Lesson 277: PreAnesthetic Assessment of the Patient With Undiagnosed Obstructive Sleep Apnea Syndrome

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A COURSE OF STUDY FOR AMA/PRA CATEGORY 1 CREDIT

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Needs statement

The American Society of Anesthesiologists has introduced guidelines for the anesthetic management of a patient population that has been increasing in number: obese patients who snore but who have not been given a formal diagnosis of sleep apnea, a syndrome that can cause serious perioperative complications. Knowledge about these potential problems is required for all anesthesiologists.

Learning Objectives

At the end of this activity, the participant should be able to:

1. Discuss the high prevalence of undiagnosed obstructive sleep apnea syndrome (OSAS) within the surgical population and how it largely parallels the prevalence of obesity.
2. Define sleep apnea and OSAS.
3. Recognize that patients with OSAS are known to be more difficult to mask ventilate and intubate after induction of anesthesia.

4. Recognize that OSAS can present as “unexplained” postoperative cardiorespiratory arrest and brain death—as revealed within the database of the American Society of Anesthesiologists (ASA) Closed Claims Project—and that appropriate interventions can be preventative.

5. Outline the pathophysiology, management, and treatment of undiagnosed OSAS.

6. Summarize the pathophysiology of sleep, including non–rapid eye movement (REM) and REM sleep, and the effects on OSAS.

7. Recognize that small doses of sedatives, narcotics, anesthetics, and muscle relaxants may cause prolonged upper airway muscle relaxation in excess of diaphragmatic relaxation, predisposing the patient to episodes of postobstructive desaturation and pulmonary edema.

8. Cite the practice parameters established by the ASA for the suggested management of the patient with OSAS.

9. Discuss the importance of identifying accurate/validated risk factors and developing models for risk stratification preoperatively for patients with OSAS—such as the ASA guidelines and the STOP questionnaire.

10. Develop an appropriate plan for postoperative monitoring of the patient with undiagnosed OSAS to ensure a safe recovery period following surgery and anesthesia.

Case History

A 45-year-old man, 5 ft 11 in (180 cm) tall with a weight of 320 lb (145 kg) and a body mass index (BMI) of 44.6, underwent general anesthesia for repair of a rotator cuff. The intraoperative period was uneventful, and he was admitted to the ward for a 23-hour observation period. Postoperatively, meperidine (100 mg) and promethazine (25 mg) were administered intramuscularly for pain at 4 hours and repeated 3 hours later. Shortly after, the patient underwent cardiac arrest; the attempt at resuscitation was unsuccessful. During a review of the case, it was noted that OSAS had been documented in the preoperative assessment by the internal medicine physician, a document that was not available to the anesthesiologist immediately preoperatively.

A past president of the American Society of Anesthesiologists (ASA) stated in a 2006 ASA news release that “the incidence of ... obstructive sleep apnea syndrome (OSAS) is likely to rise ... and ... result in greater potential for surgical complications in patients requiring sedation or anesthesia.” Orin F. Guidry, MD, stressed that as the population ages and becomes more obese, the ASA Task Force practice guidelines1 published in May 2006 should assist anesthesiologists and other perioperative personnel in the management of patients with diagnosed— and particularly undiagnosed—OSAS. The anticipated increase in the incidence of OSAS is reflected in an article published in The Philadelphia Inquirer (August 28, 2007), which stated, “Years after public health authorities declared an obesity epidemic, Americans are not only getting fatter, but they are actually getting fatter faster. In 47 of the 50 states, at least 1 person in 5 was obese (BMI >/= 30) last year.”
Incidence and Epidemiology

Eighteen million Americans are believed to have OSAS, and 16 million of these cases are undiagnosed; an estimated 1% to 10% of the surgical population have undiagnosed OSAS. In the future, the increasing use of outpatient surgery as a result of economic pressures plus the increasing prevalence of obesity and undiagnosed OSAS may become a lethal combination.

Large prospective trials addressing OSAS are lacking; evidence has been gained mostly through a review of case reports and retrospective studies. The anesthesia advisory panel of The Doctor’s Company, a medical malpractice insurer for physicians, reviewed 8 closed claims for “unexplained” cardiac or pulmonary arrest that occurred within days after surgery in hospitalized patients who received parenteral or neuraxial opioids. Although all 8 patients appeared to have OSAS, only 2 had undergone formal sleep studies and been prescribed continuous positive airway pressure (CPAP) therapy.

A search of 5,480 claims from the ASA Closed Claims Project database identified 19 involving patients with OSAS, 18 of whom had sustained brain damage following an adverse respiratory event. In a letter to the Anesthesia Patient Safety Foundation Newsletter, Benumof wrote that these adverse outcomes could likely have been prevented with appropriate postoperative monitoring of the electrocardiogram (ECG), heart rate, blood pressure, and SpO2 (oxygen saturation measured by pulse oximetry) in a qualified step-down unit where frequent visual observation was available through appropriate (1:3-1:4) nurse-to-patient staffing ratios. Upon reviewing the cases, Benumof stressed the importance of these recommendations and implied that a “simple audible SpO2 monitor in an isolated room on the ward will not work to protect the patient against respiratory complications in the immediate post-op period.”

Complications associated with OSAS do not develop solely within the postoperative period. Patients with OSAS are potentially more difficult to intubate following the induction of general anesthesia. A case-control study in 2002 of 113 patients found that 22% of those with OSAS (compared with 2% of those without OSAS) were difficult to intubate. Preoperative risk factors that predispose to difficult intubation include obesity, retrognathia, and large neck circumference. It is imperative that emergency intubation equipment (eg, fiberoptic scopes and supraglottic ventilating devices) be readily accessible when a patient with OSAS is anesthetized.

A case-control study in 2001 of patients undergoing joint replacement surgery at the Mayo Clinic found that 24% of patients with OSAS (vs 9% of controls) had serious postoperative complications (dysrhythmias, myocardial ischemia, reintubations, and unplanned admission to an intensive care unit), with most complications occurring within 72 hours after surgery (Figure 1) and resulting in an increased length of hospital stay. In this study, confounding factors included a combination of anesthetic agents, sedatives, opioids, and prolonged supine positioning.
Figure 1. Postoperative complications associated with OSAS.

The incidence and time course of postoperative complications after joint replacement surgery in 101 patients with undiagnosed (n=36, red columns; group 1A) and diagnosed (n=65, yellow columns; group 1B) OSAS at time of surgery.

OSAS, obstructive sleep apnea syndrome

Ultimately, evidence-based risk screening tools that facilitate preoperative risk stratification of patients with undiagnosed OSAS—thereby leading to appropriate perioperative care—may help reduce such complications.10 This will be particularly welcomed in ambulatory surgery practices, which administer more than 70% of all anesthetics in the United States.11,12

Pathogenesis and Pathophysiology

OSAS, a potentially fatal disorder, is characterized by witnessed prolonged periods of apnea during sleep, resulting in serious nocturnal and diurnal physiologic derangements. Sleep apnea is a pause in breathing during sleep lasting at least 10 seconds and accompanied by at least a 4% decline in oxygen saturation from baseline despite continued ventilatory efforts.10 Hypopnea is an incomplete reduction of airflow lasting at least 10 seconds, with a 50% or greater reduction of tidal volume. The apnea–hypopnea index (AHI) is the number of episodes of apnea and hypopnea per hour during sleep. OSAS is defined as the repetition of such apneic or hypopneic episodes at least 5 times per hour and the presence of symptoms associated with sleep-disordered breathing (eg, daytime hypersomnolence, cor pulmonale, and polycythemia).

A review of the architecture of normal sleep, as well as the impact of anesthesia/surgery and OSAS on sleep architecture, is useful. Note that the following review focuses on OSAS; however, it should be recognized that patients may have OSAS combined with central or mixed apnea.

Architecture of Normal Sleep

Normally, adults experience 4 to 6 sleep cycles during a typical night. Each cycle has 2 general components: non–rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep (Figure 2).
NREM sleep is further subdivided into 4 stages that progressively deepen and are marked by slowing of the electroencephalographic (EEG) waveform. NREM stages 3 and 4 show slow-wave/deep sleep, the most restful, restorative sleep that is absolutely essential to life. NREM sleep of stages 3 and 4 occurs early, within the first 2 or 3 cycles of sleep. REM sleep, which follows NREM sleep later in the night, is more akin to a wakeful state; dreaming, nightmares, and rapid eye movements readily detected by electrooculography (EOG) often accompany REM sleep. Paradoxically, all muscles—other than the extraocular muscles—exhibit a generalized loss of tone during REM sleep that is readily demonstrated by electromyography (EMG).

Polysomnography, the “gold standard” for studying sleep, uses EEG, EMG, EOG, heart rate, ECG, blood pressure, and SpO2 to quantify the AHI, diagnose OSAS, and recommend nasal CPAP (nCPAP) settings. This fairly complicated, time-consuming, and expensive overnight process may not be available or practical as a preoperative screening tool, particularly if the patient requires surgery promptly.

For the first week postoperatively, sleep architecture is largely disturbed and fragmented. Most patients do not experience NREM stages 3 and 4 sleep or REM sleep for the first 3 postoperative days. “REM rebound” then follows this period as a “catch-up” on missed REM sleep. During REM rebound, nightmares may trigger a sympathetic surge, with subsequent dysrhythmias, ischemia, and myocardial insult. Also, during REM sleep, the increase in upper airway resistance, coupled with generalized atonia and airway obstruction, may lead to severe hypoxemia. Such hypoxemic and sympathetic episodes that occur repetitively throughout the night may cause surges of hypertension with resultant myocardial and respiratory adverse events (eg, “unexplained” nocturnal death, systemic vasoconstriction and essential hypertension, pulmonary vaso-constriction and cor pulmonale, stimulation of erythropoiesis and polycythemia, vagal bradycardia, cerebral dysfunction leading to daytime hypersomnolence, personality changes, and irritability). Figure 3 lists the sequence of primary events that result from obstructive sleep apnea, with corresponding physiologic responses and clinical features.

**Figure 2. A typical adult sleep cycle during 1 night.**

Deep sleep (NREM stages 3 and 4) occurs in the early cycles of sleep, with REM sleep occurring in the late sleep cycles.

NREM, non-rapid eye movement; REM, rapid eye movement.

In patients with OSAS, numerous anatomic and functional factors may contribute to airway collapse. Obesity, a high BMI (≥30), and an enlarged neck circumference (males, ≥17 in; females, ≥16 in) are often present. Weight loss may cure most cases of OSAS. Patients who have anatomic causes of OSAS (eg, nasal polyps, septal deviation, lingual tonsils, large adenoids, retrognathia, tumor of the naso-oropharynx) may require surgical correction.

Results of animal studies show that anesthetic agents (I.V., inhalational, and benzodiazepine) depress activity in the upper airway muscles more than in the diaphragm. Similarly, diazepam has been found to cause a selective decrease in genioglossal activity compared with activity in the diaphragm, resulting in upper airway obstruction. Benzodiazepines as well as opioids (especially methadone) have been known to cause effects on the central nervous system that are followed by obstructive apneic events. Such effects are confirmed by surface EMG of the tongue and neck muscles, demonstrating that thiopentone causes a loss of tonic activity in the neck strap muscles with consequent dorsal displacement of the hyoid bone (Figure 4). Nondepolarizing neuromuscular blocking drugs (NMBDs) may also exert a greater effect on the upper airway muscles than on ventilatory muscles; thus, profound/prolonged weakness of the upper airway muscles may develop despite adequate spontaneous ventilation by the patient. Consequently, patients should be awake on extubation and monitored carefully in the immediate postoperative period, particularly for postobstructive pulmonary edema.
When OSAS is suspected, the patient may undergo a formal polysomnographic study which will define the AHI, categorize the OSAS (mild, moderate, or severe), and lead to recommendations for appropriate nCPAP. The use of nCPAP for several weeks preoperatively has proved highly effective at preserving airway patency during sleep and anesthesia, as well as diminishing reflex responses to hypoxia and hypercapnia. This effect may result from upper airway stabilization, a residual effect of nCPAP that may begin within 4 hours of uninterrupted nCPAP. Long-term use of nCPAP preoperatively has been found to abolish fluctuations in mean, systolic, and diastolic blood pressure in patients with OSAS (Figure 5). As a result, the risk is decreased for cardiac ST-segment depression and recurrent atrial fibrillation. It is recommended that nCPAP and the use of oral appliances be continued during the postoperative period. It is also important to note that patients who have had corrective surgery for OSAS, such as uvulopalatopharyngoplasty, may still have the disorder despite the current lessening or absence of symptoms.
Patients with undiagnosed OSAS pose a greater diagnostic dilemma during the preoperative screening/clinical examination because they have seldom undergone sleep studies; an accurate risk stratification (low, moderate, or severe) to guide intraoperative and postoperative management thus becomes problematic. A diagnosis of OSAS can be inferred from a history of abnormal breathing during sleep (eg, loud snoring, witnessed episodes of apnea by a bed partner), frequent arousal from sleep to wakefulness (eg, periodic twitching of extremities, vocalization, turning, snorting), severe daytime sleepiness, high BMI (≥35), an increased neck circumference (≥17 in for males; ≥16 in for females), and coexisting morbidities (eg, essential systemic hypertension, pulmonary hypertension, cardiomegaly).

The ASA Task Force on OSAS (May 2006) recommended a risk scoring system (Table).¹ The risk score—achieved through expert opinion, literature review, and consensus—has yet to be validated. A study to evaluate a new, abbreviated version of the STOP questionnaire was presented by F. Chung at the 2007 annual meeting of the Society for Ambulatory Anesthesia (scientific abstract No. 6).

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In summary, a clinical suspicion of OSAS may be the only preoperative tool available to the anesthesiologist because formal, widely used, validated questionnaires have not been established for the preoperative setting.

In addition to the OSAS risk factors mentioned, the anesthesiologist should consider the patient’s airway class and history of difficult intubation. A cardiovascular risk assessment may require an ECG (right ventricular hypertrophy secondary to cor pulmonale, left ventricular hypertrophy secondary to ischemic heart disease), echocardiography, cardiac stress testing, or preoperative cardiologist optimization. Pulmonary risk factors—morbid obesity and chronic obstructive pulmonary disease—may prompt the clinician to obtain a radiograph or measure arterial blood gases to detect pickwickian syndrome or hypercapnic chronic sleep apnea syndrome. These patients may have decreased sensitivity to CO2 in the postoperative period; they may need ventilatory support because their hypoxic drive to breathe may be abolished by O2 as well as subanesthetic concentrations of inhaled anesthetics or sedatives.
Patients with OSAS may be exquisitely sensitive to all preoperatively administered central nervous system depressants. Respiratory arrest, coma, and death can occur. Avoiding preoperative sedation with long-acting benzodiazepines and opioids may be wise. Premedication against aspiration may include histamine2-receptor antagonists (eg, famotidine), and promotility agents (eg, metoclopramide).

**Intraoperative Considerations**

Final decisions regarding the anesthetic plan—general anesthesia versus regional anesthesia versus sedation/local anesthesia—must carefully consider the severity of OSAS based on the preoperative evaluation. For the patient with OSAS, regional anesthesia with minimal, short-acting sedatives is desirable in the outpatient setting; general anesthesia combined with regional (neuraxial) or local blocks may be desirable to minimize postoperative opioid use. Continuous regional catheter techniques allow the valuable titration to effect of analgesic agents.

Use of the ASA difficult airway algorithm is important in the OSAS population, with special consideration of elective, awake fiberoptic intubation in patients with moderate to severe OSAS. Optimal patient positioning and consideration of gastroesophageal reflux disease are important during airway manipulation. It should also be noted that the administration of topical, local anesthesia to the upper airway in itself may cause upper airway obstruction, with or without upper airway nerve blocks.

General anesthesia, with tracheal intubation and controlled ventilation with a relaxant-based technique, is excellent for prolonged procedures, particularly in the morbidly obese patient. Ventilation should target normocapnia; preoperative PaCO2 values should be maintained in those patients with pickwickian syndrome. The total dose of opioids should be limited, with preferential use of shorter-acting agents and adjuvant pain-modulating drugs, such as cyclooxygenase-2 inhibitors. Volatile agents can be used safely. Intermediate-acting NMBDs (eg, vecuronium, rocuronium, cisatracurium) are preferred to longer-acting NMBDs because of the more predictable reversal patterns. For surgeries of longer duration, NMBDs may be administered by infusion pump to decrease the total overall drug dose and thereby maintain reversibility.

At the conclusion of surgery, the NMBD blockade should be fully reversed, and the fully alert patient should be able to demonstrate a strong head lift before extubation. Deflating the cuff and checking for air passing around the tracheal tube can test for a “cuff leak”—worthwhile to ensure there is no airway swelling before extubation. Careful respiratory monitoring in the immediate postoperative period is important to detect obstruction and consequent postobstructive pulmonary edema.

An appropriately sized blood pressure cuff or arterial catheter can be used to monitor blood pressure. A central venous and pulmonary artery catheter or noninvasive carbon monoxide monitors may be used to guide fluid therapy.

Prophylaxis for deep vein thrombosis is a very important consideration in the morbidly obese patient. In one study, pulmonary thromboembolism was the single most common cause of 30-day postoperative mortality after bariatric surgery. Prophylaxis for deep vein thrombosis (fractionated/unfractionated heparin) with devices for sequential compression of the patient’s calves needs to be discussed with the surgical team and timed carefully when neuraxial anesthetic techniques are employed.
**Postoperative Considerations**

Postoperative planning for the patient with OSAS can be very challenging. Key points to consider in postoperative decision making include the severity of OSAS (ASA Task Force risk score $\geq 4$, especially $\geq 5$), and the implementation of an integrated extubation plan with appropriate inpatient or outpatient monitoring in the recovery room.

Postoperative intubation and ventilation in the ICU may be warranted after a morbidly obese patient with moderate to severe OSAS, a difficult airway, and severe preexisting cardiovascular comorbidities undergoes a complex or major procedure with significant blood loss expected. Before extubation, carefully assessing for airway swelling and ensuring a “cuff leak,” complete NMBD reversal, and good pain control are crucial.

The postoperative administration of opioids requires extreme vigilance with inpatient hospital monitoring in an ICU or step-down unit with an appropriate nurse-to-patient ratio of 1:3 or 1:45—which falls between that of an ICU (1:2) and that on a surgical floor (1:5-1:7). These staffing ratios are supported by Dholakia, who studied 51 patients with moderate to severe risk for OSAS (half with a positive sleep study, half with a BMI $\geq 35$). Patients were admitted to the surgical ICU for postoperative observation after uncomplicated surgery and anesthesia with or without morphine (patient-controlled analgesia). Complications developed in 4 patients; all were readily resolved. Transient episodes of desaturation developed in 3 patients, and a nonsustained supraventricular tachycardia in 1 patient. Episodes of oxygen desaturation were reversed with oxygen supplementation and nCPAP. Dholakia concluded that these patients could be adequately monitored in a supervised step-down unit (nurse-to-patient ratio, 1:4). There are no clear-cut national guidelines delineating an exact nurse-to-patient ratio necessary for postoperative monitoring of such patients; however, Benumof, like Dholakia, recommends monitored care in the postoperative environment, including continuous electronic (respiration, SpO2, heart rate, ECG, blood pressure) and visual monitoring, along with a nurse-to-patient ratio of 1:3-1:4. Larger randomized controlled trials will be needed to make definitive recommendations for nurse-to-patient ratios.

A less complex procedure requiring minimal sedation and regional/local anesthesia in patients with mild to moderate OSAS can be managed in an ambulatory care setting. The critical period of required time in the recovery room, however, is controversial. The patient with OSAS should be carefully observed for airway obstruction, episodes of oxygen desaturation, reintubation risks, hypertension, and dysrhythmias. It should be remembered that supplemental oxygen, typically administered routinely in the postoperative period, may reduce hypoxic respiratory drive in patients with OSAS, resulting in increased apneic spells. The administration of nCPAP is preferred to oxygen supplementation alone when recurrent hypoxemia is treated, and nCPAP should definitely be used postoperatively in those patients who use it preoperatively. The anesthesiologist needs to be familiar with the CPAP machine and the pressure settings that are unique to the individual patient.

Before the patient is discharged from the recovery room, the oxygen saturation on room air should return to the preoperative baseline value. When left undisturbed, the patient should not become hypoxic and an obstruction of the airway should not develop. Because most significant postoperative complications occur within 2 hours after surgery, the ASA practice guidelines suggest that patients with OSAS be monitored 3 hours longer than their non–OSAS counterparts before discharge from the surgical facility. Also, monitoring should continue for a median of 7 hours (possibly overnight) after the last episode of airway obstruction or hypoxemia while the patient is breathing room air in an
unstimulated environment. These recommendations may be the major obstacle to having such patients undergo surgery in stand-alone ambulatory surgery centers or office settings. Patients with OSAS in ambulatory centers may not meet the criteria for safe discharge to home; therefore, it is essential that these centers have access to inpatient facilities for postoperative monitoring.

Future technology may aid clinical personnel in monitoring these patients in a sleep apnea telemetry step-down unit. The recent development and clinical availability of remote (pager-driven) alarm systems may aid nurses in monitoring more than 4 patients at one time for SpO2 and heart rate. Another interesting technology is the photoplethysmograph, a pulse oximeter that can identify respiratory variations indicative of OSAS. The device, currently undergoing further study at the Institute for Security, Technology, and Society at Dartmouth College in Hanover, NH, aims to provide real-time physiologic information to first responders in emergency situations, including civilian and military personnel. The technology uses wireless networking and portable computers to assess respiration and oxygenation. Such a device may quickly detect respiratory and hypoxic events in the patient with OSAS and alert nursing staff with the use of wireless technology.

Summary

Patients with undiagnosed OSAS who present immediately before surgery are challenging cases for anesthesiologists. Guidelines that have been developed will prove helpful to anesthesiologists in the management of these patients.

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References


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Post-test

1. Which of the following physiologic events is most likely to occur during rapid eye movement (REM) sleep in a patient with obstructive sleep apnea syndrome (OSAS)?
   a. Increased upper airway resistance and obstruction
   b. Increased muscle body tone
   c. Decreased tone of the extraocular eye muscles
   d. Absence of dreaming

2. Which of the following is the most acceptable nurse-to-patient staffing ratio for monitoring the overnight recovery of inpatients with mild to moderate OSAS?
   a. 1:2
   b. 1:3-1:4
   c. 1:5
   d. 1:7

3. What is the minimal period of time during which the preoperative application of nasal continuous positive airway pressure (nCPAP) can begin to reduce upper airway changes related to OSAS?
   a. 4 hours
   b. 3 weeks
   c. 3 months
   d. 3 years

4. The incidence of undiagnosed OSAS in the preoperative surgical population is estimated to be:
   a. 20%
   b. 0.1%
   c. 5%
   d. 70%
5. Which risk factor preoperatively may lead the anesthesiologist to suspect undiagnosed OSAS in a patient?
   a. Body mass index (BMI) \( \geq 35 \)
   b. Neck circumference (male) of 18 in
   c. Severe daytime sleepiness
   d. All of the above

6. Which drug or drug category is least likely to potentiate obstructive airway symptoms in the postoperative period?
   a. Opioids
   b. Benzodiazepines
   c. Diphenhydramine
   d. Ondansetron

7. All of the following preoperative/perioperative interventions can relieve the obstructive symptoms of a patient with OSAS, except:
   a. weight loss
   b. weight gain
   c. use of CPAP at night
   d. full reversal of muscle relaxation

8. Possible physiologic effects of chronic OSAS include all of the following, except:
   a. cor pulmonale
   b. systemic hypertension
   c. polycythemia
   d. BMI \( \leq 25 \)

9. For evaluation of the patient with OSAS, the American Society of Anesthesiologists (ASA) preoperative risk score takes into account all of the following, except:
   a. severity of sleep apnea
   b. nutritional diet
   c. invasiveness of the surgical procedure
   d. requirement for postoperative opioids

10. According to the ASA Task Force, a risk score thought to signify severe OSAS is:
    a. \( \geq 3 \)
    b. \( \geq 5 \)
    c. \( \geq 1 \)
    d. It depends on the invasiveness of the surgical procedure.