surveillance Survey (BRFSS) and The National Longitudinal Study of Adolescent Health (Add Health Study) data show that these disparities are more profound among women than men (Wang & Beydoun, 2007). Socioeconomic status (SES) disparities also exist, but are complex, as increases in obesity are seen across all categories of SES. Low-SES black men and women represent more extreme cases of the disproportional nature of the obesity epidemic (Wang & Beydoun, 2007).

Obesity is now considered to be the second most preventable cause of death in the U.S. (Wulkan & Durham, 2005). Unfortunately, obesity has also become a problem for most other Western nations (Detournay et al., 2000; Freedman, Khan, Serdula, Galuska, & Dietz, 2002; Rissanen, 1996) The health risks associated with obesity increase with increasing levels of obesity (National Institutes of Health, 1992). Obesity also makes a significant impact from a cost perspective. Obesity-related illnesses such as diabetes mellitus, knee osteoarthritis, systemic hypertension and heart failure are estimated to be responsible for 3% to 6% of total health care costs (Allison, Zannolli, & Narayan, 1999; Must et al., 1999; Rissanen, 1996). Aside from the financial burden of obesity, obesity is also a social problem. Discrimination and bias of obese individuals can be seen as early as preschool and continues through childhood and even adulthood (Buchwald, 2004). Combining these “intangible” socioeconomic costs of obesity with the calculable health care costs results in estimated costs exceeding $117 billion annually in the U.S. (Buchwald, 2004).

## 1.3 OBESITY TREATMENT MODALITIES

Treatment modalities currently available for weight loss work by inducing a state of negative energy balance. Negative energy balance occurs when an individual consumes fewer calories than the amount used by the body. Negative energy balance may be achieved by consuming fewer calories than needed, by increasing the level of physical activity or a combination of both. Dietary intervention, physical activity, pharmacotherapy and surgery are the treatment modalities currently available to accomplish the goal of negative energy balance (Klein et al., 2004). Combinations of these approaches may also be used to achieve clinically significant weight loss, as many studies have examined the effectiveness of using different combinations of these treatment methods (Wadden et al., 2005; Wadden, Butryn, & Wilson, 2007). Decreasing body fat to improve appearance, physical function, quality of life and medical health are the goals of obesity treatment (Klein et al., 2004).

### 1.3.1 **Behavior Change (Diet and Physical Activity)**

Behavioral weight loss approaches may include dietary modifications, physical activity components or a combination of the two. There are many well-known dietary modification techniques available to induce weight loss. Most methods suggest either a reduction in caloric intake or changes in the macronutrient (protein, fat and carbohydrate) composition of the diet (Hankey, 2010). The standard approach to dietary modification to achieve weight loss is a low-fat diet (Pi-Sunyer et al., 1998), but today, there are many variations in the prescribed diet. Some dietary guidelines include blanket recommendations for the number of calories an individual should consume; others make recommendations specific to the individual's BMI, which was shown to be beneficial in preventing loss to follow-up. In the end, the amount of weight lost was not significantly different (Leslie, Lean, & Hankey, 2001). Another study compared various modifications in diet macronutrient composition, and found that by year on in the intervention period, macronutrient composition only made a small difference in the amount of weight lost; compliance to the diet was the most important factor in this study (Sacks et al., 2009).

An alternative method of inducing weight loss is increasing one's level of physical activity to increase the amount of calories metabolized. Physical activity can be challenging for overweight individuals, as the amount of exercise recommended (*Physical activity and public health guidelines*, 2007) to achieve a clinically significant weight loss is 60-90 minutes, 5 days per week. Physical activity has been shown to be more important for weight maintenance (prevention of weight regain) (Jakicic et al., 2001; Saris et al., 2003).

Behavioral interventions may result in a 5% to 10% weight loss over a 6-month period. Though this amount of weight loss may seem small to the patient, it can be clinically significant for an obese patient (Yanovski & Yanovski, 2002). The difficulty in maintaining weight loss through behavior changes has lead to a search for other treatment modalities that are more effective for long term weight maintenance.

### 1.3.2 **Pharmacotherapy**

Some commonly used pharmacologic agents used to induce weight loss are sibutramine, orlistat and phentermine. Sibutramine works by blocking the reuptake of norepinephrine and to a lesser degree dopamine. The modulation of these neurotransmitters decreases food intake by producing sensation of early satiety. Also, initiation of the subsequent meal is delayed (Klein et al., 2004). Orlistat blocks the digestion and absorption of dietary fat by binding to intestinal lipases (Hadvary, Lengsfeld, & Wolfer, 1988) . Phentermine stimulates the release of norepinepherine and dopamine. It is not approved for long term use (Klein et al., 2004; Stafford & Radley, 2003), but is less expensive than sibutramine, so it is prescribed more often. Only sibutramine and orlistat are approved for long term use. Long term use is necessary (Klein et al., 2004), as most patients who respond to pharmacotherapy usually regain weight when the drug therapy is stopped (Finer, James, Kopelman, Lean, & Williams, 2000; Rossner et al., 2000). Drugs such as amphetamines and thyroid derivatives are unsafe and unapproved (National Institutes of Health 1992). Although pharmacotherapy for weight loss can be successful, the long term maintenance, cost, side effects and risks of using such therapy may make them less attractive treatment options to some patients.

### 1.3.3 **Combination Approaches**

Diet modification, physical activity, and pharmacotherapy may all be used in combination to achieve weight loss. Wadden et al. studied the effectiveness of weight loss medication (sibutramine) in combination with lifestyle modification (group therapy providing instruction and support for diet modification, physical activity and other important components of weight loss) to medication or lifestyle modification alone in 224 subjects in a randomized study. This study revealed that patients receiving sibutramine in combination with lifestyle modification lost nearly double the weight of those receiving the treatments in isolation. Also, nearly twice the number of the participants lost 10 percent or more of their initial body weight. This study indicates the potential value in combining medication therapy with lifestyle modification for the most optimal outcome (Wadden et al., 2005).

### 1.3.4 **Surgery**

The bottom line issue with the aforementioned non-surgical weight loss treatments is their failure to achieve long term, clinically significant weight loss (Wulkan & Durham, 2005). Failures inherent in these treatment modalities likely led to the development of bariatric surgery. Bariatric surgery is the most effective weight loss therapy for people who are extremely obese (Klein et al., 2004). In analysis of cost effectiveness of various means of weight loss, all major surgical obesity treatments were found to give better results than conservative treatment in morbidly obese patients (Clegg, Colquitt, Sidhu, Royle, & Walker, 2000).

# 2.0 FOCUS ON BARIATRIC SURGERY

The term "bariatric surgery" refers to several modalities for the surgical treatment of obesity. The procedures being performed today include: vertical banded gastroplasty (VBG), laparoscopic adjustable gastric band (LAGB), biliopancreatic diversion (BPD), BPD with duodenal switch (BPD/DS), roux-en-Y gastric bypass (RYGB), long-limb RYGB, and banded RYGB (Mechanick et al., 2008). Roux-en-Y gastric bypass is the safest and most efficacious bariatric surgery and, thus, is currently the most commonly performed operation, comprising about 70-75% of all bariatric procedures (Santry, Gillen, & Lauderdale, 2005; Smith, Schauer, & Nguyen, 2008). Gastric bypass was the first of the gastric procedures for morbid obesity and the first procedure that combined malabsorption with gastric restriction (Buchwald, 2004; Buchwald et al., 2004). The malabsorptive and restrictive components are intended to induce negative energy balance, and thus, weight loss.

In the RYGB procedure, the distal stomach, duodenum, and proximal jejunum are bypassed (Buchwald et al., 2004). In the U.S., RYGB is considered the gold standard surgical approach because it yields greater weight loss than LAGB and also results in better improvements of comorbidities (Buchwald et al., 2004; Carlos do Rego Furtado, 2010; Huang, Lin, Huang, Hsu, & Tien, 2010). The restrictive component of RYGB involves the creation of a small gastric pouch, which promotes a feeling of fullness early in an eating episode (Elder &

Wolfe, 2007) and decreases intake (Buchwald, 2004). After surgery, the patient's stomach is reduced to a capacity of roughly 15-25 mL (Buchwald, 2004) which is about 2% of total gastric capacity before surgery (Csendes & Burgos, 2005). Though the physiological modifications of surgery are believed to be the primary reason for weight loss after surgery, there are also changes in hormonal and neural pathways that seem to create a favorable situation for weight loss (Borg et al., 2006; Elder & Wolfe, 2007; Holdstock, Zethelius, Sundbom, Karlsson, & Eden Engstrom, 2008).

According to the American Society for Metabolic and Bariatric Surgery, the number of bariatric surgery procedures performed in the United States is increasing rapidly (Mitka, 2003). In 1998, 13,365 bariatric surgery procedures were performed (Santry et al., 2005). In 2003, 103,000 procedures were performed; in 2008, approximately 220,000 procedures were performed (Buchwald & Oien, 2009). Long waiting lists for the surgery are reported, and given the high prevalence of obesity in the United States, it seems that the procedure's acceptability and usage will continue to increase (Mitka, 2003).

Most patients who have bariatric surgery are female. One meta-analysis found that 72.6% of patients are female compared to males that represent 19.4% of bariatric surgery patients. The average age of bariatric surgery patients is 38.97 years, ranging from 16.20 to 63.60 years of age (Buchwald et al., 2004). Examination of almost 160,000 records of "morbidly obese" patients found that individuals who were non-white, male, poorer, older, non-private insurance covered, sicker and living in a rural area had substantially lower odds of receiving bariatric surgery than those with the opposite characteristics (Wallace, Young-Xu, Hartley, & Weeks, 2010). These results are of concern considering that those not receiving surgery may belong to groups in which obesity is more prevalent (Livingston & Ko, 2004; Wallace et al., 2010).

Bariatric surgery is not without risk. Although, there is a relatively small potential for complications, there are multiple challenges associated with managing these patients. Long-term consequences of surgery may include dumping syndrome, stomal stenosis, marginal ulcers, staple line disruption and internal hernias (Buchwald, 2004). Dumping syndrome is also known as rapid gastric emptying. Symptoms can be quite uncomfortable for the patient and include nausea, vomiting, abdominal pain, diarrhea, weakness, and faintness with sweating and hypoglycemia after a meal (Hejazi, Patil, & McCallum, 2010). It has been said that bariatric surgery is not always a low-risk procedure, thus patients should be selected judiciously and peri-operative management should be thorough (Mechanick et al., 2008). Whenever possible, bariatric surgery is done laparoscopically, which typically results in fewer complications, less pain postoperatively, shorter length of stay in the hospital, and more rapid recovery (Schauer PR & Ikramuddin S, 2001; Schauer, Ikramuddin, Gourash, Ramanathan, & Luketich, 2000; vila-Cervantes et al., 2002).

In addition to the peri-operative period, the postoperative period can be fraught with challenges. Many patients have maladaptive eating behaviors, nutritional deficiencies or inadequacies and may not gain resolution of these issues with surgery. Lack of resolution can sabotage the patients' chances for success after surgery (Mechanick et al., 2008). The long-term nutritional management of bariatric surgery patients is important and can be complex.

There are multiple challenges associated with the nutritional management of postoperative bariatric surgery patients, some of which include vitamin and mineral deficiencies, protein malnutrition and the potential for weight regain. Figure 1 shows sites of absorption in the gastrointestinal tract, illustrating how bypassing any of these sections of intestine may impair the body's ability to absorb nutrients after surgery. Although bariatric surgery has been done since the 1950's (Saber et al., 2008), the guidelines for the nutritional management of bariatric surgery patients have been mostly derived from expert opinion versus clinical research studies (Aills et al., 2008; Mechanick et al., 2008).

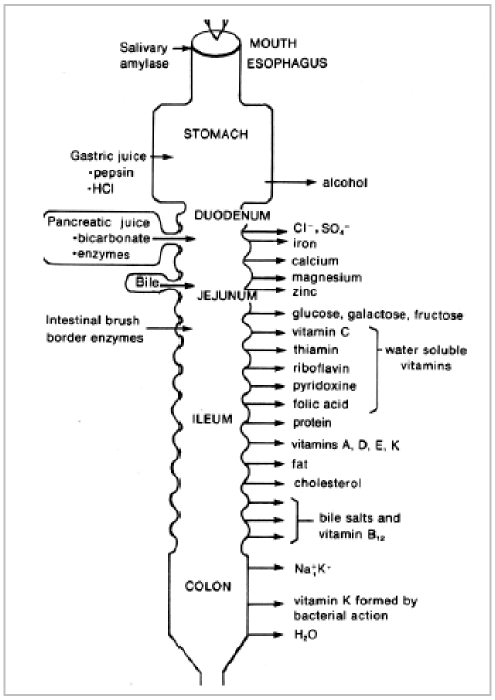


**Figure 1. Site of Absorption of Common Vitamins and Nutrients in the Gastrointestinal Tract (Image borrowed from Mahan and Escott-Stump: Krause's Food, Nutrition and Diet Therapy, 9th Edition, p. 13 ©1996 with permission from Elsevier)**

# 3.0 LITERATURE REVIEW

To determine available guidelines for bariatric surgery, several PubMed literature searches were conducted. A similar Medline search was also conducted, which yielded more articles, many of which were used in the second portion of this thesis. The PubMed search yielded more articles that were specific to guidelines published by bariatric surgery expert groups, such as the American Society for Bariatric and Metabolic Surgery (ASMBS). Terms used to search for guidelines regarding the nutritional management of bariatric surgery patients, can be found in Table 2. This search yielded 18 articles.

**Table 2: PubMed Search Terms Used to Find Guidelines**

| |
|---|
| (("Guidelines as Topic"[Mesh] OR "Practice Guideline "[Publication Type]) OR "Guidelines as Topic"[Mesh]) AND ("bariatric surgery"[MeSH Terms] OR ("bariatric"[All Fields] AND "surgery"[All Fields]) OR "bariatric surgery"[All Fields]) AND ("nutritional sciences"[MeSH Terms] OR ("nutritional"[All Fields] AND "sciences"[All Fields]) OR "nutritional sciences"[All Fields] OR "nutrition"[All Fields]) |

When filtered to show English language articles only, the search yielded 16 articles. Of these 16 articles, one had been published in 2 journals, leaving 15. Articles excluded were those focusing on bariatric surgery in adolescents and very specific populations (e.g.: Asian Indians). Although these guidelines are important, the intention of this paper was to locate optimal nutrient intake and eating pattern guidelines that could be applied to the general population. Several articles were determined to be irrelevant and therefore excluded (i.e. articles on body contouring surgery, an article regarding best practices for weight loss centers in general, and another that included weight loss guidelines (by all weight loss modalities, including bariatric surgery) for patients with cardiovascular disease).

Upon careful review of each article, several more were eliminated. The piece written by Malone (2008) provides explanation of nutrient deficiencies but in the end does not make recommendations for optimal levels of nutrients necessary to prevent deficiency. Strict guidelines were not provided. The article by Asheim, Hofso, and Sovik (2010) was an editorial, and was thus eliminated. Also, the Blackburn (2009) article was eliminated as it was an introduction to guidelines that were irrelevant to the nutritional care and management of bariatric surgery patients; it contained information such as the equipment necessary to accommodate the bariatric surgery population. The Laville article (2005) though short, was still included as it contained information that pertained to nutritional management of bariatric surgery patients. Guidelines from the National Institutes of Health (1992) were also included, as most guidelines cited those as the basis for their much more comprehensive guidelines. Table 3 provides a list of all articles considered and explanation as to which were used and which were excluded. The process used to develop each set of guidelines used is defined in Table 4.

**Table 3. Explanation of Which Articles Were Included as "Guidelines"**

| Articles Found | Included | Comments |
|---|---|---|
| Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management.<br>(Misra et al., 2009) | | Specific population (Asian Indians) |
| Vitamin supplements after bariatric surgery.<br>(Aasheim et al., 2010) | | Editorial |
| American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. | ✔ | |

**Table 3. Continued**

| Articles Found | Included | Comments |
|---|---|---|
| (Mechanick et al., 2008) | | |
| Updated evidence-based recommendations for best practices in weight loss surgery. (Blackburn et al., 2009) | | Referred to general bariatric surgery info, such as the equipment necessary to accommodate bariatric surgery patients. |
| Bariatric surgery in adolescents: mechanics, metabolism, and medical care. (Murray, 2008) | | Specific to adolescents |
| Optimization of patient safety in post-bariatric body contouring: a current review. (Colwell & Borud, 2008) | | Article not appropriate for use, addressed body contouring surgery |
| American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. (Mechanick et al., 2008) | | Duplicate article |
| Recommended nutritional supplements for bariatric surgery patients. (Malone, 2008) | | Discussed lack of guidelines, and signs/symptoms of deficiencies, but did not make specific recommendations for nutrient consumption |
| Obesity in children. Part 2: Prevention and management. (Kipping, Jago, & Lawlor, 2008) | | Specific to children, for obesity in general |
| ASMBS Allied Health Nutritional Guidelines for the Surgical Weight Loss Patient. (Aills et al., 2008) | ✔ | |
| Bariatric surgery in adolescents: an update. (Xanthakos, Daniels, & Inge, 2006) | | Specific to adolescents |
| What to look for when referring to an obesity management program. (Thompson, 2006) | | Referred to the elements of a good weight loss program, was not specific to bariatric surgery |
| Recommendations regarding obesity surgery. (Laville et al., 2005) | ✔ | |
| A proposal of guidelines for surgical management of obesity. (Carrasco et al., 2005) | | Article in Spanish |
| Best practice guidelines in pediatric/adolescent weight loss surgery. (Apovian et al., 2009) | | Specific to adolescents |
| Obesity surgery: evidence-based guidelines of the European Association for Endoscopic Surgery (EAES). (Sauerland et al., 2005) | ✔ | |
| Clinical implications of obesity with specific focus on cardiovascular disease: a statement for professionals from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: endorsed by the American College of Cardiology Foundation. (Klein et al., 2004) | | Referred to weight loss by all methods, and was specific with implications to cardiovascular disease |
| Recommendations for the treatment of obesity. (Luyckx & Scheen, 2000) | | Article in French |

Numerous authors have pointed out the dearth of guidelines available for the nutritional management of bariatric surgery patients (Malone, 2008; Moize, Pi-Sunyer, Mochari, & Vidal, 2010). In the preparation for this paper, it was realized that one must define guidelines versus a recommendation. In PubMed, "Guidelines" were defined as "Work consisting of a set of statements, directions, or principles presenting current or future rules or policy. Guidelines may be developed by government agencies at any level, institutions, organizations (such as professional societies or governing boards), or by the convening of expert panels. The text may be cursive or in outline form, but it is generally a comprehensive guide to problems and approaches in any discipline or activity. This concept relates to the general conduct and administration of health care activities rather than to specific decisions for a particular clinical condition." "Practice Guidelines" were defined as: "Work consisting of a set of directions or principles to assist the health care practitioner with patient care decisions about appropriate diagnostic, therapeutic, or other clinical procedures for specific clinical circumstances. Practice guidelines may be developed by government agencies at any level, institutions, organizations (such as professional societies or governing boards), or by the convening of expert panels. They can provide a foundation for assessing and evaluating the quality and effectiveness of health care in terms of measuring improved health, reduction of variation in services or procedures performed, and reduction of variation in outcomes of health care delivered" (from PubMed MeSH database).

After finalizing the list, the guidelines were reviewed for information relevant to nutrition management of patients after bariatric surgery, and finally, common information was compared, contrasted and synthesized. After synthesizing the guidelines, a second literature review was performed to find existing studies that examined whether guidelines are being followed by bariatric surgery patients. These studies were then analyzed, and if possible, mapped back to the guidelines. Additional literature from selected resources was also included if deemed relevant. For example, the April 2010 edition of the Journal of the American Dietetic Association focused primarily on bariatric surgery, thus many of these articles were included, even though they were not found directly via PubMed searches.

**Table 4. Methods of Development for Guidelines Reviewed**

| Guidelines Reviewed | Body Issuing Guidelines | Method of Development |
|---|---|---|
| American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. (Mechanick et al., 2008) | American Association of Clinical Endocrinologists (AACE), The Obesity Society (TOS) and the American Society for Metabolic and Bariatric Surgery (ASMBS) | Co-chairmen and writing teams from each of the respective organization combined forces to develop clinical practice guidelines (CPG). Each article included was rated from 1 (Prospective, randomized, controlled trials—large) to 4 (Expert opinion) and graded from A (more than 1 conclusive level 1 publication demonstrating benefits greater than risks) to D (no conclusive level 1, 2 or 3 publication demonstrating benefit greater than risk or conclusive level 1, 2, or 3 demonstrating that risk greater than benefit). |
| ASMBS Allied Health Nutritional Guidelines for the Surgical Weight Loss Patient. (Aills et al., 2008) | American Society for Metabolic and Bariatric Surgery Allied Health Sciences Section Ad Hoc Nutrition Committee | No explanation given, but stated directly in first paragraph that the document is not meant to be a statement of standardization or scientific consensus |
| Recommendations regarding obesity surgery. (Laville et al., 2005) | n/a | No explanation given |
| Obesity surgery: evidence-based guidelines of the European Association for Endoscopic Surgery (EAES). (Sauerland et al., 2005) | European Association for Endoscopic Surgery | Consensus panel appointed, a list of key questions was developed. Literature systematically reviewed, and attempts were made to find Randomized Controlled Trials. Consensus statements were developed for each question using Nominal Group Process. Evidence was graded for relevance and quality. |

## 4.0 NUTRITION GUIDELINES FOR BARIATRIC SURGERY PATIENTS

The presentation and content of general nutrition guidelines can vary widely, depending on their purpose. One of the most recognizable set of nutrition guidelines in the United States is "MyPyramid," which includes guidance on daily average servings of grains, meats, dairy, fruits, vegetables, oil and "discretionary calories" that the average American should consume daily. It also encourages physical activity (http://www.mypyramid.gov/pyramid/index.html).

Unfortunately, guidelines for a specific population, like bariatric surgery patients, are not as simple to develop, or easy to find. Due to the vast changes in the gastrointestinal tract, bariatric surgery patients have a very specific set of nutritional concerns. The guidelines reviewed here were found through a PubMed search. Several authors have noted that nutrition guidelines are more often based on expert opinion (Kulick et al., 2010; Kushner & Neff, 2010; Snyder-Marlow, Taylor, & Lenhard, 2010), however, they are the best available. Each set of recommendations was analyzed and recommendations for specific nutrients were grouped together for simplicity.

## 4.1 PREOPERATIVE ASSTSSMENT/EDUCATION

The dramatic change to the bariatric surgery patient's digestive system after surgery warrants education and training prior to surgery. The first step in this process is the preoperative evaluation; however, the overall preoperative assessment is outside the scope of this paper, therefore the focus will be placed only on the pieces of preoperative assessment related to nutrition (i.e., eating behavior, weight, and disordered eating). Medical history, laboratory tests and potentially psychiatric assessment and treatment are the major components of the assessment (Sauerland et al., 2005). ASMBS, TOS and AACE (2008) recommend that the preoperative assessment include an obesity-focused history, physical examination and pertinent laboratory and diagnostic testing.

The patient's eating behavior and weight history is an important part of the evaluation. Obtaining an overall view of the patient's nutrition history (i.e., knowledge and understanding of nutrition, where they shop for food, when and where they eat, typical portion sizes, who shops for food, who cooks and intake of sugar-sweetened beverages) is important in determining potential barriers to a successful surgical outcome. Identifying these barriers may allow for planning and treatment protocols that increase the likelihood that those patients will achieve clinically significant weight loss post surgery (Aills et al., 2008; Mechanick et al., 2008). Some of these assessments are also requirement for third party payment for surgery. Some payers require detailed documentation of previous weight loss efforts with medical supervision and detailed weigh-ins. Others require a 6 to 12-month medically supervised weight loss prior to authorization for surgery (Mechanick et al., 2008). Most of the guidelines reviewed say that surgical candidates should be seen by a registered dietitian or other nutrition expert, who will assess the patient's current diet and nutrition knowledge, and also provide education for the postoperative period (Aills et al., 2008; Laville et al., 2005; Mechanick et al., 2008; Sauerland et al., 2005).

The recommended laboratory testing may include the following: a complete blood count (CBC), platelets, electrolytes, glucose, iron studies, ferritin, vitamin B12, liver function test, lipid profile, 25-hydroxyvitamin D, (Mechanick et al., 2008). Other guidelines recommend baseline laboratory assessments on the following vitamins: B2, B6, B12, folate, A, D, E, K, in addition to iron, zinc, and protein levels (Aills et al., 2008; Mechanick et al., 2008). The baseline lab levels can help to differentiate between complications, deficiencies due to the surgery, noncompliance with supplement regimen or pre-existing deficiencies (Aills et al., 2008).

In addition to the standard laboratory assessments, other social and demographic factors that could impact the patient's ability to comply with the guidelines should be assessed. As has been shown with many health behaviors, living in an environment that is supportive of positive changes is predictive of success in making changes (Stokols, 1992). Some of these factors may include ability to afford supplements, high-protein foods, access to food recommended in the guidelines, etc. Assessment of the impact of the patient's socioeconomic status on their surgical outcome is also an important factor to consider in the preoperative phase (Aills et al., 2008; Sauerland et al., 2005), especially because socioeconomic problems are prevalent in the bariatric surgery population (Livingston & Ko, 2004)

## 4.2 EARLY POSTOPERATIVE DIET RECOMMENDATIONS

In the days immediately following bariatric surgery, the patient has limited ability to eat "normally." Most guidelines recommend a diet that is progressed from clear liquids eventually back to solid food in the days and weeks following surgery. The diet progression may vary based on the type of procedure performed (Mechanick et al., 2008). The goals of nutritional management of bariatric surgery patients is to promote intake of sufficient energy and nutrients (Sauerland et al., 2005) to allow healing and preservation of lean tissue during the period of rapid weight loss after surgery and to consume foods that do not cause dumping syndrome, reflux or early satiety, while keeping caloric intake low enough to allow the patient to lose weight (Aills et al., 2008).

It should be noted that there may be variations to the diet progression presented in this paper for different procedures. The progression reviewed here is for RYGB, because it is the procedure that is performed most commonly in the United States. The progression referenced by Mechanick et al. (2008) (and in this thesis) is borrowed from the Massachusetts General Hospital Weight Center in Boston, Massachusetts. They posit that there is no standardization of diet stages, and stages may change based on individual needs.

### 4.2.1 **Post-Operative Day 1-2**

A clear liquid diet should be initiated within the first 23 hours after the procedure. The clear liquids, with no carbonation, no sugar, and no caffeine, should supply fluids and electrolytes (Aills et al., 2008) with little or no energy (Mechanick et al., 2008). It is thought that a small amount of energy will encourage gut activity (Aills et al., 2008). This diet should be continued through days one and two after surgery (Aills et al., 2008; Mechanick et al., 2008). It is also recommended that a consultation with a registered dietitian, who is a member of the surgery team, be arranged during the patient's hospital stay (Mechanick et al., 2008).

### 4.2.2 **Post-Operative Day 3: Discharge Diet—Full Liquids**

Full liquids should be started 3 days after surgery. These full liquids should be sugar free or low sugar. Full liquids include milk, milk products, milk alternatives and other liquids containing solutes. Also, protein supplements may be used in this phase of the diet (Aills et al., 2008; Mechanick et al., 2008); mixed with milk or lactose-free milk (Mechanick et al., 2008). The full liquids should have $\leq$15 grams of sugar and no more than 20 grams of protein per serving (Mechanick et al., 2008). The patient should be encouraged to have salty fluids and solid liquids (i.e., sugar-free popsicles (Mechanick et al., 2008). The assumption with the diet progression is that the patient will continue to consume foods from the previous phase of the diet, in this case, clear liquids. The patient should consume a combined total of 48-64 fluid ounces of full and clear liquids, about half clear and half full liquid (Mechanick et al., 2008). The full liquid diet is believed to allow the healing process to continue while providing the protein and calories of a very low calorie diet (Aills et al., 2008). Mechanick et al. (2008) also recommends initiating a multivitamin supplement regimen on post-operative day three. The supplement should be a chewable multivitamin, given twice daily. Additionally a chewable or liquid form of calcium citrate plus vitamin D should also be taken.

### 4.2.3 **Post-Operative Days 10-14**

At this point in the diet progression, Mechanick et al. (Mechanick et al., 2008) recommend increasing the total liquid intake to 48-64 (or more) fluid ounces per day, while replacing the full liquids with ground, diced or pureed protein-rich foods that are soft and moist. The pureed foods should range from the consistency of a milkshake to mashed potatoes (Aills et al., 2008). The pureed diet allows for the gradual increase in gastric residue and tolerance of solutes and fiber. The pureed foods pass easily through the newly created pouch and into the small intestine (Aills et al., 2008).

Protein should be the macronutrient of emphasis during this phase of the diet (Aills et al., 2008; Mechanick et al., 2008). Patients may only be able to tolerate a few tablespoons of food in a given eating episode, thus food should be taken 4-6 times per day (Mechanick et al., 2008). Restricting beverage intake during meals and for the half hour following an eating episode is also recommended. Beverage intake is thought to speed gastric emptying, and limiting consumption of fluid during meals may limit the sensation of fullness. Using behavioral strategies such as placing food on small plates and using small eating utensils may also help the patient to limit portion sizes (Mechanick et al., 2008)

### 4.2.4 **Post-Operative Week 3**

During the third post-operative week, the patient may begin to consume protein rich foods like eggs, meats, poultry, and fish with added liquids like gravy, broth, or light mayonnaise. Also, beans, bean soups, cottage cheese, low-fat cheese and yogurt are good protein sources that are soft and moist (Mechanick et al., 2008).

### 4.2.5 **Post-Operative Week 4**

At this point, the diet should be advanced as tolerated by the patient. Protein foods should be eaten with priority, but well-cooked, soft vegetables and soft or peeled fruit can also be added as long as the patient is consuming enough protein (Mechanick et al., 2008).

### 4.2.6 **Post-Operative Week 5**

The patient should continue to consume protein and small amounts of fruits or vegetables. Some patients may be able to have salads around one month into their post-operative period. Until the patient is taking at least 60 grams of protein plus fruits and vegetables per day, they should avoid rice, bread and pasta (Mechanick et al., 2008). This reinforces the priority for protein over other macronutrients.

### 4.2.7 **Long-term diet recommendations**

As the patient's level of hunger increases and more foods are tolerated, they should resume a well-balanced, solid food diet. The patient should be sure to consume adequate protein, fruits, vegetables and whole grains. The calorie needs should be based on height, body weight and age. Using small plates and utensils is still recommended for the long term to help with portion control (Mechanick et al., 2008).

## 4.3 EATING PATTERNS RECOMMENDED

There are post-operative recommendations for specific nutrients and eating patterns. Both Mechanick et al. and Laville et al. recommend that patients eat slowly and chew food thoroughly to avoid dumping syndrome (Laville et al., 2005; Mechanick et al., 2008). Also, it is recommended that patients do not ingest liquids within 30 minutes of a meal, or during meal times (Laville et al., 2005; Mechanick et al., 2008). Recommendations for meal frequency differs between Laville and those from ASMBS, TOS, and AACE who respectively recommended eating 4-6 small meals per day vs. three small meals and one or more snacks per day. Both sets of recommendations call for the avoidance of high-energy density foods, to cut down calorie consumption as well as the possibility of dumping syndrome (Laville et al., 2005; Mechanick et al., 2008). The above groups (i.e., ASMBS, TOS, and AACE) also recommend that patients eat a balanced meal plan that consists of more than 5 servings of fruits and vegetables for optimal fiber consumption which will promote good colonic function. Carbohydrates (i.e., bread, rice and pasta) should be avoided until the patient is consuming 60 grams of protein per day plus fruits and vegetables (Mechanick et al., 2008). Another concern is fluid status. Adequate hydration is essential for patients during the period of rapid weight loss. Patients should consume approximately 1.5 liters of fluid each day to maintain adequate hydration (Mechanick et al., 2008).

## 4.4 SUPPLEMENTS

Supplementation is part of the long-term postoperative care of bariatric surgery patients. Daily prophylactic multivitamin/mineral use is recommended for all patients, regardless of the procedure (LAGB, RYGBP, BPD, BPD/DS). Recommendations may vary slightly with each procedure (Aills et al., 2008; Mechanick et al., 2008; Sauerland et al., 2005). Supplements are an important component of the long term nutritional management process, because nutrient deficiencies can lead to adverse health consequences. Also, vitamins and minerals that are obtained through supplements are involved in many biological processes that control metabolism, appetite, nutrient absorption, metabolism of other nutrients, energy use, and many others (Aills et al., 2008).

Guidelines supported by ASMBS, TOS, and AACE recommend 1-2 multivitamins each day (Mechanick et al., 2008). The multivitamin should include folic acid (400 mcg), which is especially important in women of childbearing age, due to its role in the prevention of neural tube defects (Mechanick et al., 2008). Most guidelines also recommend a supplement of B12, which has been shown to be a common deficiency among bariatric surgery patients. However, changes in the gastrointestinal tract disrupt the absorption of vitamin B12, so oral (sublingual) supplementation of vitamin B12 is not viewed as the best form. If oral supplements are used, it should be in 350 mcg amounts. Intramuscular (IM) vitamin B12 is absorbed more efficiently, and thus needed less frequently. If IM vitamin B12 is to be used, the patient should have injections in the following amounts and time schedule: 500 mcg weekly, 1000 mcg monthly or 3000 mcg every 6 months (Aills et al., 2008; Mechanick et al., 2008). Aills et al. point out that the IM injections require the patient to be compliant to attending a regular clinic appointment, therefore providers should consider this when making recommendations regarding the route of administration (2008). However, te issue of compliance exists regardless of administration route (i.e., via mouth each day or IM each month). Also related to B12 status, patients should have B12 levels checked annually (Mechanick et al., 2008).

ASMBS, TOS and AACE note that 150-300 mg of orally administered iron (as either ferrous sulfate, fumarate or gluconate) may be necessary in patients who have undergone a malabsorptive procedure, especially in menstruating women (Mechanick et al., 2008). Vitamin A supplementation is usually unnecessary after procedures such as RYGBP or LAGB (Mechanick et al., 2008).However, patients who have had malabsorptive procedures such as BPD/DS or BPD often have difficulty absorbing all fat soluble vitamins, therefore, it is recommended that they take supplements containing vitamins A, D, E and K (Aills et al., 2008; Mechanick et al., 2008). Table 5 shows the recommended intake levels of vitamin A, D, E and K.

Calcium supplements are also recommended in amounts of 1200-2000 mg/day, taken in two 400-800 mg doses to achieve a total daily dose of 1200-2000 mg/day. Citrated calcium is absorbed better than calcium carbonate (Aills et al., 2008; Mechanick et al., 2008). The calcium supplement should also include vitamin D because of its role in calcium absorption (Mechanick et al., 2008). Iron and calcium should not be taken together, as they interfere with the absorption of the opposing nutrient (Aills et al., 2008). Thiamine deficiency may be a concern for bariatric surgery patients, thus the multivitamin/mineral supplement should also contain this B vitamin. Screening patients for thiamine deficiency is generally unnecessary unless they suffer from protracted vomiting. In this situation, patients should be screened and treated with intravenous thiamine to avoid any potential long-term effects of thiamine deficiency (Mechanick et al., 2008). It has been suggested that noncompliance with prophylactic multivitamin supplements will contribute to an almost twofold increase in postoperative nutrient deficiencies (Brolin, Gorman, Milgrim, & Kenler, 1991). Due to the possibility of supplement noncompliance, the importance of supplement use should be reinforced at every follow-up visit (Aills et al., 2008). Table 5 provides a summary of the standard supplement regimen for individuals who have had bariatric surgery. This standard regimen may need to be modified if other nutritional complications arise.

**Table 5. Summary of Standard Supplement Regimen**

| Supplement | Amount recommended |
|---|---|
| Multivitamin containing thiamine and 400 mcg folic acid | 1-2 each day |
| Vitamin $B_{12}$ | IM: Either  mcg weekly, 1000 mcg monthly or 3000 mcg every 6 months<br>or<br>Sublingual: 350 mcg per day |
| Iron (ferrous sulfate, fumarate or gluconate) | 150-300 mcg per day (for menstruating women) |
| Calcium citrate + Vitamin D | 400-800 mg twice daily (to achieve total dose of 1200-2000 mg per day) |
| Vitamin A** | 5,000 to 10,000 units per day |
| Vitamin D** | 600-50,000 units per day |
| Vitamin E** | 400 International units per day |
| Vitamin K** | 1 mg per day |

*Note: Patients with preexisting nutrient deficiencies, or who develop other nutrient deficiencies after surgery may require additional supplementation
**For BPD and BPD/DS patients

## 4.5 MACRONUTRIENTS

### 4.5.1 **Protein**

Recommendations for protein intake after bariatric surgery are not well enumerated. It is recommended, however, that protein intake be quantified periodically, since meat, a high protein food, may not be tolerated by patients after surgery (Aills et al., 2008; Laville et al., 2005; Mechanick et al., 2008). Protein recommendations should be made based on the surgical method. For solely restrictive procedures, (i.e., LAGB or RYGB) the protein requirements are between 60 and 120 g/day. Patients who have undergone a malabsorptive procedure (BPD or BPD/DS) should consume between 80 and 120 g/day. These recommendations include protein supplements (Mechanick et al., 2008). Additionally, weight-based guidelines recommend patients consume .8 grams of protein per kilogram body weight per day (Laville et al., 2005; Seidell & Visscher, 2000). One benefit of increasing protein intake is that it may decrease the likelihood of dumping syndrome. Protein intake is important because deficits in protein intake can lead to storage of fat and breakdown of lean body tissue (muscle), which can sabotage weight loss efforts (Aills et al., 2008).

## 4.6 POSTOPERATIVE NUTRITION FOLLOWUP

As previously stated, there are multiple challenges to managing the nutritional status of bariatric surgery patients. The nutritional management of bariatric surgery patients does not end with surgery. The actual surgery should be viewed as one point along the "continuum of care" for weight loss (Kulick et al., 2010). The reduction in the size of the patient's stomach is by design (Buchwald, 2004), but the reduced food intake can lead to nutrient deficiencies. For procedures involving malabsorption, this concern is even greater. Patients who undergo either of these procedures must be monitored for life (Wulkan & Durham, 2005). The procedure results in an iatrogenic disease of the stomach and/or the intestine with digestive and nutritional consequences, namely nutrient deficiencies. Common deficiencies are: iron, folate, group B vitamins, and malnutrition (Bloomberg, Fleishman, Nalle, Herron, & Kini, 2005). In addition to the nutrient deficiencies potentially caused by bariatric surgery, many patients had nutritionally inadequate diets prior to the surgery (e.g., eating calorie dense foods of low nutritional value, or "food faddism") (Buffington, Walker, Cowan, & Scruggs, 1993; Fletcher & Fairfield, 2002). Such deficiencies are more likely to be exacerbated by bariatric surgery, especially the malabsorptive procedures (Baltasar, Serra, Perez, Bou, & Bengochea, 2004; Faintuch et al., 2004; Hamoui, Anthone, & Crookes, 2004; Maclean, Rhode, & Shizgal, 1987; Rabkin et al., 2004).

Patients should undergo laboratory surveillance every 3-6 months for the first year after surgery and then annually thereafter. The tests should include a complete blood count (CBC), platelets, electrolytes, glucose, iron studies, ferritin, vitamin B12, liver function, lipid profile, 25-hydroxyvitaamin D (with optional intact parathyroid hormone (PTH), thiamine, red blood cell count, and folate) (Mechanick et al., 2008). Sauerland et al. (2005) recommend that laboratory testing include: full blood count, liver, kidney coagulation and thyroid parameters, thyroid hormone stimulating (TSH) test, lipid profile, oral glucose screening test (only in patients not known to be diabetic) and analysis of arterial blood gas. In patients with RYGB, BPD or

BPD/DS, bone density measurements with use of dual-energy x-ray absorptiometry (DEXA) may be indicated to monitor development or presence of osteoporosis at baseline, and follow-up at approximately 2 years. This recommendation is in agreement with those from the International Society for Clinical Densiometry (Mechanick et al., 2008). Further laboratory testing for nutrient deficiencies may be indicated in patients who have persistent vomiting or diarrhea (Mechanick et al., 2008). Aills et al. suggests that post-operative laboratory testing include vitamins B2, B6, B12, folate, A, D, E, and K,  in addition to iron, zinc, and protein levels (2008). Patients found to have severe nutritional deficiencies or malnutrition should be admitted to the hospital for nutritional support (Mechanick et al., 2008).

Many recommendations discussed in this paper pertain to foods that the patient should eat. There are also foods that patients should avoid or delay consuming after surgery, including: sugar/sugar containing foods and concentrated sweets, carbonated beverages, fruit juice, high-saturated fat, fried foods, soft doughy bread, pasta, rice, tough dry, red meat, nuts, popcorn and other fibrous foods. Additionally, caffeine and alcohol should be consumed in moderation (Aills et al., 2008).

Another challenge to contend with is the potential for weight plateaus or regain in the long-term postoperative period. The average bariatric surgery patient will experience a period of rapid weight loss (Sallet et al., 2007). It is common for the patient's weight to stabilize at about 18 months after a restrictive/malabsorptive procedure (i.e., RYGB) (ASBS Public/Professional Education Committee, 2008). After this 18 month period, weight loss does not seem to follow predictable trends, sometimes exhibiting no weight loss alternating with periods of weight loss (ASBS Public/Professional Education Committee, 2008). A solely restrictive procedure, like LAGB, usually results in a more gradual and steady weight loss, averaging 5-10 pounds per month. This trend, however, usually continues for about 3 years which is longer than in RYGB procedures (ASBS Public/Professional Education Committee, 2008). Goals for weight loss must be set, and according to Sauerland and colleagues, should be set high (2005), as significant increases in quality of life have been reported in patients who have achieved greater weight loss, even among women with weight losses between 30 to 40 kg (Karlsson, Sjostrom, & Sullivan, 1998).

Bariatric surgery may cause profound changes in the patient's psychological and social situation (Laville et al., 2005). Patients should be advised to attend bariatric surgery support groups as part of their long-term follow-up (Mechanick et al., 2008). A patient's socioeconomic situation in general could potentially impact their surgical outcome, so those experiencing financial difficulty should be assisted and ensured the highest quality of care (Laville et al., 2005). Nutrition assessment and dietary management of patients experiencing surgical weight loss have been shown to be an important correlate with success (Cottam, Atkinson, Anderson, Grace, & Fisher, 2006) Obesity is a chronic disorder that requires a continuous care model of treatment. Although there are only a few comparative studies on the frequency, intensity or mode of follow-up, regular follow-up visits have become routine in most centers (Miller & Hell, 2003). Postoperatively, all patients should be seen several times by the dietitian and the psychologist (Sauerland et al., 2005).

# 5.0 SUMMARY OF EMPIRICAL RESEARCH IN RELATIONSHIP TO THE RECOMMENDATIONS

Long term follow-up with bariatric surgery patients has shown significant variability in post-operative outcomes from patient to patient (Sarwer et al., 2008). Ten to twenty percent of patients who have bariatric surgery do not achieve weight losses or experience premature weight regain (Bocchieri, Meana, & Fisher, 2002; Herpertz et al., 2003; Sarwer, Wadden, & Fabricatore, 2005; van Hout, van Oudheusden, & van Heck, 2004). The effectiveness of bariatric surgery in producing long-term weight loss and improving comorbidities is well documented; however, it is worth noting that the majority of the patients remain obese, and although much improved, co-morbidities may persist in some patients (Ledoux et al., 2006). Analysis, understanding, and implementation of predictors of success for individuals who have had bariatric surgery may contribute to better care and outcomes and better use of healthcare monies. Conversely, it is also important to understand factors for failure that may exist, and to eliminate them wherever possible. This summary of empirical research is important to determine what bariatric surgery patients are eating after surgery, and if they are following the guidelines for vitamin/mineral supplements and eating habits. Table 6 comprises a detailed explanation of the studies reviewed for this section of the paper.

## 5.1 EATING PATTERNS RECOMMENDED

The guidelines reviewed state that patients should consume 4-6 meals (Mechanick et al., 2008) or 3 meals and 1 snack (Laville et al., 2005) each day. Studies by Faria et al. showed that the higher the number of meals consumed each day, the lower the average monthly weight loss (Faria, Faria et al., 2009; Faria, Kelly, Faria, & Ito, 2009). Similarly, there was a significant positive correlation between number of meals and daily calorie intake found in another study that used convenience sampling and 4 days of food diaries from 89 subjects (Faria, Faria et al., 2009). Wardé-Kamar and colleagues reported that patients had 5.4 ±1.2 meal events per day, with an average combination of 2.8 ± 0.4 meals and 2.7 ± 1.0 snacks each day (Warde-Kamar, Rogers, Flancbaum, & Laferrere, 2004). In this study, the patients' meal patterns were in agreement with the guidelines if the snacks are counted as small meals.

A study that examined meal patterns in bariatric surgery patients also showed that snack eating after surgery was associated with the least amount of weight loss when comparing sweet-eaters and normal-eaters. This study classified subjects into snack-eating groups based on the amount of calories eaten from sweet-eating (150 calories per portion of between meal snacking from sweet snacks), snack-eating (150 calories per portion of between meal snacking), or normal eating (patients who did not participate in the aforementioned eating behaviors). The snack eating group had adequate protein intake, which is likely a reflection of their increased food intake in general (Faria, Kelly et al., 2009).

The guidelines reviewed also recommend that patients should consume well-cooked vegetables, which is thought to increase tolerance for these foods. Thomas et al. found that there was no difference in the number of patients who chose raw (56.7%) versus cooked (52.6%).

vegetables This study also found that patients were in compliance with recommendations to limit sugar-sweetened beverages, evidenced by the finding that 84.2% of subjects in this study said that bottled water was a part of their regular diet, while only 4% said that sugar-sweetened beverages were part of their normal intake. However, 24% of patients, chose fruit juice (100% juice) and 19.1% chose diluted juices, which is inconsistent with advice to avoid all calorie containing beverages (Thomas et al., 2010). This study used a convenience sample of patients returning to the surgeon's office for follow-up. There could be differences in the food selection between patients who return vs. do not return for follow-up.

In the long term, it is difficult to assess patient compliance with dietary recommendations except through self-report. A prospective study of 200 patients who underwent RYGBP assessed a number of characteristics in the individuals enrolled, including the patient's perception of adherence to the diet recommended by dietitians who were part of the bariatric surgery team. A Likert scale was used to rate patient adherence with the diet prescription. At 20 weeks postoperatively (i.e., the time by which most patients return to a normal diet), higher self-report of dietary adherence was associated with increased weight loss. By post-operative week 92, both the high and the low adherence groups had regained some of their weight, though the high adherence group netted more weight lost. A significant decline in adherence was observed in the high adherence group during the course of the 92-week study.  Those who were classified as low adherence remained lower throughout the course of the study (Sarwer et al., 2008).

## 5.2 SUPPLEMENT REGIMEN

All guidelines referenced in this paper recommended some form of a supplement regimen after bariatric surgery. A cross-sectional study of 201 consecutive obese, treatment-seeking patients at a hospital in France found that only 60% of the 40 RYGB patients were taking their multivitamins as prescribed, even when they were given explicit instructions to take the supplements (Ledoux et al., 2006). Dalcanale et al. (2010) interviewed 75 RYGB patients five or more years after their surgery and found that patients did not adequately follow the multivitamin prescription (i.e., 33.3% took the supplements reliably, 38.7% irregularly, 12% regularly "last year" and 16% never took the supplements). This study was done with patients registered in the outpatient clinic, which may suggest some bias, as patients who complete the follow-up may be more compliant than those who do not. Similar results were reported by Wardé-Kamar et al. (2004), who reported the following regarding supplement intake at various points after surgery: 77% were taking a multi-vitamin, 68% were taking iron, 66% were taking calcium, 28.6% were taking vitamin B12, 27.8% were taking folic acid and 27.4% were taking vitamin D.

Another issue related to vitamin/mineral supplementation is that of the bioavailability of supplements after bariatric surgery. The changes in the gastrointestinal tract post surgery may render their body less able to absorb certain nutrients. The bioavailability of most supplements after bariatric surgery has never been determined (Dias et al., 2006). A small randomized, double-blinded crossover study on the absorption of calcium supplements (n=18) found that calcium citrate has superior bioavailability when compared to calcium carbonate in RYGB patients (Tondapu et al., 2009).

A retrospective study of 137 patients who adhered to their prescribed follow-up schedule post-operatively found that 59% of patients needed at least one supplement by 6 months after their surgery in addition to the standard multivitamin that they were prescribed initially. More patients, 98%, needed at least one additional supplement by one year after surgery. The conclusion of this study was that standard multivitamins are not sufficient to prevent nutrient deficiencies (Gasteyger, Suter, Gaillard, & Giusti, 2008). This study also found that vitamin D and calcium deficiency increases significantly with the length of the Roux limb; consequently, this is another factor that should be considered when prescribing supplements to these patients (Gasteyger et al., 2008).

Cost is another issue related to nutrition supplementation post-operatively. The cost of supplements may be burdensome and serve as a barrier to the patient's ability to comply with the regimen as prescribed by the physician. A study in Switzerland found that the average patient spent approximately $35 per month on supplements (Gasteyger et al., 2008). For patients of lower socioeconomic status, this could become a barrier to proper supplement use. Given that many patients who have bariatric surgery fall into the lower socioeconomic status categories, this could present a significant challenge to their adhering to the recommended supplement regimen (Livingston & Ko, 2004).

## 5.3 RECOMMENDATIONS FOR SPECIFIC NUTRIENTS

Nutrient deficiencies vary based on the type of bariatric surgery performed. Nutrient deficiencies may be identified through laboratory testing, or by presentation of clinical symptoms. Symptoms of nutritional deficits may include: hair loss, dry skin, muscle pain and dental problems, among others. A study by Ledoux et al. (2006) found similar symptoms in 75% of RYGB patients and 45% of LAGB patients. A review of the symptoms of all nutrient deficiencies is beyond the scope of this paper, but several articles exist that provide a detailed explanation of the signs and symptoms and also prevention and treatment of deficiencies (Aills et al., 2008; Bloomberg et al., 2005; Schweitzer & Posthuma, 2008; Shankar, Boylan, & Sriram, 2010). It is recommended that physicians or providers caring for a post-surgical bariatric patient have at a minimum a basic understanding of the nutrient deficiencies and other nutritional concerns of their patients (Brolin & Leung, 1999). Leaving these deficiencies undiagnosed can lead to long-term adverse health effects, therefore, prompt identification and treatment is prudent for optimal patient care (Aills et al., 2008).

### 5.3.1 **Calories**

The ultimate goal of bariatric surgery is to achieve clinically significant weight loss by decreasing calorie intake. However, it is possible for patients to continue to consume more calories than needed, which can result in weight regain. A prospective study of 200 RYGBP patients by Sarwer et al. (2008) found that patient's caloric intake was decreased by 50% at 20 weeks post-operatively, from an average of 2390.9 ± 99.0 pre-operatively to 1172.9 ± 46.5 post-operatively. By week 20, the average calories consumed had increased by 150, to 1358.1 ± 60 per day.

Other studies have shown similar results. A study by Moize et al. (2003) found that patients' caloric intake, though drastically decreased initially, eventually began to increase even in the first year after surgery. This study reviewed 24-hour food recalls of 93 patients who had undergone RYGBP. They found that at 3 months, patients consumed an average of 772±323 calories per day; at 6 months they consumed an average of 866±320 calories per day and at 12 months, an average of 1075±378 calories/day. This study also revealed that patients who consumed <800 calories per day showed a trend toward greater percent excess weight loss than patients who consumed more than 800 calories/day. This study defined excess weight loss by the percent of weight lost in excess of the individual's ideal body weight (IBW). Interestingly, the study did not show a significant correlation between energy intake and the percentage of excess weight lost at any time point in the study. The investigators noted that even with the increasing energy intake over time, the distribution of macronutrients (protein, carbohydrate and fat) remained the same (Moize et al., 2003). Another prospective study of 40 patients in their first post-operative year showed a similar trend whereby caloric content of the diet started very low and increased slowly, and also that macronutrient distribution did not change even with changes in energy intake (Dias et al., 2006). A study of eating habits after bariatric surgery found that patients reported somewhat higher total calorie intake, reporting an average of 1733 ± 630 calories/day at 30 months post-operatively, based on a 24-hour recall obtained through a mailed questionnaire (Warde-Kamar et al., 2004). Other studies of post-operative caloric intake have demonstrated variable results; reporting average intake from 820 ± 130 calories per day (Trostler, Mann, Zilberbush, Avinoach, & Charuzi, 1995) at 18 months after surgery to 1885±770 calories/day at 24 months after surgery (Lindroos, Lissner, & Sjostrom, 1996) .

### 5.3.2 **Protein**

Protein is identified as a nutrient that is commonly deficient in bariatric surgery patients (Bloomberg et al., 2005). The guidelines reviewed stressed that protein is a priority nutrient for bariatric surgery patients in the post-operative period. Low protein intake is not desirable because it can lead to lean body mass loss and a consequent reduction in basal metabolic rate. These changes in body composition can make weight loss and maintenance more difficult (Faria, Kelly et al., 2009). Low protein intake can compound the problem of the patient's lesser ability to digest and absorb protein due to reduced availability of pepsin, rennin and hydrochloric acid, which results from bypassing the distal stomach. Pepsin, rennin and hydrochloric acid are released in the stomach and help the body digest protein (Halverson, 1992; Raymond, Schipke, Becker, Lloyd, & Moody, 1986) .

Guidelines recommend that protein intake should be based on the type of procedure performed (e.g., protein requirements for LAGB or RYGB are about 60-120 g/day of protein vs. those for BPD or BPD/DS call for consumption of 80-120 g/day) (Mechanick et al., 2008). Several studies found that patients have protein intake below the recommended levels (Faria, Kelly et al., 2009; Kruseman, Leimgruber, Zumbach, & Golay, 2010; Moize et al., 2003; Sarwer et al., 2008). It should be noted that the measures of sufficient protein intake varied among studies. For example, some (Faria, Faria et al., 2009; Kruseman et al., 2010)used patient reported intake by entering four days of food intake into a nutrition database software. Moize et al.(2003) used 24-hour recalls and laboratory values to assess protein intake and Sarwer et al. (2008) used Block Food Frequency Questionnaires. Sarwer et al. (2008) found that protein intake decreased during the post-operative period, but by 92 weeks after surgery, the average patient had returned to baseline (pre-surgical) protein intake, which was below the recommended amount for bariatric surgery patient. Throughout the rest of the year, however, intake increased significantly. On average, patients in this study did not achieve the recommendation to consume 1.5 grams of protein per kilogram of ideal body weight (IBW). As it relates to surgical outcome, a study by Faria, Faria et al. found that patients who consumed more protein had greater weight loss.(Faria, Faria et al., 2009). To the contrary, Kruseman et al. (2010) found that there was no association between protein intake and weight outcomes. Moize et al. (2003) found that protein intake was positively associated with percent excess weight loss at certain points; however, this was not consistent throughout the study period.

Protein intake may be affected by intolerance of high protein foods. Moize et al. (2003) found that protein intolerance decreased between months 3 and 6 after surgery. These authors believe that protein intolerance should be monitored, as the relationship between protein intolerance and reduced protein intake was not noted until a year into the study period (Moize et al., 2003).

Dalcanale et al. (2010) concluded that protein malnutrition after malabsorptive procedures (BPD or BPD/DS) had been reported by other studies, but their study did not support this finding. In their study, 5.3% of patients developed hypoalbuminemia (a marker of protein deficiency) and 13.3% had low levels of transferrin (another marker of protein deficiency). These authors suggest that protein malnutrition should not be looked at as an “overwhelming risk” for individuals who have had bariatric surgery; however, these authors suggest it should not be something that is overlooked.

### 5.3.3 **Vitamins**

The physiologic changes and potential altered food intake may induce nutrient deficiencies in bariatric surgery patients (Shankar et al., 2010). Figure 1 shows a diagram of sites of absorption of common vitamins and minerals throughout the gastrointestinal tract. Bypassing part of the small intestine does not allow for nutrient uptake where it is most effective, thus decreasing the body's ability to absorb nutrients. The type of surgery performed may impact the patient's risk for developing nutrient deficiencies. Though mixed operations (restrictive and malabsorptive) have been shown to be more effective at improving co-morbidities (especially diabetes and dyslipidemia), they have also been shown to produce more nutritional deficiencies than purely restrictive procedures (e.g. LAGB) (Ledoux et al., 2006).

Assessing vitamin intake can be difficult. Food recall is notoriously unreliable, and there is not much data available to assess the bioavailability of vitamins from food in bariatric surgery patients. This section of the paper will focus on studies of vitamin deficiencies in bariatric surgery patients. Vitamin B12, folate, and the fat-soluble vitamins (A, D, E, K) are common vitamin deficiencies in this patient population (Bloomberg et al., 2005).

Vitamin B12 is a commonly reported deficiency in bariatric surgery patients. However, Moize et al. (2003) did not find any changes or deficiency in vitamin B12 levels in the average study subject when evaluated at 3, 6 and 12 months post-operatively. Dalcanale et al. (2010), however, found deficits in vitamin B12 levels in 61.8% of their study subjects. It should be noted that another study revealed that B12 deficiency may be delayed, due to liver reserves of the nutrient, so patients should be monitored for deficiency for the long term, and prescribed supplements if needed. (Ledoux et al., 2006).

Fat soluble vitamins (A, D, E, K) are also a common deficiency in bariatric surgery patients. Ledoux et al. (2006) found that serum concentrations of vitamins A and E in the RYGB patients were markedly lower than in the control or LAGB group. These patients also had a prothrombin time that was mildly decreased, which suggests a vitamin K deficiency. RYGB patients are not typically monitored for fat-soluble vitamin status, but the results of this study indicate that perhaps they should be. Dalcanale et al. (2010) also found deficits of vitamin D and beta-carotene in 60% and 56.8% of patients, respectively, which is higher than vitamin A and D deficits reported in other studies. These authors also noted that even 12.5 times the amount of vitamin D provided through supplements in this study (5000 IU), would not be enough to normalize the serum vitamin D3 profile.

### 5.3.4 **Minerals**

Iron deficiency has also been reported in bariatric surgery patients (Bloomberg et al., 2005; Shankar et al., 2010). Iron deficiency can be a major cause of anemia in bariatric surgery patients (Shankar et al., 2010). Dalcanale et al. (2010) reported iron deficiency in 29.8% of patients, low hemoglobin in 50.8%, and low ferritin in 36.0% of patients in this study, all indicative of iron deficiency. These deficiencies were reported in the preoperative period, so the deficiencies were not necessarily attributable to the surgery. Moize et al. (2003) found that patients had iron levels that actually increased from months 3 to 12 in their postoperative follow-up period. Also, they identified few patients who were anemic. Ledoux, et al. (2006) did not find a significant difference between surgical groups and non-surgical obese controls. This study suggested that the patients were likely to have been iron deficient before they had the surgery.

The authors surmised that other studies may have overestimated the role of surgery in iron deficiency due to absence of a control group for comparison. However, other studies have reported the opposite; that many patients do experience iron deficiency after bariatric surgery (Schauer et al., 2000; Skroubis et al., 2002). These results suggest that more work needs to be done to understand the risk of iron deficiency after bariatric surgery.

Calcium is another mineral that can be deficient in bariatric surgery patients. Ledoux et al. (2006) reported that calcium has rarely been evaluated in RYGB patients, but their study showed that RYGB patients had lower calcium excretion and higher parathyroid hormone concentrations than other groups, which may reflect negative calcium balance with secondary hyperparathyroidism. A study that compared RYGB to DS did not find differences between the two surgical groups, and showed no decline in calcium after surgery (Aasheim et al., 2009). This study only examined blood concentration of calcium, and did not use other measures, such as PTH levels, which may also indicate calcium deficiency even when blood levels of calcium remain stable.

Reports of various mineral deficiencies have come from other studies. Hypomagnesemia has been reported (Dalcanale et al., 2010; Schauer et al., 2000). Zinc has been a reported deficiency (Dalcanale et al., 2010), as has potassium (Schauer et al., 2000). Trace minerals such as selenium and copper have also been reported (Shankar et al., 2010). As with other micronutrients, it must be considered that bariatric surgery is not done in a “standard” fashion, so the variations in technique may impact the likelihood of developing certain nutrient deficiencies (Shuster & Vazquez, 2005). Laboratory follow-up, as recommended, is important for monitoring deficiencies so prompt treatment can be initiated.

### 5.3.5 **Carbohydrates**

There were no guidelines specifically related to the amount of carbohydrates recommended for patients to consume, except that they should eat a well-balanced diet when ready during the postoperative period (Mechanick et al., 2008). Carbohydrate intake may be troublesome for patients who experience dumping syndrome, as the high osmotic load is thought to contribute to this problem (Mechanick et al., 2008).

Studies have examined other potential impacts of carbohydrate intake in bariatric surgery patients. Moize et al. (2003)reviewed the way that distribution of macronutrient intake impacted weight loss. Percent excess weight loss was negatively related to the percentage of carbohydrate intake at 6 months post-operatively. At 3 and 12 months, however, this relationship did not exist (Moize et al., 2003). Another study reviewed how glycemic load impacted the amount of food eaten at meals (calorie intake) as well as meal frequency (satiety). Foods that are high in carbohydrate and low in protein and fiber are considered to have high glycemic load. Glycemic load was calculated by multiplying the amount of carbohydrate in the food by the glycemic index of the food and dividing by 100. Calculating glycemic load was a way to approximate the effect that a particular food would have on a person's blood glucose levels. This study found that low glycemic load meals contributed to satiation, which may have resulted in less calorie intake at a single meal, but was not related to satiety. This study also found that for every 10 unit decrease in the glycemic load of meals, there was a 2% increase in monthly weight loss (Faria, Faria et al., 2009). This study was valuable as it suggested a potential way that patients could be guided in their eating patterns to yield better surgical outcome.

### 5.3.6 **Recommendations for Foods Groups/Foods to Avoid**

In order to avoid some of the more unpleasant side-effects of bariatric surgery, recommendations are made for foods or food groups that patients should avoid. RYGB can permanently change food selection and commonly forces food restrictions for physiological reasons such as food intolerance and altered food perception (Di Vetta, Kraytem, & Giusti, 2008; Laville et al., 2005; Mechanick et al., 2008; Thirlby, Bahiraei, Randall, & Drewnoski, 2006). Mechanick et al. (2008) and Laville et al. (2005) recommended that patients avoid high-energy density foods, both to reduce calorie consumption as well as to prevent occurrence of the dumping syndrome. The literature showed that many patients decreased their consumption of sweets in the early post-operative period (e.g. week 20), but by week 92, consumption of sweets and desserts had increased significantly (Sarwer et al., 2008). Another study looking at patient's regular food choices, found that certain items were never chosen, including heavy cream, regular caffeinated and non-caffeinated colas, regular fruit-flavored drinks and Pedialyte (Thomas et al., 2010).

Differences in food selection based on type of procedure performed have also been noted. For example, in a study comparing food choices of patients who had LAGB or RYGB to nonsurgical obese patients; direct comparison of surgery groups showed that RYGBP patients ingested more fresh fruits, eggs, and diet soft drinks but ate chocolate less frequently than GB patients. Gastric banding patients consumed less pasta, fresh fruits, and white bread but increased their intake of poultry and fish in comparison to obese controls. These results led the authors to question whether RYGBP patients choose more nutritionally sound diets, as the LAGB patients chose more unhealthy foods than the RYGBP (Ernst, Thurnheer, Wilms, & Schultes, 2009).

The development of food intolerances has been reported in many patients after surgery (Rusch & Andris, 2007). One study reported that the main food intolerances were meat, rice-bread-pasta, vegetables, eggs, sweets, milk-dairy and fruit (Moize et al., 2003). The percentage of patients with food intolerance decreased significantly from 3-12 months (Moize et al., 2003), indicating that food intolerance may be more problematic in the early preoperative phase. Patients with more reported food intolerance at 12 months post-operatively seemed to be consuming fewer calories on a daily basis than those without reported food intolerance (Moize et al., 2003). It has been reported that patients continue through their life after bariatric surgery testing the limits of their food tolerance by experimenting with foods that they may not have been able to eat, or told not to eat (Rusch & Andris, 2007).

### 5.3.7 **Long-term postoperative**

Bariatric surgery should be viewed as one point along the "continuum of care" for weight loss patients (Kulick et al., 2010). Establishing proper nutritional status and helping patients to avoid the development of maladaptive eating behaviors is a challenge to the dietetic professionals caring for bariatric surgery patients. The maintenance of proper nutritional status may be even more of a challenge (Elkins, Whitfield, Marcus, Symmonds, & Cook, 2005). The recommendations noted previously state that patients should have follow-up laboratory testing at 3 and 6 months post surgery, and then every year thereafter (Mechanick et al., 2008). Some studies have found that bariatric surgery patients have difficulty keeping follow-up appointments. Similar difficulties have also been noted in complying with exercise prescription, and compliance with weight loss instructions (Elkins et al., 2005; Toussi et al., 2009). Toussi et al. (2009) also found that patient's food choices became more of a problem after surgery, and often resulted in severe health consequences like dumping syndrome and vomiting. They noted that general noncompliance increased after surgery, which resonates with the "anecdotal" observations of those caring for bariatric surgery patients, that these patients are more compliant with recommended lifestyle changes before surgery than they are afterward because they are motivated by the prospect of having surgery.

Part of the guidelines for the post-operative diet recommended the avoidance of foods/beverages such as red meats, rice, bread, pasta, sugar sweetened beverages, alcohol and carbonated beverages (Aills et al., 2008), but the research shows that patients continue to consume these foods in spite of the negative consequences that they may endure as a result. Other studies have found that patients continue to consume sugar-sweetened beverages in the post-operative period against advice of their surgical team (Warde-Kamar et al., 2004).

Other problems with follow-up involve attending appointments with their surgeon or other members of the bariatric care team (Moize et al., 2003). Moize, et al. (2003) found patient attendance at appointments to decrease significantly over time. They reported patient attendance was 71%, 58%, and 38% at 3, 6 and 12 months, respectively; this resulted in an inability to analyze study data due to lack of significance at that point. Further follow-up attendance was only 15% and 12% at 18 and 24 months, respectively, so low that they could not analyze study data due to lack of significance at that point. Wardé-Kamar (2004) found similar results:  90% of patients came in for visits 2 weeks after surgery, followed by 80%, 75%, and 54% at 3, 6, and 12 months, respectively. At 18, 24 and 36 months, follow-up had declined further to 38%, 22% and 10%, respectively. Patients cited being too busy, feeling good, forgetting, and unsuccessful results, among others reasons, for not attending these follow-up appointments. Pontiroli et al.

(Pontiroli et al., 2007) found that compliance with scheduled visits was related to amount of weight lost. Several other studies have also reported problems with visit compliance (Elkins et al., 2005; Toussi et al., 2009).

Some researchers recommended that goals for weight loss should be set high, as greater weight loss results in greater improvements in reported quality of life (Karlsson et al., 1998; Sauerland et al., 2005). However, Poole et al. (2005) found that patients having unrealistic expectations of the surgery may be increasingly noncompliant with follow-up visits and diet prescriptions in the post-operative period. Patients who had LAGB often pressured their surgeon to inflate their band more quickly in order to see faster results, and did not believe that it was their behavior that would ultimately be responsible for their weight loss. These results seem to indicate a lack of understanding of what is causing weight loss and also how quickly the patient should expect to lose weight. Perhaps these patient's unrealistic expectations seemed to have caused unhappiness with the rate of weight loss. Perhaps findings like that of Poole et al. (2005) are in opposition to the recommendations from Sauerland et al. (2005) that recommend that goals for weight loss be set high. Having unrealistic expectations may result in disappointment and undue pressure on the surgeon. It should be noted that the Poole et al. (2005) study was small (i.e., nine patients), thus more work would needs to be done to see if the results can be replicated in a larger study.

Lack of follow-up may be due to patient non-compliance, but the noncompliance may also be related to the physician's practices. A study by Brolin and Leung (1999) surveyed bariatric surgeons to determine their prescribing and follow-up practices. Respondents underestimated the occurrence of nutritional deficiencies in bariatric surgery patients by almost half. Perhaps this leads surgeons to not stress the importance of follow-up given that they do not realize how commonly deficiencies occur. This survey found that 96% of surgeons prescribe prophylactic multivitamins for their patients. About two thirds prescribe oral iron, and less than half prescribe vitamin B12. All surgeons who perform BPD prescribed calcium supplements for the patient, but less than half of the surgeons surveyed prescribe calcium supplements for RYGBP patients. Fifty five percent of the surgeons prescribe oral protein supplements to RYGBP patients, and 21% prescribe oral protein supplement to their patients who have undergone BPD., while t wo thirds prescribe fat-soluble vitamin supplements for patients who have had (Brolin & Leung, 1999).

Postoperatively, almost all surgeons obtain a complete blood count (CBC) routinely. Two thirds obtain serum vitamin B12 and folate. Fifty eight percent of RYGB surgeons measure serum iron versus 80% of those who perform BPD. Seventy five percent of surgeons measure serum electrolytes, calcium, glucose, liver function and protein for RYGB patients versus 85% of the surgeons who perform BPD procedures. About 5% of the surgeon respondents did not routinely order lab tests after either procedure. Sixty nine percent of the surgeons who perform RYGB indicated that they would perform post-operative lab tests indefinitely, compared to 80% of the surgeons who perform BPD.

Long-term follow-up of patients who have had bariatric surgery has been shown to be of great importance to the health of the patient and the long-term outcome of their surgery (Kulick et al., 2010). Patients require laboratory studies to ascertain their nutritional status and to identify any other post-operative complications that may arise after surgery. In addition, individuals who have had surgery may need to be referred to other specialists, such as dietitians or psychologists as surgery can be a life-changing event that may introduce new challenges that did not exist for the patient prior to having surgery. Patients who have had bariatric surgery also need to have reinforcement of the importance of taking their supplements and engaging in physical activity. It seems that there are likely to be patient motivation issues at play, but also issues with physicians being inconsistent in their prescribing practices that result in the issues with supplement compliance and also compliance in attending follow-up visits.

# 6.0 DISCUSSION

The purpose of this paper was to review the nutrition guidelines for bariatric surgery patients and then to review the available literature regarding nutritional issues related to bariatric surgery. Table 3 demonstrates the method used to select guidelines for review. The Appendix, Table 6. Summary of Literature Reviewed, lists the studies reviewed for the second portion of the paper.

## 6.1 STRENGTHS

There are many recommendations for "best practices" in bariatric surgery, but there are not many recommendations that could be considered to be a guideline. Though the scope of guidelines could have been expanded, it is seen as strength of the paper that the review found only what is considered to be true guidelines. Guidelines were viewed under strict terms, and could not just come from one research group, but from the consensus of many. The guidelines reviewed stated numerous times that there is more work to be done, which is an important message to be considered based on this review. Thus to reiterate, although great strides have been made in the development of guidelines for the care of bariatric surgery patients, there is more work to be done.

Also, this paper looked for empirical research to determine if the guidelines provided are being put into place. In some areas, the research was plentiful, while in others there was a dearth of sound research to understand how guidelines are being used in practice. These analyses provide insight into the existence of current guidelines, as well as the work yet to be done.

## 6.2 LIMITATIONS

Limiting the scope of the term "guideline" in the literature search of this paper may be viewed as a strength, while others may perceive it to be a limitation. There are many articles in existence that cite "recommendations" for the nutritional management of bariatric surgery patients, which may be useful in some cases. The research reviewed had many limitations. Several studies regarding the outcomes and nutritional management of bariatric surgery patients used convenience samples, or consecutive patients from one surgery center or site. Though the research yields interesting conclusions, these results cannot be extrapolated to all bariatric surgery centers. Also, many of the studies reviewed included patients who were returning for follow-up visits, and one could assume that there are fundamental differences in the patients who returned for their follow-up visits in comparison to those who did not.

## 6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

Though much work is being done to assuage the obesity epidemic in the United States, the problem persists. Bariatric surgery has been identified as an effective treatment for obesity

(Clegg et al., 2000; Klein et al., 2004), and will likely continue to be performed in the U.S. and worldwide. Unlike anecdotal information that may exist, bariatric surgery is not a quick fix for the obesity problem (Wulkan & Durham, 2005). There are risks associated with this surgery, as with any surgery, and the patients must be dedicated to making long-term behavior changes in order to lose weight and achieve maintenance of a healthy weight. Choosing to undergo surgery is a serious choice, and there should be research and evidence-based interventions to provide patients the best chance for a successful postoperative outcome. Consequently, bariatric surgery patients need more specific nutritional guidelines. MyPyramid is not specific enough to meet the concerns of the bariatric surgery patient (Thomas et al., 2010). In order to develop specific nutritional guidelines for these patients, more work needs to be done to determine nutrient bioavailability levels, given the changes that occur in the gastrointestinal tract post-operatively. This information would provide a basis for the development of comprehensive dietary guidelines and supplement recommendations. Numerous studies have pointed out that other than supplement recommendations, no standard recommendations for post-operative macronutrient intake exist (Moize et al., 2010).

Successful surgery is considered to be a loss of $\geq$ 50% of excess body weight (EBW), but success should also be considered as it relates to the following factors: improvement or resolution of comorbidities, decreased mortality, enhanced quality of life and other positive psychosocial changes (Mechanick et al., 2008). Outcome assessment after surgery needs to include weight loss and maintenance, nutritional status, comorbidities and quality of life (Sauerland et al., 2005). These other factors may be more difficult to assess, but studying them may be important for understanding predictors of success or failure of bariatric surgery. Also, these factors should be included as part of the cost-benefit analyses performed in determining eligibility and payment for surgery. As for measuring weight-related outcomes, there are several ways to measure weight loss, including reduction in BMI, percent weight lost, and percent of excess weight lost (Kalarchian et al., 2008). Use of these varying methods makes it difficult to compare results across studies.

Though it is a difficult task, more effort should be made to include all patients who have undergone surgery, not just patients who return to their surgery center for follow-up care. The differences in these patients could be significant, and it is important to understand what, if any, differences exist, and what implications this has for patients who undergo surgery. Also, more randomized controlled studies are indicated to realize the true benefits and risks of bariatric surgery. This review found a limited number of studies that use obese or non-obese controls and/or studies that randomized individuals to different treatments or surgical methods (LAGB, RYGBP, BPD or BPD/DS).

In nutrition research in general, there are problems with dietary assessment. Dietary assessment is traditionally controversial, and the 24-h recall technique used by many studies in this review is not endorsed by all groups; some prefer more detailed instruments, such as the 72-hour recall, or home forms filled in by the patients during each meal or snack. Twenty four-hour recall can be performed in a number of ways, but most commonly involves a structured interview which asks the patient to describe in detail the foods and amounts of each food that they have eaten in the past 24 hours. Even the 72-hour assessment is not viewed as a high quality method of assessing dietary intake. Dietary assessment in obese patients is controversial, as numerous studies have shown that obese patients vastly underreport their actual intake (Braam, Ocke, Bueno-de-Mesquita, & Seidell, 1998; Lissner, 2002). Nevertheless, there are reasons to accept the 24-h recall method as valid for postoperative follow-up, given the fact that patients are, by that time, less motivated to underestimate their intake (Dias et al., 2006; Faintuch et al., 2004; Trostler et al., 1995). Dietary assessment methods also need to be improved to better assess what patients are eating, and to make recommendations based on these assessments.

Though bariatric surgery may facilitate the changes necessary to modify a patient's eating behavior after surgery, grazing on small amounts of food, drinking calorie-containing beverages, or other maladaptive eating behaviors after surgery can sabotage the surgery and result in plateaus in weight loss or weight regain (Adami, Gandolfo, Bauer, & Scopinaro, 1995; Hsu et al., 1998; Kalarchian et al., 2002). Essentially, the patient can "out-eat" their surgery. Leahey and colleagues (2009) attempted to determine the best methods of preventing these maladaptive eating behaviors and suggest that interventions to address maladaptive eating behavior be delivered to patients post-operatively, as they are more likely to be receptive to this intervention after surgery. More studies like this are needed for optimization of surgical outcomes.

## 6.4 PUBLIC HEALTH SIGNIFICANCE

Though bariatric surgery has been in existence for longer than 50 years (Saber et al., 2008), there is still much work to be done to ensure optimal patient outcomes. The development of a comprehensive set of guidelines that is adopted by health care providers in this field is one way that optimal outcomes could be better achieved. This would also make it easier to study the surgery and postoperative outcomes (e.g., when centers use different recommendations, it is difficult to draw parallels in research or conclusions).

Bariatric surgery research in the past has focused a great deal on maintaining adequate nutritional status during the time of rapid weight loss without much regard to the importance of long-term diet and eating behaviors (Olbers et al., 2006; Rusch & Andris, 2007). There are many facets to eating behavior, some of which include the following issues: psychological, community design and socioeconomic (and also the reciprocal relationship among these factors). Ecological theory is well-known in the public health field; this theory stresses the importance of structuring one's environment to facilitate success with any health behavior change. Thus far, research has not examined whether interventions with patients in the pre-operative phase, which help to set up environments conducive to weight loss success post surgery, have improved outcomes.

Public health professionals can play a major role in identifying the issues that may lead to failure in bariatric surgery patients, and help to design interventions that will prevent these issues from interfering with the patient's success. The research reviewed for this thesis did not mention health education theory in the presentation of diet and nutrition advice to patients. The implementation of behavior change can be extremely challenging, and using theories in the planning of interventions for individuals who will or have had bariatric surgery, may help make the changes and postoperative transitions of bariatric surgery more straightforward.

Also, the research did not address solutions to problems such as patients who are of low socioeconomic status, and how this may impact the feasibility of complying with post-operative diet and nutritional recommendations. Given the fact that a disproportionate number of patients having bariatric surgery are of low socioeconomic status (Livingston & Ko, 2004), this is an issue that certainly deserves exploration and resolution.

The resolution of co-morbidities that can result from surgery is certainly a benefit to the patient and for society as a whole. Resolution of chronic diseases like diabetes and hypertension can greatly improve the patient's quality of life, and also decrease health care costs for society. The fact that many patients will remain obese, and may still suffer from co-morbidities even with surgery is something that warrants a closer look. For many patients, remaining obese or experiencing a significant weight regain can have a serious impact on the person's psychological well-being. These are issues in which the public health community should be engaged. Cost-benefit analysis concerning factors other than simply average percent excess weight loss are needed to determine the true benefits and potential downsides to having bariatric surgery.

# 7.0 CONCLUSION

Treatment of obesity continues to be a topic of significant discussion as the obesity epidemic in the United States persists. Surgical weight loss has become an important component of the treatment arsenal for those with Class III obesity, as other weight loss modalities often fail to result in successful outcomes in these individuals. In the past 20 years, bariatric surgery has become increasingly more accepted as a treatment option (Saber et al., 2008), prompting physicians and other health professionals who care for individuals who have had bariatric surgery to seek the most effective methods of treatment that yield optimal weight loss and resolution of comorbid conditions. The physiologic changes that occur with bariatric surgery make the nutritional management of these individuals a challenging course (Buchwald et al., 2004).

The physiologic changes to an individual's gastrointestinal tract after surgery are not enough to "cure" their obesity. After surgery, the individual must make drastic changes to their eating habits in order to ensure that optimal weight loss will be achieved (Nagle, 2010; Wulkan & Durham, 2005). It is important that bariatric surgery be presented to the patient as a tool to help them to lose weight, not a panacea to obesity. This presentation of bariatric surgery as a tool should begin in the early pre-operative phase and reinforced throughout the patient's life after surgery. Recommendations such as this and others are part of guidelines developed by the

American Society for Metabolic and Bariatric Surgery, The Obesity Society, American Association of Clinical Endocrinologists, and the European Association of Endoscopic Surgeons.

These organizations (Aills et al., 2008; Mechanick et al., 2008; Sauerland et al., 2005) have provided guidelines on the most effective management of individuals who have had bariatric surgery with an assumed intention of maximizing the quality of care that these patients receive. Though there are several sets of guidelines for the pre-operative assessment and care of surgical candidates, and for the postoperative period, there is an absence of true consensus regarding the "best" practice guidelines (Aills et al., 2008). For the purposes of this paper, guidelines were defined as: Work consisting of a set of statements, directions, or principles presenting current or future rules or policy. Guidelines may be developed by government agencies at any level, institutions, organizations (such as professional societies or governing boards), or by the convening of expert panels.

Review of the guidelines yielded several interesting pieces of information. First, the guidelines are based on expert opinion in many cases. There is a need to conduct more randomized controlled trials to better understand the best treatment plans for bariatric surgery patients that will better serve the patients in the long term. Also, trials should be conducted to determine the best supplement regimen based on the bioavailability of each nutrient after an individual has had surgery.

In addition to review of the guidelines, this paper provided a review of literature that was relevant to the guidelines to gain a better understanding of how well these guidelines are implemented into practice and also followed by the patients. Though bariatric surgery has been shown to be a relevant and viable treatment for obesity, little is known about what the patients who have had surgery are eating after their surgery (Thomas et al., 2010). So, there is also little known about the quality of the diet these patients consume. Outcomes from bariatric surgery are variable, and most patients who undergo the surgery will remain obese, but see resolution of some comorbidities, especially diabetes (Ledoux et al., 2006). Compliance with dietary recommendations is particularly important as the patient transitions from a period of rapid weight loss during the first year, to a period of longer-term weight stabilization, and possible weight regain.

This thesis provided a review of the current dietary and nutritional guidelines and recommendations for individuals who have undergone bariatric surgery. After the nutritional guidelines were reviewed, studies regarding post-operative eating and behavior were reviewed. Compliance with dietary recommendations and supplementation seem to decrease over time during the postoperative period, thus, interventions need to be developed to prevent this decline and help patients continue their healthier lifestyle to yield better weight loss results, resolution of comorbidities, and improvements in quality of life. Thus, there is more work to be done to realize the best practices for care of patients who have had bariatric surgery to ensure these patients the best results from their surgical intervention.

# APPENDIX

# LITERATURE TABLE

**Table 6. Summary of Literature Reviewed**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| Preoperative eating behavior, postoperative dietary adherence, and weight loss after gastric bypass surgery. (Sarwer et al., 2008) | Measured on a variety of psychological measures as well as eating questionnaires to see how preoperative psychosocial state and eating behaviors/intake relate to postoperative weight loss | 200 (164 female, 36 male) | Prospective | Questionnaires mailed to participants including: Rosenberg Self-Esteem scale, Beck Depression Inventory, Positive and Negative Affect Scale, Eating Inventory (Control over food intake), Block 98 Food Frequency Questionnaire, Likert scale asking how much they are adhering to their diet. Study related these questionnaires to look for correlations between potential success factors and weight loss results after surgery. | -By postoperative week 92, patients had returned to baseline protein intake, which is inadequate.<br>-In the initial post-op period, calorie intake was decreased by 50%<br>-Calories from sweets and desserts were much lower at week 20, but by week 92, it had increased significantly.<br>-Greater dietary adherence was associated with increased weight loss (significance with self-reported adherence at week 20 postoperatively)<br>-By 92, both the high and low adherence groups had regained some weight |
| Relation between carbohydrate intake and weight loss after bariatric surgery. (Faria, Faria et al., 2009) | To look for a relationship between Glycemic index of meals and how it relates to calorie consumption, number of meals eaten and overall weight loss trends. | 89 (80% women) (Brazil) | Transversal Retrospective (Convenience Sample) | 4 Days of food journals were used to calculate: daily calories, protein, lipid, and carbohydrate intake (Nutrisurvey). Average glycemic load was calculated for each meal and compared to number of meals per day, overall caloric intake, and weight loss trends. | -The higher the number of meals per day, the lower the average monthly weight lost<br>-Significant positive correlation between number of meals and daily calorie intake (increase in number of meals favors higher calorie intake)<br>-Low Glycemic Load meals contributed to satiation, which may have resulted in lesser calorie intake, but no relation to number of meals (satiety)<br>-For every 10 unit decrement in the Glycemic load, there was an increase of two percentage points in the monthly weight loss<br>-Higher quantity of daily calories proceeding form proteins was related to higher weight loss |
| Snack-Eating Patients Experience Lesser Weight Loss after Roux-En-Y Gastric Bypass Surgery. (Faria, Kelly et al., 2009) | | 75 | Transversal/Analytical/Descriptive (Convenience Sample) | 4 Day Food Intake Records compiled. Daily number of meals, quantity of food per meal and the caloric value of snacks taken between main meals. Looked at nutrient intakes as a percentage of total intake. Identified patients as sweet or snack eaters and normal eaters to examine its relationship to weight loss and nutritional quality of diet. | -Snack eating after surgery is associated with the least amount of weight lost in comparison with sweet-eaters and normal-eaters<br>-Protein intake was deficient for the study sample (less than 80 grams)<br>-Snack eaters had adequate protein intake, probably reflective of their increased food intake as a whole<br>-Part of the inclusion criteria for this study was a minimum of 2 follow-up visits per year |
| Differential changes in dietary habits after | Description of differences between gastric bypass, | n=121 bariatric patients who had | Cross-section | -Food items consumed<br>-Weight loss | -Gastric bypass patients were heavier than the non-obese controls, but much lighter than the obese controls (similar for |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| gastric bypass versus gastric banding operations. (Ernst et al., 2009) | gastric band patients, as well as comparison of non-obese and obese control subjects | undergone surgery (48 with RYGBP, 73 with GB), Control group: 45 non-obese controls, 45 obese controls (treatment seeking) | | | GB patients, but GB patients lost less than RYGBP)<br>-Obese controls consumed more meat, white bread and diet soft drinks than non-obese controls<br>-Gastric bypass patients consumed more foods rich in protein like poultry, fish and eggs while they consumed distinctly less sweets like chocolate, cake, biscuits, and cookies than obese and non-obese control subjects<br>-Gastric banding patients consumed less pasta, fresh fruits, and white bread but increased intake of poultry and fish in comparison to obese controls |
| Dietary, Weight and Psychological Changes among Patients with Obesity, 8 Years after Gastric Bypass. (Kruseman et al., 2010) | To document the weight and body composition changes along with dietary habits, psychological state and quality of life in patients who have had bariatric surgery >5 years ago | n=80 women | Prospective | -Weight<br>BMI<br>Body Composition<br>Dietary Intake (macronutrient make-up of diet) (using 4 day food diaries)<br>Eating Disorders<br>Quality of Life<br>Steps per day<br>Physical, dietary and psychosocial difficulties/improvements with surgery (Assessed through semi-structured interview) | -Dietary intake was suboptimal at all three time points of the study (presurgery, one year after surgery and eight years after surgery)<br>-Energy intake decreased as would be expected after surgery<br>-Protein intake before surgery was 1.5 g/kg of body weight and dropped to .8 g/kg body weight at the last visit, meaning that 50% of the sample did not reach the recommended intake of .8 to 1.2 g/kg body weight<br>-Macronutrient intake was not associated with successful weight loss, but the researchers questioned whether those who did not achieve 50% excess weight loss underestimated their intake, which is common with higher BMI |
| Outcomes after laparoscopic Roux-en-Y Gastric Bypass for Morbid Obesity. (Schauer et al., 2000) | To describe complications and outcomes following roux-enY gastric bypass | n=275 | Prospective | Consecutive pts who met NIH criteria for BS were offered RYGB between July 1997 and March 2000 | Late Complications related to nutrition: 27 (9.8%) had iron deficiency, 22 (8%) had asymptomatic anemia, 14 (5%) had hypokalemia, 2 (.7%) had hypomagnesaemia, 1 (.3%) had protein-calorie malnutrition<br>-Excess weight loss at 24 and 30 months was 83% and 77% respectively |
| Obese patients have inadequate protein intake related to protein intolerance up to 1 year following roux-en-y gastric bypass (Moize et al., 2003) | To assess protein intake and intolerance in roux-en-Y gastric bypass patients | n=93 (77 female, 16 male) | Retrospective | Evaluated protein intake in 93 morbidly obese individuals who underwent RYGBP at our medical center. Participants completed 24 hour food recalls and received nutritional counseling at 3,6, and 12 months following surgery | -Although there was a drastic reduction of food and energy intake after surgery, daily energy intake increased significantly during the year. Despite this increase in energy intake, the macronutrient percentage did not differ over the 1 year period for CHO, protein, and fat.<br>-No significant changes in albumin, vitamin B12, hemoglobin or MCV at 3,6 or 12 months. No pt developed B12 deficiency. Iron increased from 3-12 months. Anemia was seen in few patients n=5 at 3 months, and n=6 at 6 months and n=5 at 12 months<br>-% EWL lost increased from 27.4+/-8.8 at 3 months, to 38.6+/- 13.3 at 6 months, and then 48.5+/-16.7 at 12 months. |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| | | | | | -Percent EWL did not correlate significantly with total energy intake or percentage of fat intake at any time pd., or with % of CHO or protein at 3 or 12 months. At 6 months, %EWL was negatively related to percentage of CHO and positively to % protein intake<br>-Patients who consumed <800 kcal per day showed a trend toward greater %EWL than those consuming more calories<br>-The percentage of patients with food intolerance decrease significantly from 3-12 months.<br>-The main food intolerances were meat, rice-bread-pasta, vegetables, eggs, sweets, milk-dairy and fruit<br>-There was a trend for lower daily energy intake in those who reported food intolerance at 12 months<br>-Protein intolerance decreased from 3 to 6 months<br>- Protein intake increased significantly over the 1 year period, but patients did not reach the goal of 1.5 g/kg IBW.<br>-Although energy and protein intake increased significantly over a 1 year period postoperative, protein remained insufficient as measured by % goal individually and was related to protein intolerance at 1 year.<br>-Long term follow up is essential, as the protein intolerance did not surface until later in the post op period, and without follow up, could lead to protein malnutrition. |
| Calorie Intake and Meal Patterns up to 4 Years after Roux-en-Y Gastric Bypass Surgery (Warde-Kamar et al., 2004) | To better understand eating behaviors and caloric intake after RYGBP in an ethnically diverse group of patients | n=62 | Retrospective Questionnaires | Current body weight, presence of co-morbidities, use of vitamin and mineral supplements, food intolerance and a 24-hour food recall | -Total calorie intake was 1786 ± 827<br>-93% of calories from food, 7% from beverages<br>-Consumed 1.7 g/kg IBW of protein<br>-Patients consumed 3.4 ± 2.3 sugar sweetened beverages per day<br>-Patients who had lost ≥50% Excess Body Weight consumed less calories than those who lost <50% EBW<br>-Total reported meal events was 5.4 ± 1.2 per day<br>-Micronutrient intake from food was at or above RDA recommendations for iron and vitamin B12<br>-Calcium and folic acid intake were less than 70% RDA<br>-77% of patients were taking a daily multivitamin tablet, 68% were taking iron, 66% were taking calcium, 28.6% were taking B12, 27.8% were taking folic acid and 27.4% were taking vitamin D<br>-Follow-up with surgical team decreased from 90% at 2 |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| | | | | | weeks post-operatively to 10% 36 months post-operatively |
| Comparison of nutritional consequences of conventional therapy of obesity, adjustable gastric banding, and gastric bypass. (Ledoux et al., 2006) | To understand the differences between the effectiveness of LAGB and RYGB and the nutritional implications of each surgery | n=201 (110 Controls, 51 AGB Patients, 40 RYGB) | Cross-sectional study of 201 consecutive patients through a weight loss center | -Patient characteristics (height, weight, BMI, blood pressure, metabolic parameters)<br>-Food intolerances and digestive symptoms (subjective reports)<br>-Nutritional parameters (vitamin and mineral concentrations, parathyroid | -High prevalence of fat soluble vitamin deficiencies in RYGB patients<br>-Did not find a decrease in vitamin D as expected in bariatric surgery patients<br>-Subclinical protein deficiency was evidenced by decreased serum prealbumin concentrations (levels were still within the normal limits)<br>-Serum creatinine were lower in RYGB patients compared to AGB patients though they achieved similar weight loss results (suggesting that RYGB results in lean tissue loss more than AGB)<br>-Did not find the expected deficiencies of vitamin B1, folate, and iron in surgery patients<br>-Only 60% of patients were taking their vitamin supplements as prescribed in spite of ardent recommendations to take them<br>-Nutrition status was more negatively impacted by RYGB<br>-Prevalence of nutrient deficiencies were similar between AGB and control groups |
| Compliance with Surgical After-care following bariatric surgery for Morbid Obesity: a Retrospective Study (Poole et al., 2005) | To understand the predictors of poor compliance with post-operative follow-up care after bariatric | n=18 LAGB patients (9 poor compliers and 9 fully compliant controls) | Case note review | -Attendance at follow-up appointments<br>-Compliance with dietary change recommendations<br>-Past or current disordered eating behavior<br>-Perceived insight as to causes of obesity and how surgery would impact their weight status<br>-Attitudes toward food, parents partners and professionals<br>-Weight<br>-Weight lost at 12 months post-operation | -Emotional eating and continual grazing was noted in the poor compliance groups more so than in the control group (but barely reached statistical significance)<br>-Patients who believe that the band was responsible for weight loss was not found in the compliant group<br>-Those who ate in response to emotional triggers were found to be less compliant with dietary advice<br>-A history of bulimia nervosa or binge eating disorder were not associated with poor-compliance<br>-Following surgery, non-compliers pressured surgeons to inflate the band faster than usual<br>-Mentioned self-efficacy theory, and how it relates to the patients belief that their actions can change their health, and make changes accordingly. This was noted in the patients who were non-compliant who believed that it was the band causing them to lose weight, not the changes in their eating. |
| Post-surgery Adherence to Scheduled Visits and Compliance, More than Personality | To study the predictors of clinical outcomes and non-compliance with scheduled visits | n=172 Consecutive LAGB patients | Prospective with consecutive patients through one bariatric surgery center | -Attendance at scheduled visits<br>-Compliance with prescribed diet<br>-Change in BMI after surgery | -BMI, compliance, percentage of attendance at scheduled visits and narcissistic personality were associated with percentage of weight loss at 12, 24 and 36 months after surgery |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| Disorders, Predict Outcome of Bariatric Restrictive Surgery in Morbidly Obese Patients (Pontiroli et al., 2007) | | | | -Presence of psychiatric and personality disorders (Structured Clinical Interview for DSM-IV Axis II Personality Disorders and NIMH Diagnostic Interview Schedule, version III-R)<br>-Presence of co-morbidities<br>-Family history of obesity | -Only percentage of visits was associated with weight loss at 48 months<br>-Age, sex and presence of comorbidities were not associated with weight loss after surgery |
| Pre- and Postsurgery Behavioral Compliance, Patient Health, and Postbariatric Surgical Weight Loss (Toussi et al., 2009) | To study the relationship between weight loss from RYGBP, patient characteristics, and compliance with physicians instructions pre- and postoperatively | n=112 (mostly well-educated, white women)—67 patients had enough data on compliance, data was compared to the 45 patients without data to look for differences | Retrospective (chart review) | -Height, weight, and BMI<br>-Demographics<br>-Mental Health Comorbidities<br>-Physical Health Comorbidities<br>-Behavioral Compliance (weight loss, diet, exercise, medication adherence) | -Patients lost less weight when they had some sort of eating disorder<br>-Patients with higher % excess weight lost tended to be from higher socioeconomic status and have a history of physical abuse<br>-Patients who missed appointments with the physician before surgery had a higher BMI<br>-Patients who had poor medication compliance postsurgery were heavier both before surgery and two years postsurgery<br>-Patients who made poor food choices postsurgery were more likely to be women, have a history of sexual and/or physical abuse and had a purging disorder<br>-Patients who were lighter at the time of surgery, female, white and with higher SES lost more weight 2 years postsurgery than other groups<br>-Patients in this study had the most trouble making scheduled appointments, complying with prescribed exercise routines, and compliance to weight loss instructions |
| Noncompliance with Behavioral Recommendations Following Bariatric Surgery (Elkins et al., 2005) | To examine rates of noncompliance with behavioral recommendations after bariatric surgery | n=100 (81 women, 19 men) consecutive patients | Prospective | -Demographic information<br>-Compliance with behavioral interventions<br>-Psychological and medical complications at 6 and 12 months | -Recommendations regarding exercise and avoidance of snacking had the highest rates of noncompliance<br>-Recommendations to avoid alcohol were followed by all patients at 6 and 12 months<br>-41% of patients experienced medical complications<br>-21 and 25% at 6 and 12 months respectively did not comply with recommendations to attend support groups |
| Differential Changes in Dietary Habits after Gastric Bypass Versus Gastric Banding Operations (Ernst et al., 2009) | To assess the dietary intake of bariatric surgery patients after RYGBP and LAGB | n=121 (48 RYGBP and 73 LAGB patients)<br>45 severely obese non-surgery patients<br>45 nonobese controls | Cross-sectional | Food frequency questionnaire (FFQ)<br>BMI<br>% Excess Weight Lost<br>% Excess BMI Lost | -Obese control subjects consumed more red meat, white bread, toast and diet soft drinks than the nonobese control subjects<br>-Gastric bypass patients more frequently consumed foods rich in protein such as poultry, fish and eggs and consumed less fatty sweets like chocolate, cake, biscuits and cookies than obese and nonobese control subjects<br>-Gastric bypass patients consumed more cooked vegetables |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| | | | | | than the subjects of the control groups<br>-Gastric banding patients consumed less pasta, fresh fruits and white bread and greater amounts of poultry and fish compared to the obese controls<br>-Gastric bypass patients ingested more fresh fruit, eggs and diet soft drinks, but less frequently chocolate than gastric banding patients<br>-Overall, it appeared that the gastric bypass patients ate a generally healthier diet than the gastric banding patients |
| Survey of Vitamin and Mineral Supplementation after Gastric Bypass and Biliopancreatic Diversion for Morbid Obesity (Brolin & Leung, 1999) | To determine whether physicians who perform bariatric surgery are prescribing supplements for patients according to literature. | n=109 surgeons | Questionnaire | -Supplements prescribed after RYGB and BPD<br>-Lab tests ordered after RYGB and BPD<br>-Estimates of prevalence of deficiencies after RYGB and BPD<br>-Estimates of incidence of hospitalization after RYGB and BPD | -All respondents did not prescribe prophylactic multivitamins<br>-An even lower number prescribed additional vitamins (believed to be attributable to the lack of published evidence regarding the efficacy of additional supplements at warding off deficiency)<br>-More surgeons that perform RYGB prescribed protein supplements, which is not in line with the literature that says that BPD patients have more protein deficiencies than RYGBP<br>-58% of RYGBP surgeons measure patient's serum iron levels versus 80% of BPD surgeons<br>-Some of the labs ordered after RYGBP were considered to be superfluous, as they measured for deficiencies that are uncommon in RYGBP patients<br>-RYGBP Surgeons often underestimated the incidence of vitamin deficiencies after surgery |
| Comparison of the Absorption of Calcium Carbonate and Calcium Citrate after Roux-en-Y Gastric Bypass (Tondapu et al., 2009) | The compare the absorptability of calcium in the citrated form compared to the carbonated form in RYGBP patients | n=18 | Ramdomized, double-blinded, crossover study | -Serum and urine calcium levels assessed for peak values<br>-Serum parathyroid hormone (PTH) levels | -Calcium citrate is better absorbed in RYGBP patients |
| Nutritional deficiencies after Roux-en-Y gastric bypass for morbid obesity often cannot be prevented by standard multivitamin supplementation (Gasteyger et al., | To assess the pattern and types of nutritional deficiencies that result from RYGBP, to determine the amount of supplements prescribed to each patient and to evaluate the cost of supplementation | n=137 (110 women and 27 men) | Retrospective chart analysis | -Age, BMI at surgery, Weight lost<br>-Roux-en-Y limb length<br>-Proportions of patient at 3, 6, 12, 18 and 24 months after RYGBP who needed supplementation<br>-Which supplements were needed and when<br>-Cost of necessary supplementation | -The standard multivitamin preparation prescribed was not enough to prevent deficiencies, as 60% of patients needed additional supplements at 6 months after surgery and almost all needed additional supplements by 2 years after surgery<br>-The prevalence of vitamin D and calcium deficiency increases with the length of the Roux-en-Y limb<br>-Study estimates that cost of supplementation will be $35 per month after surgery, which may be a significant cost if not |

**Table 6. Continued**

| Title (Year) | Purpose | Sample | Design | Variables/ Instruments | Results |
|---|---|---|---|---|---|
| 2008) | | | | | covered by healthcare insurance<br>-Study did not assess nutrition status pre-operatively, so may have found deficiencies that existed prior to surgery<br>-Common deficiencies were vitamin B12, iron, calcium, vitamin D and folic acid |
| Dietary intake of female bariatric patients after anti-obesity gastroplasty | To document dietary intake during the first postoperative year in female RYGBP patients | N=40 | Prospective observational cohort study, 1 year follow-up period | -Demographic questionnaire<br>-24 hour dietary recall | -By last follow-up visit, only 13 subjects remained in study<br>-Calorie content of the diet started low and increased slowly.<br>-Macronutrient make-up of diet did not change during the follow-up period<br>-Diet contribution to micronutrient intake was below recommended levels, but the mean vitamin intake was acceptable (with supplements included)<br>-Many patients experienced vomiting, nausea and hair loss after surgery<br>-Iron and zinc intake was inadequate, but deficiency was avoided through supplements<br>-Protein intake was reduced at 12 month visit<br>-Patients did not achieve recommended calorie or protein intake by the end of year one postoperatively |
| Long-term Nutritional Outcome After Gastric Bypass (Dalcanale et al., 2010) | To assess nutritional status 5or more years after RYGBP | n=75 (89.3% female) | Prospective study of patients who had undergone RYGBP 5 or more years ago, registered in outpatient care center | -Demographic information<br>-Clinical findings (presence of disease)<br>-Laboratory profile<br>-Gastrointestinal symptoms<br>-Use of supplements | -By 2 years post-op, 1 patient did not achieve excess weight loss of >50%.<br>-23% of patients failed to maintain surgical success at the interview at the end of the study<br>-32.1% of patients experienced magnesium deficiency, 50.8% experienced hemoglobin deficiency, 29.8% had iron deficiency, 36.0% had ferritin deficiency, 61.8% experienced vitamin B12 deficiency, 60.5% experienced vitamin D deficiency, 56.8% experienced beta carotene deficiency<br>-Some of these deficiencies had been uncovered preoperatively, including iron, transferring, zinc and vitamin B12<br>-Values (except zinc and folic acid)remained stable at the two year visit.<br>-GI symptoms common, 56.8% experienced dumping syndrome<br>-Patients did not follow multivitamin prescription, with only 33.3% reporting that they took the multivitamin as prescribed. |

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