Screening for obstructive sleep apnea before surgery: why is it important?

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Purpose of review

The purpose of this article is to review the screening tools available in the preoperative clinic for patients at risk of obstructive sleep apnea.

Recent findings

Obstructive sleep apnea (OSA) is the most prevalent sleep disorder. An estimated 82% of men and 92% of women with moderate-to-severe sleep apnea have not been diagnosed. Patients with undiagnosed OSA may have increased perioperative complications. The perioperative risk of patients with OSA may be reduced by appropriate screening to detect undiagnosed OSA in patients. The snoring (S), tiredness (T) during daytime, observed apnea (O), and high blood pressure (P) (STOP) questionnaire is a concise and easy-to-use screening tool to identify patients with a high risk of OSA. It has been validated in surgical patients at preoperative clinics as a screening tool. Incorporating BMI, age, neck size and gender into the STOP questionnaire (STOP-Bang), will further increase the sensitivity and negative predictive value (NPV), especially for patients with moderate-to-severe OSA.

Summary

The STOP questionnaire is short and can be easily incorporated into routine screening of general or surgical patients.

Keywords

anesthesia, obstructive sleep apnea, perioperative complications, screening tests, STOP questionnaire, STOP-Bang model

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Introduction

Obstructive sleep apnea (OSA) is the most prevalent sleep-breathing disturbance, affecting 24% of men and 9% of women in the general population [1,2]. An estimated 82% of men and 92% of women with moderate-to-severe OSA have not been diagnosed [3]. Sleep apnea events are defined as a complete cessation of breathing (apnea) or a marked reduction in airflow (hypopnea) during sleep, and are considered clinically relevant if they last more than 10 s. The episodes of apneas and hypopneas may persist for 30–60 s in some individuals. OSA is characterized by repetitive obstruction of the upper airway often resulting in oxygen desaturation and arousals from sleep. The classic daytime manifestation is excessive sleepiness and other symptoms such as unrefreshing sleep, poor concentration and fatigue are commonly reported [4].

OSA is a serious condition that diminishes quality of life and is also associated with many common comorbid conditions [5]. Studies have documented an increased incidence of coronary artery diseases, hypertension, congestive heart failure, cerebrovascular accidents and gastroesophageal reflux disease in patients with OSA [6,7]. It is estimated that the average life span of a patient with untreated OSA is 58 years, much shorter than the average life span of 78 years for men and 83 years for women [8].

Diagnosis of obstructive sleep apnea

The symptoms and signs of OSA are shown in Table 1. The predisposing conditions for OSA are shown in Table 2. The diagnosis of OSA is established by an overnight sleep study, polysomnography. Polysomnography is expensive to perform, requiring highly trained personnel, sophisticated equipment, and an entire night of recording. Most sleep centers typically have long waiting lists for polysomnography and patients have to wait for their diagnosis and then the subsequent treatment. These long waiting lists and the limited resources have created interest in clinical research to 'predict' from the clinical features whether patients may have OSA. In this way, polysomnography may be used in the optimal fashion for those patients who stand the most to gain from the investigation.

Table 1 Symptoms and signs of obstructive sleep apnea

Diurnal symptoms of OSA	Nocturnal symptoms of OSA
Daytime sleepiness; memory and concentration dysfunction; sexual dysfunction; gastroesophageal reflux; behavioral irritability (irritability, depression, chronic fatigue, delerium); road traffic accident	Heavy persistent snoring, worse in supine position or after alcohol or sedatives; apnea with limb movement, witnessed by bed partner; sudden awakening with noisy breathing; accidents related to sleepiness; nocturnal sweating; wake up with dry mouth; nocturnal epilepsy; nocturia
Signs associated with OSA	
Edamatous soft palate or uvula	
Long soft palate and uvula	
Decreased oropharyngeal dimensions	
Nasal obstruction	
Maxillary hypoplasia	
Retrognathia	
Central adiposity and increased neck circumference	
Hypertension and other cardiovascular consequences	

OSA, obstructive sleep apnea.

OSA is strongly correlated with obesity and is particularly prevalent in the morbidly obese (i.e. patients with a BMI ≥40 or a BMI ≥35 with significant associated comorbid conditions). It is found in 40% of obese females and 50% of obese males. OSA is a serious comorbid problem that should be evaluated and treated before undergoing bariatric surgery. It has been suggested that all patients with a BMI more than 40 should be screened for OSA [9]. It has been suggested that OSA screening by polysomnography should be mandatory for all patients undergoing bariatric surgery [10]. Also OSA screening has implications for carrying out the surgery on an ambulatory basis [11,12].

Screening tools for obstructive sleep apnea

Clinical models designed for OSA screening usually require the assistance of a computer and may not be suitable for clinical practice [13••]. Most screening tools for OSA so far have been validated in patients referred to sleep clinics or sleep laboratories. A number of predictive models, based on the different combinations of witnessed apneas, snoring, gasping, BMI, age, sex, and hypertension, were developed and validated in patients from sleep centers [9,14–18]. These may not apply to the preoperative patients.

Table 2 Predisposing conditions to obstructive sleep apnea

Condition	Example
Obesity	Adult obesity
Age	More than 50 years
Gender	Male
Neck circumference	More than 40 cm
Nasal obstruction	As in septal deviation
Pharyngeal obstruction	Tonsillar and adenoidal hypertrophy
Laryngeal obstruction	Laryngomalacia, tracheomalacia
Craniofacial abnormalities	Down's, micrognathia, achondroplasia, acromegaly, macroglossia
Endocrine and metabolic causes	Hypothyroidism, Cushing's disease
Neuromuscular disorders	Stroke, cerebral palsy, head injury, poliomyelitis, myotonic dystrophy
Connective tissue disorders	Marfan's
Genetic predisposition	
Alcohol, sedatives and smoking	
Medications and anesthesia	Benzodiazepines, anesthetics and narcotics

Development of the different questionnaires

Surgical patients normally have their preoperative clinic visits a few weeks before their surgery. The American Society of Anesthesiologist (ASA) recently published a guideline recommending that patients should be screened for risk of OSA before their surgery [19]. As a result, different questionnaires were developed, such as the ASA checklist, the snoring, tiredness during daytime, observed apnea, and high blood pressure (STOP) questionnaire, and the Berlin questionnaire [13••,20].

The Berlin questionnaire

The Berlin questionnaire is one of the commonly known questionnaires for OSA, which has been validated in patients in primary care [20]. It includes 11 questions organized into three categories. The predictive performance of the Berlin questionnaire varies in different patient populations. It has been shown to perform well in a large population of 744 primary care patients with a sensitivity of 0.89 and specificity of 0.71 [20].

The 10-item Berlin questionnaire is composed of five questions on snoring, three on excessive daytime sleepiness, one on sleepiness while driving and one inquiring about a history of hypertension. Details of age, gender, weight, height and neck circumference are also recorded. The Berlin questionnaire stratifies patients into high or low risk of having OSA based on their endorsement of symptom severity.

Preliminary studies indicate that at an apnea–hypnea index (AHI) of more than 15, about half of the high-risk patients identified by the Berlin questionnaire are subsequently found to have OSA by polysomnography [20]. We screened 318 patients using the Berlin questionnaire and 24% [$n = 76$, 95% confidence interval (CI), 19–298] were found to be at high risk of having OSA [21••]. Our

Table 3 STOP questionnaires

Serial number	Questions	Answer
1	Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?	Yes, No
2	Tired: Do you often feel tired, fatigued, or sleepy during daytime?	Yes, No
3	Observed: Has anyone observed you stop breathing during your sleep?	Yes, No
4	Blood pressure: Do you have or are you being treated for high blood pressure?	Yes, No

High risk of OSA, answering yes to two or more questions. Low risk of OSA, answering yes to less than two questions. Adapted from [13••].

results showed that the Berlin questionnaire had a moderately high level of sensitivity in surgical patients (68.9) with a specificity, positive predictive value (PPV) and negative predictive value (NPV) of 56.4, 77.9 and 44.9 respectively [22••].

Even if the Berlin questionnaire has moderately high sensitivity and specificity for identifying OSA in the preoperative setting, the number of questions and the complicated scoring procedure may be too cumbersome for anesthesiologists and their patients.

The STOP questionnaire

Chung *et al.* [13••] developed and validated the STOP questionnaire in surgical patients to facilitate the widespread usage of an OSA screening tool. The Berlin Questionnaire was condensed and modified into a shorter four-item OSA screening questionnaire (STOP). The STOP questionnaire contains four questions: S, 'Do you snore loudly, loud enough to be heard through closed door?'; T, 'Do you feel tired or fatigued during the daytime almost every day?'; O, 'Has anyone observed that you stop breathing during sleep?'; and P, 'Do you have a history of high blood pressure with or without treatment?' (Table 3) [13••].

In order to keep the questionnaire concise and easy to use, the questions were designed in a yes/no format (Table 3) [13••]. The sensitivity of the STOP questionnaire at an AHI of more than 5, more than 15 and more than 30 cutoff levels was 65.6, 74.3 and 79.3% respectively (Table 4) [22••].

The STOP-Bang model

An alternative scoring model combining the STOP questionnaire and Bang–BMI (*B*), age (*a*), neck circumference (*n*) and sex (*g*)–further improves the sensitivity of the STOP questionnaire to detect most patients with OSA, especially moderate and severe OSA (Table 4) [13••]. BMI greater than 35, age older than 50 years, male gender and neck circumference greater than 40 cm are scored positive. Patients are considered to be at high risk of OSA if they answer yes to three or more items [13••]. The sensitivity of the STOP questionnaire was increased to 83.6, 92.9 and 100% for the AHI cutoffs of 5, 15 and 30 respectively by using the STOP-Bang model (Table 5) [13••].

The STOP questionnaire demonstrated a moderately high level of sensitivity and specificity in surgical patients, and it was more sensitive to detect those patients with moderate (AHI > 15) to severe (AHI > 30) OSA. In those patients with certain clinical characteristics, such as male sex, age older than 50 years, BMI greater than 35, and neck circumference greater than 40 cm, the positive predictive value for the STOP questionnaire was almost 100% [13••]. By incorporating BMI, age, neck circumference, and sex (Bang) into the STOP questionnaire, the STOP-Bang model reached a very high level of sensitivity and NPV, especially for patients with moderate and severe OSA. If the patient is ranked as a low risk of OSA by the STOP-Bang scoring model, we could be highly confident about excluding the possibility that the patient would have moderate-to-severe sleep apnea [13••].

The American Society of Anesthesiologists' checklist

In the recent guidelines for the perioperative management of patients with OSA, the ASA taskforce on OSA

Table 4 STOP-Bang scoring model

Serial number	Questions	Questions	Answer	Answer
1	Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?		Yes	No
2	Tired	Do you often feel tired, fatigued, or sleepy during daytime?	Yes	No
3	Observed	Has anyone observed you stop breathing during your sleep?	Yes	No
4	Blood pressure	Do you have or are you being treated for high blood pressure?	Yes	No
5	BMI	BMI more than 35	Yes	No
6	Age	Age over 50 years	Yes	No
7	Neck circumference	Neck circumference greater than 40 cm	Yes	No
8	Gender	Male	Yes	No

High risk of OSA, answering yes to three or more items. Low risk of OSA, answering yes to less than three items. Adapted from [13••].

Table 5 Predictive parameters of STOP, STOP-Bang, Berlin and ASA questionnaires

	STOP	STOP-Bang	Berlin	ASA
AHI > 5				
Sensitivity (%)	65.6	83.6	68.9	72.1
Specificity (%)	60.0	56.4	56.4	38.2
PPV (%)	78.4	81.0	77.9	72.1
NPV (%)	44.0	60.8	44.9	38.2
Odds ratio	2.857	6.587	2.855	1.559
AHI >15				
Sensitivity (%)	74.3	92.9	78.6	78.6
Specificity (%)	53.3	43.0	50.5	37.4
PPV (%)	51.0	51.6	50.9	45.1
NPV (%)	76.0	90.2	78.3	72.7
Odds ratio	3.293	9.803	3.736	2.189
AHI > 30				
Sensitivity (%)	79.5	100	87.2	87.2
Specificity (%)	48.6	37.0	46.4	36.2
PPV (%)	30.4	31.0	31.5	27.9
NPV (%)	89.3	100	92.8	90.9
Odds ratio	3.656	>999.999	5.881	3.862

Data are presented as mean. AHI, apnea–hypopnea index; ASA, American Society of Anesthesiologists; NPV, negative predictive value; PPV, positive predictive value.

developed a 14-item checklist to assist anesthesiologists in identifying OSA [19]. The checklist is composed of three categories of predisposing physical characteristics, symptoms and complaints attributable to OSA (Table 6). Patients endorsing symptoms or signs in two or more of the categories are to be considered at high risk of having OSA. The major drawback to this screening tool is the time commitment because the checklist needs to be completed by the clinician. The checklist is a consensus of the Task Force and has not been validated in any patient population. Recently, we validated the ASA checklist in surgical patients and found that its sensitivity and specificity in predicting OSA is similar to the STOP questionnaire [22••]. The sensitivity of the ASA checklist was, at AHI cutoff levels of more than 5, more than 15 and more than 30, 72.1, 78.6 and 87.2 respectively (Table 5) [22••].

Other questionnaires

There are a number of screening tools in the literature [4,23–27], for example the Wisconsin questionnaire, the sleep disorder questionnaire (SDQ), the Hawaii sleep questionnaire, the self-report questionnaire by Haraldsson *et al.* [25], the self-reported questionnaire by Pouliot *et al.* [26], and the modified Berlin questionnaire, were all developed and tested in patients mainly from sleep centers. Patients referred to sleep centers are suspected of having sleep-related disorders especially OSA. They are preselected patients; therefore, screening tools for OSA developed and validated in sleep centers cannot be applied to other patient populations without validation in the target patient population [13••].

Obstructive sleep apnea and perioperative setting

There has been very little research on patients with OSA and their perioperative mortality and morbidity. Most of the literature was case reports. It has been postulated that the cardiorespiratory consequences of OSA may be exacerbated in the perioperative setting due to the adverse effects of anesthetics and analgesics on the ventilatory control and upper airway muscle tone, particularly during

Table 6 ASA checklist

Category 1: predisposing physical characteristics	Category 2: history of apparent airway obstruction during sleep	Category 3: somnolence
BMI >35	Two or more of the following are present (if patient lives alone or sleep is not observed by another person, then only one of the following need be present)	One or more of the following are present
Neck circumference >43 cm/17 inches (men) or 40 cm/16 inches (women)	Snoring (loud enough to be heard through closed door)	Frequent somnolence or fatigue despite adequate 'sleep'
Craniofacial abnormalities affecting the airway	Frequent snoring	Falls asleep easily in a nonstimulating environment (e.g. watching television, reading, riding in or driving a car) despite adequate 'sleep'
Anatomical nasal obstruction	Observed pauses in breathing during sleep	[Parent or teacher comments that child appears sleepy during the day, is easily distracted, is overly aggressive, or has difficulty concentrating][a]
Tonsils nearly touching or touching the midline	Awakens from sleep with choking sensation Frequent arousals from sleep	[Child often difficult to arouse at usual awakening time][a]

Scoring: If two or more items in category 1 are positive, category 1 is positive. If two or more items in category 2 are positive, category 2 is positive. If one or more items in category 3 are positive, category 3 is positive. High risk of OSA, two or more categories scored as positive. Low risk of OSA, only one or no category scored as positive.
[a] Items in brackets refer to pediatric patients.
Adapted from [19].

the early postoperative period [28••,29]. In addition, there are theories that sleep disturbances, including sleep deprivation and fragmentation as well as rebound increases in rapid eye movement sleep during the later postoperative period, may have additional adverse effects on the cardiorespiratory system [30]. In clinical studies of patients with OSA, the potential clinical exacerbations in the perioperative setting include upper airway collapse, exacerbation of hypoxemia and hypercapnia, cardiac arrhythmias and ischemia, difficulties in airway management, increased rate of postoperative infections, as well as other adverse events [28••,29,31]. The dose-dependent depression of muscle activity in the upper airway by general anesthesia has been well established–most anesthetic or narcotic agents used for analgesia can alter the control of breathing by affecting the chemical, metabolic or behavioral control of breathing.

There is one retrospective case–control study in surgical patients with OSA. Gupta *et al.* [32] found an increased incidence of postoperative complications, an elevated rate of transfers to the ICU and prolonged overall length of hospital stay in patients with OSA versus control patients matched for age, sex and BMI. Receiving continuous positive airway pressure therapy prior to surgery appeared to reduce the rate of serious complications and shorten the average length of hospital stay by 1 day.

Increased risk of difficulty with tracheal intubation

Difficult tracheal intubation is a significant concern for anesthesiologists. Difficult tracheal intubation and OSA seem to share similar etiological pathways of predisposing upper airway abnormalities. A retrospective case–control study of 253 patients was conducted to determine the occurrence of difficult intubation in patients with OAS [33]. The patients with OSA were matched with controls of the same age, sex and type of surgery. Difficult intubation was assessed by laryngoscopy using the Cormack and Lehane classification [34]. Difficult intubation was found to occur eight times as often in patients with OSA compared with controls ($P < 0.05$) [35]. Of those patients with OSA undergoing ear, nose, and throat surgery, a 44% prevalence of difficult intubation had similarly been reported [36]. Furthermore, patients with severe OSA ($\text{AHI} \geq 40$) were found to have a much higher prevalence of difficult intubation [37].

Upper airway abnormalities have been described in patients with OSA or difficult intubation. A short thick neck, limited head extension and reduced thyromental distance have been associated with difficult tracheal intubation [38]. Oropharyngeal crowding with reduced upper airway caliber because of excess soft tissue and greater neck circumference have been described in patients with OSA. The upper airway abnormalities predisposing to difficult tracheal intubation may also predispose to OSA [39••]. Chung *et al.* [39••] found a prevalence of 66% in patients with OSA who had unexpected difficult intubation. Therefore, unexpected difficult airway may be related to OSA. Patients should be referred to a sleep study for polysomnography.

Effects of sedatives, anesthetics and analgesics on the respiratory function in patients with obstructive sleep apnea

Premedication sedatives, especially benzodiazepines with longer elimination half-lives such as flunitrazepam or midazolam, have been shown to cause postoperative airway obstruction in patients without OSA [30].

In patients without OSA, the dose-dependent depression of muscle activity in the upper airway by general anesthesia has been well established–most anesthetic or narcotic agents used for analgesia can alter the control of breathing by affecting the chemical, metabolic or behavioral control of breathing [30].

Opioids can profoundly impair respiration in the postoperative period leading to obstructive apneas and oxygen desaturation. Although there remains a lack of good evidence in the literature of the impact of opioid administration on respiration in patients with OSA, the general recommendation is that opioids and other drugs with central respiratory and sedating effects should be avoided, if possible [28••].

Postoperative pain control in patients with obstructive sleep apnea

The evidence of the potential deleterious effect of sedatives, anesthesia and analgesics in patients with OSA and the increased risk of perioperative adverse events implies that clinical management strategies need to be specifically tailored [28••].

The ASA guidelines recommend regional anesthesia to reduce the possibility of negative adverse events associated with systemic opioids [19]. A multimodal approach with combinations of analgesics from the different classes and different sites of analgesic administration is a prudent strategy for perioperative pain management [28••]. The use of nonsteroidal anti-inflammatory analgesics is strongly recommended. Agents such as acetaminophen, tramadol and other nonopioid analgesics and their combination can be used to provide effective pain relief and reduce opioid consumption, thus alleviating the opioid-related adverse effect of respiratory depression. Other novel approaches such as ketamine, clonidine, or gabapentin can be utilized. In a case report of a morbidly obese patient, the nonopioid sedative dexmedetomidine has been shown to reduce the need for postoperative opioids [40].

Postoperative management strategies for patients with obstructive sleep apnea

It is important for anesthesiologists to meet the challenge of maintaining upper airway patency and preventing perioperative complications in patients with OSA. The recently developed ASA guidelines emphasize the importance of evaluation, detection and preparation in the preoperative workup and the necessity of employing forethought and vigilance when developing perioperative management for patients with OSA undergoing surgery [19].

The ASA guidelines recommend that the preoperative evaluation be conducted well in advance of the surgery in patients suspected of having OSA [19]. This procedure would allow for the necessary preoperative evaluation and development of an appropriate perioperative management plan. However, patients with undiagnosed OSA would likely be identified at the time of the preoperative visit, when there may not be time to do further testing before surgery. In this event, the ASA guidelines recommend that a presumptive diagnosis of OSA can be made from criteria based on the signs and symptoms of OSA [19]. Therefore, the use of the simple and concise STOP questionnaire in the preoperative clinic is invaluable.

Conclusion

There is a high prevalence of undiagnosed OSA. Surgical patients with OSA are vulnerable to sedation, anesthesia and analgesia. Episodic sleep-related desaturation and incidence of unexplained cardiorespiratory arrest may be attributable to undiagnosed OSA in surgical patients. The perioperative risk of patients with OSA may be reduced by the appropriate screening to detect undiagnosed OSA and to plan a specific perioperative management plan for OSA.

The STOP questionnaire is a concise and easy-to-use screening tool to identify patients with a high risk of OSA. It has been validated in surgical patients at preoperative clinics as a screening tool. Incorporating BMI, age, neck size and sex into the STOP questionnaire (STOP-Bang) will further increase the sensitivity and NPV, especially for patients with moderate-to-severe OSA. The STOP questionnaire is short, only four questions with a yes or no format, and should be incorporated into routine screening of the general or surgical population.

References and recommended reading

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