Introduction
The prevalence of obesity is rapidly increasing worldwide. Morbidly obese, particularly those with central fat distribution, have an increased risk of significant comorbidities, and therefore pose considerable challenges to the anesthesiologist [1]. One of the major co-morbidities associated with obesity includes obstructive sleep apnea (OSA), which is associated with hypertension, stroke, depression and diabetes [2]. It is estimated that 60-80% of people with OSA are obese. Of note, the prevalence of OSA is higher in the surgical population than that reported in the general population [3, 4]. With approximately 60-70% of all surgical procedures performed on an outpatient basis, it is inevitable anesthesiologists will encounter morbidly obese patients with OSA in an ambulatory setting. This update discusses the potential challenges and optimal perioperative care of the morbidly obese, with emphasis on patients with OSA, scheduled for ambulatory surgery.

Concerns in the Morbidly Obese and OSA Patients
Obesity is generally defined as a body mass index (BMI) >30 kg/m², morbid obesity as BMI >35 kg/m², and super morbid obesity as BMI >50 kg/m². Morbidly obese patients suffer from numerous chronic medical conditions (Table 1). The comorbidities associated with obesity and OSA should be optimized preoperatively [5].

Table 1: Comorbidities Associated With Obesity

| Cardiac: | systemic hypertension, coronary artery disease, dysrhythmias, cardiomyopathy, CHF |
| Respiratory: | restrictive pulmonary disease, obstructive sleep apnea, asthma, pulmonary hypertension |
| Neurologic: | stroke |
| Renal: | renal dysfunction |
| Metabolic: | metabolic syndrome, type 2 diabetes mellitus, hypothyroidism |
| Abdominal: | hiatal hernia, gastroesophageal reflux, fatty liver infiltration |
| Others: | airway abnormalities, deep vein thrombosis, primary open-angle glaucoma |

Preoperative Considerations
Preoperative assessment of the obese may be focused mainly to cardiovascular, respiratory, and endocrine systems, and the airway. In addition to assessment of functional status, patients should be questioned to determine symptoms of angina, paroxysmal nocturnal dyspnea, orthopnea, and arrhythmia (i.e., palpitations). Because OSA is undiagnosed in an estimated 60-70% of patients, and failure to recognize OSA preoperatively is one of the major causes of perioperative complications [4], it is necessary that all patients be screened for OSA. Preoperative suspicion of OSA should lead to increased efforts to modify the anesthetic techniques and improved monitoring in the postoperative period. A presumptive diagnosis of OSA may be derived based upon the presenting symptoms and signs. A recent systematic review and metaanalysis of clinical screening tests for OSA reported that the STOP-BANG screening tool was user friendly and a good predictor of severe OSA (AHI>30) (Table 2) [6, 7]. Of note, a patient who has had corrective airway surgery for OSA should be assumed to remain at risk for OSA complications unless the symptoms and sleep studies have normalized.

Table 2: STOP-BANG Scoring System

- **S** = Snoring. Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
- **T** = Tiredness. Do you often feel tired, fatigued, or sleepy during daytime?
- **O** = Observed Apnea. Has anyone observed you stop breathing during your sleep?
- **P** = Pressure. Do you or are you being treated for high blood pressure?
- **B** = BMI > 35 kg/m²
- **A** = Age > 50 years
- **N** = Neck circumference > 40 cm
- **G** = Male Gender

**High risk of OSA: 3 or more questions answered yes**
**Low risk of OSA: less than 3 questions answered yes**
Preoperative Testing

Commonly performed preanesthesia tests include complete blood count, glucose, electrolytes, renal function, and hepatic function tests. However, preanesthesia tests should be based on clinical indications and the invasiveness of the surgical procedure. Although obesity can influence pulmonary function (e.g., reduced expiratory reserve volume, forced expiratory volume [FEV], and functional residual capacity [FRC]), pulmonary function tests (e.g., spirometry, chest X-ray and room air arterial blood gas analysis), are of no added benefit unless COPD is suspected [8]. According to the ACC/AHA guidelines patients scheduled for bariatric surgery, which is considered an intermediate- to high-risk surgery, should have an ECG based upon age or presence of concomitant medical illnesses rather than obesity per se [9]. Obese patients with low functional capacity make cardiac risk assessment imperative. In the obese, stress echocardiography has a high negative predictive value. Echocardiograph contrast agents improve the ability to identify endocardial borders and assess ventricular wall motion and may be used with stress and non-stress imaging protocols [9].

If OSA is suspected during preoperative evaluation, one could proceed with a presumptive diagnosis of severe OSA or obtain a sleep study. However, it is unclear if a routine sleep study would improve patient safety and outcome, as the optimal duration of preoperative continuous positive airway pressure (CPAP) therapy before proceeding with elective surgical procedures is unknown, and the compliance with CPAP is variable.

Because an overnight-attended sleep study may not always be available, and is associated with high costs, unattended portable screening home-based devices with single or multiple channels have been explored. However, the reliability of these home-based diagnostic devices remains controversial. The American Academy of Sleep Medicine recommends that the portable monitoring might be used as an alternative to a sleep study for the diagnosis of OSA in patients with high probability of moderate-to-severe OSA [10]. Portable monitoring must record airflow, respiratory effort, and blood oxygenation. In addition, the device must allow for display of raw data with capability of manual scoring or editing of automated scoring. Importantly, portable monitoring is not suitable for screening of asymptomatic patients [10].

The severity of OSA may be determined from a sleep study using the apnea-hypopnea index (AHI), which measures the frequency of apnea (cessation of breathing for ≥10 seconds despite continuing ventilatory efforts) and hypopnea (more than 50% diminished airflow for ≥10 seconds) events per hour. An AHI of 6-20 indicates mild OSA, AHI 21-40 indicates moderate OSA, and AHI >40 indicates severe OSA. Of note, sleep laboratories differ in their criteria for defining severity of OSA. If a sleep study is not available, and the diagnosis is based on symptoms and signs, patients should be treated as though they have moderate-to-severe OSA.

Patient Information

Patients who use CPAP devices at home should be advised to bring their device for postoperative use. Because there is a possibility that OSA patients may not always meet criteria for safe home discharge, the option of admission should be discussed with the patient prior to surgery.

Preoperative Medications

Obese patients may be on multiple medications including prescription, non-prescription (i.e., over-the-counter), or herbal diet drugs that might have detrimental cardiopulmonary effects as well as adversely interact with anesthetic drugs. Patients should be asked to continue their preoperative medications until the day of surgery, except for their antidiabetic therapy that might need some modification. Because morbid obesity is one of the major risk factors for the development of pulmonary embolism (PE), prophylaxis for deep vein thrombosis (DVT), low dose heparin in combination with intermittent pneumatic compression, are recommended. Extended low-molecular-weight heparin therapy (dalteparin 2500 IU preoperatively, followed by 5000 IU daily until 1 week postoperatively) has been shown to reduce the rate of DVT without increasing the incidence of bleeding complications [11]. Prophylactic inferior vena cava filters have been recommended in patients with BMI >55 kg/m² [12] as well as in patients with thrombophilia, history of PE, or more than one episode of DVT [11].

Preoperative prophylaxis against acid aspiration (e.g., H2-receptor antagonists and proton pump inhibitors) is commonly used. However, their routine use is questioned as they may increase the risk of postoperative infections [13]. Furthermore, risk of regurgitation of gastric contents for the morbidly obese and the non-obese appears to be similar [14]. Midazolam (1-2 mg, IV) has been used to provide anxiolysis and reduce the incidence of intraoperative awareness; however, it is prudent to avoid midazolam, if possible.
Ambulatory Surgery in Morbidly Obese

Because weight (or BMI) alone may not influence postoperative complications or unplanned admissions [15], it should not be considered the sole patient selection criterion for ambulatory surgery [1]. Not surprisingly, the BMI limit for ambulatory surgery has gradually increased, with BMI of 40-50 kg/m² now considered acceptable. Overall, the suitability for ambulatory surgery should depend upon the severity of comorbidities and ability to optimally control the preexisting conditions as well as the type of anesthetic and type and invasiveness of the surgical procedure.

Ambulatory Surgery in OSA Patients

The scientific literature regarding the safety of ambulatory surgery in OSA patients is sparse and of limited quality [3, 16]. Therefore, the suitability of ambulatory surgery in OSA patients remains controversial. It is recommended that patient selection for ambulatory surgery should depend upon the severity of OSA, presence of coexisting comorbidities, invasiveness of surgery, type of anesthesia, anticipated postoperative opioid requirements, and adequacy of post-discharge observation [16]. In addition, the ability of the facility to manage OSA patients should also be taken into consideration.

The ASA-OSA practice guidelines propose a scoring system that may be used to estimate whether an OSA patient is at increased perioperative risk of complications [16], and thus determine the suitability for ambulatory surgery (Table 3). It is recommended that patients who are at significantly increased risk of perioperative complications (score ≥5) are not good candidates for ambulatory surgery. Patients with mild OSA undergoing superficial or minor surgical procedures under local, regional or general anesthesia, and expected to have minimal postoperative opioid requirement may undergo ambulatory surgery. On the other hand, ambulatory surgery is not recommended in patients undergoing airway surgery or upper abdominal laparoscopic surgery. Thus, OSA patients requiring bariatric surgery would not be suitable for ambulatory surgery; however, there is no data to support this conviction. This scoring system needs validation, and therefore, should serve only as a guide. Clinical judgment should be used to assess the risk in individual patient. A recent preliminary study in OSA patients undergoing a variety of surgical procedures found that the ASA-OSA Risk Score did not correlate with either intraoperative complications or postoperative desaturation [17]. Thus, the investigators questioned the validity of the ASA-OSA Risk Scoring system.

Table 3: Scoring system to estimate perioperative complications (proposed in the ASA practice guidelines).

<table>
<thead>
<tr>
<th>A: Severity of sleep apnea based on sleep study (i.e., AHI) or clinical indicators if sleep study not available:</th>
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<tbody>
<tr>
<td>None = 0; Mild OSA = 1; Moderate OSA = 2; Severe OSA = 3.</td>
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<tr>
<td>Subtract a point in patients using CPAP or BiPAP preoperatively and postoperatively, and add a point in a patient with PaCO₂ &gt;50 mmHg.</td>
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<th>B: Invasiveness of surgery and anesthesia:</th>
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<tr>
<td>Superficial surgery under local or peripheral nerve block anesthesia without sedation = 0</td>
</tr>
<tr>
<td>Superficial surgery with moderate sedation or general anesthesia or peripheral surgery under spinal or epidural anesthesia (with no more than moderate sedation) = 1</td>
</tr>
<tr>
<td>Peripheral surgery with general anesthesia or airway surgery with moderate sedation = 2</td>
</tr>
<tr>
<td>Major surgery or airway surgery under general anesthesia = 3</td>
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<th>C: Requirement for postoperative opioid:</th>
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<tr>
<td>None = 0, Low dose oral opioids = 1, High dose oral opioids or parenteral or neuraxial opioids = 3</td>
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<th>D: Estimation of perioperative risk:</th>
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<tr>
<td>Overall score = score of A + greater score of either B or C:</td>
</tr>
<tr>
<td>Patients with overall score of 4 or greater may be at increased perioperative risk from OSA.</td>
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<tr>
<td>Patients with a score of 5 or greater may be at significantly increased perioperative risk from OSA.</td>
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Ambulatory Bariatric Surgery

With limited benefits of diet and drug therapy, bariatric surgery is rapidly growing. Bariatric surgical procedures include gastric restrictive surgery in which food intake is restricted (e.g., adjustable gastric banding) or a combination of restrictive and malabsorption surgery in which food is diverted from absorption via a gastrointestinal bypass (e.g., Roux-en-Y gastric bypass). Majority of bariatric surgical procedures in the United States are being performed laparoscopically because this approach reduces postoperative pain, improves postoperative pulmonary function, facilitates ambulation, and allows rapid return to normal activities.
Numerous observational case series have reported that laparoscopic adjustable gastric banding (LABG) can be safely performed on an outpatient basis [14]. However, all studies have emphasized that patient selection and preoperative optimization of medical conditions are essential for patient safety. In addition, the training and experience of the surgeon has also been shown to influence the incidence of complications as well as the approach to the management of complications and the conversion to “open” procedure. Furthermore, the ability of the facility to manage these patients should also be taken into consideration. Facilities with high volume have been reported to have lower rates of morbidity and mortality. It is expected that the establishment of Centers of Excellence Program may reduce perioperative complications and improve the quality of bariatric surgery [18].

A recent study reported that the overall 30-day mortality and incidence of major adverse outcomes after bariatric surgery (Roux-en-Y gastric bypass or laparoscopic adjustable gastric banding) were low (i.e., 0.3% and 4.3%, respectively) [19]. The complications included PE, percutaneous, endoscopic, or operative reintervention, and failure to be discharged from the hospital. A history of DVT or PE, presence of OSA, and impaired functional status were found to be independent risk factors. Other factors that contributed to increased adverse outcome include patient characteristics (e.g., male gender, coexisting medical conditions, and high BMI), surgical characteristics (i.e., degree of invasiveness), and surgeon’s experience.

Intraoperative Considerations

Although the type and extent of surgery and the need for postoperative opioids, rather than the choice of anesthetic technique appear to be more important determinants of perioperative complications in the morbidly obese particularly those with OSA, local or regional anesthesia should be preferred [20]. Local/regional anesthesia obviates the need for airway manipulation as well as avoids hypnotic-sedatives, opioids, and muscle relaxants. In addition, these techniques provide postoperative analgesia and reduce postoperative opioid requirements.

Sedation and Analgesia in the Obese

Patients with OSA are more sensitive to sedative-hypnotics and opioids, which cause dose-dependent upper airway collapse, respiration depression, and reduced respiratory responses to hypoxia and hypercapnia. In patients who require sedation, midazolam and propofol have a similar propensity for upper airway obstruction at similar levels of sedation [21]. However, compared with midazolam, the recovery from propofol is more rapid and respiratory problems disappeared more quickly (within 15 min) suggesting that propofol may be preferred in this patient population. Of note, during sedation previously unrecognized patients may develop OSA. Therefore, during sedation, ventilation should be continuously monitored using capnography as it allows detection of upper airway obstruction prior to oxygen desaturation. Because CPAP counteracts sedation-induced airway closure, it should be considered during moderate sedation, particularly in patients using CPAP preoperatively. If deep sedation is required, general anesthesia (with a secure airway) may be preferable, particularly for procedures that might mechanically compromise the airway.

General Anesthesia

The optimal general anesthetic technique would allow rapid and clear-headed recovery including early return of the patient’s protective airway reflexes, which would allow maintenance of a patent airway. In addition, early recovery should reduce postoperative cardiac complications due to residual anesthetic effects.

Pre-induction Considerations

Alterations in pulmonary function (e.g., reduced FRC and oxygen reserves) in the obese may result in severe hypoxemia even after short periods of apnea. Positioning of the patient in the head elevated laryngoscopy position (HELP), which can be achieved by “stacking” with blankets or a specially designed foam pillow, structurally improves maintenance of the passive pharyngeal airway and may be beneficial for mask ventilation as well as improve the success of tracheal intubation. Other techniques used to avoid post-induction hypoxemia include preoxygenation with 100% oxygen until the end-tidal oxygen is at least 90% and use of 10 cm H2O CPAP with the patient in 25º head-up position [22]. Preinduction techniques followed by 10 cm H2O PEEP during mask ventilation and after intubation have been shown to reduce post-intubation atelectasis and improve arterial oxygenation [23].

Airway Management

Because BMI alone is not a predictor of difficult intubation, ‘awake’ tracheal intubation may not always be necessary [24, 25]. Nevertheless, OSA has been reported to be a predictor of difficult airway [24]. Therefore, it is imperative that emergency airway equipment (e.g., video laryngoscopes, supralaryngeal devices, and fibrescope) as well as additional help is immediately available during induction and emergence. Predictors of difficult tracheal
If ‘awake’ intubation is necessary, sedatives and opioids must be utilized judiciously as they may cause airway obstruction before the airway is secured. Dexmedetomidine is a highly selective alpha-2 adrenergic agonist with sedative, amnestic, analgesic, and sympatholytic properties, which does not cause respiratory depression. It reduces salivary secretions through sympatholytic and vagomimetic effects, which should improve visualization during fiberoptic tracheal intubation, and facilitate ‘awake’ tracheal intubation. Of note, oropharyngeal and upper airway topicalization necessary for ‘awake’ tracheal intubation may impair the upper airway protective reflexes and increase the frequency of OSA, which may lead to post-extubation airway obstruction.

**Induction of General Anesthesia**

Rapid sequence induction of general anesthesia with propofol (dosed according to lean body weight) and succinylcholine (1-1.5 mg/kg ideal body weight) or rocuronium (0.8-1 mg/kg ideal body weight), and cricoid pressure is considered the standard of care in the morbidly obese. However, the need for rapid sequence induction in the obese with no other risk factors (e.g., diabetes) is being questioned [1]. Controlled induction of anesthesia should allow appropriate titration of intravenous anesthetic and prevent hemodynamic instability that might occur from a predetermined dose as well as allow adequate ventilation and avoid hypoxia between induction and tracheal intubation.

**Maintenance of General Anesthesia**

There is lack of evidence for superiority of a specific maintenance technique (e.g., inhalation vs. total intravenous anesthesia). Nevertheless, inhalation anesthesia remains the mainstay of current anesthesia practice because of the ease of titratability. In addition, inhaled anesthetics exert some neuromuscular blocking effect, which may reduce the need for muscle relaxants.

The overall clinical differences between newer inhaled anesthetics (i.e., desflurane and sevoflurane) appear to be small. However, several studies have reported that in the morbidly obese, desflurane allows earlier emergence compared with sevoflurane. Compared with sevoflurane, desflurane allows earlier ability to swallow water without coughing or drooling, suggesting an earlier return of protective airway reflexes [26]. In addition, increasing duration of anesthesia further delayed the recovery of protective airway reflexes after sevoflurane [26]. In these studies the inhaled anesthetics were not titrated down towards the end of the surgery. It is possible that titration of sevoflurane concentrations towards the end of surgery may have allowed an earlier recovery. A recent study used anesthesia information management system and metaanalysis of 29 randomized controlled trials comparing desflurane and sevoflurane to determine the time from end of surgery to tracheal extubation [27]. They found that compared with sevoflurane, desflurane reduced the mean extubation time by 25% as well as reduced the variability of extubation time by 20-25% [27].

Because of its amnestic and analgesic properties, nitrous oxide (N2O) reduces anesthetic and analgesic requirements and facilitates recovery. Nevertheless, the use of N2O is questioned due to concerns of increased incidence of postoperative nausea and vomiting (PONV) and pressure effects through expansion of closed spaces. However, a recent systematic review concluded that there is no convincing reason to avoid N2O [28].

Opioids continue to play an important role in anesthesia practice; however, opioid-related sedation, airway obstruction, and respiratory depression are of concern in this patient population. Therefore, opioids should be used sparingly. Remifentanil (titrated to hemodynamics) may be preferable in the obese because of its unique pharmacokinetics and ultra-short duration. It is suggested that recurrent hypoxia, which typically occurs in patients with OSA, may affect endogenous opioid mechanisms that may alter responsiveness to exogenous opioid administration [29]. One study found that opioid requirements of patients with preoperative hypoxia (e.g., those with OSA) were lower than those without preoperative hypoxemia suggesting an increased sensitivity to opioids in this patient population [29]. Because lower opioid doses may be sufficient to achieve adequate analgesia, opioid therapy in OSA patients should be individualized and carefully titrated. Importantly, opioids should be administered according to ideal body weight NOT actual body weight [30]. Dexmedetomidine may be used to reduce opioid requirements; however, it can cause bradycardia and hypotension. Furthermore, it is generally assumed that dexmedetomidine is a short-acting drug; however, it may have prolonged sedative effects. The role of dexmedetomidine in the outpatient setting is yet to be established.

Because even minor degree of residual neuromuscular blockade (usually not appreciated clinically), particularly the obese and OSA patients, can increase postoperative morbidity such as inadequate ventilation, hypoxia, and the need for reintubation, muscle relaxants should be used sparingly. In addition, reversal with neostigmine (in appropriate doses) should be utilized without hesitation [31].
**Mechanical Ventilation**

Obesity is associated with changes in pulmonary function (e.g., reduction in lung volumes, increase in peak inspiratory pressures, and decrease in pulmonary compliance). Lung protective ventilation strategies in the obese would include the use of pressure-controlled ventilation with low tidal volumes (6-8 ml/kg IBW) and PEEP of 10-15 cmH2O [32, 33]. Recruitment maneuvers are beneficial in obese patients and should be applied, particularly before and after laparoscopic surgery [34]. Unfortunately, the effects of recruitment maneuvers are short lasting and often limited by hemodynamic instability. It is important to avoid hyperventilation (and hypocapnia), as this may result in metabolic alkalosis and lead to postoperative hypoventilation. Mild hypercapnia (i.e., ETCO2 of 40 mmHg) can improve tissue oxygenation through improved tissue perfusion resulting from increased cardiac output and vasodilatation as well as increased oxygen off-loading from the shift of the oxyhemoglobin dissociation curve to the right.

**Pain Prophylaxis**

Because opioid-related sedation, airway obstruction, and respiratory depression are of concern in this patient population, opioids should be used sparingly. Preventive analgesia with non-opioids (e.g., NSAIDs, acetaminophen, and local anesthetics) should reduce perioperative opioid requirements and lower opioid-related side effects as well as improve postoperative pain relief. Recently, there is increasing interest in using analgesic adjuncts such as corticosteroids (e.g., dexamethasone 4-8 mg) and ketamine 25-50 mg to provide improved pain relief.

**Nausea and Vomiting Prophylaxis**

Patients undergoing ambulatory surgery are at a higher risk of PONV and should receive prophylactic multimodal antiemetic therapy (e.g., combinations of 5-HT3-receptor antagonists, droperidol, and dexamethasone). Although it is recommended that the number of antiemetics be based on the patient’s level of risk as determined by risk factor assessment, double or triple antiemetic prophylaxis is optimal for this patient population.

**Intraoperative Fluid Management**

Adequate preoperative hydration (i.e., encourage patients to consume water until 2 h preoperatively) and higher intraoperative fluid administration (20-40 ml/kg) have been reported to reduce postural hypotension, postoperative dizziness, drowsiness, nausea, and fatigue [35]. Of note, absolute values of fluid requirements may seem high in the morbidly obese (e.g., 4-5 L). In addition, because the morbidly obese are at a high risk of rhabdomyolysis [36], administration of higher fluid volumes may reduce the potential for myoglobinuric acute renal failure associated with rhabdomyolysis.

**Emergence From Anesthesia**

In contrast to traditional practice, the primary aim at the end of the surgery should be to washout the inhaled anesthetic rather than increase the CO2 levels. Adequate ventilation (probably with the use of pressure support ventilation) during recovery from anesthesia and muscle relaxants should allow washout of inhaled anesthetics and facilitate emergence as well as reduce postoperative pulmonary atelectasis and hypoxemia.

One of the major concerns in obese patients, particularly those with OSA, is the risk of airway obstruction after tracheal extubation. Thus, prior to tracheal extubation, the patient must be fully awake, alert, and follow verbal commands (i.e., deep extubation is not advisable). Importantly, coughing and reflex movements of the hand towards the tracheal tube should not be confused as purposeful movements. Extubation should be performed in a semi-upright (25-30º head-up) position, when possible. A recent study reported that CPAP instituted immediately after tracheal extubation is superior in maintaining lung function at 24 h after laparoscopic bariatric surgery than CPAP initiated later in the recovery room [37].

**Postoperative Considerations**

Although BMI is not of itself a predictor of postoperative outcome [14], presence of comorbidity such as OSA can increase postoperative complications including airway obstruction, oxygen desaturation, and the need for reintubation as well as systemic hypertension and cardiac arrhythmia. Once in the PACU, patients should be maintained in a semi-upright (25-30º head-up) position, if possible.

**Postoperative CPAP/BiPAP**

Patients who use CPAP preoperatively should use CPAP postoperatively. Although supplemental oxygen is beneficial for most patients, it should be administered with caution as it may reduce hypoxic respiratory drive and increase the incidence and duration of apneic episodes. Because obese patients might have unrecognized OSA,
recurrent hypoxemia may be better treated with CPAP or bi-level positive airway pressure (BiPAP) along with oxygen rather than oxygen alone. Interestingly, one study found that postoperative CPAP/BiPAP can be safely omitted in laparoscopic Roux-en-Y gastric bypass patients with known OSA, provided they are observed in a monitored non-intensive care unit setting and their pulmonary status is optimized by aggressive incentive spirometry and early ambulation [39].

Because determination of optimal CPAP settings may be difficult in patients who have not previously used the device, use of automatic self-adjusting or auto-adjusting positive airway pressure (APAP) devices may be preferred in the postoperative period. The APAP devices change the pressure level based on feedback from various patient measures such as airflow, pressure fluctuations, or measures of airway resistance. The pressure titration with APAP devices allows for the changes in upper airway pressures that might occur in the immediate postoperative period due to varying degrees of residual anesthetic and muscle relaxant effects. Of note, the potential benefits of APAP in the postoperative period need to be confirmed in future trials. Anesthesiologists involved in the management of OSA patients should familiarize themselves with CPAP devices.

One of the concerns with the use of positive pressure devices after upper intestinal surgery is the potential for increased risk of anastomotic disruption and leakage. However, several studies have not observed increase in anastomotic leaks and pouch perforations with the use of CPAP/BiPAP after gastric bypass surgery [40].

**Post-PACU Discharge Care**

Prior to discharge from the PACU the oxygen saturation on room air should return to baseline and the patient should not become hypoxic or develop airway obstruction when left undisturbed in the recovery area. It has been suggested that most significant postoperative complications in OSA patients usually occur within 2 hours after surgery. Therefore, it may be worthwhile to observe these patients in the recovery room for at least 2 h. Of note, complaints of postoperative shoulder, hip, or buttock pain along with unexplained elevations in serum creatinine and creatine phosphokinase (>5000 IU/L) levels should raise suspicion of rhabdomyolysis [36].

Discharge home might be considered if the patient can maintain baseline oxygen saturation on room air, and the propensity to develop airway compromise and respiratory depression no longer exists. The ASA-OSA Practice Guidelines suggest that OSA patients be monitored for a median of 3 hours longer than their non-OSA counterparts before discharge from the facility [16]. In addition, the monitoring should continue for a median of 7 hours after the last episode of airway obstruction or hypoxemia while breathing room air in an unstimulated environment [16]. Unfortunately, the recommendation for longer postoperative stays are not based upon any scientific evidence, and may be the major limitation of performing surgical procedures in an ambulatory setting. Obesity alone is not associated with increase in anticipated admissions after ambulatory surgery [15].

**Care After Discharge Home**

One of the major concerns after ambulatory surgery is nocturnal apnea with catastrophic consequences. However, a preliminary study that monitored home nocturnal oximetry for 48 hours after ambulatory surgery found that although severe desaturation occurred in almost one-fourth of patients, this did not result in any complications or need for intervention. Patients who were difficult to mask ventilate and/or intubate were unable to maintain oxygen saturation >90% and had more severe desaturation. CPAP appeared to be protective from severe desaturation (30% without CPAP vs. 16% with CPAP) [41].

The risk of respiratory complications may last for several days after surgery because postoperative surgical stress response, anxiety, pain, and opioid use cause sleep deprivation and fragmentation, which may reduce REM sleep and exacerbate sleep disorders. This period is followed by a rebound REM sleep that makes patients with OSA even more vulnerable to airway obstruction and life-threatening apnea. Of note, postoperative sleep disturbances appear to be related to the location and invasiveness of the surgical procedure and opioid usage. Fewer sleep disturbances occur after mild-to-moderately invasive surgery, commonly performed on an outpatient basis than inpatient surgical procedures. It is important that the post-discharge instructions emphasize the potential for aggravation of OSA and the need to use opioids judiciously. Patients should have well-informed escorts who would also provide care at home.

**Summary**

Obese patients, particularly those with OSA, are at a high risk of perioperative complications and pose several challenges to the anesthesiologist including difficult tracheal intubation, intraoperative cardiopulmonary complications, and life threatening airway obstruction and respiratory depression that might last for several days after surgery.
Because undiagnosed OSA is common, a focused history and physical examination can help identify patients with OSA. It is unclear if routine preoperative sleep studies would influence perioperative outcome. Nevertheless, when a sleep study is not available, it is prudent to treat the patients as though they have severe OSA. There is uncertainty regarding scheduling and management of OSA patients for outpatient surgery. With limited understanding of their postoperative (particularly post-discharge) course, any recommendations remain speculative.

Prudent perioperative management should be guided by the awareness of the potential complications based on the severity of comorbidities, invasiveness of diagnostic or therapeutic procedure, and requirement of postoperative opioids. Use of fast-track anesthesia techniques with pain and PONV prophylaxis should allow rapid emergence, reduce postoperative cardiopulmonary complications, and hasten recovery.

Patients should be educated regarding the deleterious effects of opioids and asked to limit their use. Patients on preoperative CPAP should be instructed to use CPAP at night for several days postoperatively. Patients who are placed on OSA protocol based on clinical indicators should be asked to follow-up with their primary physician for possible sleep study.

Finally, developing and implementing protocols is the best way to avoid adverse events and improve postoperative outcome.

References

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