Obstructive sleep apnoea and perioperative medicine: a growing concern

Abstract

Obstructive sleep apnoea represents a sizable public health and economic burden. Owing to rising obesity rates, the prevalence of obstructive sleep apnoea is increasing, and it is a condition that is significantly underdiagnosed. Exacerbated by the COVID-19 pandemic, the backlog of elective surgeries is also sizable and growing. A combination of these factors means that many patients due to have surgery will have obstructive sleep apnoea, either diagnosed or otherwise.

Patients with obstructive sleep apnoea have a significantly increased risk of operative complications, but the evidence base for optimum perioperative management of these patients is limited. This article reviews sleep apnoea, its prevalence and its impact on operative management and perioperative outcomes for patients. The evidence base for screening and treating undiagnosed obstructive sleep apnoea is also comprehensively assessed. Finally, a pathway to manage patients with possible undiagnosed obstructive sleep apnoea is proposed, and areas for further research identified.

Key words: Continuous positive airway pressure; Obesity; Obstructive sleep apnoea; Perioperative medicine; Sleep medicine; Sleep-disordered breathing

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Introduction: obstructive sleep apnoea, obesity and perioperative medicine

Obstructive sleep apnoea is an increasingly common, weight-related condition, with an estimated prevalence of 6–17% of those affected at a clinically significant severity (Senaratna et al, 2017). Obstructive sleep apnoea is a risk factor for all-cause mortality (Dodds et al, 2020) and increases the risk of a range of perioperative complications (Ng et al, 2020).

In 2017, approximately 5.1 million surgical procedures were performed annually by the NHS (Abbott et al, 2017). This number will continue to increase as a result of the ever-growing backlog of elective procedures, exacerbated by the COVID-19 pandemic, and is predicted to rise to 12 million by 2025 (Iacobucci, 2021).

The prevalence of obesity (defined as a body mass index of ≥30 kg/m^2) is increasing. Between 1993–2019, rates of obesity rose from 15% to 28% (Commons Library, 2022). The COVID-19 pandemic and its associated lockdowns have exacerbated this growing problem. Lin et al (2021), in their American study, found that adults gained a mean of 0.68 kg per month spent in shelter during lockdown. Although data on adult obesity are not yet available, obesity rates rose by 4.5% between 2019 and 2020 in children between 10–11 years of age (NHS, 2021), which marks the highest rate of increase since the child measurement programme began.

In response to the increasing complexity of high-risk patients undergoing surgery, the Royal College of Anaesthetists founded the Perioperative Medicine Programme in 2014. Now termed the Centre for Perioperative Care, this initiative aims to promote the highest quality of preoperative, intraoperative and postoperative care, to reduce variation and improve outcomes. Obesity and obstructive sleep apnoea, alongside the surgical backlog, pose a significant perioperative challenge.

This review examines sleep apnoea and its related complications, alongside assessing the condition's impact on perioperative outcomes. It will focus on the growing problem of undiagnosed sleep apnoea in the perioperative period, and identify which questions remain unanswered.

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What is obstructive sleep apnoea, and why does it matter?

Obstructive sleep apnoea is the most common respiratory disorder of sleep (Faria et al, 2021). It features episodes of cessations in breathing (apnoeas) or significant reductions in breathing (hypopneas) during sleep, which are caused by an obstructed upper airway. Resultant hypoxaemia and sleep disruption causes characteristic daytime somnolence. Obstructive sleep apnoea falls under the banner of sleep-disordered breathing, which also encompasses central sleep apnoea and sleep-related hypoventilation.

Obstructive sleep apnoea is diagnosed by a sleep study, and severity is based on the number of apnoeas or hypopneas occurring hourly, which is documented through the use of the apnoea–hypopnoea index (National Institute for Health and Care Excellence, 2021). Severity is classified as either mild (5≤apnoea–hypopnoea index<15), moderate (15≤ apnoea–hypopnoea index<30) or severe (apnoea–hypopnoea index≥30). Gold standard treatment for obstructive sleep apnoea is the use of a continuous positive airways pressure machine, which works to splint the upper airways open, preventing obstruction and resultant desaturation events.

Untreated obstructive sleep apnoea is linked to hypertension, diabetes, stroke and heart disease (National Institute for Health and Care Excellence, 2021), and severe obstructive sleep apnoea carries an increased risk of 1.9 in all-cause mortality (Ge et al, 2013). Treatment with continuous positive airways pressure for patients with severe obstructive sleep apnoea has been shown to reduce mortality, as well as reducing the incidence of type 2 diabetes and cardiovascular disease (Ge et al, 2013; Dodds et al, 2020). Evidence of harm in untreated obstructive sleep apnoea in lower severity categories is less definitive. National Institute for Health and Care Excellence guidance (2021) advises continuous positive airways pressure as first-line therapy for anyone with moderate or severe obstructive sleep apnoea.

Up to 80% of adults with moderate to severe obstructive sleep apnoea remain undiagnosed (Faria et al, 2021). It is linked to obesity, and prevalence is significantly higher in those with an increased body mass index (Senaratna et al, 2017). Peppard et al (2000) demonstrated that a 10% weight increase predicted a sixfold increase in the odds of developing moderate or severe obstructive sleep apnoea; conversely, weight loss of 10% was linked to a 26% reduction in a patient's apnoea–hypopnoea index score.

Obstructive sleep apnoea is a significant public health concern. Research from Faria et al (2021) suggests that over 1400 of the car accident fatalities recorded in the USA in 1 year were attributable to obstructive sleep apnoea. Faria et al (2021) also indicated that the cost to the healthcare system stemming from sleep disorders is similar to that of diabetes.

How does obstructive sleep apnoea impact perioperative outcomes?

Obstructive sleep apnoea presents a unique perioperative challenge. Patients with obstructive sleep apnoea have up to a four-fold risk of difficult intubation (Nagappa et al, 2018). They are more sensitive to anaesthetic agents, particularly opioids, and are more likely to require higher levels of postoperative care (Memtsoudis et al, 2018).

Complication rates are higher in patients with obstructive sleep apnoea. In a large cohort study of patients undergoing shoulder arthroscopy, Masarachhia et al (2018) demonstrated 4.92 times greater odds in patients with obstructive sleep apnoea for pulmonary complications, including pneumonia, pulmonary oedema and respiratory failure, when compared to controls.

The incidence of cardiac complications, including myocardial infarction and cardiac arrest, is also increased (Mutter et al, 2014; Chan et al, 2019). Heightened risk of intensive care admission, unplanned invasive or non-invasive ventilation, acute kidney injury and postoperative delirium, alongside an increase in the duration of time spent in hospital, have all been linked to obstructive sleep apnoea (Masaracchia et al, 2018; Chan et al, 2019; Ng et al, 2020).

Undiagnosed obstructive sleep apnoea is particularly challenging. Diagnosis facilitates the anticipation of a high-risk patient and suitable subsequent planning. For example, steps can be taken to reduce the use of central depressant medications. As Cozowicz et al (2019)

have demonstrated, lessening opioid usage through multimodal analgesia in patients with known obstructive sleep apnoea is associated with a reduction in complications, including respiratory failure. Bed planning can also be actioned, as patients with obstructive sleep apnoea may be less suitable for day surgery (Nightingale et al, 2015).

The number of patients with undiagnosed sleep apnoea is significant and expanding. In a 2019 prospective cohort study of patients undergoing major non-cardiac surgery, Chan et al (2019) found that, in 1218 high-risk patients without a previous diagnosis, 68% had undiagnosed obstructive sleep apnoea, with 11.2% of these patients having severe obstructive sleep apnoea. In the same study, those with undiagnosed severe disease displayed significantly increased rates of cardiovascular complications within 30 days of surgery, including death, heart failure and stroke (Chan et al, 2019). Conversely, Mutter et al (2014), in their retrospective cohort study, demonstrated that patients with a preoperative diagnosis of obstructive sleep apnoea and a subsequent continuous positive airways pressure intervention (used before and after surgery) were less than half as likely to experience cardiovascular complications as those diagnosed after surgery.

However, the evidence for the benefit of perioperative continuous positive airways pressure in obstructive sleep apnoea is limited. A meta-analysis by Nagappa et al (2015) showed no significant difference in postoperative adverse events in patients with obstructive sleep apnoea using preoperative and/or postoperative continuous positive airways pressure vs those not using continuous positive airways pressure. Evidence was of low quality. This meta-analysis included six studies (comprising 904 patients) and excluded five studies that demonstrated positive impacts linked to continuous positive airways pressure because of a lack of data. However, there was a reduction in patients' length of stay when continuous positive airways pressure was used either pre- or postoperatively.

It is possible that the lack of high-quality data on the positive impact of continuous positive airways pressure stems from low continuous positive airways pressure adherence. Suen et al (2021) found that, in patients with obstructive sleep apnoea and a continuous positive airways pressure prescription, only 61% were using continuous positive airways pressure for at least 4 hours a night prior to their scheduled surgery. Rates of non-adherence to continuous positive airways pressure therapy in patients with obstructive sleep apnoea are notoriously high, and any intervention requires a concentrated multidisciplinary team approach to optimise adherence.

What can be done about it?

Patients with a previous diagnosis of obstructive sleep apnoea and a prescription of continuous positive airways pressure should use their device both before and as soon as possible after their operation. However, more challenging questions arise when confronting how to manage the increasing number of high-risk patients with undiagnosed obstructive sleep apnoea. This matter is complex, and high-quality evidence is lacking in all areas; however, the critical points can be summarised by a few key questions.

Question 1: how should patients at high risk of obstructive sleep apnoea be screened?

Sleep-disordered breathing should be considered in all patients with a body mass index of ≥30 (Nightingale et al, 2015). Validated screening tools include the American Society of Anesthesiologists checklist, Berlin questionnaire and, in particular, the STOP-Bang questionnaire (Figure 1) (Nagappa et al, 2017). This last has the largest evidence base and is recommended by National Institute for Health and Care Excellence and the Royal College of Anaesthetists. This eight-question tool has been validated across different geographic regions; a positive result is typically achieved when an answer of 'yes' is returned to three questions. It has a sensitivity of 88% and a specificity of 30% in detecting moderate–severe obstructive sleep apnoea (Nagappa et al, 2017; Pivetta et al, 2021).

Given the low specificity of the STOP-Bang questionnaire, Nagappa et al (2017) suggested adding the measurement of serum bicarbonate level to improve accuracy. A STOP-Bang score of ≥3, alongside a serum bicarbonate level of ≥28 mmol/litre, increases the specificity of detecting moderate-severe obstructive sleep apnoea from 30% to 82% (Nagappa et al,

1. Snoring?
Do you **Snore Loudly** (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night?)
- Yes/No

2. Tired?
Do you often feel **Tired, Fatigued, or Sleepy** during the daytime (such as falling asleep during driving or talking to someone)?
- Yes/No

3. Observed?
Has any **Observed** you **Stop Breathing** or **Choking/Gasping** during your sleep?
- Yes/No

4. Pressure?
Do you have or are you being treated for high blood pressure?

5. Body mass index more than 35 kg/m^2
- Yes/No

6. Age older than 50?
- Yes/No

7. Neck size large? (Measured around Adams apple)
For male, is your shirt collar 17 inches/43 cm or larger?
For female, is your shirt collar 16 inches/41cm or larger?
- Yes/No

8. Gender: male?
- Yes/No

Scoring criteria:
Low-risk OSA: Score: 0,1,2
Intermediate-risk OSA: Score 3,4
High-risk OSA: Score 5,6,7,8
- or a STOP score ≥2 + male gender
- or a STOP score ≥2 + BMI >35kg/m^2
- or a STOP score ≥ 2 + neck circumference (male 17”/43cm; female 16”/41cm)

Figure 1. The updated STOP-Bang screening questionnaire. Patients are classified into three risk groups with intermediate risk patients being upgraded to high risk with a STOP score of ≥2 with other specific risk factors. BMI = body mass index; OSA = obstructive sleep apnoea. From Nagappa et al (2017).

2017). However, this is achieved only through a loss of ease and of sensitivity, which reduces from 88% to 49%. Other options include using a higher positive cut-off STOP-Bang score or a two-step model for intermediate-risk patients (Figure 1). Assessing a patient’s Epworth Sleepiness Score, alongside their STOP-Bang score, is an attractive proposition, as daytime symptoms may predict future adherence to continuous positive airways pressure therapy (Bonsignore et al, 2021).

Question 2: how should possible sleep apnoea be investigated?

Once patients are classified as high risk, if surgery is not urgent, a sleep study should be performed. The gold standard for diagnosis of sleep-disordered breathing is using a laboratory polysomnogram. This includes the monitoring of respiratory channels, eye movements and muscle tone signals, and the use of an electroencephalogram, which assesses sleep staging. This facilitates diagnosis of a range of other sleep disorders, such as periodic limb movement disorders or other parasomnias. It can also provide detail on which sleep stage in which apnoeas are occurring in cases of obstructive sleep apnoea.

In practice, a full polysomnogram is rarely needed to diagnose obstructive sleep apnoea, and the National Institute for Health and Care Excellence (2021) recommend that respiratory polygraphy should be used first line in diagnosis of sleep-disordered breathing. This is because of the speed and cost-effectiveness of this sleep study, which is even maintained outside of the perioperative period, when time and resources are likely to be even more limited. Respiratory polygraphy includes four channels assessing nasal airflow, thoracic and abdominal wall movements, oxygen saturations and heart rate, snoring and body position.

An even easier and cheaper type of sleep study is overnight oximetry, which measures heart rate and oxygen saturations to calculate an oxygen desaturation index to diagnose sleep apnoea. It is not as accurate as polygraphy, cannot distinguish central from obstructive

events and is more prone to underrepresentation of severity of sleep apnoea, so is not recommended as first-line for diagnosis (National Institute for Health and Care Excellence, 2021). However, the Association of Anaesthetists' (Members of the Working Party et al, 2015) guideline on the management of the obese patient suggests that home oximetery can be used to diagnose the majority of obese patients preoperatively. Although this method can be quickly implemented in the preoperative period, specialist sleep clinics may be less likely to see obstructive sleep apnoea diagnosed by an oximeter as valid, which has implications for any suggested patient pathways.

In recent years, more detailed home sleep tests have become available. One such device is a WatchPAT Home Sleep Test (Itamar Medical, 2022). This comprises a wrist band, a probe that measures oxygen saturations and peripheral arterial tone, and a chest sensor. This device provides more detail than an oximeter, and is more portable than the respiratory polygraphy method. It has been validated against the polysomnogram for the detection of obstructive sleep apnoea (Zhang et al, 2020), is accurate in patients with other comorbidities, such as chronic obstructive pulmonary disease (Jen et al, 2020), and is approved as a diagnostic home sleep test by the American Academy of Sleep Medicine (Kapur et al, 2017).

Question 3: who should be treated and how long for?

This complex question has the smallest underlying evidence base. Clearly, each case will be different and will depend on a variety of factors, including the urgency and type of surgery, patient comorbidities, hospital resources and more.

Who to treat perioperatively

Once a diagnosis of obstructive sleep apnoea has been made, all patients should be educated on the diagnosis and its perioperative outcomes, alongside being given advice on smoking cessation and weight loss. The next question lies in which cohort of patients to offer continuous positive airways pressure. In an outpatient setting, continuous positive airways pressure is the advised first-line intervention for all patients with moderate and severe obstructive sleep apnoea (National Institute for Health and Care Excellence, 2021). This reflects the fact that patients with a more severe case of this condition are increasingly likely to benefit from therapy. This is also true during the perioperative period, with data showing that the benefit of perioperative continuous positive airways pressure is seen in those with severe obstructive sleep apnoea, rather than in milder instances of the condition (Mutter et al, 2014).

However, continuous positive airways pressure, when used postoperatively in major abdominal surgery, may reduce respiratory complications, such as postoperative pneumonia and reintubation, even in patients without obstructive sleep apnoea (Kokotovic et al, 2021). This strengthens the proposition of treating those with mild obstructive sleep apnoea during the perioperative period, and the National Institute for Health and Care Excellence (2021) recommends that those with mild obstructive sleep apnoea and excessive sleepiness should be managed first line with continuous positive airways pressure in the preoperative period.

The length of preoperative treatment

Evidence in this area is particularly sparse. If surgery is time-critical, the setting up of the continuous positive airways pressure machine should not delay the operation. Knowledge of the diagnosis alone is useful. In cases where surgery can be safely delayed, the question lies in how long continuous positive airways pressure should be used to achieve a clinical benefit. Postoperative continuous positive airways pressure alone may provide some benefit in preventing airway obstruction, reducing respiratory complication and reducing intensive treatment unit admissions (Kokotovic et al, 2021; Suen et al, 2021), but a prolonged period of preoperative continuous positive airways pressure may have further benefits.

Proposed benefits of preoperative continuous positive airways pressure include a reduction in airway inflammation (Liu et al, 2020) and pulmonary artery pressures, which are variables shown to increase mortality in obstructive sleep apnoea (Sharma et al, 2021). Improving these variables before surgery could positively impact patient outcomes. It has been suggested that 1 month of preoperative continuous positive airways pressure may be optimal before surgery (Verbraecken et al, 2017).

Looking forward: a proposed pathway for patients with suspected undiagnosed obstructive sleep apnoea

The burden of undiagnosed obstructive sleep apnoea in the perioperative period is large. Patients are at a high risk of complications, and discrepancies in care exist. Bamgbade et al (2021) surveyed 4000 UK anaesthetists and found that there was a huge range in how clinicians screened and managed those with suspected obstructive sleep apnoea.

Studies to assess optimum ways to screen and treat high risk patients will be of interest and may soon demonstrate the morbidity and mortality benefits of such screening. The outcomes of the POPCORN study (van Veldhuisen et al, 2020) will be of particular interest in its role as a prospective cohort study investigating screening and treating patients before bariatric surgery.

For now, pathways should exist for these patients, and the benefits of these are multifold. Diagnosis facilitates planning, such as in the levels of postoperative care required. It enhances shared decision making, a nuanced process in which clinicians and patients make decisions together about risks and benefits of certain treatments (Hester et al, 2019). There are long-term health and economic benefits to diagnosing obstructive sleep apnoea, and the preoperative period represents an opportunity to achieve this. It may also represent a teachable moment, where patients are motivated to use their prescribed continuous positive airways pressure, potentially improving adherence in the long term. Finally, it may improve perioperative outcomes for patients, reducing morbidity and mortality.

A proposed perioperative pathway is shown in Figure 2. As a standard, body mass index should be calculated for all patients attending the pre-assessment clinic. Obese patients

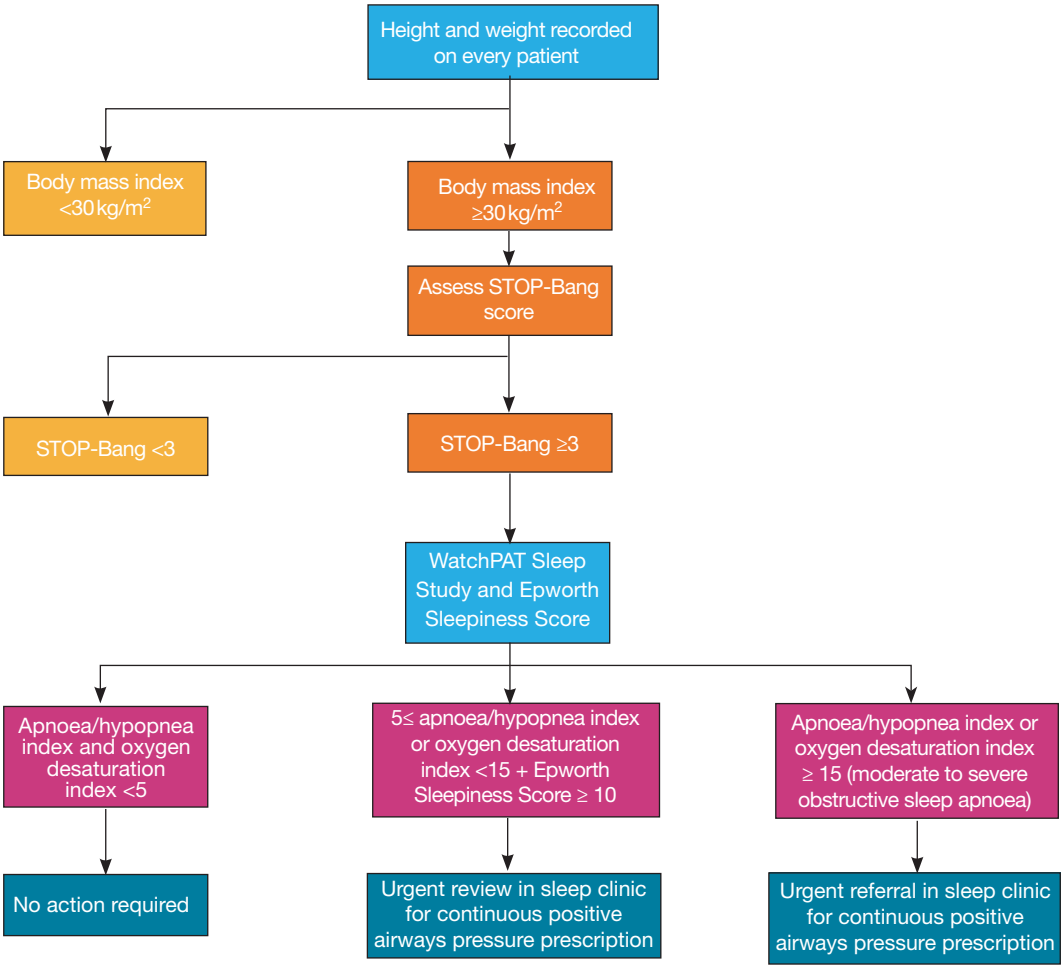

Figure 2. A proposed perioperative pathway for management of patients with suspected undiagnosed obstructive sleep apnoea. STOP-Bang = 8-point screening questionnaire.

Key points

- Rates of obesity and obstructive sleep apnoea are increasing and represent a huge public health burden.
- Obstructive sleep apnoea significantly increases the risk of operative complications. Patients known to have obstructive sleep apnoea should be encouraged to use their continuous positive airway pressure machine both pre- and postoperatively.
- Standardised pathways to manage possible undiagnosed obstructive sleep apnoea should be in place. Diagnosis of obstructive sleep apnoea is beneficial in both the perioperative period and the long term.

should have their STOP-Bang score calculated and, if ≥3, should have a sleep study and an Epworth Sleepiness Score assessed. Using a cut off of 3 will yield high sensitivity from the STOP-Bang tool, and the lower specificity incurred will be offset by performance of a diagnostic sleep study on these patients. A WatchPAT Home Sleep Test represents a reasonable compromise between gold standard accuracy and speed of diagnosis in a time-critical situation.

An urgent referral to a sleep clinic should be made for those with moderate or severe obstructive sleep apnoea, and for those with mild obstructive sleep apnoea with daytime somnolence, for initiation of preoperative continuous positive airways pressure. Review in a specialist respiratory clinic, rather than in a preoperative clinic, allows access to specialist clinicians to assess other sleep pathologies, alongside review by physiotherapists to optimise mask fitting and improve adherence to continuous positive airways pressure.

Conclusions

The COVID-19 pandemic has highlighted the discrepancy between supply and demand for surgeries. The effort to manage this will be a significant one, and perioperative medicine will be at the forefront of this challenge.

As obesity rates increase, so too will rates of diagnosed and undiagnosed obstructive sleep apnoea. These patients are at significant risk of increased complications, and discrepancies in care exist. Care should be standardised, although exactly what this standard should be is yet to be seen.

No large-scale, prospective study has yet shown improvement in perioperative outcomes for screening and treating patients at a high risk for obstructive sleep apnoea. This may be because complication rates in surgeries are fortunately very low, and awareness of obstructive sleep apnoea and associated perioperative complications is improving. It could also be accounted for by low adherence rates to continuous positive airways pressure therapy. There is a large evidence gap in the optimal ways to screen and manage patients in the perioperative period and this should be a priority for researchers.

It is important to stress that a pathway to identify these patients is not just beneficial for perioperative outcomes, but also for a variety of other reasons. Perioperative medicine departments should have a system in place to identify, diagnose and optimise these patients both pre- and postoperatively.

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Conflicts of interest

The authors declare that there are no conflicts of interest.

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