ORIGINAL ARTICLE

Preventing Opioid-Induced Respiratory Depression in the Hospitalized Patient With Obstructive Sleep Apnea

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Purpose: *To enhance the role of nursing interventions in the management of perioperative opioid-induced respiratory depression (OIRD) in patients with obstructive sleep apnea (OSA).*
Design: *Narrative review of the literature.*
Methods: *Literature reviewed with emphasis on recommendations by professional and accrediting organizations.*
Findings: *Postsurgical OIRD increases hospital stay (55%), cost of care (47%), 30-day readmission (36%), and inpatient mortality (3.4 fold). OSA increases the risk of OIRD and may result in legal claims averaging $2.5 million per legal claim.*
Conclusions: *Nursing interventions are essential to improving outcome and reduce cost in the management of postsurgical OIRD in OSA patients.*

Keywords: *obstructive sleep apnea, positive airway pressure, opioid induced respiratory depression, PACU, sleep disordered breathing.*

OBSTRUCTIVE SLEEP APNEA (OSA) and opioid-induced respiratory depression (OIRD) are interrelated problems that are of concern for regulatory and accrediting organizations. In 2015, The Joint Commission issued a sentinel event alert titled "At risk: Obstructive sleep apnea patients," which cited many concerns that fall within nursing practice including (1) lack of training for health care professionals to screen for and recognize OSA, (2) failure to assess patients for OSA, (3) failure to implement appropriate monitoring of patients with risk factors associated with OSA, (4) lack of communication among health care providers regarding patients with OSA or potential risk factors associated with OSA, and (5) lack of postoperative evaluation and treatment for OSA.[1]

Patients have been found dead in bed after receiving appropriate opioid medications for pain. According to Benumof[2] a prototypical patient found dead in bed is middle aged, has severe OSA, underwent orthopaedic, upper airway, or abdominal surgery under general anesthesia and was in an unmonitored bed without continuous positive airway pressure (CPAP) or oxygen. OIRD-related adverse events such as these cost hospitals on average of $2.5 million per claim.[3,4]

In 2011, The Joint Commission issued a sentinel event alert titled "Safe Use of Opioids in Hospitals," which found that the two most common causes of opioid-related adverse events were (1) wrong dose medication error (47%) and (2) improper monitoring (29%). The sentinel alert also listed patient

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characteristics that are associated with increased risk for OIRD, which included (1) sleep apnea or sleep disorder diagnosis, (2) morbid obesity with high risk of sleep apnea, (3) snoring, (4) older age, (5) postsurgery, particularly if upper abdominal or thoracic surgery, (6) increased opioid dose requirement or opioid habituation, (7) receiving other sedating drugs, (8) pre-existing pulmonary or cardiac disease, and (9) being a cigarette smoker.[5] Understanding the pathophysiology of sleep-disordered breathing and how opioid and sedating medications aggravate this disorder and result in adverse events is important for nurses. Adequate knowledge of the interaction between opioids and sleep-disordered breathing as well as understanding best monitoring practices will improve patient safety and decrease opioid-related adverse events.

Prevalence of Sleep-Disordered Breathing

OSA is the most common type of sleep-disordered breathing (80% to 90%) but can coexist with the two less common types: central sleep apnea and obesity hypoventilation syndrome. OSA is highly prevalent in the general population and most cases (80% to 90%) are undiagnosed. The prevalence of moderate to severe OSA among adults aged 30 to 70 years is estimated to be 13% of men and 6% of women.[6] This translates to OSA affecting more than 20 million people in the US population. Central sleep apnea is not common in the general population but is common in specific populations such as patient with congestive heart failure (33%) and patients on chronic opioid medications (14% to 60%).[7] Sleep-disordered breathing is associated with increased risk of adverse outcomes in the perioperative setting.[3,8] Anesthetic, sedative, and opioid medications enhance respiratory depression and airway collapse and thus can exacerbate all forms of sleep-disordered breathing.

Pathophysiology and Diagnosis of Sleep-Disordered Breathing

OSA is characterized by sleep-induced recurrent episodes of upper airway collapse resulting in oxygen desaturations and arousals from sleep more than five times per hour. Central sleep apnea is characterized by diminished or absent respiratory effort, coupled with the presence of symptoms including excessive daytime sleepiness, frequent nocturnal awakenings, or both. Obesity hypoventilation syndrome is the presence of daytime alveolar hypoventilation (awake, sea-level, arterial PCO_2 greater than 45 mm Hg) among patients with body mass index (BMI) 30 kg/m^2 or greater in the absence of other causes of hypoventilation. In this condition, the severely overweight patients fail to breathe rapidly enough or deeply enough, especially during sleep, and results in low blood oxygen and high blood carbon dioxide (CO_2) levels. The three types of sleep disorder can occur in the same patient.

The number of respiratory events per hour is used to grade the severity of sleep-disordered breathing.[9,10] The average hourly number of apnea (90% or more decrease in airflow for apnea of 10-seconds or more) and hypopnea (50% reduction in airflow with 3% or more reduction in SaO_2) events is expressed as the apnea-hypopnea index (AHI).[9,10] An AHI of 5 to 14 is mild, 15 to 29 is moderate, and 30 and greater is severe. Treating sleep-disordered breathing is important as it is associated with (1) intermittent hypoxemia, (2) hypercapnia, (3) excessive intrathoracic pressure changes from inspiration against an obstructed airway, (4) sympathetic activation, and (5) inflammatory endothelial dysfunction.[11,12] Endothelial dysfunction can result in increased risk (1) hypertension, (2) congestive heart failure, (3) atrial fibrillation, (4) pulmonary hypertension, (5) right heart failure, (6) diabetes, (7) obesity, (8) cognitive impairment, (9) depression, (10) stroke, (11) dementia, (12) gastroesophageal reflux, and (13) cancer.[13-18]

Perioperative Management of OSA

OSA is associated with increased perioperative mortality, hospital length of stay, cost of care,[3,19-23] and cardiopulmonary complications that increase admission to intensive care units.[24-27]As indicated previously, about 80% to 90% of patients with sleep-disordered breathing are undiagnosed, which emphasize the need for screening for sleep-disordered breathing among surgical patients.[6,28]

Screening for Sleep-Disordered Breathing

Professional societies have developed clinical practice guidelines for the perioperative management of patients with OSA.[29-33] All guidelines recommend the use of screening questionnaires for OSA such as the STOP-BANG instrument.[34] The STOP-BANG questionnaire screens for common manifestations and risk factors of OSA. The acronym STOP-BANG stands for Snoring, Tired during daytime, Observed to stop breathing during sleep, high blood Pressure, Body mass index greater than 35 kg/m^2, Age greater than 50 years, Neck size greater than 17 inches for men, or 16 inches for women, male Gender.[35,36]

There is also some evidence that adding as assessment of metabolic alkalosis (HCO_3 greater than 27 mmol/L) to the STOP-BANG screening increases the likelihood of detecting obesity hypoventilation in patients with BMI greater than 30 kg/m^2.

Furthermore, nurses in the postanesthesia care unit are in the perfect situation to observe apneic events during patient recovery. Identifying the high risk patient by assessing for apneic events during recovery from anesthesia and communicating the findings with recommendations for increased vigilance and monitoring procedures at hand off will improve patient safety.

Health Care Team Interventions

During the perioperative care period, nursing interventions are essential in facilitating the implementation of screening tools, monitoring, and therapeutic interventions as well the communication of essential information during transfer of care. Communication with the patient about their signs and symptoms of OSA is necessary to ensure outpatient follow-up and treatment.

Nurses should take the initiative to advocate for positive airway pressure (PAP) therapy and to fully understand the mechanism of action and how to troubleshoot difficulties. There is sufficient evidence in a recent systematic review and meta-analysis that found postoperative use of PAP therapy in OSA patients is associated with decreased AHI.[37] There are several forms of PAP therapy used to address the various forms of sleep-disordered breathing (Table 1). The mechanisms of action of PAP therapy in OSA is to increase the pharyngeal transmural pressure (pneumatic splint effect), reducing pharyngeal wall thickness and airway edema, and increasing end-expiratory lung volume.

CPAP or automatically titrated PAP (APAP) is standard first line therapy for most patients with OSA.[38] Modified modes of PAP therapy have been developed to augment ventilation, maximize comfort, and enhance compliance but have not demonstrated increased compliance in randomized controlled trials.[39] PAP therapy should be initiated after confirming diagnosis of OSA through an acceptable method such as polysomnography or home sleep apnea testing. Common practice is to start patients on APAP once the diagnosis of OSA is determined. For moderately obese patients (BMI 35 to 40 kg/m^2) with moderate OSA (AHI 15 to 50), a starting CPAP with 7 to 12 cm H_2O would be near the mean pressure needed for most patients. The newer APAP devices will provide statistics on the previous nights' PAP therapy in the window on front of the device. Patients are able to see if they experienced too much mask leak and if obstructive or central events (residual events) continued to occur during the previous night. If PAP was effective, the residual events should display as less than 5 per minute.

Providing CPAP at levels higher than what is needed to relieve symptoms of OSA (overtitration)

Management of the Patient with Sleep-Disordered Breathing in the Perioperative Setting

- Preoperative screening of all patients for sleep-disordered breathing
- If previously diagnosed and using positive airway pressure (PAP) therapy or an oral appliance at home, educate patient or family member to bring PAP therapy device or appliance to hospital and initiate continuous monitoring during first 48 h postoperatively
- If screened positive or found to have sedation-related apneic episodes in postanesthesia care unit, initiate continuous monitoring, sleep in upright position, and opioid sparing pain management protocol

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Table 1. Positive Airway Pressure (PAP) Therapy: Modes, Mechanisms, and Applications

Mode	Mechanism	Application
Continuous PAP (CPAP)	Single fixed pressure maintained during inhalation and exhalation	Suitable for most obstructive sleep apnea (OSA) patients and some CSA patients and OHS patients as well
CPAP with expiratory relief pressure (ERP)	ERP lowers CPAP during early exhalation	Patients with expiratory pressure discomfort
Automatically titrated PAP	Devices deliver a range of pressure in response to the presence of airway obstruction. Pressure is same during inhalation and exhalation	Patients with uncomplicated, moderate-severe OSA who need significantly different PAP during different sleep positions (supine vs lateral) or sleep stages (REM vs NREM).
Bilevel PAP	Two fixed levels of PAP are provided, a higher inspiratory PAP and a lower expiratory PAP	Patients in need of both expiratory and inspiratory assist (eg, neuromuscular disease, obesity hypoventilation syndrome, and COPD)
Adaptive servo ventilation	Baseline PAP with variable pressure support for each breath adjusting for both hyperventilation and hypoventilation to maintain preset minute ventilation	Patients with breathing periodicity with or without coexistent OSA (eg, NMD, chronic opioid use, or treatment-emergent CSA)
Volume assured pressure support	Pressure is automatically adjusted with each breath to ensure preset tidal volume	Patients with variable needs from breath to breath such as patients with overlap syndrome (OSA with [COPD]), OHS, restrictive lung disease, and neuromuscular disease weakness

CSA, central sleep apnea; OHS, obesity hypoventilation syndrome; REM, rapid eye movement; NREM, nonrapid eye movement; COPD, chronic obstructive pulmonary disease; NMD, neuromuscular disease.

can contribute to the development of treatment-emergent central apnea and intolerance by the patient.[40] Adaptive servo ventilation is suitable when the pathophysiology of sleep apnea results in periodic breathing including cases of treatment-emergent central sleep apnea and in patients with opioid-induced central sleep apnea.[41-43]

Common but mild adverse effects of PAP therapy include skin breakdown and dryness of the eyes, nose and mouth. Rare but serious adverse effects may include epistaxis and pneumothorax.[44] Social adverse effects relate to bed partner disturbance or intolerance, and reduced self-image, although bed partners frequently appreciate the cessation of snoring. Addressing these adverse effects improves compliance, which is estimated to be 50% to 70%.[45] Newer masks help address issues related to skin breakdown, and bulkiness and noise of the device. Heated humidification can reduce symptoms of dryness and congestion of the eyes, nose, and mouth and has been shown to improve compliance with CPAP therapy.[46] Mask selection, nasal versus full face mask, might affect patient tolerance of and compliance with CPAP therapy. Patient education and follow-up appear to be the most important factors in enhancing compliance with PAP therapy, and early compliance (1 week) is a predictor of later compliance (1 month).[46]

Case Presentation 1

A 62-year-old man with obesity (BMI 35 kg/m^2), hypertension, snoring, excessive daytime sleepiness is admitted to the hospital for the treatment of leg cellulitis. He does not have a confirmed diagnosis of OSA, but was noted to have loud snoring and periods of apnea while sleeping in the hospital. As the hospital does not provide sleep study equipment for diagnosis of OSA, the nurses initiated opioid sparing, multimodal pain management strategies along with continuous monitoring using capnography.

Rationale

Loud snoring and observed apneas is highly indicative of OSA. Nurses play an important role in identifying OSA through their recognition of these symptoms, particularly in patients without partners at home to advise them of their presence. Treating his OSA may improve healing, decrease lower extremity swelling, and in some cases perhaps decrease length of stay. Home sleep tests (in this case unattended in hospital sleep tests) meet the standards for diagnosing OSA if interpreted by a physician boarded in sleep medicine.[47,48] In situations where unattended in-hospital sleep tests are not available, it is prudent to institute opioid-sparing pain management strategies and increased monitoring strategies. To date, there is not sufficient evidence to institute pre-emptive PAP therapy without a diagnostic study. Discharge planning should include educating the patient on their symptoms and providing communication to their primary care provider to initiate a referral for a sleep study.

Case Presentation 2

A 56-year-old woman with moderate obesity (BMI 32 kg/m^2), rheumatoid arthritis, and severe OSA (AHI 34) that is being treated with nightly CPAP of 8 cm H_2O is using her device that she brought from home. She was admitted to hospital floor after total abdominal hysterectomy. Postoperatively the patient was requiring frequent doses of analgesics including opioids for her surgical pain and chronic pain because of rheumatoid arthritis. She was placed on continuous, supplemental oxygen at 2 L/minute via CPAP at her home settings of 8 cm H_2O. The patient is witnessed to have apneas and irregular breathing after opioid use. Respirations are noted to be less than 10 per minute on assessment. There is no snoring noted. Her level of consciousness is level 3 on the Pasero Opioid Sedation Scale reflecting drowsiness yet arousable, but drifts off to sleep during conversation. The nurse holds further opioid pain medications and initiates a call to the unit provider and the respiratory therapist. As the patient is exhibiting signs of central sleep apnea, the CPAP was switched to an autotitrating adaptive servo ventilation device.

Rationale

Opioids in combination with anesthetics have resulted in the development of central sleep apnea/complex sleep apnea. Complex sleep apnea is the combination of obstructive events and central events. Opioids cause respiratory depression by suppressing respiratory drive, but they also can worsen OSA by decreasing pharyngeal tone. Increasing the CPAP pressure is reasonable, but pressures too high can increase central sleep apnea events. Just using CPAP or increasing CPAP pressures will not prevent apneic episodes during periodic breathing. This patient is also on supplemental oxygen therapy, which may obscure concurrent hypoventilation. When using electronic monitoring in this patient capnography would be the best choice for monitoring patients on supplemental oxygen therapy because of the oxygen masking respiratory depression as measured by pulse oximetry. The difficulty arises with using capnography cannulas and a CPAP mask. There are adaptive masks available to allow both capnography monitoring and CPAP use. The best outcome for a patient occurs when there is communication among the patient, family, nurse, respiratory therapist, and physician to address patient complaints and concerns by a teamwork approach. Also, it is important to educate the patient on their sensitivity to opioids and communicate this finding to their primary care provider.

Conclusions

Sleep is a most vulnerable state for respiration and with the addition of sedating agents, breathing can rapidly decline resulting in adverse outcomes for our patients. Adverse events can be avoided with accurate assessment for signs and symptoms of OSA and obesity hypoventilation syndrome followed by implementation of opioid-sparing pain management as needed. The use of PAP therapy in the postoperative setting is useful in preventing OSA-related adverse events. Adequate monitoring strategies must be put in place, especially in the first 24 to 48 hours postoperatively. As nurses are not available at the bedside during sleep to monitor respiration, electronic monitoring is recommended by many professional organizations including the American society of Anesthesiology and the Anesthesia Patient Safety Foundation. Although capnography is becoming more widely available, continuous pulse oximetry may be more comfortable for the patient and not interfere with PAP therapy such as seen with capnography nasal sensors. Oxygen therapy can mask respiratory events by acting to minimize association desaturations when using pulse oximetry. Newer monitoring systems are being developed, including noninvasive measurement of minute ventilation.[49] Nurses play a vital role in troubleshooting and supporting the use of continuous electronic monitoring during the patient care.

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