**Abstract**

**Introduction**

Bariatric Surgery is unique in terms of anatomical changes imposing a resetting of the physiological milieu. Although many changes are beneficial, adverse effects, complications and impact on psychological wellbeing may occur. Healthcare professionals need to be aware of the impact of these changes and respond appropriately. The aim of the review was to analyse the existing corpus of literature and identify areas to inform a future long-term follow-up strategy for post-surgical patients.

**Methods**

A narrative review was carried out, allowing a wide range of inclusion criteria across a broad range of topics. Two independent literature searches were carried out using PubMed.

**Results**

Searches returned 49 results. Critical analysis of the literature was carried out, with consensus reached on topics of relevance and importance to post-bariatric surgery long-term follow up.

**Conclusions**

This review highlights twelve common issues that bariatric patients may face after surgery, to facilitate prompt diagnosis and treatment, to inform Primary Care professionals to deal with presenting symptoms and ensure appropriate action to inform best possible treatment and outcomes. We recommend these areas are discussed further with the responsibility of follow-up, frequency of follow up, and patient education taken into consideration when planning post-bariatric care and support.

**Abbreviations:**

**ASMBS:** American Society for Metabolic & Bariatric Surgery

**BOMSS:** British Obesity and Metabolic Surgery Society

**NICE:** National Institute for Health and Care Excellence

1. **Introduction**

Patients undergoing bariatric surgery experience a complex range of anatomical, physiological, psychological, and social changes, many of which are the subjects of ongoing research to gain a more in-depth understanding. These changes have a far-reaching consequence on patients' physical and mental health, which may extend throughout a patients’ life. Though most of the adjustments and complications occur within the first few of years following surgery, other issues can manifest in the longer-term, which require long term monitoring, follow-up and support.

Although bariatric surgery is associated with a reduction in the long-term all-cause, cardiovascular, and cancer-related mortality [1], this cohort of patients appear to be at higher risk of mortality due to liver failure and suicides [2]. Moreover, patients can develop nutritional complications [3] or surgical complications like an internal hernia [4] several years after surgery. It is therefore widely recognised that lifelong follow up should form an essential part of the aftercare of these patients [5].

The current guidelines on follow up of bariatric surgery patients by the American Society for Metabolic & Bariatric Surgery (ASMBS) [6] and the British Obesity and Metabolic Surgery Society (BOMSS) [7] are useful but do not cover all aspect of long-term follow up of these patients, and are based on varying levels of available evidence. Despite published guidance, ensuring adequate long-term follow up of bariatric surgery patients is a challenge for healthcare professionals involved in providing care for these patients [8]. This suggests a need to develop more robust strategies for follow up of these patients. There is further a need to address the knowledge gap in primary care on issues concerning bariatric surgery [9]. Any comprehensive long-term follow-up strategy for bariatric surgery patients must monitor patients for weight loss (including excessive weight loss and later weight regain), compliance with recommended nutritional supplements, surgical and nutritional complications, loose skin, psychological and relationship issues, addiction transfer, and re-emergence of co-morbidities.

The aim of the review was to identify the existing corpus of literature and identify areas needed to inform a pragmatic long-term follow-up strategy for post-surgical patients.

**2. Materials and Methods:**

The subject of long-term follow up of bariatric patients is broad, extending beyond traditional biomedical clinical outcomes to encompass social and psychological aspects, necessitating a method which would capture both a wide range of literature and the complexities of the subject. A narrative review was thus chosen as the method for carry out the literature synthesis. Narrative reviews are a method of synthesizing a body of extant literature and have a wider scope for inclusion criteria than a systematic review, allowing a range of studies to be included to provide a comprehensive overview of a subject [10]. Narrative reviews can provide context to an area which is ambiguous, and by presenting the existing publications in the area, can inspire debate and discussion [11]. Owing to a current lack of consensus on a definitive checklist, varied evidence base on different and broad aspects of bariatric patient after-care, a narrative review was agreed as the most pragmatic approach.

In order to capture a wide range of subjects and published literature within the broad field of bariatric surgery, PubMed was chosen as the electronic database to conduct literature searches. Two independent searches of the PubMed database were carried out by two authors (KM and YG) to identify all articles published in the English language on various aspects of long-term care of patients who have undergone bariatric or metabolic surgery. The key words used in various permutations to carry out the searches were "bariatric surgery", "metabolic surgery", "obesity surgery", "bariatric", "gastric bypass", "sleeve gastrectomy", "gastric banding", "follow-up", "vitamin", "mineral", "supplementation". Relevant articles were also identified from the reference lists of included articles. No time filter was used in order to allow a broad range of articles to be included. Case reports were excluded. The last of these searches were carried out on 13th June’ 2018. Both KM and YG produced two independent list of papers which were selected based on agreed criteria of frequency of topic, and relative to the presupposition from clinical and academic practice. The blinded lists were then given to CH, who independently validated the findings of both. The results were then compared and discussed amongst the authors, with a final consensus of articles selected for inclusion in the review agreed.

1. **Results**

The searches returned 49 results. An in-depth critical analysis of the literature was carried out to identify common topics of relevance to post-bariatric surgery long-term follow upA consensus of the areas of priority for long-term care and follow up of bariatric surgery patients were independently cross-validated between the three researchers, with of twelve areas of priority agreed.

* 1. **Dietary Advice**

There is an emerging body of data suggesting that sustained long-term weight loss achieved through bariatric surgery is largely due to its effect on hunger and satiety [12]. At the same time, these effects on hunger and satiety are most pronounced in the first year after surgery and it is uncommon for bariatric surgery patients to experience significant weight loss after the first year of surgery. After 2 years on average, most patients experience some weight regain [13]. There is evidence to suggest that a high protein diet may not only enhance weight loss but also lead to better preservation of lean body mass [14]. Although that bariatric surgical patients, similar to other individuals, will benefit from following a healthy diet, there is currently no evidence to support other practices, such as avoiding water with food intake [15]. Patients should be advised to monitor their weight regularly and adjust calorie intake accordingly to achieve their desired healthy weight. Reduced hunger after bariatric surgery should enable patients to maintain a lower calorie intake to match their own calorie expenditure long term. It is generally recognised that poor diet quality, inappropriate food choices, and lack of nutritional counselling can lead to weight regain [13]. It is thus important that appropriate dietary counselling forms a key component of every bariatric follow-up visit.

**3.2 Physical Exercise**

Though post-bariatric surgery patients subjectively report increased activity levels after surgery [16], the objective assessment shows that they have low physical activity levels and lead sedentary lifestyles [17-18]. There is a recognised significant positive association between higher post-surgery physical activity levels and better postoperative weight loss outcomes [13, 18-19]. Long-term follow-up after bariatric surgery must hence encourage patients to increase their physical activity levels and take up regular exercise. Patients who exercise also experience higher loss of fat mass and higher gain of lean body mass, though the total weight loss might be similar between the exercise and non-exercise groups [20].

**3.3 New Medication Use**

Bariatric surgery generally leads to an overall reduction in the use of medicines [21], but patients may also be started on several new medications and are further recommended a number of vitamin and mineral supplements. They are generally prescribed proton pump inhibitors for a period of several months to aid healing of staple lines after sleeve gastrectomy and for prophylaxis of marginal ulcers after gastric bypass. Though most patients are able to stop their proton pump inhibitors after 6-12 months, those deemed at high risk of marginal ulcers - such as those who continue to smoke or those on Non-steroidal anti-inflammatory drugs (NSAIDS) or corticosteroids [21] could benefit from continued long-term prophylaxis, although evidence to support this advice is currently lacking. Patients are also advised Ursodeoxycholic acid for prophylaxis of gallstones during the first 6 months after surgery when the weight loss is most rapid. There is data that supports dosages of 1000-1200 mg daily are superior to lower dosages but the compliance is better with dosages of 500-600 mg daily [22].

**3.4 Adjustment to Patients’ Routine medications**

Bariatric surgery alters the bioavailability of drugs through its effect on gastric emptying, gastric acid, reduced small bowel absorptive surface, and concomitant use of medications like proton pump inhibitors [23]. It also generally lowers the requirement of medicines by altering total body mass, lean body mass and through improvement on a range of medical conditions. In most cases, it is sufficient to closely follow up patients for the clinical effect of the drugs and make dose adjustment as necessary. Generally, medications for diabetes, hypertension, dyslipidaemia, asthma, etc. can be monitored clinically and can be either significantly reduced or discontinued. For drugs that have narrow therapeutic spectra like Lithium, anti-epileptics, or immunosuppressants, it may be necessary to closely monitor serum levels and adjust dosages accordingly until weight stabilises. Though dose adjustments for drugs used to treat common conditions like diabetes, hypertension, dyslipidaemia etc. may have to be left to patients’ general practitioners, monitoring of levels and subsequent dose adjustment of drugs like anti-epileptics, antipsychotics, immunosuppressants, anticoagulants etc. is best carried out by respective specialists. Patients should, therefore, be advised to consult appropriate doctors regarding their pre-existing medications as soon as possible after bariatric surgery.

**3.5 Micronutrient Supplementation and monitoring**

Patients undergoing bariatric surgery suffer from a number of pre-existing micronutrient deficiencies [24]. In addition, because of the reduction in total calorie intake after bariatric surgery, the intake of various micronutrients is significantly reduced. Though this reduced intake of micronutrients is most pronounced in the early period after bariatric surgery, changes persist in the long term [25]. Additionally, bariatric surgery results in a variable reduced capacity of the body to absorb a range of micronutrients [26]. This places bariatric surgery patients at high risk of developing a number of micronutrient deficiencies [Table 1].

*Insert Table 1 here*

It is therefore crucial that patients are on lifelong supplementation with a range of micronutrients after bariatric surgery. Though there are guidelines on the topic [8-9], the evidence base for these guidelines is generally poor, and the precise supplementation dose for each micronutrient after each procedure has yet to be determined [28-30]. As a result, there are considerable variations in the supplementation protocol recommended by different bariatric surgery centres [31]. Table 2 makes an attempt to summarise recommendations from major guidelines for supplementation after various bariatric procedures.

*Insert Table 2 here*

Compliance with supplements is another major issue [32-33]. As a result, a significant proportion of patients become anaemic after surgery or suffer from other micronutrient deficiencies [34-35]. This is the rationale for guidelines’ [7-8] to recommend regular testing for a range of micronutrients after bariatric surgery (see Table 3).

*Insert Table 3 here*

These recommendations to detect and treat every single subclinical micronutrient deficiency can, however, result in unnecessary patient anxiety and costs [28-29]. The effort and expenditure incurred in monitoring and optimising all the possible micronutrient deficiencies can deter primary care practitioners from following up bariatric surgery patients. The current guidelines may place a significant burden in terms of time and cost on healthcare systems. Owing to the lack of Level 1 evidence to suggest that regular, intensive haematological monitoring is practical, beneficial and cost-effective, the authors propose a practical algorithm (see Figure 1) that can be used in general practice for majority of the post-bariatric surgery patients.

*Insert Figure 1 here*

Patients deemed to be high-risk within a bariatric surgical cohort should be identified at follow-up. For example, pregnant women will need additional monitoring to ensure adequate folate levels and should be referred back to the bariatric team for careful monitoring. Similarly, patients who are known to be suffering from Cirrhosis, those undergoing distal gastric bypass, those who have undergone malabsorptive procedures like Duodenal Switch or Bilio-Pancreatic Diversion, those presenting with new illnesses, losing weight too rapidly or show signs and symptoms of protein-calorie malnutrition should have their liver functions checked [35] and urgently referred back to their bariatric teams. Those with neurological symptoms should also be sent back to their parent teams promptly.

**3.6 Identify and Treat Complications**

In addition to the nutritional issues described above, bariatric surgery patients are at risk of developing a number of long-term surgical complications (Table 4). Healthcare professionals looking after these patients should be aware of the common modes of presentations of these complications. Signs that may indicate serious problems include, patients experiencing abdominal pain, nausea/vomiting, inability to eat, hypoglycaemic symptoms, Gastro-Oesophageal Reflux Disease uncontrolled on medical management, excessive weight loss, and protein-calorie malnutrition should be urgently referred back to the bariatric surgical centre for further diagnosis and management.

**3.7 Importance of Follow up**

Though some studies suggest that patients who do not attend follow up appointments have poorer weight loss outcomes [36-37], it is currently unclear if this is a cause and effect relationship, with conflicting studies in this area [38]. Regardless of the impact on weight loss, regular follow up also allows for earlier identification of problems and enables long-term evaluation of bariatric procedures. Furthermore, there is a negative correlation between weight loss and distance to bariatric centre [37] suggesting a need for local follow up mechanisms for patients who do not reside close to the centre.

**3.8 Support Group**

Many bariatric programmes facilitate a patient support group [39] where patients can learn from each other’s’ experience. Patients value these interactions where they can share their feelings and issues informally but there is a risk that wrong messages get disseminated in these groups. It may hence be useful to ensure that a healthcare professional is present for the support group meetings.

**3.9 Contraception and Pregnancy**

Women of childbearing age are advised to avoid pregnancy for at least 2 months after their weight loss has stabilised [40] as the outcome of pregnancies conceived during the early phase of rapid weight loss may not be favourable. Since the absorption of oral contraceptive pills may be unreliable, especially after a gastric bypass, these patients should look at alternative modes of contraception [41]. Furthermore, since bariatric teams may not feel comfortable offering advice on contraception, it may be best to organise referrals to providers or signpost patients to a range of contraceptive providers[42].

**3.10 Body Contouring Surgery**

Owing to the amount of weight loss and change to body shape, many patients have a degree of loose skin after bariatric surgery. The magnitude of the problem depends on patients’ pre-existing state as it is not uncommon for patients to have a large abdominal apron even prior to surgery, and the weight loss. A recent large study from France found that by 7 years follow up, 21.0 % patients had undergone a plastic surgery after bariatric surgery [43]. There is little doubt that adequate provisions of body contouring surgery, as the plastic surgery to deal with loose skin is sometimes referred as not only improves patients’ psychological well-being [44] but also has a beneficial effect on long-term weight loss outcomes [45].

**3.11 Psychological Support**

Bariatric surgery results in overall improvement in psychological health through its effect on body weight, body image, and self-esteem but some patients struggle with weight loss, altered body image, complications, and later, weight regain [46]. There is data to suggest a higher risk of relationship breakdown [47] and self-harm [48] after bariatric surgery suggesting a need to identify and support the at-risk group postoperatively. Bariatric surgery patients further report that social aspects of the surgery are not widely appreciated by others in the society [49]. It is crucial that clinicians looking after these patients understand how patients adjust to life after surgery to be able to support them better.

**3.12 Haematological Monitoring**

The purpose of haematological monitoring at the time of long-term bariatric review is to monitor patients’ other health conditions like diabetes or dyslipidaemia and to screen for common nutritional problems after bariatric surgery. Since anaemia [50] and secondary hyperparathyroidism [51] are relatively common in post-bariatric surgery patients, especially those undergoing a gastric bypass, it may make sense to screen all the patients for them. Concurrently, screening these patients for every possible vitamin and mineral deficiency, some of which are rare, may not be cost-effective [28-29] and might engender a false sense of security. The focus could be on determining the appropriate dosages for the prophylactic supplementation of each vitamin or mineral after each bariatric procedure, then ensuring that patients are compliant with their supplementation regime.

There is a further need to ensure that patients and clinicians do not ignore warning signs of early nutritional deficiencies. Most vitamin or mineral deficiencies are easily corrected if diagnosed in time. The current scenario of over-reliance on blood tests means that the diagnosis and treatment of nutritional issues following bariatric surgery is often delayed with significant consequences for the patients.

**4. Discussion**

From the twelve identified areas of proposed care of post-bariatric surgical patients, there were three core key considerations identified, the responsibility of follow-up, the frequency of follow up, and patient education.

**4.1 The responsibility of follow up:**

It is generally accepted that until weight-loss is stabilised, the follow up of patients should be primarily led by the bariatric surgical teams. However, there is less clarity on who should look after patient's pre-existing medical comorbidities during this period. Furthermore, there is no consensus on if and when the primary responsibility for the follow up should be transferred to primary care after a stable weight has been achieved.

In the United Kingdom, the provisions of bariatric surgery are shaped by the National Institute for Health and Care Excellence (NICE) Guideline CG 189. The guideline advises that follow up for the first two years after surgery should be within “the bariatric service” and that it should include monitoring of “nutritional intake (including protein and vitamins) and mineral deficiencies, monitoring for co-morbidities, medication review, dietary and nutritional assessment, advice, and support, physical activity advice and support, psychological support tailored to the individual, and information about professionally led or peer-support groups” [5].

The time frame of 2-year period after surgery appears to be arbitrary, but it seems appropriate because most patients can be expected to have reached a plateau weight by the end of this period, and because most complications related to surgery are likely to occur during this period. It is reasonable for bariatric teams to provide most of the aspects of the follow up recommended in the NICE guidance, but the expectation of the bariatric team to concurrently monitor a number of co-morbidities that these patients might suffer from and review the medications, puts the onus on bariatric teams to provide all encompassing medical care in areas in which they may not have the appropriate skills or resources to deliver aspects of care. It is hence recommended that a shared approach towards follow up is adopted right from the outset where primary care continues to take responsibility for looking after patients’ other medical conditions while bariatric surgery teams look after surgery and its related issues.

After the 2-year period, NICE advises that patients are discharged from the bariatric surgery service. Though this is a reasonable goal and there is no reason why healthcare professionals in primary care cannot provide most of the routine post-bariatric surgery advice and care, there needs to be a close liaison with the bariatric surgical teams as patients remain at risk of developing a number of surgical and nutritional complications in the long term. These issues should be promptly identified and patients urgently referred back into the surgical units.

**4.2 The frequency of follow-up:**

The purpose of follow up during early stages after surgery is early identification of any complications, to ensure appropriate dietetic and lifestyle advice is reinforced, and monitor the nutritional status of patients. Obviously, this will mean that patients are seen once or twice in the first couple of months and at regular intervals thereafter until the weight reaches a plateau stage and patients are comfortable with their new dietary patterns and lifestyle. One reasonable protocol can be to offer follow-up at 10-14 days, 6 weeks, 6 months, and then at 6 monthly intervals until the stable state is reached or 2 years, whichever is later. The purpose of medium to long-term follow up is to reinforce appropriate diet and lifestyle messages, monitoring of weight, early identification of surgical and nutritional complications, monitoring of co-morbidities, and haematological monitoring as indicated. Though most of these objectives can be achieved at the time of patients’ annual health check in the primary care, there has to be a recognition that patients may develop issues at other times.

**4.3 Patient Education:**

Current guidelines almost entirely focus on the role of the healthcare professionals without involving patients in the decision-making and follow-up process. NICE guidelines [5] clearly state that bariatric surgery is only a treatment option if the patient “commits to the need for long-term follow up" and this should be explained to the patients before surgery and afterward. Patients could be further provided with a list of warning symptoms [Table 5] that should prompt them to contact their General practitioners.

**Conclusion**

Patients should further be educated about the need to take lifelong micronutrient supplements as advised by their bariatric team. Repeated blood tests on a patient who is not compliant with supplements without even an attempt to understand the reasons for lack of compliance can only achieve little. The review has several limitations. Firstly, the broad nature of the subject means that not all literature pertaining to post-surgical follow up was identified. The use of a narrative as opposed to systematic approach may have influenced findings. Only one electronic database was used for this review, but other databases may have uncovered additional literature. Additionally, we did not search the grey literature in this field, and we acknowledge that the personal biases of the authors may have influenced the literature chosen for inclusion in the review.

There is currently a need to streamline and improve long-term follow up of bariatric surgery patients. This paper attempts to identify all the various aspects of follow up of these patients and suggest a pragmatic multidisciplinary pathway. Further research into the subject of long-term follow up after bariatric surgery in terms including cost-benefit analysis is recommended.

# Author contributions:

XX conceived the idea of the paper, undertook one of the blind literature searches and led on the writing up of the manuscript. XY undertook a further blind literature search and assisted with the writing up. XZ assisted with the writing up of the manuscript. All authors have seen the final draft and approve of it.

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