Obstructive Sleep Apnea and Anesthesia– What an Anesthesiologist Should Know?

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Obstructive Sleep Apnea (OSA) syndrome is a disease characterized by recurrent episodic cessation of breathing lasting ≥ 10s during sleep. In this condition, there is exaggerated depression of pharyngeal muscle tone during sleep and anesthesia, resulting in a cyclical pattern of partial or complete upper airway obstruction with impaired respiration.[1] Clinically, this manifests as repeated nocturnal arousals and increased sympathetic output, daytime hypersomnolence, memory loss, and executive and psychomotor dysfunction.[2]. Its estimated prevalence are 1 in 4 males and 1 in 10 females for mild OSA[3,4], and 1 in 9 males and 1 in 20 females for moderate OSA.[5,6] The economic cost of OSA is considerable.[7] A significant number of patients with OSA are undiagnosed when they present for elective surgery.[8] Approximately 24% of surgical patients were found to be at high risk based on screening, of whom 81% had not been previously diagnosed with OSA.[9,10]

OSA Diagnostic Criteria Classically, the gold standard for the definitive diagnosis of OSA requires an overnight polysomnography or sleep study. The Apnea Hypopnea Index (AHI), defined as the average number of abnormal breathing events per hour of sleep, is used to determine the presence of and the severity of OSA. An apneic event refers to cessation of airflow for 10s, while hypopnea occurs with reduced airflow with desaturation ≥4%.[11] The American Academy of Sleep Medicine (AASM) diagnostic criteria for OSA requires either an AHI ≥15, or AHI ≥5 with symptoms, such as daytime sleepiness, loud snoring, or observed obstruction during sleep.[12] The Canadian Thoracic Society guidelines for the diagnosis of OSA specifies the presence of an AHI ≥5 on polysomnography, and either of (1) daytime sleepiness or (2) at least 2 other symptoms of OSA (e.g. choking or gasping during sleep, recurrent awakenings, unrefreshing sleep, daytime fatigue).[13] OSA severity is mild for AHI ≥5 to15, moderate for AHI 15 to 30, and severe for AHI >30.[12]

Comorbidities Associated with OSA OSA is associated with multiple comorbidities such as myocardial ischemia, heart failure, hypertension, arrhythmias, cerebrovascular disease, metabolic syndrome, insulin resistance, gastroesophageal reflux, and obesity. The prevalence of OSA was 78% in morbidly obese patients planned for bariatric surgery.[14] Various pathophysiological, demographic and lifestyle factors also predispose to OSA. These include anatomical abnormalities which cause a mechanical reduction in airway lumen diameter (e.g. craniofacial deformities, macroglossia, retrognathia), endocrine diseases (e.g. Cushing disease, hypothyroidism), connective tissue diseases (e.g. Marfan Syndrome), male gender, age above 50 years, neck circumference >40 cm, and lifestyle factors of smoking and alcohol consumption.[15]

Postoperative Complications in Patients with OSA Chronic untreated OSA leads to multisystemic adverse consequences and is an independent risk factor for increased all-cause mortality in the general population.[16, 17] The anatomical inherent collapsibility of the airway and the systemic effects of the disease also place the surgical OSA patients at increased risk of serious complications. Memtsoudis et al found a 2X higher risk of pulmonary complications in OSA patients after non-cardiac surgery vs non-OSA.[18] In bariatric surgical patients, the presence of OSA was found to be an independent risk factor for adverse postoperative events.[19] Flink et al reported a 53% incidence of postoperative delirium in OSA patients vs 20% in non-OSA patients.[20] A meta-analysis by Kaw et al showed that the presence of OSA increased the odds of postoperative cardiac events including myocardial infarction, cardiac arrest and arrhythmias (OR 2.1), respiratory failure (OR2.4), desaturation (OR 2.3), ICU transfers (OR 2.8), and reintubations (OR2.1).[21] However, a recent study found that neither an OSA diagnosis nor suspected OSA was associated with increased 30-day or 1-year postoperative mortality.[22] Also, Mokhlesi et al examinated large nationally representative cohorts in elective orthopedic, prostate, abdominal and CV surgery in 1 million patients.[23] and 90,000 patients undergoing bariatric surgery.[24] Both studies showed increased complications but not an increase in mortality. A recent large population study showed OSA patients are more likely to receive ventilatory support, more ICU, stepdown and telemetry services, consume more economic resourses, and have longer lengths of hospitalization.[25] Given the body of evidence associating a diagnosis of OSA with adverse perioperative outcomes, precautions should be taken perioperatively to reduce complications in this vulnerable group of patients.

Clinical Pathways and Perioperative Management Principles In an attempt to improve the perioperative care for OSA patients, various societies and authors have constructed guidelines or clinical pathways.[26-30]

Preoperative Evaluation of the Patient with Diagnosed OSA (Figure 1) A thorough history and physical examination are essential. Focused questions regarding OSA symptoms should be asked. Polysomnography results should be reviewed to confirm the diagnosis of OSA and evaluate the severity of the disease. Patients with long standing OSA may manifest a myriad of signs and symptoms suggesting the development of systemic

complications, such as hypoxemia, hypercarbia, polycythemia and cor pulmonale. The patient should also be assessed for significant comorbidities including morbid obesity, uncontrolled hypertension, arrhythmias, cerebrovascular disease, heart failure and metabolic syndrome. Obesity hypoventilaton syndrome occurs in 0.15 -0.3 of the general population.[31] Pulmonary arterial hypertension is a fairly common long term complication of OSA, occurring in 15-20% of patients.[32] Its significance lies in the fact that certain physiological derangements may raise pulmonary artery pressures further and should be avoided intraoperatively. The American College of Chest Physicians does not recommend routine evaluation for pulmonary arterial hypertension in patients with known OSA.[33] However, should there be anticipated intraoperative triggers for acute elevations in pulmonary arterial pressures, for example, high risk surgical procedures of long duration, a preoperative transthoracic echocardiography may be considered.[27] Simple bedside investigations may be performed in the preoperative clinic to screen for OSA related complications. Patients with preoperative mean overnight SpO2 <93%, or oxygen desaturation index >29 events/h were recently shown to be at higher risk for postoperative adverse events.[34] In the absence of other attributable causes for hypoxemia, a baseline oximetry reading of $\leq$ 94% on room air suggests severe long standing OSA, and may be a red flag signaling postoperative adverse outcome.

Frequently, OSA patients may be on PAP devices for treatment, for example the continuous positive airway pressure (CPAP), bilevel positive airway pressure (BiPAP), and automatically adjusting positive airway pressure (APAP) machines. Automatically adjusting PAP devices provide respiratory assistance based on airflow measurements, fluctuations in pressure or airway resistance.[35] The compliance of OSA patients to such treatment should be evaluated. The patient's updated PAP therapy settings should be obtained. Reassessment by a sleep medicine physician may be indicated in patients who have defaulted follow up, have been non-compliant to treatment, have had recent exacerbation of symptoms, or have undergone upper airway surgery to relieve OSA symptoms. Patients who default PAP use should be advised to resume therapy.

Interestingly, there is to date insufficient evidence to prove conclusively the benefit of PAP therapy in the preoperative setting; and the duration of therapy required to effectively reduce perioperative risks has not been delineated. A retrospective matched cohort study by Liao et al suggested that preoperative PAP therapy may possibly be beneficial based on the observation that OSA patients who did not use home PAP devices prior to surgery but required PAP therapy after surgery had increased complication rate.[36] Perioperative auto-titrated continuous positive airway pressure treatment was shown to significantly reduce postoperative apnea hypopnea index and improved oxygen saturation in surgical patients with moderate and severe obstructive sleep apnea.[37] However, one study did not show benefit for APAP applied postoperatively to PAP naïve patients at high-risk for sleep apnea.[38] A recent study showed that the preoperative patients identified to have OSA and treated with CPAP have long term health benefits in terms of improved snoring, sleep quality, daytime sleepiness and reduction of medications for comorbidites.[39] However, adherence to prescribed CPAP therapy during the perioperative period was extremely low.[40]

Current guidelines recommend that patients with *moderate or severe OSA* already on PAP therapy should continue PAP use prior to surgery.[26] The anesthesia team should be informed early to allow for advanced intraoperative management planning and risk mitigation. *Mild OSA* may not be a significant disease entity for patients undergoing surgery and anesthesia. From the published results of the Busselton Health Cohort Study, mild OSA was not an independent risk factor for higher mortality in the general population.[17] Based on expert opinion and symptomatology of OSA patients, preoperative PAP use may not be indicated in patients with *mild OSA*. Figure 1 suggests an algorithm for the preoperative evaluation and management of the patient already diagnosed with OSA.[27,41]

Methods for Perioperative Screening for OSA An overnight polysomnography is the gold standard diagnostic test for OSA. However, routine screening with polysomnography is costly and resource-intensive, due to equipment constraints and the requirement for special technical expertise. As a result, several tools have been developed to meet this need for simple, economical and sensitive screening tests for the detection of patients with suspected OSA. These include questionnaire-based methods such as the Sleep Apnea Clinical Score,[42] the Berlin Questionnaire,[43] the ASA checklist,[26] the P-SAP score[44] and the STOP-Bang questionnaire.[45] The STOP-Bang questionnaire was originally developed in the surgical population but has been validated in many patient populations.(www.stopbang.ca). Patients with STOP-Bang scores 0-2 may be considered low risk, 3-4 intermediate risk, and 5-8 high risk of OSA.[46] The higher the STOP-Bang score, the more likely the patient will suffer from moderate-severe sleep apnea.[46] If the patient scores two of four STOP question and is a male gender or BMI >35, there is a higher likelihood of sleep apnea.[47] For obese or morbidly obese patients, a STOP-Bang score of 4 or greater can be used as a cut-off.[48] Apnea/hypopnea during sleep can lead to intermittent hypercapnia and result in serum bicarbonate retention. The addition of serum bicarbonate level to the STOP-Bang questionnaire may improve its specificity.[49] The STOP-Bang questionnaire (www.stopbang.ca) is useful in the preoperative setting to predict OSA severity, triage patients for further confirmatory testing, and exclude those without disease.

Preoperative Evaluation of the Patient with Suspected OSA (Figure 1) In patients suspected of OSA, a thorough clinical examination should be performed with emphasis on pertinent symptoms and signs of OSA. The subsequent management is determined by the urgency of surgery. In emergency situations, the patient should proceed for surgery. Extensive testing for OSA will result in a delay of vital surgery. Perioperative precautions should be taken based on the clinical suspicion of OSA. A clinical algorithm is suggested in the elective setting (Figure 1).[28] Where non-urgent elective surgery is planned, the decision for further evaluation rests on (1) the risk of surgery, and (2) the presence of other significant comorbidities suggestive of chronic OSA, such as uncontrolled hypertension, heart failure, arrhythmias, pulmonary hypertension, cerebrovascular disease, morbid obesity and metabolic syndrome. For patients with STOP-Bang score 5-8, scheduled for major elective surgery, and have comorbid disease(s) associated with long standing OSA, a preoperative assessment by the sleep physician and a polysomnography should be considered for diagnosis and treatment.[26] Sometimes, major elective surgery may have to be deferred to allow adequate evaluation and optimization of suspected severe OSA. The eventual decision to evaluate a patient preoperatively should ultimately be made based on the clinical judgment of the attending physician, after taking into account patient-related and logistical factors. We suggest that patients scored as high risk but without significant comorbidities be considered for further evaluation with portable monitoring devices, or proceed with surgery with a presumed diagnosis of moderate OSA and with perioperative OSA precautions. These patients can be referred after surgery.

Patients with an intermediate risk of OSA based on STOP-Bang may proceed for surgery without further testing with perioperative OSA precautions. This subset of patients may have previously undergone anesthesia uneventfully, and represent false positives on screening, or may have less severe OSA. Nonetheless, increased vigilance is prudent in managing these "at risk" patients. If the subsequent perioperative course suggests a higher likelihood of OSA, for example difficult airway,[50] or recurrent postoperative respiratory events such as desaturation, hypoventilation or apnea,[51] a subsequent sleep physician referral and polysomnography may be indicated. Patients deemed to be low risk on screening with score 0-2 on STOP-Bang are unlikely to have OSA. These patients may proceed for surgery with routine perioperative care.

Portable Polysomnography and Overnight Oximetry Home sleep testing may be a viable alternative to standard polysomnography for the diagnosis of OSA in certain subsets of patients. Such monitoring equipment are classified into level 2 (full unattended polysomnography with $\geq$7 channels), level 3 (devices limited to 4-7 channels), and level 4 (1-2 channels including nocturnal oximetry) devices. In particular, the level 2 portable polysomnography has been shown to have a diagnostic accuracy similar to standard polysomnography,[52] while nocturnal oximetry is both sensitive and specific for detecting OSA in STOP-Bang positive surgical patients.[53] The oxygen desaturation index derived from nocturnal oximetry correlates well with the AHI obtained from polysomnography.[53] Furthermore, patients with mean preoperative overnight SpO2 <93% or ODI > 29 events/h are at higher risk for postoperative adverse events.[34]

The Portable Monitoring Task Force of the American Academy of Sleep Medicine (AASM) suggests that portable devices may be considered when there is high pretest likelihood for moderate to severe OSA without other substantial comorbidities.[54] Following the AASM 2007 guidelines, the Canadian Thoracic Society 2011 update on the diagnosis and treatment of sleep disordered breathing recommended that level 2, 3 and 4 portable monitoring devices including nocturnal oximetry may be used as confirmatory tests for the diagnosis of OSA, provided that proper standards for conducting the test and interpretation of results are met.[55]

Intraoperative Risk Reduction Strategies for OSA Patients (Table 2) Various strategies can be employed to mitigate the risks and avert adverse outcomes in OSA patients perioperatively (Table 2). Preoperatively, sedative premedication should be avoided.[56] Pain adjuvants such as the alpha-2 agonists (dexmedetomidine) have an opioid sparing effect and also reduce anesthetic requirement.[57] A history of OSA may be associated with difficult mask ventilation[58] as well as 8 times more likely of difficult intubation.[59] Adequately skilled personnel and appropriate equipment, including a range of airway adjuncts, should be available prior to induction of anesthesia.[60] The entire anesthesia team should be familiar with a specific difficult airway algorithm, such as the ASA Guidelines for the management of difficult airway.[61] Preoxygenation using 100% oxygen with continuous PAP of 10 cmH_2O for 3-5 min with a 25 degree head-up tilt has been reported to achieve higher end-tidal concentrations of O2.[62,63] Triple airway maneuvers and two-handed mask ventilation may be needed to attain adequate ventilation. Gastroesophageal reflux disease secondary to hypotonia of the lower esophageal sphincter is common among patients with OSA.[64] Measures to decrease the risk of gastric acid aspiration should be considered, and include preoperative proton pump inhibitors, antacids, and rapid sequence induction and cricoid pressure. Notably, use of cricoid pressure may further impede mask ventilation and tracheal intubation.[65]

Many of the anesthetic agents, for example, volatile agents, anxiolytics and opioids, cause respiratory depression. OSA patients have a heightened sensitivity to the respiratory depressant effects of these drugs due to their increased susceptibility for airway collapse, chronic sleep deprivation, and blunted response to hypercarbia

and hypoxia. Nocturnal hypoxemia in patients at high risk for OSA was associated with an increased potency of opioid analgesia.[66] At the same time, nocturnal arterial desaturation may be associated with an increased pain in subjects with sleep-disordered breathing, independently of sleep fragmentation and inflammation.[67] Short acting agents such as propofol, remifentanil and desflurane are preferred while long acting agents should be avoided or their use minimized. Pulmonary hypertension is a known complication of chronic OSA. Intraoperative triggers for elevation of pulmonary artery pressures namely hypercarbia, hypoxemia, hypothermia and acidosis should be avoided.

Intraoperative use of opioid sparing agents like NSAIDs, COX-2 inhibitors, paracetamol, tramadol, and adjuvants such as the anticonvulsants pregabalin and gabapentin are helpful with reducing postoperative opioid requirements. Previous studies showed that desaturation was 12 to 14 times more common in OSA patients who received opioids postoperatively.[68] Other novel opioid sparing adjuvants being investigated include corticosteroids like dexamethasone, NMDA receptor antagonist ketamine,[69] alpha 2 agonists clonidine and dexmedetomidine[70] A recent study investigating the beneficial effects of intraoperative intravenous doxapram found that post anesthetic recovery and outcomes of OSA patients undergoing bariatric surgery were improved with the use of central respiratory stimulants.[71]

The use of intermediate acting neuromuscular blocking agents during anesthesia was associated with an increased risk of respiratory adverse events.[72] Even minute amounts of residual neuromuscular blockade can result in greater postoperative morbidity with increased risks of aspiration, airway obstruction, hypoventilation, hypoxia and reintubation.[73] Patients should be extubated only when awake – fully conscious, obeying commands and airway patency confirmed. Purposeful movements must be distinguished from involuntary actions such as coughing and reflex reaching for the endotracheal tube. Post extubation, patients should be nursed in a semi-upright or lateral position.[26]

A recent study utilizing nationwide data of 40,316 patients with sleep apnea diagnosis who underwent hip and knee arthroplasty, the use of neuraxial anesthesia vs general anesthesia was associated with decreased odds for the need for mechanical ventilation, use of ICU, prolonged length of stay and cost.[74] Local and regional anesthesia techniques may be preferable to general anesthesia as they avoid manipulation of the airway and reduce postoperative requirement for analgesic.[26] Patients receiving sedation for surgical procedures under monitored anesthetic care should be monitored for adequacy of ventilation by capnography. Patients previously on PAP therapy at home may require the use of their PAP devices during procedures under mild to moderate sedation.[75] A secured airway is preferred to an unprotected one for procedures requiring deep sedation.[26] Pregnant patient with OSA will require special care.[76] Clinical practice guideline has been published on the management of childhood OSA and the indication for polysomnography before tonsillectomy.[77,78]

Postoperative Disposition of Known and Suspected OSA Patients after General Anesthesia (Figure 2)

The postoperative disposition of the OSA patient will depend on three main components: the invasiveness of the surgery, the severity of OSA, and the requirement for postoperative opioids (Figure 2). To illustrate, a patient with severe OSA who just had major surgery and receiving high dose opioids would be more likely to require continuous monitoring than another patient with suspected OSA undergoing minor surgery. The final decision regarding the level of monitoring is determined by the attending anesthesiologist, taking into account all patient-related, logistical and circumstantial factors.

A practical algorithm (Figure 2) has been formulated based on the ASA guidelines on the perioperative management of patients with OSA, and on evidence from recent research.[28,41] All patients with known or suspected OSA who had received general anesthesia should have extended monitoring in PACU with continuous oximetry. There are currently no evidence-based guidelines addressing the optimal length of monitoring required in PACU.[75] We propose extended PACU observation for an additional 30-60 minutes in a quiet environment after the modified Aldrete criteria for discharge has been met.[28, 41]

The occurrence of recurrent respiratory events in PACU is another indication for continuous postoperative monitoring.[51] PACU respiratory events are: (1) episodes of apnea $\geq$ 10 seconds, (2) bradypnea <8 breaths/min, (3) pain-sedation mismatch, or (4) repeated O2 desaturation <90%. Any of the above events occurring repeatedly in separate 30-minute intervals may be considered recurrent PACU respiratory events. Patients with suspected OSA and who develop recurrent PACU respiratory events are at increased risk of postoperative respiratory complications.[51,79,80] Continuous monitoring with oximetry in a unit with ready access to medical intervention is advocated. These would include ICU, step down units, or the surgical ward equipped with remote telemetry and oximetry monitoring. These patients may require postoperative PAP therapy.[75]

Advances incorporating smart technologies have been made with monitoring equipment. Multiple parameters including heart rate, blood pressure, temperature, capnography and oxygen saturation can be tracked

continuously and the trends analysed according to pre-programmed algorithms. This will potentially improve the sensitivity in detecting at risk patients during their recovery, while reducing false alarms, making the postoperative care of OSA patients safer.[81,82]

One should consider discharging a patient with known OSA to a monitored environment if the patient has severe OSA, is non-compliant to PAP therapy, or has recurrent PACU respiratory events (Figure 2). Furthermore, monitoring with continuous oximetry is recommended with parenteral opioids due to possible drug induced respiratory depression.[83] Patients with moderate OSA who require high dose oral opioids should be managed in a surgical ward with continuous oximetry (Figure 2) regardless of the number of PACU respiratory events.

Known OSA patients already on PAP devices should continue PAP therapy postoperatively. While there is insufficient high level evidence demonstrating an improvement of outcomes with postoperative PAP therapy in OSA patients, a recent retrospective review of 797 patients scheduled for bariatric surgery suggested that timely recognition and management of OSA with perioperative continuous PAP may mitigate the risk of postoperative complications.[84] Where possible, a multimodal approach to analgesia should be employed to minimize the use of opioids postoperatively. Apart from oral or systemic administration of opioid sparing agents, other effective techniques include local anesthetic wound infiltration, peripheral nerve block catheters and neuraxial infusions of local anesthetic agents. If postoperative parenteral opioids are necessary, consideration should be made for the use of patient controlled analgesia with no basal infusion and a strict hourly dose limit, as this may help reduce the total amount of opioid used. OSA patients may have an upregulation of the central opioid receptors secondary to recurrent hypoxemia, and are therefore more susceptible to the respiratory depressant effects of opioids. As such, they may benefit from supplemental oxygen while on parenteral opioids.[85] The Anesthesia Patient Safety Foundation advises that ventilation should be monitored for the detection of hypoventilation when supplemental oxygen is delivered.[83]

Recently, Swart et al published a PACU order-based approach to facilitate postoperative decision making for patients with sleep apnea. The orders prompt anesthesiologists to consider the factors and events associated with higher risk of complications from OSA, diagnostic follow-up and possible sleep medicine consult.[86] (The orders are available on www.stopbang.ca) A recent study found that patients had no significant increase in postoperative complications if managed on the OSA risk management protocol.[87] The authors indicated that it may be clinically safe to proceed with elective surgery without delay for formal polysomnography confirmation.[87] For the perioperative management, it is important to educate surgeons, nurses, patients, and their family. Pharmacy involvement to prevent multiple drugs with potential to cause sedation and limiting the upper dose of opioids is essential. Nurse training in detecting respiratory depression and in rapid administration of naloxone will prevent mortality and morbidity.

We have found that the disturbances in sleep architecture were greatest on postoperative N1 and breathing disturbances during sleep were greatest on postoperative N3.[88] Patients with a higher preoperative AHI were predicted to have a higher postoperative AHI. Preoperative AHI, male gender and 72h opioid dose were positively associated with postoperative AHI.[89] At present, deciding on the optimal level and duration of monitoring for OSA patients remains a daunting challenge. The vulnerable OSA patient is at risk of serious postoperative complications and even death. Granted, the incidence of postoperative OSA-related mortality is low; however, it only takes one unnecessary death or one case of hypoxic encephalopathy to be the impetus for closer postoperative monitoring.[90,91]

Ambulatory Surgery for OSA Patients

The ASA guidelines on the perioperative management of OSA patients advised that superficial surgery, minor orthopedic surgery under local anesthesia or regional anesthesia, and lithotripsy may be performed as day cases.[26] The newly published Society for Ambulatory Anesthesia (SAMBA) consensus statement addressed the selection of suitable OSA patients for ambulatory surgery.[92] Despite a higher incidence of desaturation and need for supplemental O2 among OSA patients, there was no significant difference in rates of serious adverse outcomes such as reintubation, mechanical ventilation, surgical airway or death. The authors recommend that known OSA patients with well controlled comorbid diseases and compliance with PAP therapy may be considered for ambulatory surgery. Patients are advised to apply their PAP devices when sleeping even in daytime for several days postoperatively. Diagnosed or suspected OSA patients without significant comorbidities, recurrent PACU respiratory events or need for high dose oral opioids may be considered for discharge home after minor surgery at the discretion of the attending physician (Figure 2).[28,92,93] Emphasis was placed on advanced planning of the perioperative anesthetic and analgesic options, and timely education of patients and caregivers regarding their post-discharge care. Patients with severe OSA and uncontrolled comorbid diseases are not suitable for ambulatory surgery.[92,93] With regards to the type of procedures suitable

for day surgery, the SAMBA guidelines recommend that painful operations where postoperative non opioid analgesia would be inadequate should not be performed on an outpatient basis.

All OSA patients should be escorted home by a reliable adult upon discharge. Caution should be exercised if diagnosed or suspected OSA patients develop repeated respiratory events in the early postoperative period; and there should be a lower threshold for unanticipated hospitalization. Ideally, ambulatory surgical centers that manage OSA patients should have transfer agreements with better equipped inpatient facilities and should also have the capacity to handle the postoperative problems associated with OSA.

Retrospective observational studies have reported low (<0.5%) postoperative complication rates with ambulatory or short stay surgery for OSA patients undergoing bariatric surgery.[94-96] Such approaches are still deemed unconventional.[97] Importantly, a discriminating patient selection criteria, meticulous preoperative risk stratification and optimization of OSA and related comorbidities, together with well-trained medical personnel, experienced high volume facilities, and strict discharge criteria are all essential for the delivery of safe ambulatory surgery for this subset of patients.

Conclusion

It is well known that OSA patients can suffer serious postoperative consequences. This has led to the formulation of various screening methods for the detection and risk stratification of OSA patients. While every patient deserves individualized care, practical algorithms to guide the perioperative management of such high risk patients would be advantageous. We formulated clinical algorithms to guide the care of diagnosed and suspected OSA patients in the preoperative, intraoperative and postoperative periods. To date, many care pathways and recommendations are based on consensus or expert opinion rather than high level evidence. Future research in these areas and collaboration between the fields of anesthesiology and sleep medicine will be instrumental in shedding light on these lingering OSA-related perioperative care issues.[98]

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Table 1:
STOP-Bang Questionnaire

Yes	No	
○	○	**Snoring?** Do you **Snore Loudly** (loud enough to be heard through closed doors or your bed-partner elbows you for snoring at night)?
○	○	**Tired?** Do you often feel **Tired, Fatigued, or Sleepy** during the daytime (such as falling asleep during driving)?
○	○	**Observed?** Has anyone **Observed** you **Stop Breathing** or **Choking/Gasping** during your sleep?
○	○	**Pressure?** Do you have or are being treated for **High Blood Pressure**?
○	○	**Body Mass Index more than 35 kg/m^2?**
○	○	**Age older than 50 year old?**
○	○	**Neck size large? (Measured around Adams apple)** For male, is your shirt collar 17 inches or larger? For female, is your shirt collar 16 inches or larger?
○	○	**Gender = Male?**

Scoring Criteria:

For general population
Low risk of OSA: Yes to 0-2 questions
Intermediate risk of OSA: Yes to 3-4 questions
High risk of OSA: Yes to 5-8 questions
Yes to 2 of 4 STOP questions + individual's gender is male
Yes to 2 of 4 STOP questions + BMI > 35 kg/m^2
Yes to 2 of 4 STOP questions + neck circumference male 17"
Female 16"

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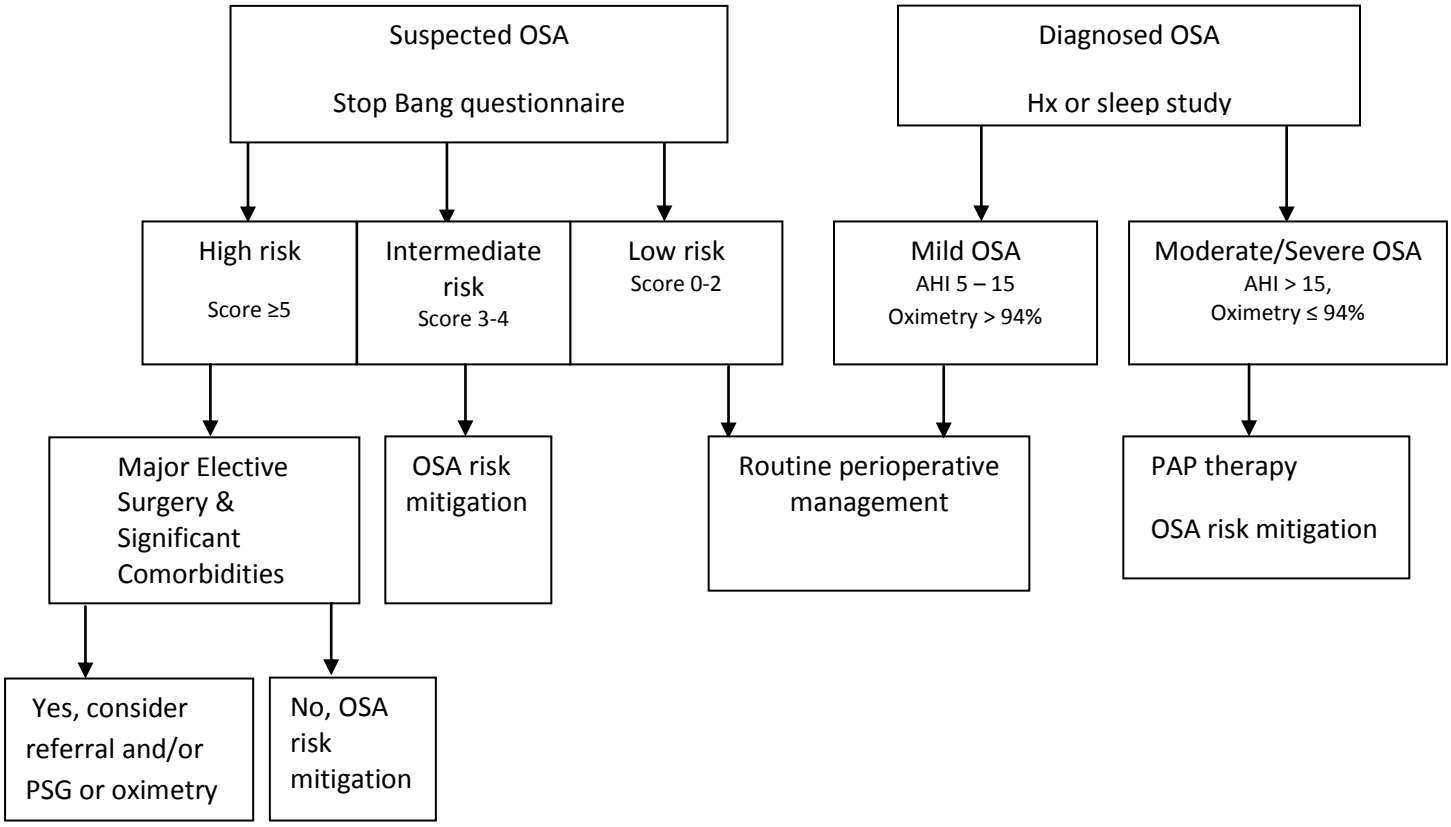
Table 2: Perioperative Precautions and Risk Mitigation for OSA Patients

Anesthetic Concern	Principles of Management
Premedication	Avoid sedating premedication[56] Consider Alpha-2 adrenergic agonists (clonidine, dexmedetomidine)[57]
Potential difficult airway (difficult mask ventilation and tracheal intubation)[58, 59]	Optimal positioning (Head Elevated Laryngoscopy Position) if patient obese Adequate preoxygenation Consider CPAP preoxygenation[62] Two-handed triple airway maneuvers Anticipate difficult airway. Personnel familiar with a specific difficult airway algorithm[61]
Gastroesophageal reflux disease[64]	Consider proton pump inhibitors, antacids, rapid sequence induction with cricoid pressure
Opioid-related respiratory depression[56]	Minimize opioid use Use of short-acting agents (remifentanil) Multimodal approach to analgesia (NSAIDs, acetaminophen, tramadol, ketamine, gabapentin, pregabalin, dexmedetomidine, clonidine, Dexamethasone, melatonin) Consider local and regional anesthesia where appropriate
Carry-over sedation effects from longer-acting intravenous and volatile anesthetic agents	Use of propofol / remifentanil for maintenance of anesthesia Use of insoluble potent anesthetic agents (desflurane) Use of regional blocks as a sole anesthetic technique
Excessive sedation in monitored anesthetic care	Use of intraoperative capnography for monitoring of ventilation[26]
Post-extubation airway obstruction	Verify full reversal of neuromuscular blockade[26] Extubate only when fully conscious and cooperative[26] Non-supine posture for extubation and recovery[26] Resume use of positive airway pressure device after surgery[26]

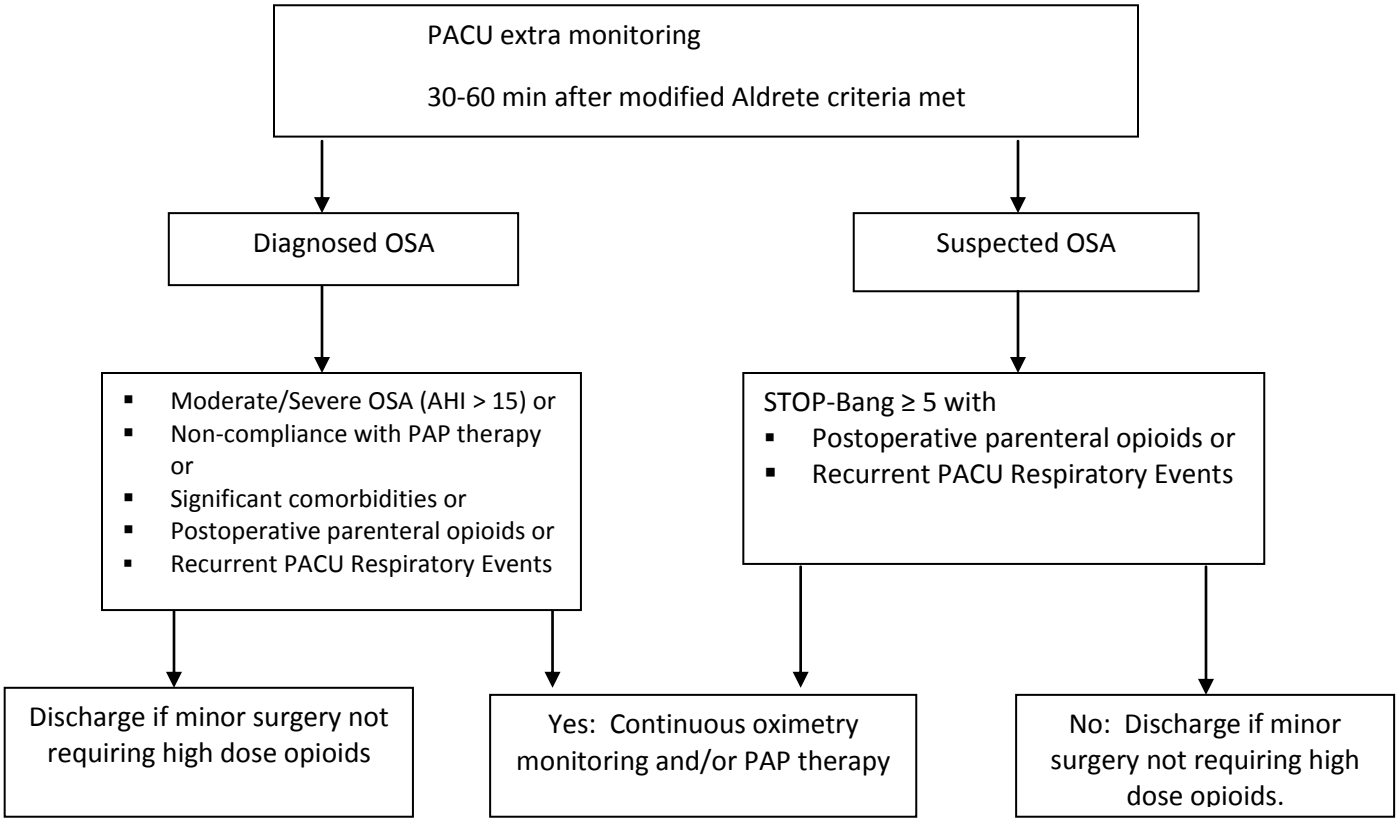
Adapted from Seet E, Chung F Can J Anesth 2010; 57: 849-64

Figure 1: Preoperative Evaluation of Suspected or Diagnosed OSA Patient in the Anesthesia Clinic



Adapted from Seet E, Chung F Can J Anesth 2010; 57: 849-64

Figure 2 - Postoperative Management of the Diagnosed or Suspected OSA Patient after General Anesthesia



Adapted from Seet E, Chung F Can J Anesth 2010; 57: 849-64