Metabolic and bariatric surgery: Postoperative management

Clinical Practice Guideline for the Management of Obesity in Adults in South Africa

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SOUTH AFRICAN METABOLIC MEDICINE AND SURGERY SOCIETY

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KEY MESSAGES FOR HEALTHCARE PROVIDERS

- Adherence to consistent postoperative behavioural changes (behaviour modification for nutrition plans, physical activity and vitamin intake) can optimise management and health of people living with obesity (PLWO) who have had metabolic and bariatric surgery (MBS), while minimising postoperative complications.
- Working in partnership, the MBS centre, the local bariatric medicine specialist, the primary healthcare provider (HCP) and the PLWO need to establish and commit to a shared care model of chronic disease management for long-term follow-up.
- The primary HCP should refer patients with post-MBS complications back to the MBS centre, or to a local bariatric medicine specialist.

KEY MESSAGES FOR PATIENTS WHO HAVE HAD METABOLIC AND BARIATRIC SURGERY

- If you have had MBS, it is important for you to take your nutritional supplements lifelong and to continue to follow the post-surgery nutrition plan, exercise, and any other recommendations given by your original specialist team. By doing this, you will increase your chances of staying healthy and reduce complications that can arise from bariatric surgery.
- Alcohol metabolism may be altered after MBS, which could increase your chance of developing a high-risk alcohol problem. Alcohol intake should be stopped or kept to a minimum.[1]
- Attend all scheduled appointments and programmes offered by your MBS centre. Once you are discharged from the centre, schedule annual appointments with your primary care provider to check your blood work, reassess your medications, and address any issues related to changes in your weight.
- After MBS, it is possible that there can be a negative impact on mood, relationships and body image, development of addictions, and reduced ability to cope with stress. If you are struggling, discuss this with your original specialist team or, if you have been referred to primary care, with your primary care provider.
- Remember that your lowest weight after surgery will be reached between 12 and 18 months. After this, a natural increase in weight occurs. If you are gaining excessive amounts of weight, discuss it with your specialist team or your primary care provider.
- If, 12 to 18 months after MBS, you are planning a pregnancy (pregnancy is not recommended earlier than this), discuss this with your primary care provider, specialist team and obstetrician.

RECOMMENDATIONS

1. HCPs can encourage PLWO who have undergone MBS to participate in and maximise their access to behavioural interventions and allied health services at an MBS centre (Level 2a, Grade B).[2,3]
2. We suggest that MBS centres communicate a comprehensive care plan to primary HCPs for patients who are discharged, including MBS procedure, emergency contact numbers, annual blood tests required, long-term vitamin and mineral supplements, medications, behavioural interventions, and when to refer back (Level 4, Grade D, Consensus).
3. We suggest that after a PLWO has been discharged from the MBS centre, HCPs should annually review nutritional intake, activity, compliance with multivitamin and mineral supplements and weight, as well as assess comorbidities, order laboratory tests to assess for nutritional deficiencies, and investigate abnormal results and treat as required (Level 4, Grade D, Consensus).
4. We suggest that HCPs consider referral back to the MBS centre or to a local bariatric medicine specialist for technical or gastrointestinal symptoms, nutritional issues, pregnancy, psychological support, weight regain, or other medical issues related to MBS as described in this chapter (Level 4, Grade D, Consensus).

5. We suggest that MBS centres provide appropriate follow-up and laboratory tests at regular intervals after surgery with access to appropriate HCPs (dietitian, nurse, social worker, surgeon, bariatric physician, psychologist/psychiatrist) until discharge/referral to primary care level is deemed appropriate for the patient (Level 4, Grade D, Consensus).

Health behaviour changes after metabolic and bariatric surgery

Diet after surgery

Centres that perform metabolic and bariatric surgery (MBS) will typically provide people living with obesity (PLWO) with a postoperative dietary protocol to follow. Initially, over several weeks, the PLWO transitions from a liquid to a soft and then to a solid diet. Over the long term, PLWO are encouraged to follow a structured post-MBS diet involving small portions, three to five balanced and structured meals per day, and healthy snacks (chew foods slowly and avoid sweets). With regard to beverages, PLWO should not eat and drink at the same time (avoid liquids within 30 minutes of eating solids). Carbonated beverages and caffeinated drinks are to be avoided, as phosphoric acid and caffeine can both increase the risk of ulceration.

After MBS, PLWO need to follow a low-fat, moderate-carbohydrate and high-protein diet. Postoperative protein recommendations range from 1.2 to 1.5 g/kg/day based on goal body weight (minimum of 60 g protein/day for laparoscopic sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (RYGB), and 80 - 120 g/day for duodenal switch (DS). Consulting a registered dietitian can support changes in eating behaviours and guide PLWO on their nutrition needs.[4] This is especially applicable where examples of low-cost and culturally accepted alternatives must be considered, while adhering to recommendations. There is no advantage to prescribing alternative diets (e.g. low carbohydrate, high protein), probiotics or amino acids.[5-7]

Other behavioural changes to consider

- **Alcohol intake** should be minimal or avoided owing to changes in pharmacokinetics. For example, in women who have had RYGB, two alcoholic beverages are equivalent in absorption to four alcoholic beverages. Seven percent of PLWO reported new high-risk alcohol use 1 year after MBS, although, on a more positive note, half who reported high-risk alcohol use before surgery discontinued high-risk drinking.[3]
- **Activity.** Long term, a standard of 150 - 300 minutes of activity per week is recommended for post-MBS patients. Postoperative higher-volume exercise can help promote further weight loss,[8-10] but sustaining this level of activity is difficult.[11]
- **Smoking cessation.** Abstaining from cigarettes is recommended. Cigarette smoking can increase the risk of peptic ulcer disease, particularly marginal ulcers.
- **Marijuana.** There is a paucity of studies on the use of marijuana after MBS. One concern would be the impact on weight of the regular use of marijuana, which is traditionally known for its 'munchies' effect. At this point moderation, if not abstention, would be a safe recommendation.

Vitamin supplementation after metabolic and bariatric surgery

The evidence for the role of vitamin supplementation (amount, duration) varies depending on which vitamin, mineral or type of MBS procedure is studied. Generally, some type of vitamin supplementation is needed for all MBS procedures, with tailoring for those that have a hypoabsorptive component (RYGB and DS).

Practically, it makes sense that a standardised minimum prescription of vitamins be set for all MBS procedures. It should be noted that there are cost-effective preparations available for supplementation that may require taking vitamins and minerals separately, as opposed to a combination formulation, but ensure accessibility in resource-constrained settings. It is a natural human tendency to eventually forget to take supplements. Setting a standard means that HCPs can be consistent in their messaging about taking vitamins. Deficiencies of vitamins and some minerals can have serious and potentially non-reversible side-effects. Frequency of laboratory monitoring may vary depending on the individual and the type of procedure, but at minimum an annual check should be conducted to ensure that PLWO are not becoming malnourished. Tables 1 and 2 summarise the recommendations for vitamin supplementation, associated adverse health effects that can occur with various deficiencies, and frequency of monitoring. Table 3 summarises clinical features that may indicate nutrient deficiency. A dietitian can help determine what combination of vitamins makes sense for a patient. Gummy vitamins should be avoided, as they do not contain essential minerals.

Complications after metabolic and bariatric surgery

Many gastrointestinal (dumping syndrome) and metabolic complications (e.g. bone, kidney stones) can be prevented by following the recommended post-MBS nutrition plan and vitamin intake.

Dumping syndrome

Dumping syndrome is divided into early and late phases. Early dumping syndrome occurs within the first hour after a meal. Because of the hyperosmolality of the food, rapid fluid shifts occur from the plasma compartment into the intestinal lumen, resulting in hypotension and a sympathetic nervous system response. Early dumping is characterised by gastrointestinal symptoms such as abdominal pain, bloating, borborygmi, nausea and diarrhoea, and vasomotor symptoms such as fatigue, desire to lie down after meals (a classic symptom), flushing, palpitations, perspiration, tachycardia, hypotension and, rarely, syncope. In contrast, late dumping usually occurs 1 - 3 hours after a meal and is a result of an incretin-driven hyperinsulinaemic response after carbohydrate ingestion. Hypoglycaemia-related symptoms are related to neuroglycopenia (fatigue, weakness, confusion, hunger and syncope) and autonomic/adrenergic reactivity (perspiration, palpitations, tremor and irritability).[12]

Symptoms that persist despite returning to a post-MBS diet may benefit from a trial of calcium channel blockers, diazoxide or octreotide. Referral to a bariatric medicine specialist or an endocrinologist for management and to rule out other causes of hypoglycaemia (nesidioblastosis, insulinoma, factitious) may be warranted.[13]

Glucagon-like peptide-1 (GLP-1) receptor agonists may potentially reduce the number of postprandial hypoglyaemic episodes and improve glycaemic variability in PLWO after MBS who have dumping. This may prove to be a helpful treatment option in the future pending further studies.[14] People living with type 2 diabetes undergoing MBS may be using sodium glucose co-transporter-2 (SGLT-2) inhibitors

Table 1. Recommendations for diet, exercise, vitamin and mineral supplementation, and laboratory monitoring after MBS

Nutrition and exercise

- Eat 3 - 5 small meals a day
- Chew food slowly
- Aim for minimum 60 g protein/day (SG/RYGB) or 80 - 120 g protein/day (DS)
- Separate liquids and solids by 30 minutes
- No carbonated or caffeinated beverages
- Minimal to no alcohol intake
- No smoking
- No NSAIDs or DOACs post RYGB and DS
- Complete MV and mineral supplement (containing thiamine, iron, selenium, zinc and copper) is recommended daily after all bariatric procedures[73]

Physical activity 150 - 300 minutes/week				
Vitamins and minerals	**Dosing recommendations vary by procedure type as indicated in the columns. Where a single value is provided across columns, there is no evidence for different dosing**			**Description of supplement with suggested timing (most patients will require complete MVs with additional supplementation of vitamins B_{12} and D, calcium and iron)**
	LAGB or SG	**RYGB**	**DS**	
Vitamin B_2 (riboflavin)		3.4 mg		Take complete MVs at breakfast. The vitamins and minerals listed on the left can be found in OTC MVs. Patients and clinicians need to check labels carefully, as formulations differ between brands and sometimes can change. Generally, patients will need two complete OTC MVs per day to reach the daily recommendations post MBS. The ratio of zinc/copper should remain 8 - 15 mg/1 mg. Serum copper should be monitored in patients taking zinc supplements, and vice versa.[73] Some marketed vitamins are labelled as post-MBS vitamins but may still need additional calcium, iron, vitamin B_{12} or vitamin D supplementation. Read labels carefully and adjust according to laboratory results. If the patient is pregnant, switch OTC MV to prenatal vitamin, not to exceed 5 000 IU of vitamin A per day. Avoid retinol-based vitamin A during pregnancy and lactation; it is safe to continue beta-carotene. Additional screening and increased requirements of vitamin A in DS or if steatorrhoea presents.
Vitamin B_3 (niacin)		40 mg		
Pantothenic acid (B_5)		20 mg		
Vitamin B_6		4 mg		
Biotin		60 µg		
Vitamin C		120 mg		
Selenium		140 µg		
Magnesium		400 mg		
Manganese		4 mg		
Chromium		120 µg		
Molybdenum		50 µg		
Zinc	15 mg	30 mg[73]	30 mg	
Copper	1 mg	2 mg	2 mg	
Vitamin A	5 000 - 10 000 IU	10 000 IU	10 000 IU	
Vitamin K	90 - 120 µg	300 µg	300 µg	
Vitamin E	100 IU[73]			
Folic acid	400 µg			
Folic acid (pre-conception to 12 weeks' GA)	5 mg[77]			
Folic acid from >12 weeks to breastfeeding/ or 4 - 6 weeks postpartum	5 mg[77]			
Vitamin B_1 (thiamine)	12 mg			If insufficient amount in complete MV, add a 50 mg B-complex supplement. Take at breakfast.
Vitamin B_1 for at-risk patients*	50 - 100 mg			Take two 50 mg B-complex supplements.
Vitamin B_{12}	350 - 500 µg			Oral: 350 - 500 µg/day (take at breakfast) Nasal spray: as directed by manufacturer Parenteral (IM or SC): 1 000 µg monthly
Vitamin D	3 000 IU			Take at breakfast. Titrate vitamin D supplementation: to maintain 25(OH)D levels at >75 nmol/L to PTH levels It is not uncommon that for DS, higher supplementation of vitamin D (as high as 50 000 IU 2 - 3 times/week) may be required. Vitamin D_3 (cholecalciferol) is preferred over D_2 (ergocalciferol) for its more potent effect.

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Table 1. (continued) Recommendations for diet, exercise, vitamin and mineral supplementation, and laboratory monitoring after MBS

Calcium (from food and supplements)	1 200 - 1 500 mg	1 200 - 1 500 mg	1 800 - 2 400 mg	Take in divided doses. Calcium citrate (preferred) with or without meals. Calcium carbonate with meals. Titrate to serum calcium and PTH levels.
Iron				
Low risk (men and patients without history of anaemia)	200 mg ferrous sulphate 300 mg ferrous gluconate[73]			Take before bed. Do not take with calcium as absorption blocked.
Menstruating women	45 - 60 mg elemental iron (up to 300 mg ferrous sulphate)			Ferrous sulphate is the preferred iron supplement, but others may be considered if this supplement is not tolerated. Take with vitamin C 250 - 500 mg for better absorption with non-haem iron supplements. Formulations of different non-haem iron supplements (elemental iron mg): ferrous sulphate 300 mg (60 mg) ferrous gluconate 300 mg (35 mg) ferrous fumarate 300 mg (99 mg) There is no evidence for the role of haem iron supplements (11 mg elemental haem iron/tablet) for prevention of anaemia in post-MBS patients. However, if this is what is tolerated clinically, careful monitoring of FBC and ferritin levels are warranted.
Laboratory tests monitoring schedule[68]				
	LAGB or SG	**RYGB**	**DS**	**Comments**
Laboratory values to monitor	FBC, electrolytes, creatinine, liver function, ferritin, vitamin B_{12}, folate, calcium, 25(OH)D, PTH (if not tested before surgery)	Same as LAGB/SG + vitamin A	Same as RYGB + INR, vitamin E, zinc, copper, selenium, vitamin K	Screen for thiamine for at-risk patients* or those who have clinical features related to thiamine deficiency (see Table 2). For unexplained anaemia, check zinc, copper, selenium, vitamin E. Screen selenium for chronic diarrhoea, metabolic bone disease and cardiomyopathy. Screen zinc if hair loss or change in taste occurs. For unexplained neuropathy check vitamin E level. HbA1c and lipograms checked in patients with pre-surgery diabetes or dyslipidaemia.
Lab frequency: First year post op; thereafter	3, 6, 12 months; yearly	3, 6, 12 months; yearly	Every 3 months; every 6 - 12 months	During pregnancy, labs should be monitored each trimester: FBC, ferritin, albumin, vitamin B_{12}, 25(OH)D, calcium, PTH, folate.

MBS = metabolic and bariatric surgery; SG = laparoscopic sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; DS = duodenal switch; LAGB = laparoscopic adjustable gastric banding; NSAIDs = non-steroidal anti-inflammatory drugs; DOACs = direct oral anticoagulants; MV = multivitamin; OTC = over the counter; GA = gestational age; IM = intramuscular; SC = subcutaneous; 25(OH)D = 25-hydroxy (OH) vitamin D; PTH = parathyroid hormone; FBC = full blood count; INR = international normalised ratio; HbA1c = glycated haemoglobin; CBC = complete blood count.
*At-risk factors include gastrointestinal symptoms such as intractable nausea and vomiting, malnutrition, excessive and/or rapid weight loss, excessive alcohol use.

for glucose control. There is a significant reduction in carbohydrate intake in a preoperative liver volume-reducing diet, as well as a reduction in overall calorie intake after surgery. This may be the reason for reported cases of euglycaemic ketoacidosis in PLWO who continue to take SGLT-2 inhibitors. Conversely, SGLT-2 inhibitors may reduce postprandial hypoglycaemia, so judicious use could be beneficial. Further research will be valuable in determining when to use these agents.[15,16]

Abdominal discomfort

Abdominal discomfort has a long list of differential diagnoses, from dietary indiscretion (overeating) to dumping syndrome, biliary colic, stenosis of the gastrojejunostomy, marginal ulcer or small-bowel obstruction. Presentation with small-bowel obstruction can occur at any time but can be divided into early (<30 days; secondary to adhesions or incarcerated hernias) or late (>1 year; internal hernia, which can occur after RYGB or DS). During the first year, there is a need for an increased level of suspicion for pain secondary to a surgical complication. Tachycardia, unstable vital signs and abdominal pain may be suggestive of a surgical leak, internal hernia or cholecystitis, which warrant immediate surgical referral. The surgeon should have a low threshold to consider a diagnostic laparoscopy early to prevent serious complications with diarrhoea, constipation or bloating. Referral to a dietitian can help identify healthier food choices and proper fibre content. Probiotics may improve symptomatic gastrointestinal episodes.[17,18]

There should be a high level of suspicion for ulceration for PLWO who use non-steroidal anti-inflammatory drugs (NSAIDs). Referral to the MBS centre should be considered when clinical red flags appear such as unexplained, frequent, moderate to severe abdominal

Table 2. Treatment for post-MBS deficiencies and suggested supplementation[78-82]

Micronutrient	Post-MBS deficiency prevalence	Food sources	Signs/symptoms of deficiency	Treatment for deficiency
Vitamin B_3 (niacin)		Yeast, liver, cereals, legumes, seeds	'4Ds' of pellagra: Dermatitis: photosensitive (pigmented), diarrhoea, dementia, death	
Magnesium	32%		Muscle contractions, pain, spasms, osteoporosis	Oral magnesium
Zinc	SG: 12% RYGB: 21 - 33% DS: 74 - 91%	Meat, chicken, nuts, lentils, fortified breakfast cereals	Skin lesions, poor wound healing, dermatitis, blunting of taste sense, hair loss, altered immune function, alopecia, glossitis, infertility	Remember: Zinc/copper ratio: 8 - 15 mg/1 mg as zinc supplementation can cause a deficiency in copper (e.g. if taking zinc 50 mg/d, then add copper 4 mg/d). Toxicity level: 24-h urine >1 200 µg/day
Copper	RYGB: 2% DS: 10 - 24%	Everything (vegetables, grains, meat, fish, poultry)	Anaemia, leucopenia, hypopigmentation of hair, skin, nails, unsteady gait, numbness and tingling in hands and feet, painful paraesthesia, poor wound healing, peripheral neuropathy, myelopathy, paralysis	If copper deficient: Mild-moderate deficiency (including low haematological indices): 3 - 8 mg/day copper gluconate or sulphate Severe deficiency: 2 - 4 mg/day IV copper for 6 days or until serum levels return to normal and neurological symptoms resolve Toxicity level: Women >155 µg/dL Men >140 µg/dL
Vitamin A	RYGB: 8 - 11% DS: 61 - 69%	Preformed vitamin A (retinol): liver, kidney, egg yolk, butter Provitamin A (beta-carotene): leafy greens, carrots, sweet potatoes	Loss of nocturnal vision, Bitot's spots (foamy white spots on sclera), itching, dry hair, xerophthalmia, decreased immunity, poor wound healing, hyperkeratinisation of the skin, loss of taste (vitamin A and zinc metabolism interrelated)	No corneal changes: 10 000 - 25 000 IU/day orally for 1 - 2 weeks Corneal lesions present: 50 000 - 100 000 IU/day IM for 3 days followed by 50 000 IU/day IM for 2 weeks
Vitamin E		Olive oil, meat, eggs, leafy vegetables	Gait ataxia, hyporeflexia/weakness, nystagmus, ophthalmoplegia, ceroid deposition in muscle	Toxicity level: >80 µg/dL
Vitamin K			Skin haemorrhages (petechiae, purpura, ecchymosis)	For post-MBS patients with hypoabsorption, the recommended dosage of vitamin K is either 1 - 2 mg/day orally or 1 - 2 mg/week parenterally.
Folic acid	9 - 38%	Animal products, leafy vegetables; easily destroyed by heat of cooking	Macrocytic anaemia, palpitations, fatigue, neural tube defects, changes in pigmentation or ulceration of skin, nails or oral mucosa	1 mg/day orally for 1 - 3 months
Vitamin B_1 (thiamine)	Up to 49%	Yeast, legumes, pork, rice, cereals; denatured at high temperature	Dry beriberi: Symmetrical peripheral neuropathy; convulsions, muscle weakness ± pain of lower and upper extremities, brisk tendon reflexes Wet beriberi: Heart failure, tachycardia or bradycardia, lactic acidosis, dyspnoea, leg oedema, RV dilatation Wernicke's encephalopathy: Polyneuropathy and ataxia, ocular changes (ophthalmoplegia and nystagmus), confabulation, short-term memory loss Korsakoff psychosis: Psychosis and or hallucinations	Treat for suspected thiamine deficiency before or in the absence of laboratory confirmation. Oral: 100 mg BID-TID until symptoms resolve IV: 200 mg TID or 500 mg OD-BID for 3 - 5 days, followed by 250 mg/d for 3 - 5 days or until symptoms resolve IM: 250 mg OD for 3 - 5 days or 100 - 250 mg monthly Simultaneous administration of magnesium, potassium and phosphorus should be given to patients at risk for refeeding syndrome.

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Table 2. (continued) Treatment for post-MBS deficiencies and suggested supplementation[78-82]

Micronutrient	Post-MBS deficiency prevalence	Food sources	Signs/symptoms of deficiency	Treatment for deficiency
Vitamin B_{12}	2 years post RYGB/DS: 4 - 62% 5 years post RYGB/DS: 19 - 35%	Meat and dairy products	Pernicious anaemia, tingling in fingers and toes, depression, dementia, ataxia, sore tongue, smooth and 'beefy red' tongue, pale skin, slightly icteric skin and eyes	1 000 or 2 000 µg/day (1 - 2 ampoules) orally or 1 000 µg/week IM
Vitamin D	25 - 80%		Osteomalacia, arthralgia, depression, fasciculation, myalgia	Vitamin D_3 is more potent than vitamin D_2 when comparing frequency and amount needed for repletion. Vitamin D_3 3 000 - 6 000 IU/day or Vitamin D_2 50 000 IU 1 - 3 times weekly Toxicity level: >150 ng/mL
Calcium (from food and supplements)	Approx. 10%	E.g.: food (mg calcium): 1 cup milk = 300 mg 28 g cheese = 250 mg ¾ cup yogurt = 200 mg ½ cup cooked leafy greens = 50 mg	Low bone density, osteoporosis, muscle contractions, bone pain, spasms, paraesthesia, muscle weakness, tetany	Adjust calcium and vitamin D intake based on normalising laboratory values of calcium, 25(OH)D and PTH.
Iron	SG: 17% RYGB/DS: 30% (45% after 2 years)		Fatigue, impaired work performance and productivity, microcytic anaemia, decreased immune function, enteropathy, glossitis, dysphagia, spoon-shaped nails (koilonychia), vertical ridge on nails	Can increase oral non-haem iron intake in divided doses to provide 150 - 200 mg elemental iron daily (e.g. ferrous sulphate 300 mg TID). Take separately from calcium supplements, acid-reducing medications. If no response, then consider parenteral iron administration. Haem iron for treatment of post-RYGB iron deficiency is not recommended as first line but may be considered if patient does not tolerate non-haem iron. The dose would be 4 tablets of haem iron daily.

MBS = metabolic and bariatric surgery; SG = laparoscopic sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; DS = duodenal switch; IV = intravenous; IM = intramuscular; RV = right ventricular; BID = twice a day; TID = three times a day; OD = once daily; 25(OH)D = 25-hydroxy (OH) vitamin D; PTH = parathyroid hormone.

pain, daily intolerance to most solid foods, or daily nausea and vomiting. Any MBS patient suffering from persistent vomiting severe enough to interfere with regular nutrition should be promptly started on oral or parenteral thiamine supplementation, even in the absence of or before confirmatory laboratory data.[19]

In addition, patients who have undergone MBS and show clinical deterioration as defined by the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) should be referred back to their MBS team. This includes a weight regain of ≥30% of the initial surgical weight loss or if there is any worsening of a complication of obesity that was the original indication for MBS.[20]

Bone health

After MBS, bone demineralisation[21-23] and fracture risk,[24] particularly after DS, are increased. A major cause of bone loss is impaired intestinal calcium absorption, which leads to stimulation of parathyroid hormone (PTH) (secondary hyperparathyroidism) and bone resorption.[21] The evidence for monitoring, prevention and treatment is not well described. At minimum, adequate protein intake in combination with routine physical activity in addition to routine supplementation of calcium and vitamin D are recommended.[21,25] It is recommended to adjust calcium and vitamin D intake to achieve normal serum calcium, vitamin D and PTH levels. Calcium citrate is preferred over calcium carbonate, as it is better absorbed in the absence of gastric acid.[26] Elevated PTH in the setting of inappropriately high serum calcium and normal vitamin D levels is suggestive of primary hyperparathyroidism and requires further investigation.

The role of bone mineral density testing prior to MBS is controversial,[27] particularly in view of technical difficulties in PLWO. We suggest ordering bone mineral density testing on PLWO 2 years after surgery, when weight is at its nadir. Subsequent bone mineral density testing can be ordered based on clinical need.[27] If a PLWO does have osteoporosis, intravenous bisphosphonates (zolendronate 5 mg once a year, ibandronate 3 mg every 3 months) are the preferred choice, as there is a risk of anastomotic ulcer with oral bisphosphonates.[28] Prior to starting bisphosphonate therapy, it is important that vitamin D levels be fully replete to prevent the development of hypocalcaemia, hypophosphataemia and osteomalacia.[28,29]

Nephrolithiasis

PLWO who have had MBS are at increased risk of new-onset nephrolithiasis, with the mean interval from surgery to diagnosis of

Table 3. Clinical features that patients might present after MBS with possible related nutrient deficiency[78-82]

Clinical features	Possible micronutrient deficiency
Hair	
Alopecia	Iron, zinc, biotin, protein
Corkscrew hair	Vitamin C
Eyes	
Night blindness, ocular xerosis, keratomalacia, Bitot's spots	Vitamin A
Ophthalmoplegia	Thiamine, vitamin E
Optic neuropathy	Vitamin B_{12}, thiamine (Wernicke), copper (rarely folate)
Face/skin	
Dermatitis: hyperpigmentation around sun-exposed skin: face, neck and hands	Niacin
Impaired wound healing	Zinc, vitamin C, protein
Petechiae, purpura	Vitamin C, vitamin K
Mouth	
Soreness, burning	Riboflavin (vitamin B_2)
Angular stomatitis or cheilitis	Vitamin B_2, niacin, iron, vitamin B_6, vitamin B_{12}; or vitamin A toxicity
Pica	Iron, zinc
Hypogeusia or dysgeusia	Zinc
Glossitis (sore, swollen, red and smooth tongue)	Folate, riboflavin, niacin, vitamin B_6, vitamin B_2, folate, severe iron deficiency
Gingival bleeding	Vitamin C, niacin, folate, zinc, severe vitamin D deficiency; or vitamin A toxicity
Beefy red tongue	Folate, niacin, vitamin B_{12}
Nails	
Beau's lines (transverse ridges, horizontal grooves)	Zinc, protein, calcium
Koilonychia	Iron, protein, anaemia
Splinter haemorrhage	Vitamin C, iron
Brittle, soft, dry, weak, thin, split easily	Magnesium; or vitamin A toxicity and selenium toxicity
Musculoskeletal	
Bone pain	Vitamin D
Calf tenderness, absent deep tendon reflexes, foot and wrist drop	Thiamine
Peripheral neuropathy, tingling, 'pins and needles'	Folate, vitamin B_6, pantothenic acid, phosphate, thiamine, vitamin B_{12}
Muscle twitching, convulsions, tetany	Calcium, vitamin D, magnesium, vitamin B_6; or excess magnesium and vitamin B_6
Muscle cramps	Chloride, sodium, potassium, magnesium, calcium, vitamins, dehydration
Muscle pain	Vitamin D, biotin
Sexual	
Hypogonadism, erectile dysfunction	Zinc
Haematology	
Anaemia and fatigue	Protein, zinc, copper, selenium
Microcytic anaemia	Iron, copper, pyridoxine, vitamin E
Macrocytic anaemia	Vitamin B_{12}, folate
Neutropenia	Copper
Nervous system	
Ataxia	Vitamin B_{12}, copper
Myelopathy	Vitamin B_2, copper (rarely folate, vitamin E)
Polyradiculopathy	Thiamine
Neuropathy	Vitamin B_{12}, thiamine (Wernicke), copper (rarely pyridoxine, folate, niacin, vitamin E)
Myopathy	Vitamin D, vitamin E
Dementia	Niacin, vitamin B_{12}
Amnesia, hallucinations, confabulation	Thiamine (Korsakoff)
Confusion, encephalopathy	Thiamine (Wernicke), vitamin B_{12}
Heart	
Cardiomyopathy	Selenium
Heart failure	Thiamine

MBS = metabolic and bariatric surgery.

Table 4. Pharmacotherapy recommendations after MBS

Increased concentration	Decreased concentration
Atorvastatin short term 8 weeks[39]	Atorvastatin long term 2 years[39]
Metformin[83]	Levothyroxine[47]
Morphine[84]	Cyclosporin[47]
Acetaminophen (Paracetamol)	Phenytoin[47]
Moxifloxacin[85]	Rifampin[47]
Lithium[86]	Sertraline
	SRI (SSRI more likely to decrease than SNRI) reduced at 1 month and then normal at 1 year[87]
	Tamoxifen[88]
List of medications not to be crushed	
Alendronate, bisacodyl, bupropion, ciprofloxacin, diltiazem, dipyridamole/ASA, divalproex, felodipine, ferrous sulfate, fexofenadine, finasteride, glipizide, lansoprazole, lithium, loratadine, metformin, metoprolol, morphine, nifedipine, omeprazole, pantoprazole, phenytoin, piroxicam, prednisolone, pseudoephedrine, rabeprazole, tamsulosin, verapamil[48]	

MBS = metabolic and bariatric surgery; SRI = serotonin reuptake inhibitor; SSRI = selective serotonin reuptake inhibitor; SNRI = serotonin-norepinephrine reuptake inhibitor; ASA = aspirin.

nephrolithiasis ranging from 1.5 to 3.6 years. The risk of nephrolithiasis, typically calcium oxalate stones, varies by procedure, being highest for hypoabsorptive procedures (22 - 28.7%), intermediate for RYGB (7.65 - 13%) and lowest for purely restrictive procedures (laparoscopic adjustable gastric banding, laparoscopic SG), where it approaches that of non-operative controls.[30] Unabsorbed fat in the intestine binds with calcium, which typically would bind oxalate. Oxalate is reabsorbed from the intestine and is subsequently filtered by the kidneys, resulting in hyperoxaluria. With concomitant hypocitraturia (from intestinal alkali loss), there is a higher propensity for calcium oxalate stone formation. Basic therapeutic strategies to manage hyperoxaluria include calcium citrate supplementation, increased hydration, limiting dietary oxalate, and adhering to a low-fat diet.[18,21] PLWO often believe that kidney stones are caused by taking too much calcium, and that calcium supplementation should be discontinued. The exact opposite is true, in that they should remain on their calcium citrate supplementation, which not only helps bind intestinal oxalate but also provides citrate for the urine. There is some evidence to suggest that pyridoxine (vitamin B_6) deficiency plays a role in kidney stone formation, highlighting the importance of taking vitamin supplementation consistently.[31] Certain probiotics (containing either *Lactobacillus* alone or in combination with *Streptococcus thermophilus* and *Bifidobacterium*) may play a complementary role in reducing gastrointestinal oxalate absorption if basic strategies are insufficient.[32,33]

Postoperative psychological complications and treatments

Although MBS is one of the most effective treatment options for managing PLWO, HCPs should be aware of the potential post-MBS psychological issues that may arise, including depression, suicide,[34,35] body image disorder, eating disorders,[36] and substance and alcohol abuse.[3] Results of MBS may not meet PLWOs' expectations or may not lead to hoped-for improvements in quality of life, therefore affecting mood.[19] Beyond providing knowledge on diet and exercise, HCPs should address improvement in PLWOs' self-esteem and self-motivation. PLWO who have had post-MBS comprehensive behavioural-motivational nutrition education have decreased risk for depression and improved weight loss outcomes.[2,37,38] Primary HCPs may need to refer the post-MBS PLWO for more in-depth psychological counselling, such as cognitive or dialectical behaviour therapy. (See the chapters 'The role of mental health in obesity management' and 'Effective psychological and behavioural interventions in obesity management' for more details.)

Weight regain

Nadir weight (lowest weight point) occurs 1 to 2 years after MBS. Weight loss stops partly because of adaptive changes in the intestine, changed patient habits and metabolic adaptation.[36,39] After this, it is normal to expect some weight regain. Studies that have been conducted in the MBS population show that significant weight regain (≥15% gain of initial weight loss after MBS) occurs in 25 - 35% of PLWO who undergo MBS, 2 to 5 years after their initial surgical date.[40] The Swedish Obese Subjects study, the largest non-randomised intervention trial comparing weight loss outcomes in a group of over 4 000 surgical and non-surgical individuals, reported that at 10 years, individuals who underwent RYGB had a mean weight regain of 12% of total body weight, which translates into regaining 34% of the maximal lost weight achieved at 1 year.[36,41] The IFSO defines a late postoperative clinical deterioration after MBS as either weight gain of more than 30% of the initial surgical weight loss, or worsening of an obesity complication that was originally a significant indication for the MBS.[20,42] The underlying factors that influence weight regain after MBS are multifactorial, and include endocrine/metabolic alterations, anatomical surgical failure, nutritional indiscretion, mental health issues and physical inactivity.[36]

Even before MBS, emphasising realistic weight trajectories and expectations may theoretically help reduce the anxiety that some PLWO go through as they mentally try to transition from losing weight to healthy living and maintaining weight loss. PLWO who experience weight regain may perceive that the MBS has failed, or they may enter a cycle of helplessness by blaming themselves and feeling shamed. It is important that HCPs mitigate these feelings by explaining that some weight regain following MBS is normal and then proceeding in a stepwise approach to address the weight regain. It is neither necessary nor economical to order an oesophagogastroduodenoscopy or an upper gastrointestinal contrast study to evaluate the gastrointestinal tract on all PLWO who experience weight regain following MBS. The following steps are suggested to address weight regain:

- Ensure that PLWO continue to follow the recommended post-MBS nutrition plan and vitamin intake. Check blood work to ensure that vitamin and mineral levels are in the normal range. If PLWO are malnourished at baseline, then more harm occurs trying to help them to lose further weight. Referral to a dietitian

can be helpful at this stage.
- Psychological intervention may be required to address mood, anxiety or an eating disorder, or to help PLWO to make behaviour changes.
- If on subsequent follow-ups, despite adherence to the post-MBS nutrition plan and vitamin intake, weight does not decrease, an oesophagogastroduodenoscopy or upper gastrointestinal contrast study may rule out an anatomical failure. Detection of an anatomical failure would lead to a referral back to the MBS team.
- Consideration of medications for obesity management after MBS may be made for PLWO who are trying to follow the post-MBS nutrition plan and taking their vitamin supplementation. Orlistat should not be used in patients who have had hypoabsorptive procedures. Retrospective reports have demonstrated that liraglutide,[43,44] semaglutide[45] and naltrexone/bupropion[46] may play a role in reducing weight regain.

After all the above steps, if weight regain still remains an issue, then consider referring back to a MBS centre for eligibility for surgical revision.

Medications

After MBS and the resulting weight loss, many studies demonstrate a reduction of medications for diabetes and dyslipidaemia, and cardiovascular and antihypertensive agents. There are a limited number of publications that focus on the pharmacodynamics of medications postoperatively (Table 4). Ultimately, there remains a large inter-individual variation, and the therapeutic effects of a medication must be individually dose adjusted.

For the first 3 to 8 weeks after surgery, medications should be consumed in a crushed or liquid form or by opening capsule contents. It is important that the liquid form does not contain absorbable sugars to avoid dumping syndrome.[47] Some medications, however, should not be crushed (Table 4).[48] After RYGB and DS, the pharmacokinetic profile of many medicines may be altered as a result of changed intestinal absorption surface, lipophilicity of drugs, increased pH in the stomach, reduced cytochrome P450 enzyme activity and first-pass intestinal metabolism, time after MBS, and changes in volume of distribution.[49] Immediate-release formulations are generally preferred over extended release. NSAIDs should be avoided after RYGB or DS owing to risk of anastomotic ulceration/perforations. For other MBS procedures, NSAID use should be accompanied by proton pump inhibitors (PPIs) for mucosal protection.[50] PLWO who need to remain on low-dose aspirin for secondary prevention may do so, but should have additional PPI protection.

Especially after RYGB and DS procedures, PLWO taking long-term warfarin require a postoperative dose reduction of >20% with closely monitored international normalised ratio. Direct oral anticoagulants should be avoided owing to the potential for decreased drug absorption.[51,52] If a beta-blocker is needed after MBS, a hydrophilic compound such as atenolol may be preferred. Bioavailability of oral contraceptives may be reduced after MBS, and alternative methods of contraception need to be considered. Antidiabetic medications with a risk for hypoglycaemia (such as sulphonylureas) should be discontinued and insulin doses adjusted. Metformin may be continued, but the dose may need to be reduced owing to increased absorption.[53] Primary HCPs may benefit from working with a patient's community pharmacist for medication adjustments.

Choledocholithiasis and marginal ulcer prophylaxis

Decreased postoperative oral intake predisposes to biliary stasis and choledocholithiasis after MBS. The 2025 American Society for Metabolic and Bariatric Surgery (ASMBS) guidelines recommend prophylaxis with ursodiol 10 days after surgery in PLWO with a high level of concern or risk for biliary disease.[54] Treatment should be continued for 6 months. Reported rates of marginal (stomal) ulceration after RYGB reach as much as 51% in smokers.[55] The 2025 ASMBS guidelines suggest prophylactic PPI therapy for at least 90 days after MBS.[54,56]

Gastro-oesophageal reflux disease after sleeve gastrectomy

Recent studies have highlighted the potential risks of gastro-oesophageal reflux disease (GORD) and Barrett's oesophagus (BE) following laparoscopic SG.[57,58] A systematic review and meta-analysis reported a pooled prevalence of BE of approximately 11.6% of PLWO after SG, with BE appearing as early as 3 years after surgery and with no correlation with GORD symptoms.[59] Given these findings, the IFSO recommends routine surveillance endoscopy after SG at 1, 3 and 5 years.[60] In addition, the ASMBS calculated a 10.7% rate of *de novo* BE after SG,[58] which is comparable to the American Society for Gastrointestinal Endoscopy recommendation that any population at an estimated 10% risk for BE should undergo endoscopic screening.[1,61]

Special considerations regarding fertility after metabolic and bariatric surgery

MBS should not be considered a treatment for infertility.[62] Many studies related to fertility in women after MBS are small, and appropriate control groups have not always been included. Together, the evidence suggests that MBS improves fertility, whether it is through improvements in sex hormone profiles or resolution of polycystic ovary syndrome markers that influence fertility (including anovulation, hirsutism, hormonal changes, insulin resistance, sexual activity and libido).[63] The type of MBS does not appear to be related to changes in fertility, as only the amount of weight lost (a body mass index [BMI] decrease of >5 kg/m^2) and the BMI achieved at time of conception were predictive of the patient becoming pregnant.[64]

In men, surgery-induced massive weight loss does not affect sperm quality, but it does increase the quality of sexual function, total testosterone, free testosterone and follicle-stimulating hormone, and reduces prolactin. Overall, in men, the balance between positive (hormonal, psychological and sexual improvements) and negative (nutritional depletion as a result of selective food maldigestion and malabsorption) impacts will determine the final effect on seminal quality and fertility.[65]

Women who became pregnant less than 1 year after MBS had a higher rate of fetal loss in comparison with women whose pregnancy occurred after this period of time (35.5% v. 16.3%).[66] Pregnancy is therefore not recommended in the first 12 to 18 months after MBS,[66] by which time weight is more stable, and women are able to consume a nutritionally balanced diet. Adequate contraception should therefore be offered to women of reproductive age who undergo MBS. As oestrogen is absorbed in the upper gastrointestinal tract, which is modified during bariatric surgery, oral contraceptive pills should be avoided after RYGB and DS. Instead, alternative forms of hormonal contraception (subdermal implant, e.g. etonogestrel,[67] or a levonorgestrel-releasing intrauterine device[68]) may be considered.

There is no definitive contraindication to oral contraceptive pills for gastric banding and SG.[19,69]

Special considerations in women who become pregnant after metabolic and bariatric surgery

Compared with women who have not undergone MBS, women who became pregnant after MBS had a lower risk of gestational diabetes, hypertensive disorders and macrosomia.[70] However, the risk of small-for-gestational-age newborns increases after MBS.[70]

Pre-conception care

Women planning a pregnancy after MBS should have daily oral supplementation with a multivitamin containing 1.0 mg folic acid, beginning at least 3 months before conception. Women should continue this regimen until 12 weeks' gestational age. From 12 weeks' gestational age, continuing through the pregnancy, and for 4 to 6 weeks postpartum or as long as breastfeeding continues, continued daily supplementation should consist of a multivitamin with 0.8 - 1.0 mg folic acid.[71] Vitamin B_{12} levels should be checked and corrected if deficient prior to initiation of additional folic acid. Women are advised to avoid vitamin and mineral preparations that contain vitamin A in the retinol form in the first 12 weeks of pregnancy, as supplements containing retinol may increase the teratogenic risk (especially in the first trimester). It is therefore recommended that pregnant women and those planning pregnancies after MBS are supplemented with vitamin A in the beta-carotene form.

Nutritional monitoring during pregnancy

Standard complete multivitamins routinely used after MBS should be replaced by prenatal multivitamins to reduce vitamin A intake, which should not exceed 5 000 IU/day and be delivered in the form of beta-carotene. Continue all other regular supplementation that the patient would typically be on and then adjust according to laboratory testing. Laboratory testing at each trimester should include full blood count, ferritin, albumin, vitamin B_{12}, 25-hydroxy (OH) vitamin D, calcium, PTH and folate. Patients who have had hypoabsorptive surgery should additionally have zinc, copper and vitamin A levels (and possibly vitamin E and K levels with DS) monitored during pregnancy.[19,63,72,73] If the patient is vitamin A deficient, supplementation should be in the form of beta-carotene.[73] Patients suffering from nausea and intractable vomiting should have immediate vitamin B_1 supplementation and careful monitoring of B_1 levels. Nutrition advice from an experienced registered dietitian should be offered to review deficiencies and vitamin supplementation and ensure a recommended daily protein intake of 60 g.[61] Possible recommended gestational weight gain would be based on the pre-pregnancy BMI as per the Institute of Medicine.[74]

Other considerations during pregnancy

In addition to nutritional deficiencies, there is also the potential for severe, life-threatening complications such as internal hernias, bowel obstructions, volvulus, intussusception and gastric perforations, which generally occur 1 to 3 years after MBS. Because of the upward pressure from the gravid uterus, these late sequelae may present in pregnancy and during the immediate postpartum period. Abdominal pain in a post-MBS gravid woman would need to include these potential complications in the differential diagnosis. Radiological evaluation with a computed tomography scan should be reviewed by MBS specialists or radiologists with specialised expertise in this area.[75] Post-surgical patients may not tolerate the glucose solution commonly administered at 24 - 28 weeks' gestation to screen for gestational diabetes. Alternative measures to screen for gestational diabetes should be considered for patients who have undergone hypoabsorptive-type surgery. One proposed alternative is home glucose monitoring (fasting and 2-hour post-prandial blood sugar) for approximately 1 week during weeks 24 - 28 of gestation.[62]

Postpartum

Breastfeeding should be encouraged. It is important that postpartum MBS women continue their recommended vitamin supplementation, as there have been documented cases of nutritional deficiencies in breast-fed infants born to mothers who have had RYGB.[76]

Please note that it is recommended that women who become pregnant following MBS, be referred for appropriate specialist care.[77]

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