

Biochemical monitoring and micronutrient replacement for patients undergoing bariatric surgery: A review of British Obesity and Metabolic Surgery Society guidelines

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The British Obesity and Metabolic Surgery Society (BOMSS) recently published the first UK guidelines on perioperative and postoperative biochemical monitoring and micronutrient replacement for people undergoing bariatric surgery. In doing so, BOMSS aimed to provide guidance for safe practice and to reduce the variation in monitoring and prescribing between different units in the UK. In this article, we review these guidelines and provide a helpful summary for all healthcare professionals involved in the care of people who undergo bariatric surgery.

The British Obesity and Metabolic Surgery Society (BOMSS) published the first UK guidelines for the perioperative and postoperative biochemical monitoring and micronutrient replacement for people undergoing bariatric surgery in September 2014 (O’Kane et al, 2014). The guidelines were based upon a comprehensive literature review and existing bariatric societies’ guidelines from across the world, and the aim was to produce a series of recommendations for tailored safe practice in the UK.

Bariatric surgery, which is often performed on people with existing malnutrition, is associated with long-term deficiencies in vitamins and minerals, which may have deleterious effects on the individual’s health and wellbeing and may even result in death. Two of the 29 reported deaths following bariatric surgery in the National Confidential Enquiry into Patient Outcome and Death report were due to malnutrition (Martin et al, 2012).

This article provides a summary of the current BOMSS guidelines with regard to postoperative monitoring and nutritional supplementation following the most common bariatric procedures performed in the UK, namely gastric balloon,

laparoscopic adjustable gastric band (LAGB), laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (RYGB).

Obesity and malnutrition

Obese individuals tend to consume food that is either unhealthy or of poor nutritional value; contains high levels of fat, salt and/or sugar; and frequently lacks proteins, vitamins, minerals and fibre (Kaidar-Person et al, 2008a; 2008b). Between 35% and 80% of bariatric surgery candidates can be described as having “high-calorie malnutrition”, a state of excess caloric intake with concurrent nutritional deficiencies that results in inadequate ability to utilise these calories effectively. The toxic by-products of incomplete biochemical reactions create a vicious cycle resulting in further weight gain, depression, eating disorders, metabolic syndrome, fatigue and other comorbidities, all of which are common features in the morbidly obese population. As all bariatric operations affect nutritional intake and absorption to various degrees, they will not necessarily result in a nutritionally improved diet (Sarwer et al, 2008). Hence, lifelong supplementation of vitamins, trace elements and micronutrients is advocated to ensure

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Article points

1. The British Obesity and Metabolic Surgery Society have recently published the first UK guidelines on the biochemical monitoring and micronutrient replacement for people undergoing bariatric surgery.
2. Obese people should have their nutritional status assessed preoperatively and postoperatively by an experienced multidisciplinary team.
3. After bariatric surgery, obese patients need lifelong monitoring and supplementation with vitamins and minerals.
4. Obese women considering getting pregnant need to avoid vitamin A in the retinol form.

Key words

- Bariatric surgery
- BOMSS
- Nutritional supplements

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For author details, see the end of the article.

Page points

1. All candidates for bariatric surgery should first be assessed by a multidisciplinary team to determine other non-surgical factors that may affect nutritional status before and after the procedure, and to test for and correct any deficiencies that may be present prior to surgery.
2. Gastric balloons are only recommended for short-term weight loss and should be replaced or removed after 6 months.
3. They only require supplementation with a once-daily complete multivitamin and do not require blood monitoring unless there are concerns over nutritional intake.
4. While they do not directly cause malabsorption, gastric balloons can result in vomiting, with secondary nutritional deficiencies; people with prolonged vomiting require thiamine and vitamin B supplements.

a well-balanced diet for the postoperative bariatric surgery patient.

Bariatric surgery in the UK

The latest figures from the UK National Bariatric Surgery Registry (NBSR) show that 18 283 bariatric procedures were performed in the UK and Ireland in the three financial years from 2011 to 2013 (Welbourn et al, 2014). RYGB remains the most common operation performed, followed by LAGB and then LSG (9526, 4705 and 3797 operations, respectively). These figures show a sharp rise in the number of bariatric procedures being carried out in the UK and Ireland compared to the first NBSR report (Welbourn et al, 2010). These numbers are only going to rise, given the good safety profile of bariatric surgery that was demonstrated in the 2014 NBSR report, the rising trend of obesity in both men and women in the UK, the cost-effectiveness of bariatric surgery and the fact that surgery is currently the most effective and sustainable method of weight loss for the treatment of morbid obesity (Buchwald et al, 2004; Sjöström et al, 2007).

Summary of guidelines

Preoperative care

All people being considered for bariatric surgery should be assessed by a multidisciplinary team with experience in the preoperative assessment, counselling and management of such individuals (Mechanick et al, 2008). Input from an experienced bariatric dietitian can help to identify additional factors that may impact on nutritional status preoperatively and postoperatively, such as dietary beliefs and behaviours, cultural background, psychosocial issues and economic factors.

Any deficiencies identified at this stage should be investigated and corrected prior to attempting surgery (Heber et al, 2010). *Box 1* provides a summary of the essential blood tests that should be performed prior to bariatric surgery. Additional tests (e.g. pregnancy or thyroid function tests) may be required according to individual needs.

Postoperative care

The recommendations for postoperative care vary in accordance with the type of procedure performed.

Box 1. Recommended preoperative blood tests before undergoing bariatric surgery.

Full blood count	Parathyroid hormone
Urea and electrolytes	Calcium
Liver function tests	Vitamin D
Ferritin	Fasting blood glucose
Folate	HbA _{1c}
Vitamin B12	Lipid profile

Gastric balloon

The BOMSS guidelines were the first to include recommendations on postoperative monitoring and nutritional supplementation following the insertion of a gastric balloon. Guidelines from the American Association of Clinical Endocrinologists (AACE), the American Society for Metabolic and Bariatric Surgery and The Obesity Society (Mechanick et al, 2013), which were recently endorsed by the International Federation for the Surgery of Obesity and Metabolic Disorders, have no mention of this.

Gastric balloons are not intended for long-term weight loss and their use in the UK is mainly as an adjunct to help people lose enough weight to make any further definitive bariatric procedure safe and feasible. Gastric balloons should be replaced or removed 6 months after insertion.

BOMSS recommend performing the full blood count (FBC), urea and electrolyte (U&E) and liver function tests (LFT) after the insertion of a gastric balloon only if there are concerns about the nutritional intake of the patient. Once in place, people with a gastric balloon need a once-daily “complete” multivitamin and mineral supplement.

Although gastric balloons do not cause malabsorption, they can induce nausea and vomiting, with secondary nutritional deficiencies. Patients with prolonged vomiting will always need additional thiamine prescribed (thiamine 200–300 mg daily and one to two vitamin B compound strong tablets three times per day). In extreme cases, these patients may need hospital admission for intravenous thiamine.

Laparoscopic adjustable gastric band

LAGB is the second most common bariatric operation performed in the UK and Ireland, although there has been a steady decline in the

number of procedures undertaken over the last few years. LAGB was originally classified as a “restrictive procedure”; however, recent research has shown that it activates peripheral satiety mechanisms without physically restricting meal size, and it should not be classified as such any more (Burton and Brown, 2011). The precise mechanism behind the weight loss with LAGB remains to be delineated.

BOMSS recommend that all people with an LAGB should have an annual FBC, U&E and LFT. People with preoperative diabetes should have their fasting blood glucose and/or HbA_{1c} levels monitored regularly. Lipid profiles should only be monitored in those with dyslipidaemia. People with an LAGB need to be prescribed a once-daily complete multivitamin and mineral supplement for as long as they are using the band.

Just as with a gastric balloon, people with an LAGB can experience prolonged vomiting. In these circumstances, they will need additional thiamine prescribed (thiamine 200–300 mg daily, and one to two vitamin B compound strong tablets three times per day). In extreme cases, these patients may need hospital admission to receive intravenous thiamine.

Laparoscopic sleeve gastrectomy

LSG is an emerging surgical approach that has seen a surge in popularity because of its perceived technical simplicity, feasibility and good outcomes (Rosenthal et al, 2012). Originally, LSG was believed to be a purely restrictive procedure that works by reducing the size of the gastric reservoir to 60–100 mL; however, its mechanism of action is more complex and is not fully understood. LSG reduces the levels of circulating ghrelin, an endogenous hunger-regulating peptide hormone produced mainly in the fundus of the stomach (Karamanakos et al, 2008).

In the first year following LSG, patients need close monitoring. They need their FBC, U&E, LFT and ferritin, folate, calcium, vitamin D and parathyroid hormone levels checked at 3, 6 and 12 months postoperatively. They also need their vitamin B12 levels checked at 6 and 12 months. These tests need to be repeated annually thereafter. However, if the patient is receiving regular intramuscular vitamin B12 injections, regular B12 measurements are not necessary.

People with diabetes will need to have their fasting blood glucose and/or HbA_{1c} levels monitored as appropriate, and lipid profiles will need to be checked in those with dyslipidaemia. Routine monitoring of thiamine, trace elements (zinc, copper, selenium) and water-soluble vitamin (A, E and K) levels is not recommended after an LSG unless clinically indicated.

After LSG, BOMSS recommends that patients should receive lifelong supplements of multivitamins and minerals (once-daily Forceval® or twice-daily complete multivitamin and mineral supplements). They need to receive 1-mg intramuscular vitamin B12 injections every 3 months from 6 months post-surgery onwards, although the guidelines acknowledge that these injections can be less frequent after LSG compared with RYGB.

An iron intake of 45–60 mg from complete multivitamin and mineral supplements plus additional iron is recommended following LSG. This may be achieved with 200 mg ferrous sulphate, 210 mg ferrous fumarate or 300 mg ferrous gluconate once daily, in addition to the multivitamin and mineral supplement. Women of reproductive age who are menstruating have additional requirements of at least 100 mg elemental iron daily (two ferrous sulphate or ferrous fumarate doses daily; Brolin et al, 1998). Generally, following LSG, usual practice for calcium and vitamin D supplementation is in the region of a minimum of 800–1200 mg calcium and 20 µg (800 IU) vitamin D per day. Calcium and iron supplements should not be taken at the same time. It is recognised that calcium citrate is more bioavailable than calcium carbonate; however, it is not readily available in the UK (Kim and Brethauer, 2015).

Laparoscopic Roux-en-Y gastric bypass

RYGB, which has long been considered the gold standard of bariatric surgery, is the most commonly performed bariatric procedure in the UK and Ireland. It is a combination procedure that acts via both food restriction and neurohormonal changes. Additionally, it causes a moderate degree of malabsorption. It is associated with nutritional deficiencies due to gastric reduction, intestinal bypass, reduced caloric intake, avoidance of nutrient-rich foods, non-compliance with

Page points

1. A laparoscopic adjustable gastric band requires annual monitoring of full blood count (FBC), urea and electrolytes (U&E) and liver function tests (LFT), and a once-daily complete multivitamin should be taken for as long as the band is in place.
2. People who undergo laparoscopic sleeve gastrectomy (LSG) require frequent monitoring of FBC, U&E, LFT and ferritin, folate, calcium, vitamin D and parathyroid hormone levels in the first year post-procedure; thereafter, these tests should be performed annually.
3. LSG requires supplementation with a daily complete multivitamin, iron, calcium and vitamin D, as well as 3–6-monthly injections of vitamin B12.

Table 1. Recommended nutritional supplements after different bariatric procedures.

Nutritional supplement	Procedure			Product example	Dosage
	Laparoscopic adjustable gastric band	Laparoscopic sleeve gastrectomy	Roux-en-Y gastric bypass		
Multivitamin and mineral	Yes	Yes	Yes	Forceval® Centrum®	One daily Two daily
Iron	No	Yes	Yes	Iron sulphate Iron fumarate Iron gluconate	200 mg once daily 210 mg once daily 300 mg once daily
Folate	As part of multivitamin and mineral	As part of multivitamin and mineral	As part of multivitamin and mineral	Forceval® Centrum®	One daily Two daily
Vitamin B12	No	Yes	Yes	Hydroxocobalamine	1 mg every 3 months
Calcium and vitamin D	No	Yes	Yes	Calcichew® D3 Forte	Three times per day
Zinc	As part of multivitamin and mineral	As part of multivitamin and mineral	As part of multivitamin and mineral	Forceval® Centrum®	One daily Two daily
Copper	As part of multivitamin and mineral	As part of multivitamin and mineral	As part of multivitamin and mineral	Forceval® Centrum®	One daily Two daily
Selenium	As part of multivitamin and mineral	As part of multivitamin and mineral	As part of multivitamin and mineral	Forceval® Centrum®	One daily Two daily

supplementation and poor food tolerability (Levinson et al, 2013).

The postoperative blood monitoring requirements in patients undergoing RYGB are identical to those of LSG; however, as RYGB involves an element of malabsorption, additional blood monitoring is warranted. After an RYGB, patients will need annual zinc, copper and vitamin A measurements, and in the presence of symptoms they will need to check their levels of vitamin E (if there is unexplained anaemia or neuropathy), vitamin K (if there is excessive bruising or coagulopathy) and selenium (if there is unexplained fatigue, anaemia, metabolic bone disease, chronic diarrhoea or heart failure). The postoperative nutritional supplements following RYGB are identical to those of LSG as mentioned above. *Table 1* provides a summary of the nutritional supplements following LAGB, LSG and RYGB, and *Table 2* provides the frequency at

which monitoring blood tests should be performed for the same procedures.

Bariatric surgery and pregnancy

The evidence behind the advice to be given in relation to pregnancy after bariatric surgery is both limited and debatable. Pregnancy is not recommended in the first 12–18 months after surgery (Mechanick et al, 2008). Evidence regarding oral contraceptives' effectiveness following a bariatric surgical procedure is quite limited (Paulen et al, 2010). The BOMSS guidelines do not mention the contraceptive method of choice for women following bariatric surgery; however, oral contraception and Depo-Provera are not recommended because of issues with absorption and weight gain, respectively (Parretti et al, 2014). A long-acting, reversible contraceptive of the patient's choice is the preferred method. Obese women need a higher dose of folic

Table 2. Recommended schedules of blood monitoring after different bariatric procedures.

Blood test	Procedure		
	Laparoscopic adjustable gastric band	Laparoscopic sleeve gastrectomy	Roux-en-Y gastric bypass
Full blood count	Annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Urea and electrolytes	Annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Liver function test	Annually	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Calcium	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Vitamin D	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Parathyroid hormone	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Ferritin	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Folate	N/A	3, 6, 12 months after surgery, then annually	3, 6, 12 months after surgery, then annually
Vitamin B12	N/A	6, 12 months after surgery, then annually	6, 12 months after surgery, then annually
Vitamin A	N/A	If clinically indicated	Annually
Zinc, copper	N/A	If clinically indicated	Annually
Selenium	N/A	If clinically indicated	If clinically indicated

N/A: These blood tests are not required for this procedure.

acid (5 mg) prior to conception until the twelfth week of pregnancy.

Prior to getting pregnant, women are advised to avoid vitamin and mineral preparations that contain vitamin A in the retinol form for the first trimester of their pregnancy, as these supplements are believed to have a teratogenic effect. Instead, they are advised to take vitamin A in the beta-carotene form. Nutritional screening for women who become pregnant after bariatric surgery should be performed every 3 months.

Discussion

BOMSS have introduced the first UK consensus

guidelines for perioperative and postoperative biochemical monitoring and micronutrition supplementation in people undergoing bariatric surgery. These guidelines aim to reduce the variation in practice in units across the UK and improve clinical practice and safety for patients undergoing these procedures.

Despite this attempt to standardise practice across the NHS, a recent publication has shown that many units across the UK consider the AACE guidelines (Mechanick et al, 2013) to be the gold standard. Dunstan et al (2015) compared the practice in 37 bariatric units across England against the AACE guidelines. They found that

“Bariatric surgery is the most effective intervention for producing sustained and significant weight loss, with concurrent reductions in obesity-related comorbidities. As a result, the number of people undergoing operative intervention is likely to rise, and hence the number of postoperative patients will also increase.”

there is no clear consensus on preoperative and postoperative nutritional supplementation, and there remains a variation in practice. Hence there is a clear need to standardise practice and ensure that current recommendations are followed.

The BOMSS guidelines suggest that using over-the-counter, non-branded complete multivitamins and mineral supplements can be a safe practice. Dunstan et al (2014) have shown that this is more cost-effective and equally safe, as most non-branded supplements have similar compositions as the branded ones.

It is not clear in these guidelines as to whose responsibility it is to provide the follow-up and monitoring of nutritional status and supplements for patients after bariatric surgery once they have been discharged from the care of the Tier 4 service. Should it be the patients’ GPs, who can do so with input from Tier 3 weight assessment and management clinics (BOMSS, 2014)? If so, there is the issue of educating GPs and relying on them to do so alongside all the duties and responsibilities they already have. The Royal College of GPs have recently produced a “*Top Ten Tips*” advice leaflet aimed at healthcare professionals looking after post-bariatric surgery patients in the primary care setting (Parretti et al, 2014; see page 68 of this Journal). This leaflet aims to simplify and provide a quick reference guide to GPs when following and monitoring patients who had undergone bariatric surgery. Alternatively, should the monitoring be done by Tier 3 services? Here there are issues of funding and resources, as a number of these clinics do not have separate prescribing budgets.

There are two aspects in the BOMSS guidelines that have not been mentioned in this article. The first is the topic of nutritional monitoring and supplementation following duodenal switch (DS) surgery. DS is rarely performed nowadays in the UK and Ireland. Recent figures show that over the financial years 2011–2013, only 19 DS surgeries were performed out of a total of 18 283 procedures, representing only 0.1% of all bariatric surgery procedures in the British Isles (Welbourn et al, 2014). The second topic was the issue of management of various nutritional deficiencies after bariatric surgery. The BOMSS guidelines have a whole section about deficiencies of various trace minerals and elements and the

topic of anaemia following weight loss surgery. In this article, we aimed to produce a summary of the recommendations on monitoring and supplementation, and we believe that the testing and management of deficiencies is beyond our scope and merits a separate discussion of its own.

Conclusion

Bariatric surgery is the most effective intervention for producing sustained and significant weight loss, with concurrent reductions in obesity-related comorbidities. As a result, the number of people undergoing operative intervention is likely to rise, and hence the number of postoperative patients will also increase. This cohort of patients requires lifelong nutritional monitoring and follow-up appropriate to the type of operation, and this is currently provided in primary care. Thus, an awareness of the current UK guidelines is invaluable to ensure that post-bariatric surgery patients receive optimal management. ■

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