Guidelines on Managing the Obese Surgical Patient
Joint document from AAGBI and SOBA

Members of working party


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2. Society for Obesity and Bariatric Anaesthesia
3. Obstetric Anaesthetists’ Association
4. British Association of Day Surgery
5. Difficult Airway Society
6. Resuscitation Council (UK)
7. Royal College of Anaesthetists

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1. Summary of Recommendations

- Every hospital should nominate an anaesthetic lead for obesity.
- Operating lists should include the patients’ weight and body mass index (BMI).
- Experienced staff, both anaesthetic and surgical, should manage obese patients.
- Additional specialised equipment is necessary.
- Central obesity and metabolic syndrome should be identified as risk factors.
- Sleep-disordered breathing, and its consequences, should always considered in the obese.
- Anaesthetising the patient in the operating theatre should be considered.
- Regional anaesthesia is recommended as desirable but is often technically difficult, so may be impossible to achieve.
- A robust airway strategy must be planned and discussed, as the obese patient desaturates quickly and airway management can be difficult.
- Use of the ramped or sitting position is recommended as an aid to induction and recovery.
- Drug dosing should generally be based upon lean body weight and titrated to effect rather than dosed to total body weight.
- Caution is required with the use of long acting opioids and sedatives.
- Neuromuscular monitoring should always be used whenever neuromuscular blocking drugs are used.
- Depth of anaesthesia monitoring should be considered, especially when total intravenous anaesthesia is used in conjunction with neuromuscular blocking drugs.
- Appropriate prophylaxis against venous thromboembolism and early mobilisation are recommended; the incidence of venous thromboembolism can be high in the obese.
- Postoperative intensive care support should be considered, but is determined more by comorbidities and surgery than by obesity per se.

What other guidelines statements are available on this topic?
The first Association of Anaesthetists of Great Britain and Ireland (AAGBI) guidelines on the peri-operative management of the obese patient were published in 2007 (1). In 2012 a consensus statement was published on anaesthesia for patients with morbid
obesity, written and endorsed by SOBA (2). The Centre for Maternal and Child Enquiries (CMACE) and the Royal College of Obstetricians and Gynaecologists (RCOG) have published a Joint Guideline on management of women with obesity in pregnancy (3).

Why was this guideline developed?
There is increased recognition that obese patients present a different set of challenges and require specific peri-operative care when compared with non-obese patients. This guideline is intended to specifically inform anaesthetists about best-practice management of obese surgical patients throughout the peri-operative period, as members of a multidisciplinary team.

How does this statement differ from existing guidelines?
This guideline includes new material on several topics including pharmacology, positioning and sleep disordered breathing, plus a single sheet aide-memoire. The advent of bariatric (weight treatment) surgery has produced a subgroup of anaesthetists with more specific experience in the management of obese patients. The Society for Obesity and Bariatric Anaesthesia (SOBA) was set up in 2009 to share the knowledge gained from bariatric anaesthesia to improve the anaesthetic care of obese patients in general. This experience forms the basis of these guidelines.

2. Introduction

The World Health Organization uses a class system to define obesity (Table 1). Statistics for 2013 from the UK, Health and Social Care Information Centre show that in adults, 24% of men and 25% of women are classified as obese (BMI>30 kg.m⁻²) and over 3% have class 3 obesity (BMI >40 kg.m⁻²)(4). For an average UK district general hospital serving an adult population of 200,000 this equates to 52,000 obese and over 6,000 class 3 obese patients (5).

Obese patients are more likely to present to hospital because they are more prone to concomitant disease. Between 2001/02 and 2011/12 there was an eleven-fold increase in the number of patients (1,019 to 11,736) of all ages admitted to NHS hospitals with a primary diagnosis of obesity [Figure 1] [5]. In 2007, the UK Government’s Foresight Report predicted that 50% of the UK population would be clinically obese by 2050, costing the NHS an extra £45.5 billion per year, but even this may be an underestimate (6).

This is a consensus document produced by members of a working party made up of experts from the Society for Obesity and Bariatric Anaesthesia (SOBA) and The Association of Anaesthetists of Great Britain and Ireland (AAGBI). It is a synthesis of expert opinion, current practice and literature review, designed to replace the 2007 edition and to act as a guide to the delivery of safe anaesthesia to this clinically demanding group.

3. Pathophysiology of Obesity
3a. Fat distribution (Patient Shape)
Not all fat within the body is identical. Unlike peripherally deposited fat, intra abdominal fat is highly metabolically active and is known to be a contributor to several disease states (8). Patients with centrally distributed or ‘visceral fat’ are at greater perioperative risk than those with peripherally distributed fat and are far more likely to exhibit the metabolic syndrome, which consists of central obesity, hypertension, insulin resistance and hypercholesterolema (9,10).

Central obesity can be defined as a waist circumference greater than 88 cm in a woman and 102 cm in a man; or a waist to height ratio greater than 0.55 (10,11).

People who exhibit central, or visceral, obesity are often male and can be described as “apple shaped”, while those with a predominantly peripheral fat distribution are more likely to be female and are described as “pear shaped”.

3b. Respiratory System
Obesity results in reduced functional residual capacity (FRC), significant atelectasis and shunting in dependent lung regions (12); but resting metabolic rates work of breathing and minute oxygen demand are increased. This combination means that, following the cessation of breathing, arterial oxygen levels decrease rapidly. Wheeze in the obese may be due to airway closure rather than asthma. 50% of patients diagnosed with asthma ‘recover’ with weight loss (13). A formal assessment of the effectiveness of bronchodilator therapy may be useful in differentiating the two conditions (14).

3c. Sleep Disordered Breathing (SDB)
- Sleep disordered breathing is very common in the obese
- Untreated SDB is associated with significant morbidity and mortality
- Preoperative treatment with positive airway pressure is likely to reduce risk
- An “SDB-Safe anaesthetic” is highly recommended for all obese patients.

Sleep disordered breathing describes the spectrum of conditions ranging from obstructive sleep apnoea (OSA) through to obesity hypoventilation syndrome (OHS). Each of these conditions has a spectrum of severity, described according to the number and severity of oxygen desaturations occurring every hour and their impact upon the patient. (15).

10-20% of patients with BMI >35kg.m⁻² have severe OSA, which is often undiagnosed. Overall, a diagnosis of sleep apnoea is associated with a greater than doubling of the incidence of postoperative desaturation, respiratory failure, postoperative cardiac events, and ICU admission (16). During SDB the presence of multiple and prolonged oxygen desaturations increases the sensitivity to opioid-induce respiratory depression (17) However, if identified pre-operatively, and treated appropriately with CPAP, the risk of complications is much reduced (18).

Increasing severity of OSA is associated with older age, cardiovascular disease secondary to heart strain, and the development of left ventricular dysfunction. It is also associated with a difficult airway and difficult laryngoscopy.
If untreated, OSA may progress to obesity hypoventilation syndrome (OHS), a triad of obesity (BMI > 35 kg·m$^{-2}$), SDB (Usually OSA) and daytime hypercapnia (pCO2 > 6 kPa) (19). The combination of chronic hypoxaemia and hypercapnia make this sub-group particularly susceptible to the effects of anaesthetic agents and opioids, which may precipitate acute on chronic hypoventilation and respiratory arrest in the early postoperative period (20).

Formal diagnosis of SDB is with polysomnography, but in the majority, diagnosis can be made by overnight oximetry testing at home (21). Nocturnal continuous positive airway pressure (CPAP) is the usual treatment in patients with significant degrees of OSA, but around 50% of patients are poorly compliant with CPAP therapy and thus will not obtain benefit, usually because of problems with the fitting of the mask. Seeking information on compliance during pre-assessment is advised.

3d. Cardiovascular System
Obesity leads to increased blood pressure, cardiac output and cardiac workload. People with untreated OSA may have associated pulmonary hypertension and heart failure (15).

There is an increased incidence of dysrhythmias, predominantly secondary to sino-atrial node dysfunction and fatty infiltration of the conducting system. This results in an obesity relative risk of 1.5 for atrial fibrillation (22), and a markedly increased risk of sudden cardiac death (23). There is an increased incidence of prolongation of the QT interval with increasing BMI (24), and therefore a potential increased risk with drugs such as ondansetron (25).

Ischaemic heart disease and heart failure are more prevalent in the obese population, with heart failure the predominant risk factor for postoperative complications (26).

3e. Thrombosis
Obesity is a prothrombotic state. This is associated with increased morbidity and mortality from thrombotic disorders such as myocardial infarction, stroke, and venous thromboembolism (VTE) (27). The postoperative incidence of VTE may be 10 times higher in obese women compared with their healthy weight counterparts (28). Previous VTE is an independent risk factor for patients having gastric bypass surgery (29). A hypercoagulable state may extend beyond 2 weeks warranting extended postoperative VTE prophylaxis depending on the type of surgery and the patient’s BMI (30).

3f. Diabetes
Obesity is strongly associated with increased insulin resistance (31). Poor glycemic control in the perioperative period is associated with increased morbidity and good glycemic control is recommended (32).

Gastric bypass surgery causes a unique neurohumeral response resulting in a rapid dramatic reduction in insulin requirement, starting immediately after surgery. In this cohort of patients, cautious postoperative reintroduction of diabetic medication and frequent blood sugar monitoring are essential steps. (33).
4. Pharmacology

4a. Body composition

There are a number of terms used to describe the weight of a patient, the four most useful are:

- Total Body Weight (TBW). The actual weight of the patient.
- Ideal Body Weight (IBW). What the patient should weigh with a normal ratio of lean to fat mass. It varies with age, and is usually approximated to a function of height and gender.
  - IBW (kg) = Height (cm) - x (where x = 105 in females and 100 in males)
- Lean Body Weight (LBW). Many of the formulae for LBW calculation are complex but the best available is by Janmahasatian et al. Regardless of total body weight, LBW rarely exceeds 70kg in women and 100kg in men (34).
  - LBW (kg) = \( \frac{9270 \times TBW (kg)}{6680 + 216 \times BMI (kg.m^2)} \)
- Adjusted Body Weight (ABW). This takes into account the fact that the obese individual has increased lean body mass and an increased volume of distribution for drugs. It is calculated by adding 40% of the excess weight to the ideal body weight (35).
  - ABW (kg) = IBW + 0.4(TBW-IBW)

Figure 2. Shows how Lean body mass effectively plateaus despite increasing BMI. Example for a male height 190cm and demonstrating how ideal body weight includes a normal 15% fat mass.

4b Drug dosing

There is limited information of the effect of obesity on the pharmacology of the commonly used anaesthetic drugs. Much of the excess weight is fat, which has a relatively low blood flow. While lipophilic drugs will have a larger volume of distribution (Vd) than hydrophilic ones, the current evidence indicates that Vd changes in the obese are drug-specific so generalisations are difficult (36). For most anaesthetic agents, dosing to total body weight is rarely appropriate and increases the risk of relative overdose. Fortunately most anaesthetic agents are dosed to effect: loss of eyelash reflex, nerve stimulator response or relief of pain are examples. Given the paucity of information the recommendation, based on current practice amongst experts in bariatric anaesthesia, is that LBW or ABW are used as the scalars for calculating initial anaesthetic drug doses rather than TBW (Table 2).

The fifth National Audit (NAP5) into accidental awareness under anaesthesia (AAGA) showed a disproportionate number of obese patients suffered AAGA. Half of the incidents of awareness occurred during induction of anaesthesia and neuromuscular blocking agents (NMB) were used in 93% of these cases (37). In the obese patient, after a bolus of anaesthetic induction agent, anaesthesia will occur before redistribution from the central compartment, and the induction dose required to produce unconsciousness correlates well with lean body weight (LBW)(38). However more rapid redistribution of induction agents into the larger fat mass means patients wake up more quickly after a single bolus dose. With induction agents a TBW dose will last longer than one calculated using LBW or ABW but is likely to result in significant hypotension. It is likely that in the cases of AAGA found in NAP5, small doses of induction agent...
based on LBW or ABW were not quickly followed by the introduction of maintenance anaesthesia, thus raising the risk of awareness. Thiopentone is associated with a greater risk of awareness than propofol. It is strongly recommended that additional induction agent be given if there is a delay in commencing effective maintenance anaesthesia after induction.

Hydrophilic drugs such as muscle relaxants are distributed primarily in the central compartment and LBW is a suitable dosing scalar. A TBW dose of rocuronium does not significantly shorten the onset time, but will markedly increase the duration of action (39). However due to increased plasma cholinesterase activity, TBW is appropriate for suxamethonium. Neostigmine and sugammadex doses are related to the timing and total dose of muscle relaxant to be reversed and can usually be titrated to effect.

For opioids the clinical effect is poorly related to the plasma concentration (40). Dosing using LBW is therefore a sensible starting point until the patient is awake and titration to effect is possible.

For target controlled infusions of propofol (TCI) the Marsh and Schnider formulae become unreliable for patients weighing over 140-150kg (39). Because of this none of the commercially available pumps allow input of weights above 150kg using the Marsh model, or BMI > 35 kg.m\(^{-2}\) (female) and 42 kg.m\(^{-2}\) (male) using the Schnider model. There is a lack of evidence as to the best weight scalar to use with TCI techniques and when used with neuromuscular blocking agents awareness is a potential significant risk. In these situations some form of depth of anaesthesia monitoring is strongly recommended (41).

5. Pre-operative Preparation

5a. General considerations
The vast majority of obese patients presenting for surgery are relatively healthy and their peri-operative risk is similar to that of normal weight patients. The patients at high risk of peri-operative complications are those with central obesity and metabolic syndrome rather than those with isolated extreme obesity (10).

Particular attention should be focused on screening patients for sleep-disordered breathing and those at particularly high risk of VTE. A clear pathway for referral for specialist sleep studies should be identified.

The Obesity Surgery - Mortality Risk Stratification score (OS-MRS) [Table 3] is validated for patients undergoing gastric bypass surgery to identify those at risk of developing postoperative complications (42). It includes features of metabolic syndrome and SDB. Although only validated for bariatric surgical patients it may be applicable to the obese patient undergoing non-bariatric operations. Patients who score 4-5 on the OS-MRS are more likely to require closer postoperative monitoring.

All patients should have their height and weight recorded and BMI calculated. BMI and total weight should both be recorded on the operating list to inform the teams that additional time, equipment and preparation may be needed. There may be an
advantage in estimating lean body weight and adjusted body weight and recording these in the patient’s documentation to aid the calculation of drug doses.

Diagnostic testing should be based on the need to evaluate comorbidity and the complexity of surgery rather than merely as a result of the presence of obesity.

In bariatric surgery it is routine to initiate a pre-operative “liver shrinking” diet to lessen liver size and make access to the stomach technically easier. There is evidence that two to six weeks of intense pre-operative dieting can improve respiratory function and facilitate laparoscopic surgery, and may be worth considering in the higher risk patients (43).

Pre-operative discussion can promote smoking cessation, clarify the importance of thromboprophylaxis and early mobilisation, plan medication management prior to admission and remind relevant patients to bring their own CPAP machine into hospital.

5b. Respiratory assessment
Clinical evaluation of the respiratory system and patients exercise tolerance should identify functional limitations and guide further assessment. It is helpful to assess SpO₂ in the pre-assessment clinic. Spirometry is also often useful.

The following features may indicate the presence of significant underlying respiratory disease and should prompt consideration of pre-operative arterial blood gas analysis (44).

- SpO₂ <95% on air
- Forced vital capacity is less than 3 litres or FEV1 less than 1.5 litres
- Respiratory wheeze at rest
- Serum bicarbonate >27mmol/l

A PaCO₂ > 6kPa indicates a degree of respiratory failure and consequently the likelihood of increased anaesthetic risk.

It is essential to screen for sleep-disordered breathing. There are several screening tools available, however the STOP-BANG questionnaire (Table 4) is the best validated in obese patients. It is easy to calculate and has shown good correlation with the severity of postoperative apnoeas. A STOP-BANG score of 5 or greater indicates the possibility of significant SDB and should prompt a referral to a sleep physician if time allows (45, 46). Even in the presence of a low STOP-BANG score, a history of marked exertional dyspnœa, morning headaches and ECG evidence of right atrial hypertrophy may indicate the presence of SDB and should prompt a referral for assessment.

Patients with undiagnosed OSA, or those unable to tolerate CPAP are at highest risk of perioperative respiratory and cardiovascular morbidity (47), while patients fully compliant with CPAP (usually indicated by symptomatic benefit) are at lower risk of perioperative events. In general, patients with adequately treated SDB do not have problems requiring high dependency care and may even be suitable for day surgery (48) (see 8c).
5c. Airway assessment
Obesity is associated with a 30% greater chance of difficult/failed intubation, although predictors for difficult laryngoscopy are the same as for the non-obese (49). A large neck circumference is a useful additional indicator and when greater than 60cm is associated with a 35% probability of difficult laryngoscopy (50).

Bag mask ventilation (BMV) is also known to be more difficult in the obese (51, 52). Beards in particular can cause problems with BMV and are quite common in the obese male population. If time allows, it is recommended that all facial hair should be removed pre-operatively, or at the very least clipped short.

5d. Cardiovascular assessment
Obese patients should be assessed in the same way as any other patient group. Features of the metabolic syndrome should be actively identified as there is a strong association with cardiac morbidity (53). Assessment of exercise tolerance can be a valuable tool. The requirement for specific cardiac investigations should be based on: the degree of exercise tolerance, the presence of additional comorbidity, and the site and extent of the anticipated surgery,

Cardio-pulmonary exercise testing (CPET) can predict those at high risk of postoperative complications and increased length of stay (54, 55). Standard CPET equipment may not be suitable and recumbent bikes are available for heavier patients.

5e. Planning Postoperative location
The planned postoperative management of most obese patients should resemble the enhanced recovery programmes of many surgical specialities.

Obesity alone is not a clinical indication for high dependency post-operative care. Factors that warrant consideration for a level 2 or 3 setting include:

- Pre-existing co-morbidities
- Indicated high risk (e.g. OS-MRS 4-5 or limited functional capacity)
- Surgical procedure
- Untreated OSA plus a requirement for post operative parenteral opioids
- Local factors including the skill mix of ward staff

An important consideration for all patients is the degree and site of surgery. If longer acting opioids (e.g. morphine) are necessary, then these patients will require closer monitoring, specifically watching for developing hypercapnia and level 2 care may be indicated (56).

6. Intraoperative Care

6a. Patient Preparation
Patient dignity is important so suitable sized theatre gowns and disposable underwear should be available. Antacid and analgesic premedication should be considered. As previously mentioned, consider asking male patients with beards to shave/trim before surgery.
6b. Theatre & Staff Preparation (The WHO Checklist)
The specific peri-operative requirements for the obese patient should be included in the pre-operative team brief to ensure the presence of appropriate equipment, including suitable operating tables, beds and trolleys. See 8a.

Extra time should be allowed for positioning and performing anaesthesia in the obese patient. Anaesthetists should recognise when additional personnel (another trained anaesthetist or extra operating department practitioners) are needed.

Consider the seniority of both the anaesthetist and surgeon. Patients with an OS-MRS score >3 should be discussed with a consultant, and those with a score of 4-5 should be anesthetised by an experienced anaesthetist. An experienced surgeon will reduce operative time and this will help to limit perioperative morbidity.

6c. Regional Anaesthesia
Where possible central regional anaesthesia (RA) is preferred to general anaesthesia, although a plan for airway management is still mandatory (57). There is a higher risk of failure of regional techniques in the obese, and appropriate patient counselling/consent is advised. (58) If sedation is required during regional anaesthesia this should be kept to the minimum. Specific equipment such as additional length spinal or epidural needles should be available and ultrasound might be a useful adjunct (59).

There are advantages to the patient (comfort) and practitioner (success rates) in using the sitting position, and it may be helpful to tilt the bed towards the operator so the patient naturally leans forward (60). To reduce epidural catheter migration, it is recommended that at least 5cm of catheter should be left in the epidural space (61). Ideal body weight should be used to calculate local anaesthetic drug doses, and for central neuraxial blockade, standard doses of local anaesthetic are recommended. Finally the anaesthetist should be aware that hypotension may be more problematic in the obese as they do not tolerate lying flat or the adoption of the Trendelenberg position.

6d. General Anaesthetic Technique; Induction
Fast onset and offset, easily reversible drugs are the agents of choice for obese patients.

Anaesthetising the patient in the operating theatre has the advantages of avoiding the problems associated with transporting an obese anaesthetised patient and will also prevent the desaturation and potential for awareness associated with disconnection of the breathing circuit during transfer (37, 62). In addition the patient can position themselves on the operating table and can help identify pressure points for protection.

There were a number of learning points from the Fourth National Audit (NAP4), which looked at airway complications, that are pertinent to the airway management of the obese patient (63).

- There was often a lack of recognition and planning for potential airway problems.
- As a result of the reduced safe apnoea time, when airway complications occurred, they did so rapidly and potentially catastrophically.
• There was evidence that rescue techniques such as supraglottic airway devices and emergency cricothyroidotomy were associated with an increased failure rate.
• Adverse events occurred more frequently in obese patients when anaesthetised by inexperienced staff.

Since the work of spontaneous breathing is increased in the obese patient, tracheal intubation and controlled ventilation is the airway management technique of choice. Supraglottic airway devices as a primary airway device should be reserved for highly selected patients undergoing short procedures and where the patient can be kept head-up during surgery. The upper airway should be accessible at all times and a tracheal intubation plan must be in place.

During induction of anaesthesia, the patient should be positioned in a ramped position with the external auditory meatus level with the sternum, and the arms away from the chest (Figure 3). This will improve lung mechanics thereby assisting oxygenation and ventilation and as a result maximising the safe apnoea time. The addition of PEEP may further facilitate pre-oxygenation (64). Minimising induction to intubation time will reduce oxygen desaturation should bag-mask ventilation prove difficult. It has been demonstrated that ramping improves the view at laryngoscopy in the obese patient and is therefore the recommended default patient position during induction in all obese patients (65). Any difficulty/failure with direct laryngoscopy should be promptly managed in accordance with the Difficult Airway Society (DAS) guidelines.

Suxamethonium-associated fasciculations increase oxygen consumption and have been shown to shorten the safe apnoea time (66) consequently it is unlikely to wear off before profound hypoxia occurs, and so may not be the drug of choice for obese patients (67). With the advent of sugammadex, aminosteroids could instead be considered the muscle relaxants of choice. The use of rocuronium can minimise the apnoea time from cessation of spontaneous ventilation to control of ventilation via a secure airway if bag mask ventilation is difficult. The dose of sugammadex for emergency reversal should be pre-calculated and be immediately available for preparation if required (68).

Ideal Body Weight should be used to size endotracheal tubes and to calculate tidal volume during controlled ventilation (69). During controlled ventilation, no particular mode of controlled ventilation has been proven to be superior however greater tidal volumes for a given peak pressure can often be achieved using pressure rather than volume controlled ventilation. The addition of sufficient PEEP and recruitment manoeuvres will reduce intra-operative and post-operative atelectasis (70) For laparoscopic surgery, forward flexion of the patient, i.e. a slight sitting position allows increased abdominal excursion and slightly lower airway pressures (71).

As intravenous access is often difficult in the obese it is prudent to site two intravenous cannulae while in theatre. Ultrasound may prove useful to help locate peripheral veins but consideration should be given to unusual sites for intravenous access such as upper arm and anterior chest wall. Central venous access should only be used if peripheral access is impossible, or if specifically indicated.
6f. The “SDB-Safe Anaesthetic”
A simple and safe principle is to assume that all obese patients have some degree of sleep-disordered breathing (whether formally tested or not) and to modify the anaesthetic technique accordingly. Useful perioperative strategies therefore include:

- Avoidance of general anaesthesia and sedatives where possible.
- Use of short acting agents.
- Consider using depth of anaesthesia monitoring techniques to limit anaesthetic load, particularly when NMB agents or a TIVA technique are utilised.
- Neuromuscular monitoring should be utilised to maintain a level of block compatible with surgery and must be used to ensure complete block reversal prior to waking the patient.
- Maximise the use of local anaesthetic and multi-modal opioid-sparing analgesia.
- Maintaining the head–up position throughout recovery.
- Monitor oxygen saturations until mobile post operatively.

If long acting opioids are required and the patient is not stabilised on CPAP pre-operatively, then the use of level 2 care is recommended.

6g. Maintenance of anaesthesia
There is limited evidence at present to favour either target-controlled infusions (TCI) of propofol or volatile agents for maintenance of anaesthesia in the obese. However, due to the increased risk of awareness in the obese, it is important that maintenance is commenced promptly (37). With inhalational anaesthetic agents, fat insoluble volatile agents such as desflurane or sevoflurane have a faster onset and offset than isoflurane. There is evidence of faster return of airway reflexes with desflurane compared with sevoflurane in the obese (72).

Multimodal analgesia techniques including local anaesthesia enables opioid sparing and are strongly recommended.

6h. Emergence from anaesthesia
Both NAP4 and NAP5 showed a high incidence of problems during extubation in the obese. An extubation plan must therefore be in place in accordance with the Difficult Airway Society (DAS) extubation guidelines.

Neuromuscular blockade should be reversed guided by a nerve stimulator. The aim is to restore motor capacity prior to waking the patient (37). Patients should have return of their airway reflexes and be breathing with good tidal volumes prior to tracheal extubation. This should be performed with the patient awake and in the sitting position. In those patients with confirmed OSA, the insertion of a nasopharyngeal airway prior to waking the patient helps mitigate partial airway obstruction commonly seen during emergence from anaesthesia.
7. Post-operative Care

7a. Immediate Post Anaesthesia Care
Full monitoring should be maintained in the post anaesthesia care unit (PACU). The patient should be managed in the sitting position or with a 45-degree head up tilt. Oxygen therapy should be applied to maintain pre-operative levels of arterial oxygen saturation and should be continued until the patient is mobile postoperatively. If the patient was using CPAP therapy at home, it should be reinstated on return to the ward or even in the PACU if oxygen saturation levels cannot be maintained by the use of inhaled oxygen alone (56). If supplemental oxygen is necessary this can either be given via the patient’s CPAP machine or via nasal specula under the CPAP mask.

Before discharge from PACU, all obese patients should be observed whilst unstimulated for signs of hypoventilation, specifically apnoeas or hypopnoeas with associated oxygen desaturation, which will warrant an extended period of monitoring in the PACU. Ongoing hypoventilation will require anaesthetic assessment to establish the need for further respiratory support and level 2 care.

The patient is safe to return to the ward only when:
- Routine discharge criteria are met.
- The respiratory rate is normal and there are no periods of hypopnea or apnoea for at least one hour.
- The arterial oxygen saturation returns to the pre-operative values with or without oxygen supplementation.

7b. Analgesia and ward care
An enhanced recovery protocol is essential (73). Early mobilisation is vital and most patients should be out of bed on the day of surgery. If possible avoid restricting the patient with a urinary catheter, intravenous infusions or other devices. Calf compression devices can be disconnected for mobilisation.

The intramuscular route of drug administration is to be avoided due to unpredictable pharmacokinetics.

The use of patient controlled analgesia (PCA) systems needs careful consideration because of the increased risk of respiratory depression in those with undiagnosed SDB. In those patients with suspected or poorly treated SDB, increased post operative monitoring in a Level 2 unit is recommended if a PCA is required.

Subarachnoid block with an opioid adjunct is a useful technique resulting in reduced postoperative opioid requirement. Epidural infusions are associated with reduced postoperative mobility and may be counterproductive.

Ward oxygen therapy should be continued until baseline oxygen saturations are achieved, and oxygen saturation monitoring should continue until oxygen saturations remain at baseline without supplemental oxygen and parenteral opioids are no longer required.

A postoperative tachycardia may be the only sign of a post-operative complication and should not be ignored. See 8b
7c. Thromboprophylaxis
Obesity per se is a risk factor for VTE and it is recommended that all obese patients undergoing all but minor surgery should receive VTE prophylaxis. Guidelines for post surgical VTE prophylaxis were published by NICE in 2010. Strategies to reduce VTE risk include: early postoperative mobilisation, mechanical compression devices, thromboembolic device (TED) stockings, anticoagulant drugs and vena caval filters. There is currently limited evidence to support the use of TEDs in obesity, but if used, it is essential that they be fitted correctly to avoid vascular occlusion. Current evidence does not support the routine use of venal caval filters in the obese population (74).

The mainstay of VTE prophylaxis in obesity is pharmacological, with the criteria for pharmacological prophylaxis including:

- Prolonged immobilisation
- Total theatre time of >90 minutes
- Age >60 yrs.
- BMI >30kg.m⁻²
- Cancer
- Dehydration
- Positive family history of VTE.

Newer oral agents such as rivaroxiban and dabigatran are licensed for VTE prophylaxis following orthopaedic surgery but there is limited evidence for their use in obesity. At present dose adjustment for oral agents is not recommended for the obese.

There is evidence regarding dose adjustments for low molecular weight heparins in obesity. The Haemostasis, Anticoagulation and Thrombosis (HAT) Committee published the dosing schedule reproduced in Table 5 in April 2010 (75).

7d. Rhabdomyolysis
A rare but serious complication in the obese patient is rhabdomyolysis. Apart from obesity, predisposing risk factors include hypotension, immobility, prolonged operative procedures and dehydration.

Rhabdomyolysis should be considered if the patient has postoperative deep tissue pain, classically in the buttocks. Serum creatinine kinase should be measured promptly, and if rising, aggressive fluid resuscitation, diuretics and urinary alkalinisation may all be required to prevent further acute kidney injury (76).

8. Special Circumstances

8a. Sedation
Preoperative evaluation for patients undergoing sedation should be similar to those having general anaesthesia. Patients with sleep-disordered breathing are likely to have airway obstruction with even minimal sedation. Obese patients are not suitable for a solo operator-sedator procedures (77).
8b. Emergency Surgery
It is particularly important that obese patients requiring emergency surgery are managed by an anaesthetist experienced in the care of the obese along with an experienced surgeon in order to minimise the operative time and the risk of complications. (78) Postoperative Level 2 nursing care is far more likely to be required due to the much higher risk of emergency surgery complications.

Obese patients can look deceptively well and abdominal examination can be notoriously difficult. A tachycardia, new onset of abdominal pain or unexplained fever may be the only signs of intra-abdominal sepsis and should be an indication for measuring arterial blood gases and serum lactate.

8c. Day Surgery
It is acceptable for obese patients to undergo surgery as a day case if:

- The management would not be modified if they were admitted as an inpatient
- Being treated as a day case will not alter the perioperative risk.

The exclusion of obese patients from the advantages that day surgery may offer should not be made on the basis of weight alone. There is an increased risk of anaesthetic related complications in obese patients in the day surgery environment, but these tend to occur on induction of anaesthesia, intra-operatively or in the early recovery phase (79). Obesity has no influence on the rate of unanticipated admission, postoperative complications, readmission or other unplanned contact with health professionals after home discharge (80).

Current guidelines advocate automated acceptance of patients with a body mass index less than 40 kg.m\(^{-2}\) (81, 82). A case note review should be carried out by an anaesthetist to determine whether individualised discussion and assessment may be required prior to the day of surgery for those with comorbidities or a BMI >40 kg.m\(^{-2}\).

A review and meta-analysis by the Society for Ambulatory Anaesthesia provides useful advice on day surgery for patients with sleep disordered breathing (83). Patients with a known diagnosis of OSA can be considered for day surgery if:

- They have, and are able to use a continuous positive airway pressure device after discharge
- Comorbid conditions are optimised
- Post-operative pain relief can be provided predominantly by non-opioid analgesics.

Laparoscopic cholecystectomy and laparoscopic gastric banding (84-86) are increasingly being performed as a day case procedure.

8d. Obstetric patients
Maternal obesity is recognised as one of the most commonly occurring risk factors seen in obstetrics, with outcomes for both mother and baby poorer than the general population (3).
The CMACE report and the Obstetric Anaesthetists Association have made a number of recommendations regarding the care of obese pregnant women (87, 88). Obese women have an increased risk of comorbidity during pregnancy, in particular gestational diabetes and pre-eclampsia (89, 90). Obesity and pregnancy are both significant risk factors for the development of thromboembolic disease in pregnancy.

Compared with a non-obese parturient an obese woman is more likely to have her labour induced and require instrumental delivery (91, 92). There is an increased rate of operative and postoperative complications including increased rates of post-partum haemorrhage, prolonged operative times, and infective complications such as endometritis and wound infection (93).

Fetal outcomes in obese pregnant women are poorer when compared with the general population, with stillbirth rates in women with a BMI >35 kg.m$^{-2}$ twice as high as the national stillbirth rate. There is an increased risk of preterm delivery in pregnant obese women (94).

In addition babies born to obese mothers are at increased risk of shoulder dystocia, brachial plexus lesions, fractured clavicle and congenital birth defects such as neural tube defects (95).

Specific anaesthetic considerations are similar to those in the non-obstetric obese patient:

- Obese patients are particularly vulnerable to aortocaval compression
- Vascular access may be more difficult and should be established early in labour in a woman with a BMI >40 (3)
- The provision of general anaesthesia and central neuraxial blockade is associated with increased difficulties (96-98). This can lead to an increased “decision to delivery” interval in women who require a category 1 or 2 caesarean section.

The obese obstetric patient is particularly at risk of thromboembolism and conversely post-partum haemorrhage. The recommended dosing of anticoagulants is generally higher for pregnant women; the Royal College of Obstetricians and Gynaecologists’ Green top guideline provides current recommendations (99).

8e. Critical Care

Outcomes of obese patients in critical care remain controversial. In several recent studies obesity was not associated with increased mortality however it was associated with a prolonged requirement for mechanical ventilation, tracheostomy placement and length of stay in a critical care unit (100, 101).

Airway interventions in the obese are associated with an increased risk of hypoxia and complications and should only be undertaken by appropriately skilled personnel. Many would advocate an early tracheotomy if long-term airway management is anticipated. Custom-made tracheostomy tubes with an adjustable flange may be required ensuring adequate length to reach the trachea. Tracheostomies are usually performed in ICU using a percutaneous approach, but surgical placement may be considered depending on the experience of the available medical staff.
For mechanical ventilation ideal body weight is used to calculate the initial recommended tidal volume of 5-7 ml.kg\(^{-1}\) ensuring the peak inspiratory pressure remains less than 35 cmH\(_{2}\)O (102).

Enteral absorption of drugs is not altered in the morbidly obese. However, due to the altered pharmacokinetics, monitoring of serum levels is considered more important in this group of patients to ensure that drug levels remain within the therapeutic range (103).

Prophylaxis against venous thromboembolism is vitally important for the morbidly obese patient in critical care and should follow the guidelines given in 7c.

All critically ill patients are prone to develop protein malnutrition as a result of metabolic stress and despite having excess fat stores, the morbidly obese are no different. However, there is some evidence suggesting hypocaloric feeding regimens can achieve adequate nitrogen balance with more favourable outcomes (104).

Early aggressive rehabilitation and physiotherapy should be undertaken as soon as is possible to encourage early mobilization. Increased numbers of staff are needed to roll these patients to prevent pressure sore formation.

8f. Cardiopulmonary resuscitation (CPR)
Morbid obesity presents additional problems during CPR. There may be delays caused by difficulties in placement of defibrillator pads, establishment of vascular access, or securing an effective airway. Physical and biological factors related to obesity may affect the quality of chest compressions delivered, the efficacy of administered vasoactive drugs, or the efficacy of defibrillator shocks applied because none of these measures are standardised to a patient’s BMI. The American Heart Association has concluded that no alterations to resuscitation have been shown to affect outcome (105).

Inspiratory airway pressures will be higher than normal and excessive leak with supraglottic airway devices (SADs) may mean that chest compressions will have to be paused to enable ventilation (i.e. a standard 30:2 compression-ventilation ratio). The high airway pressures that can occur during resuscitation of very obese patients may impair coronary perfusion pressure and ultimately reduce the chance of survival (106).

Chest compressions will be difficult to perform in many patients, simply because of sub-optimal rescuer positioning. A step or platform may be required or compressions can be performed from the head end of the patient. Recommended defibrillation energies remain unaltered in the morbidly obese, though there is evidence that the thoracic impedance is higher (107). If defibrillation remains unsuccessful, reposition the defibrillator pads and increase the shock energy to the maximum setting.

If intravenous access is difficult the intraosseous route for drug delivery is recommended. The upper humerus is a well-established point of access and drug delivery during resuscitation is effective via this route. Use standard doses of adrenaline and amiodarone.
**8g. Patients with adjustable gastric bands in situ**

Laparoscopic adjustable gastric banding (LAGB) is a recognised treatment for obesity. However, patients with a LAGB in situ are at increased risk of pulmonary aspiration during induction of general anaesthesia due to oesophageal dilatation above the band. There are case reports of regurgitation of food even after prolonged fasting. For major surgery it is recommended the band is deflated preoperatively and reinflated before hospital discharge. For minor surgery, the band can be left inflated but an endotracheal tube is recommended.

An important side note is that patients with gastric bands in situ that present with sudden onset of dysphagia or upper abdominal pain should be considered as having a band slippage until proved otherwise. This is a surgical emergency and should be treated by immediate deflation of the gastric band and referral to a competent general surgeon. Delay in deflating the band can lead to gastric infarction and perforation.

For the management of other bariatric surgical emergencies refer to the American Society for Metabolic and Bariatric Surgery website (see 9d).

### 9. Resources

**9a. Equipment**

The 2011 National Patient Safety Agency report obesity highlighted that many of the critical incidents involving the obese patient related to inadequate provision of suitable equipment. This is a clinical governance issue and hospitals need to invest in appropriate equipment to assist in the safe management of obese patients. A suggested but not exhaustive list of equipment to be considered is given in Table 6.

An ‘obesity pack’ is useful; this can include specialised documentation, the SOBA single sheet guidelines (See below) and smaller items of equipment plus a list of where the larger items are located.

**9b. Staff**

All units managing the obese surgical patient must have the ability to escalate care appropriately in the event of acute patient deterioration.

It is recommended that a single person in the department be nominated as the obesity lead. It would be their responsibility to ensure equipment and training is up to standard and could act as a point of contact for advice.

Theatre teams should have training in managing obese patients, which can be provided either internally or externally. In hospitals where there is a bariatric service, all staff should periodically observe practice in this area. Specific training on moving the morbidly obese patient should be provided.

In ideal circumstances, all anaesthetic trainees should complete a module in bariatric anaesthesia to gain insight and hands on experience in the management of the morbidly obese surgical patient.
9c. The SOBA Single Sheet Guide
This is designed as an aide memoire to be laminated and left in the anaesthetic room for reference when required. It is available on the SOBA website and updated every 6 months as new evidence becomes available. ([www.SOBAUK.COM](http://www.SOBAUK.COM))

9d. Useful Websites
The Society for Obesity and Bariatric Anaesthesia UK [www.SOBAuk.com](http://www.SOBAuk.com)
British Obesity Surgery Patient Association [www.BOSPAUK.org](http://www.BOSPAUK.org)
British Obesity and Metabolic Surgery Society [www.BOMSS.org.uk](http://www.BOMSS.org.uk)
American Society for Metabolic and Bariatric Surgery [www.asmbs.org](http://www.asmbs.org)

10. References


72. McKay RE, Malhotra A, Cakmakkaya OS, Hall KT, McKay WR, Apfel CC. Effect of increased body mass index and anaesthetic duration on recovery of protective airway reflexes after sevoflurane vs desflurane. *British Journal of Anaesthesia* 2010; 104: 175–82.


101. Akinnusi ME, Pineda LA, El Solh AA. Effect of obesity on intensive care


11. Tables

Table 1. WHO classification of obesity (7).

<table>
<thead>
<tr>
<th>Body Mass Index (kg.m$^2$)</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;18.5</td>
<td>Underweight</td>
</tr>
<tr>
<td>19-24.9</td>
<td>Healthy weight</td>
</tr>
<tr>
<td>25-29.9</td>
<td>Overweight</td>
</tr>
<tr>
<td>30-34.9</td>
<td>Obese 1</td>
</tr>
<tr>
<td>35-39.9</td>
<td>Obese 2</td>
</tr>
<tr>
<td>&gt;40</td>
<td>Obese 3 Previously “morbid obesity”</td>
</tr>
</tbody>
</table>

Table 2: Suggested initial dosing scalars for commonly used anaesthetic drugs for healthy obese adults. Notwithstanding the fact that titration to a suitable end point may be necessary.

<table>
<thead>
<tr>
<th>Lean Body Weight (rarely &gt; 100kg Males, Females 70kg)</th>
<th>Adjusted Body weight (IBW+ 40% of excess weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propofol induction</td>
<td>Propofol infusion (see text)</td>
</tr>
<tr>
<td>Thiopentone</td>
<td>Antibiotics</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>LMWH</td>
</tr>
<tr>
<td>Rocuronium</td>
<td>Lidocaine</td>
</tr>
<tr>
<td>Atracurium</td>
<td>Alfentanil</td>
</tr>
<tr>
<td>Vecuronium</td>
<td>Neostigmine (max 5mg)</td>
</tr>
<tr>
<td>Morphine</td>
<td>Sugammadex</td>
</tr>
<tr>
<td>Paracetamol</td>
<td></td>
</tr>
<tr>
<td>Bupivacaine</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3. Obesity Surgery Mortality Risk Score: OS-MRS (42)

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Score</th>
<th>Mortality Risk %</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI &gt;50 kg/m²</td>
<td>1</td>
<td>Class A 0-1 points: 0.2-0.3</td>
</tr>
<tr>
<td>Male Gender</td>
<td>1</td>
<td>Class B 2-3 points: 1.1-1.5</td>
</tr>
<tr>
<td>Age &gt;45 years</td>
<td>1</td>
<td>Class C 4-5 points: 2.4-3.0</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Risk Factors for PE:</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- Previous VTE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Vena Caval filter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Hypoventilation (SDB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Pulmonary Hypertension</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As score increases, mortality and post-operative complications increase.
Table 4. “STOP BANG” screening questionnaire for obstructive sleep apnoea (46)
(Adapted with permission)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S</strong></td>
<td>Snoring: Do you snore loudly (louder than talking or heard through a closed door?)</td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>Tired: Do you often feel tired, fatigued or sleepy during the daytime? Do you fall asleep in the daytime?</td>
</tr>
<tr>
<td><strong>O</strong></td>
<td>Observed: Has anyone observed you stop breathing or choking or gasping during your sleep?</td>
</tr>
<tr>
<td><strong>P</strong></td>
<td>Blood Pressure: Do you have or are being treated for high blood pressure?</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>BMI: BMI &gt; 35kg/m²</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>Age: Age &gt; 50 years</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>Neck large (measured around Adams apple) Males &gt;43cm (17 inches), Females &gt;41cm (16 inches)</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>Gender: Male</td>
</tr>
</tbody>
</table>

Score 1 point for each positive. ≥5 is a significant risk.

Table 5. Dosing schedule for thromboprophylaxis (71).

<table>
<thead>
<tr>
<th></th>
<th>&lt;50kg</th>
<th>50-100kg</th>
<th>100-150kg</th>
<th>&gt;150kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enoxaparin</td>
<td>20mg daily</td>
<td>40mg daily</td>
<td>40mg BD</td>
<td>60mg BD</td>
</tr>
<tr>
<td>Dalteparin</td>
<td>2500 units daily</td>
<td>5000 units daily</td>
<td>5000 units BD</td>
<td>7500 units BD</td>
</tr>
<tr>
<td>Tinzaparin</td>
<td>3500 units daily</td>
<td>4500 units daily</td>
<td>4500 units BD</td>
<td>6750 units BD</td>
</tr>
</tbody>
</table>
### Table 6. Equipment for managing obese surgical patients.

<table>
<thead>
<tr>
<th>Ward equipment</th>
<th>Theatre equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialised electrically operated beds that can raise a patient to standing</td>
<td>Bariatric operating table. These should be able to incorporate arm boards and table extensions, attachments for positioning such as leg supports for the lithotomy position, shoulder and foot supports.</td>
</tr>
<tr>
<td>without the need for manual handling with a pressure-relieving</td>
<td></td>
</tr>
<tr>
<td>mattresses.</td>
<td></td>
</tr>
<tr>
<td>Suitable bathrooms with floor-mounted toilets, suitable commodes</td>
<td>Gel pads and padding for pressure points</td>
</tr>
<tr>
<td>Large blood pressure measuring cuffs</td>
<td>Wide Velcro strapping to secure the patient to the operating table.</td>
</tr>
<tr>
<td>Extra Large gowns</td>
<td>Ramping device/ pillows</td>
</tr>
<tr>
<td>Suitably sized compression stockings and intermittent compression devices</td>
<td>Raised step for the anaesthetist</td>
</tr>
<tr>
<td>Larger chairs, wheelchairs and trolleys all marked with the maximum</td>
<td>Large tourniquets</td>
</tr>
<tr>
<td>recommended weight</td>
<td></td>
</tr>
<tr>
<td>Scales capable of weighing up to 300Kg</td>
<td>Readily available difficult airway equipment</td>
</tr>
<tr>
<td>On site blood gas analysis</td>
<td>Anaesthetic ventilator capable of PEEP and pressure modalities</td>
</tr>
<tr>
<td>CPAP or high flow oxygen delivery device for PACU</td>
<td>Hover mattress or slide sheet</td>
</tr>
<tr>
<td>Patient hoist or other moving device (maybe shared with other departments)</td>
<td>Portable ultrasound machine</td>
</tr>
<tr>
<td></td>
<td>Depth of anaesthesia monitoring to minimise residual sedation.</td>
</tr>
<tr>
<td></td>
<td>Neuromuscular monitor</td>
</tr>
<tr>
<td></td>
<td>Long spinal and epidural needles.</td>
</tr>
<tr>
<td></td>
<td>Long arterial lines if femoral access is necessary.</td>
</tr>
</tbody>
</table>
12. Figures

Figure 1. Trend in obesity prevalence among UK adults from www.NOO.org.uk
Figure 2 shows how Lean body mass effectively plateaus despite increasing BMI. Example for a male height 190cm and demonstrating how ideal body weight includes a normal 15% fat mass.

Figure 3. Ramping. Ear level with sternum, reduces risk of difficult intubation and improves ventilation.