Obstructive Sleep Apnea and Surgery: Quality Improvement Imperatives and Opportunities

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Abstract Obstructive sleep apnea (OSA) is more common in surgical candidates than in the general population and may increase susceptibility to perioperative complications that range from transient desaturation to catastrophic injuries. Understanding the potential impact of OSA on patients' surgical risk profile is of particular interest to otolaryngologists, who routinely perform airway procedures—including surgical procedures for treatment of OSA. Whereas the effects of OSA on long-term health outcomes are well documented, the relationship between OSA and surgical risk is not collinear, and clear consensus on the nature of the association is lacking. Better guidelines for optimization of pain control, perioperative monitoring, and surgical decision making are potential areas for quality improvement efforts. Many interventions have been suggested to mitigate the risk of adverse events in surgical patients with OSA, but wide variations in clinical practice remain. We review the current literature, emphasizing recent progress in understanding the complex pathophysiologic interactions noted in OSA patients undergoing surgery and outlining potential strategies to decrease perioperative risks.

Keywords Obstructive sleep apnea (OSA) · Otolaryngologic surgery · Quality improvement · Patient safety · Anesthesia · Narcotics

Introduction

Patients with sleep disorders frequently present for surgery and may be at increased risk for perioperative complications [1, 2•]. Recently, there has been growing concern regarding the effects of obstructive sleep apnea (OSA) in surgical patients [2•, 3•]. Growing awareness of the effects of sleep disorders on several health-related outcomes [4–10] has coincided with epidemic increases in the prevalence of obesity [11] and OSA. The care of surgical patients with OSA is thus fraught with potential safety and liability concerns [12•]. Otolaryngologists may encounter not only more difficult airway management and post-obstructive pulmonary edema risk, but also altered drug sensitivity and a high risk of undiagnosed comorbid disease [13, 14]. Available data, consensus statements, and guidelines provide direction for efforts to reduce the risk of adverse events [15, 16•, 17•]. We evaluate the current state of the evidence regarding surgery in patients with OSA, and we outline the most promising strategies that may help the surgical team and patient navigate the perioperative period safely.

Prevalence of Obesity and OSA in Surgical Patients

In recent decades, the prevalence of obesity has soared, with the US having a prevalence that is three-fold higher than in most European countries [18]. Sleep-associated breathing disorders are estimated to affect 70 million

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people in the US, representing one in four men and one in ten women between the ages of 30 and 60 [19, 20]. The overall prevalence of OSA in surgical patients not undergoing airway surgery is estimated to be at least 22 % [21]. In a recent questionnaire-based study, 41 % of surgical patients were found to be at high risk for OSA [22]. In high-risk populations, such as bariatric surgery patients, OSA has a prevalence of up to 97 % [23]. As the rate of obesity increases in the US and globally, the population of obese patients with OSA can be expected to rise correspondingly [24]. Thus, surgeons, hospitals, and health systems will need to increasingly confront the safety, quality, and economic ramifications of OSA in the over 40 million surgical procedures performed annually [2•].

In the pediatric population, obstructive sleep apnea is now the most common indication for tonsillectomy and adenoidectomy (T&A). Several key studies have emerged in the past year in this area [25, 26•, 27•, 28]. Most notably, the widely publicized CHAT (Childhood Adenotonsillectomy Trial) study found beneficial effects of early adenotonsillectomy compared to watchful waiting in areas of behavior, quality of life, and polysomnography findings, although significant improvements were not demonstrated in attention or executive function [26•]. In another study, obese children demonstrated more severe OSA, behavioral problems, and poorer quality of life than normal-weight children. The degree of obesity did not linearly predict OSA severity in these children [27•]. Quality of life instruments such as the OSA-18 show promise as useful adjuncts for identifying children with mild OSA likely to benefit from early intervention [28]. The role of polysomnography is also now better delineated. It appears most helpful in children with obesity, Down syndrome, craniofacial disorders, hypotonia, or where there is clinical uncertainty as to the diagnosis of OSA. Admission is advisable for children <3 years or with severe OSA [29•, 30].

Pediatric patients undergoing adenotonsillectomy for OSA have a well-recognized risk for desaturation. In a study of 37 children who underwent adenotonsillectomy for polysomnography-diagnosed OSA, several patients showed marked oxygen desaturations, instances of respiratory failure, and prolonged hospital stay. Risk factors included young age, hypotonia, morbid obesity, medical complexity due to craniofacial anomalies, previous upper airway trauma, cor pulmonale, and failure to thrive [31]. A recent study of 4,092 consecutive pediatric tonsillectomy cases used a case control design to identify factors linked to desaturation [32•]. The authors' algorithm for admission identified 92 % of the patients who desaturated and benefited from admission but also would have required admission in 60 % of their control group. The study also

demonstrated that children with Down syndrome, age <3 years old, extremes of weight (<5th percentile or >95th percentile for age), and cardiopulmonary/neurologic impairment were most at risk. The study sheds some light on the question of admission criteria, potentially identifying children at risk for life-threatening apnea, but also illustrates that there is likely not a single algorithm that will identify only those who definitively require admission. There are significant parallels between the risk factors identified in this study cohort and one reported by otolaryngologists in a study of death or anoxic brain injury after tonsillectomy [33•].

In adult patients with OSA, perioperative risk can be compounded by a variety of comorbid conditions including cardiovascular disease, hypertension, morbid obesity, metabolic syndrome, pulmonary hypertension, diabetes, chronic pain, and stroke [1, 13, 14, 34, 35•]. Severity of OSA is correlated with risk of complications [36]. Patients with OSA undergoing surgery appear more likely to require intensive care monitoring and incur increased costs [37]. OSA is exacerbated by opiate analgesics, anesthetic agents, and deprivation or fragmentation of sleep [38], all of which make up parts of the OSA surgical patient's milieu. Nonetheless, not all studies report adverse outcomes attributable to OSA [39•]. A systematic review found a higher rate of postoperative hypoxemia in patients with OSA but did not demonstrate a correlation between "surrogate" adverse events (desaturation, supplemental oxygen requirement, need for additional monitoring, or atelectasis) and the need for a surgical airway, anoxic brain injury, or death. Limitations of the analysis included difficulties with OSA diagnosis, suitable control groups, and stratification. The incidence of OSA was unknown in most of the control groups reviewed, and OSA was diagnosed using methods of varying reliability, including screening questionnaires, clinical symptoms, polysomnography, or ICD-9 codes from administrative data [16•].

Effects of Codeine and Opioids in Patients with OSA

Codeine, formerly a mainstay of many otolaryngologists for treatment of postoperative adenotonsillectomy pain, has fallen into disfavor because of increasing awareness of severe outcomes (including death) related to its use in pediatric patients. In the summer of 2013, the US Food and Drug Administration (FDA) required manufacturers of all codeine-containing products to add a boxed warning describing the risk of postoperative death posed by codeine after a child has undergone tonsillectomy or adenoidectomy [40, 41•]. This decision prompted changes in post-tonsillectomy pain management across the country. The

FDA's decision reflected a growing understanding of the pharmacogenomics of ultra-rapid metabolism of codeine and awareness of rare adverse outcomes reported with codeine [41•, 42]. Codeine's analgesic effects depend on its conversion to morphine by the cytochrome P-450 isoenzyme 2D6 (CYP2D6). The gene encoding CYP2D6 has many genetic variations, and functional duplication of the gene results in accelerated production of morphine (ultra-rapid metabolism). Elevated circulating levels of morphine can result in life-threatening respiratory suppression in individuals who are ultra-rapid metabolizers. Opiates metabolized through the CYP2D6 pathway include codeine, tramadol, hydrocodone, and oxycodone, although ultra-rapid metabolism has been best studied with codeine.

The early clinical cases pertaining to the potential dangers of codeine perioperatively included a report of two deaths and one case of respiratory depression in children 3–5 years of age who had been administered codeine after undergoing tonsillectomy, adenoidectomy, or both for the treatment of obstructive sleep apnea [43]. Two children who died were confirmed to be ultra-rapid metabolizers, with postmortem morphine levels well above the therapeutic range. A more comprehensive investigation thereafter identified 13 cases, including 10 deaths and 3 cases of life-threatening respiratory depression associated with standard codeine use in patients from 21 months to 9 years of age [41•]. The Patient Safety and Quality Improvement Committee of the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) recently reported results of a nationwide survey of otolaryngologists querying about post-tonsillectomy death. The study found numerous cases of seemingly unexplained post-tonsillectomy death, often in the context of codeine or other narcotic use [33••]. A separate report from the anesthesia literature also examined the relationship between obstructive sleep apnea and pediatric post-tonsillectomy mortality with similar findings [44••].

Although concerns with codeine have significantly reduced the use of opioids in pediatric patients, opioids continue to be the most commonly used treatment for postoperative pain in adults, despite the availability of a variety of alternative options [45]. Opioid-induced central sleep apnea is thought to be a major factor in opioid-related mortality [46]. Chronic opioid use, impaired cardiopulmonary reserve, and polymarmacy all conspire to complicate opioid dosing and management in OSA patients. The opioid receptors are located in the same regions of the brain that regulate sleep, have strong influences on REM sleep, and can predispose to hypoxemia and respiratory failure [47]. Obesity adds another layer of complexity, particularly when hypoventilation is accompanied by hypercapnia [35•].

Preventing Perioperative Complications in the OSA Patient

Success in improving safety for surgical patients with OSA is predicated on improving our awareness of OSA in the surgical population and tailoring care appropriately. OSA remains undiagnosed in up to 80 % of patients at the time of surgery [2•]. Although under-diagnosis is best studied in adults [48], the presence of OSA is also easily overlooked in children undergoing adenotonsillectomy for a primary indication of recurrent tonsillitis. The STOP-Bang screening questionnaire [49] has been recommended for adult OSA screening by the ASA because it is easy to administer, has high sensitivity, and may provide information on the severity of OSA. The specificity improves when using a greater number of positive indicators, typically six or more [16••]. While OSA syndrome is the most common of these sleep disorders, other sleep disorders may also be present. For example, obesity-hypoventilation syndrome (Pickwickian syndrome) is a life-threatening condition in which affected individuals exhibit alveolar hypoventilation, which results in low oxygen saturation, blunted respiratory response, and high CO₂ levels with predisposition to CO₂ narcosis (Fig. 1).

Much discussion has centered on the relative safety of ambulatory care settings for surgical procedures in pediatric and adult patients with OSA. In the case of pediatric adenotonsillectomy, monitoring and hospital admission practices are not well standardized. A recent publication noted striking variation in post-adenotonsillectomy admission patterns among 24 pediatric hospitals [50•]. Children ages 2 and younger were regularly admitted, and children with obstructive sleep apnea or complex chronic medical conditions were more likely to be admitted; nonetheless, overall admission rates showed major unexplained variability across institutions. These observations point to a need for greater consensus regarding admission and discharge parameters based on available evidence. A recent study found that use of admission guidelines based on age, polysomnography data, BMI, craniofacial syndromes, and comorbidities decreased the risk of subsequent readmission [51•]. In the absence of robust evidence-based guidelines, surgeon judgment informed by existing literature provides the primary determinant.

Currently, most surgery for OSA is performed on an ambulatory basis [52•], a finding at odds with the American Society of Anesthesiologists 2006 guidelines that generally discouraged ambulatory surgery for patients with OSA [15]. Adult patients with OSA have the potential for difficult airway anatomy, increased sensitivity to anesthetic agents, and altered requirements for medications to manage pain and hemodynamic fluctuations [53]. Despite these

Fig. 1 STOP-BANG questionnaire. Courtesy of www.stopbang.ca

STOP-Bang Questionnaire

Is it possible that you have Obstructive Sleep Apnea (OSA)?

Please answer the following questions below to determine if you might be at risk.

Yes No **S**noring ?

Do you **Snore Loudly** (louder than talking or loud enough to be heard through closed doors) ?

Yes No **T**ired ?

Do you often feel **Tired, Fatigued, or Sleepy** during the daytime ?

Yes No **O**bserved ?

Has anyone **Observed** you **Stop Breathing** during your sleep ?

Yes No **P**ressure ?

Do you have or are being treated for **High Blood Pressure** ?

Yes No **B**ody Mass Index more than 35 ?

Yes No **A**ge older than 50 ?

Yes No **N**eck size large ? (Neck Measures more than 16 inches / 40 cm around at Adam's Apple)

Yes No **G**ender = Male ?

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.

obstacles, the literature suggests that ambulatory surgery to treat OSA can be performed safely for many patients [52•]. A recent study of 452 OSA patients found that 89 % of surgical procedures were performed on an ambulatory basis with a 0 % catastrophic complication rate. Such experience prompted a reappraisal of the literature. The Society for Ambulatory Anesthesia (SAA) conducted a systematic review and issued a revised algorithm for perioperative management of patients with OSA, concluding that patients with mild-to-moderate OSA and appropriately managed comorbidities could safely undergo ambulatory surgery. Strategies to minimize airway-related complications included use of short-acting opiates, intravenous propofol for anesthetic induction and maintenance, and preparedness for potentially difficult intubation [46]. Admission was recommended for those patients with severe OSA without optimized comorbid conditions, BMI ≥ 35 , and those with repeated postoperative respiratory events or in whom postoperative pain relief cannot be achieved with predominantly non-opioid techniques [54].

Continuous Positive Airway Pressure (CPAP) treatment has been reported to reduce OSA-related complications in adults after elective surgery. A meta-analysis of nine controlled trials reported a reduction of pulmonary complications when using CPAP in postoperative management [55]. Noncompliance with CPAP was associated with an increased rate of complications [56]. In several recent

studies of perioperative outcomes in the OSA population, patients with OSA have often used CPAP or BiPAP postoperatively, indicating a greater awareness of optimal perioperative management in these patients and likely contributing to a safer perioperative course [57]. Patients' ability and willingness to use CPAP is therefore a useful criterion in gauging candidacy for outpatient surgery [58]. For patients with OSA on chronic opioid therapy, BiPAP therapy may be more effective than CPAP alone for improving hypoxic episodes. According to the SAA consensus statement [16••], patients with mild or moderate OSA with optimized comorbid conditions are appropriate for ambulatory surgery if able to use CPAP postoperatively. It warrants mention however that to date no large, randomized, prospective clinical studies have been conducted to evaluate the impact of such interventions on OSA patients during the perioperative period.

Several other recommendations are also included in the SAA consensus statement. Monitoring for 3 hours after procedural anesthesia is recommended, although in a study of OSA patients undergoing procedural sedation, a large number left against medical advice before the monitoring period had passed, so compliance may be a limiting factor [59•]. Patients and family should be counseled regarding the possible need for admission and instructed to bring their CPAP device with them. Patients also need to be counseled regarding the need for increased vigilance after

discharge home. Patients with preoperative CPAP should use their CPAP device for several days postoperatively, particularly whenever sleeping, even during the daytime. Postoperative pain relief should be predominantly with non-opioids [15]. Postoperative disposition of the OSA patient should be based on the severity of the sleep disorder, recurrent post-anesthesia care unit respiratory events, and the need for opioid analgesia [60]. Close observation in the postoperative period, use of continuous pulse oximetry, and a low threshold for arterial line monitoring have all been recommended [61]. Monitoring of the respiratory rate alone is insensitive for detecting respiratory failure, since obstruction, hypoxemia, and hypercapnia may occur despite frequent (ineffectual) ventilatory effort. Some OSA protocols incorporate continuous pulse oximetry monitoring and nasal flow capnography to allow patients with OSA to be more safely monitored on general nursing floors [62].

Progress in Surgical Treatment of OSA

Although surgery rarely cures OSA, evidence increasingly shows excellent outcomes for surgery in long-term health and quality of life [63•]. The literature of the past year has included data on technical refinements [64, 65•], comparative effectiveness [66], and the safety of ambulatory otolaryngologic surgical procedures for OSA [52•, 67]. Awareness is increasing regarding outcome measures beyond the apnea hypopnea index. Other measures, such as general quality of life, OSA-specific quality of life, measurements of sleepiness, and performance, are being considered as reportable metrics [68, 69•]. Studies attest to the efficacy of uvulopalatopharyngoplasty (UPPP) on subjective symptoms with appropriate patient selection, in some cases even where polysomnographic improvement was not apparent [70]. Outcomes for sleepiness and snoring were shown to improve significantly across reviews, although the level and quality of evidence were not as robust as desired [71].

Our understanding of quality and outcomes in surgery is also improving. A recent study found surgeon and hospital volume to be important markers for the quality in OSA surgery, with lower volume surgeons and hospitals associated with higher mortality rates, increased instances of desaturation, longer average length of stay, and higher hospitalization charges [72•]. Maxillomandibular advancement remains a highly effective intervention for OSA and may reduce AHI more than UPPP alone [66], but a 2013 study concluded that UPPP is the ideal option for management of OSA when patient selection is optimized, combining the Friedman stage with site of obstruction (as detected by videoendoscopy with Müller's maneuver). The authors reported a success rate of 95.2 % with success

being defined as a 50 % reduction in preoperative AHI resulting in a postoperative AHI < 20/h [73]. Two 2013 studies noted potential benefits of nasal surgery, one in improving patient compliance with CPAP [74] and another in subjective symptoms of sleep disordered breathing such as sleepiness and quality of life [75]. Enhancement of residency training in the surgical treatment of obstructive sleep apnea, particularly regarding current practice recommendations for multilevel treatment of OSA [76], should assure continued progress in OSA surgery.

Strategies for Pain Management in Children

Non-opiate regimens are recommended for postoperative pain control after pediatric tonsillectomy (Table 1) [77, 78]. A single intraoperative dose of intravenous dexamethasone significantly reduces postoperative pain, nausea, and vomiting [79•]. Postoperatively, an alternating regimen of ibuprofen and acetaminophen can provide safe and effective analgesia without the risk of respiratory depression posed by opiates. Nonpharmacologic strategies may also be of help. Preoperative counseling with the patient and parent can reduce perioperative anxiety about avoidance of opiates after tonsillectomy. Adequate hydration is another effective pain reducing measure.

We strongly recommend avoiding codeine for postoperative pain relief in pediatric patients, particularly in those with obesity and/or known OSA. The majority of fatalities related to codeine use have been observed in young and often obese children with obstructive sleep apnea. Use of opiates for postoperative pain in children undergoing tonsillectomy has not been found to improve pain control and may increase nausea and vomiting [78, 80]. The FDA black box warning on codeine, which contraindicates use of codeine after adenotonsillectomy, does not address use of the codeine in other settings. However, the FDA recommends that if codeine-containing medications are used, the lowest effective dose should be used for the shortest amount of time on an “as needed” basis. Ketorolac is not recommended as it may increase the risk of postoperative

Table 1 Recommendations for pediatric post-tonsillectomy pain control

Intraoperative
<i>Dexamethasone</i> 0.15–1 mg/kg up to maximum of 10 mg
Postoperative
<i>Acetaminophen</i> 15 mg/kg every 4–6 h as needed; max dose 75 mg/kg/day not exceed 1 g/4 h and 4 g/day
<i>Ibuprofen</i> 10 mg/kg every 6–8 h as needed; max dose 40 mg/kg/day

bleeding, and antibiotics are not recommended as adjunctive treatment [79••].

Otolaryngologists should contribute to intraoperative decisions bearing on pain control. In addition to use of steroids, other intraoperative measures may also be considered. A study of the administration of intraoperative dexmedetomidine in children undergoing adenotonsillectomy for OSA showed reduced postoperative opioid requirements, fewer episodes of desaturation, and decreased emergence agitation [81]. It also improved hemodynamic stability in patients undergoing OSA surgery and decreased the need for use of multi-drug regimens [82]. Ketamine has also been reported as a safe and effective alternative to opioids in the immediate postoperative period after tonsillectomy for OSA [83]. Intravenous (IV) acetaminophen is an appealing option for improving postoperative pain management that has been shown to decrease opioid requirements in the perioperative period [84]. Caution is warranted, however, as this effect has not been well studied in patients with OSA and rodent data have suggested an increased risk of liver and kidney damage with obesity and hypoxia [85].

Strategies for Pain Management in Adults

Strategies for pain management in adult patients with OSA emphasize the use of multimodal analgesic therapy. Strategies include long-acting local anesthetic infiltration in the surgical wound, regional analgesic techniques, acetaminophen and nonsteroidal anti-inflammatory drugs such as ibuprofen, systemic steroids (e.g., dexamethasone), minimizing the use of sedatives and opioids, and, where applicable, noninvasive ventilation technique [35•]. Opioids were shown to increase central sleep apnea in patients with OSA in a prospective, double-blind, placebo-controlled study [86]. Tramadol, a synthetic opioid of the aminocyclohexanol group, is an alternative for patients with OSA as it induces fewer apneic events [87]. Tramadol is available as an orally disintegrating tablet of 50 or 100 mg given every 4–6 h (not to exceed 400 mg/day) for pain relief. Postoperative pain relief with nonopioid-based analgesics (or local/regional strategies) has a greater margin of safety than the use of systemic opiates [88].

Several NSAIDs may also be used in the postoperative period with beneficial opioid-sparing effects. NSAIDs are classified as selective or nonselective based on inhibition of cyclooxygenase enzymes (COX-1 and COX-2) [89]. Ibuprofen has an approximately equal effect on COX-1 and COX-2 enzymes and is available in both oral and IV forms; the IV form was approved by the FDA for use in adults in

2009 [90]. The IV dose is 400–800 mg over 30 min every 6 h up to maximum dose of 3.2 g/day. Diclofenac is a nonselective NSAID that can be administered orally with an immediate release tablet in the dosage of 150–200 mg/days in 3–4 divided doses. The first COX-2 selective NSAID (Celebrex) was developed in the 1990s, and it remains available in the US, although other COX-2 agents were removed from market because of concerns of increased risks of heart attack or stroke [91]. Combinations of acetaminophen and NSAIDs may offer superior analgesia in comparison to either drug alone [92]. Ketorolac is a nonselective NSAID available in both oral and IV (bolus or continuous infusion) forms [93]. Although an effective analgesic, it is not recommended here because of the increased hemorrhage risk.

New approaches to postoperative pain control in patients with OSA include use of novel delivery mechanisms or alternative pharmacology. Nasal administration of medications is one promising strategy. A study in patients with OSA undergoing uvulopalatopharyngoplasty showed reduced need for opioids with transnasal butorphanol [94]. Intravenous acetaminophen is another recently available option, although clinical data on efficacy are limited in OSA, and similar concerns exist for adults as for children with its use in obese patients or those with hypoxia [85]. Several other analgesic adjuncts with opioid-sparing properties include steroids, tramadol, tapentadol, and dexmedetomidine [35•]. Pregabalin has become popular because of its dual analgesic and anxiolytic properties [95], but sedation and respiratory depression have been noted with concomitant narcotic use in patients with OSA. Tapentadol is a newer analgesic with a mechanism of action involving opioid receptor agonism and central reuptake inhibition of noradrenaline [96]. Short-acting sedatives, such as propofol and nitrous oxide, may be helpful in allowing faster recovery of ventilatory function [97]. If an opioid PCA is used, continuous infusions of narcotics should be avoided, and dosing should be based on lean body mass [61].

Conclusions

Although patients with OSA and comorbid conditions are at increased risk for perioperative complications, the diagnosis of OSA is not made prior to the patient undergoing surgery [98]. If OSA is diagnosed, there are several opportunities to improve safety and quality. Efforts should focus on standardization—in diagnosis, perioperative management, patient counseling, and discharge planning. The STOP-BANG questionnaire is a validated tool for initial OSA screening, and it may be helpful in determining

a patient's candidacy for ambulatory surgery. The cornerstones of a perioperative OSA safety protocols include appropriate preparation of the surgical team, use of multimodal therapy for pain management (which minimizes reliance on opioids), ensuring patient-appropriate monitoring for respiratory events, and use of CPAP where indicated in the perioperative period. Surgeons should also enlist the help of appropriate primary care and specialty colleagues to optimize preoperative management of comorbidities, such as coronary artery disease and diabetes mellitus.

There are still many unanswered questions concerning OSA in surgical patients. Whereas substantial data address desaturation, hypoxemia, or rates of difficult intubation in patients with OSA, less is certain about risks for major complications. Prospective large-scale studies are needed to evaluate the impact of interventions on key outcomes such as the incidence of emergent surgical airway placement, anoxic brain injury, myocardial infarction, and death—as well as utilization parameters, such as ICU admission, delayed discharge, unplanned hospital admission, and readmission after discharge. Future studies must also consider the impact of opioids on perioperative outcomes and evaluate the role of preoperative and postoperative CPAP/BiPAP use. Although such research is much needed, existing data provide valuable guidance for nascent quality improvement efforts.

Institutional awareness is needed regarding the significance of OSA in the perioperative setting for children and adults—particularly in the high-risk OSA patient who also exhibits morbid obesity and multiple comorbidities. In the future, health care institutions that assume a passive role in implementing protocols for surgical patients with OSA are likely to have an increased incidence of complications and higher costs than proactive institutions. As healthcare entities increasingly compete on the basis of quality, cost, and safety [99], institutions that adopt a systems-based approach and embrace the challenges of our changing demographics will likely flourish, and those who do not will lag behind. Meaningful progress will require collective efforts across the spectrum of perioperative disciplines. The OSA epidemic and its pervasive effect on the discipline of surgery afford a unique opportunity for innovative collaborations among surgeons, anesthesiologists, and policymakers.

Compliance with Ethics Guidelines

Conflict of Interest Michael J. Brenner and Julie L. Goldman declare no conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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