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Evidence-Based Practice Guidelines for the Surgical Patient with Obstructive Sleep Apnea

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Abstract

Obstructive Sleep Apnea (OSA) is a medical condition which many people may be affected by but may be unaware of the presence of the condition. The incidence of OSA has increased in direct correlation with the rising rate of obesity in the general population. While chronic conditions may arise if OSA goes untreated, patients with OSA also have an increased risk for acute complications following surgical procedures such as airway obstruction, hypoxia, brain damage, and death. Many anesthetic medications administered during surgery exacerbate the pathological consequences of OSA, predisposing patients to adverse respiratory events during the recovery period following a procedure. As advancements in medicine and the methods of anesthesia delivery continue to be made, there are certain techniques which can be included in the care plan of a patient with OSA to mitigate the risks associated with the disease. This project aims to create evidence-based practice guidelines (EBP) for the care of patients with OSA who may be at an increased risk for developing respiratory complications following surgical procedures. It was developed utilizing The Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Healthcare. Although many of the postoperative complications seen in patients with OSA are preventable, updated guidelines for the care of this patient population have not been published since 2014. As a current nurse anesthesia graduate student, this scholar aims to explore the topic and to identify the safest way to provide anesthetic care for patients with OSA.

Keywords: obstructive sleep apnea, respiratory failure, regional anesthesia, capnography, body mass index

Identifying Triggering Issues/Opportunities

Introduction

As healthcare evolves and surgical procedures are being performed less invasively and more efficiently, more procedures than ever are being completed at outpatient surgery centers rather than the hospital setting. The ability to perform procedures at outpatient surgery centers saves time and resources for both healthcare systems and patients (Shapiro et al., 2014). However, there are certain populations at high risk for postoperative complications. Populations with increased risks of postoperative complications due to respiratory failure include those who are obese and those with obstructive sleep apnea. According to Nagelhout and Elisha (2017), around 75% of adults in the United States are classified as being obese. One study reports the rate of obesity continues to rise, stating the obesity prevalence was 10% for men and 16% for women from 1959-1962, and has increased to 32% for men and 36% for women from 2007-2008 (Inoue et al., 2018). Furthermore, Hallowell et al. (2007) suggests 71-77% of patients with a body mass index (BMI) greater than 35kg/m^2 have OSA. The increasing prevalence of obesity is significant for anesthesia providers because of the significant risk of OSA and postoperative respiratory failure associated with the disease. The Society of Anesthesia and Sleep Medicine (2022) states anywhere from 60-90% of patients with OSA are without a formal diagnosis. The implementation of preoperative screening tools such as the STOP-Bang questionnaire allows anesthesia providers to determine if someone is suspected to have OSA. However, the general problem is that there is not an up-to-date evidence-based practice guideline for the intraoperative or postoperative care for patients who have been diagnosed with or are suspected to have OSA (The Society of Anesthesia and Sleep Medicine, 2022). The intent of this project is to help identify patients at risk for OSA who present for surgery and to help provide practice changes to

decrease the risks of respiratory complications which anesthesia predisposes patients to developing.

Background

Obesity predisposes people to developing additional health complications, one of which many people are unaware of. OSA affects nearly 18 million Americans with its incidence increasing in direct proportion to increasing levels of obesity (Spence et al., 2015). While preoperative screening tools exist to assess for patients at risk for having OSA, a formal diagnosis is made only after completion of polysomnography, or a study in which a patient sleeps under medical observation to assess his/her apnea-hypopnea index (AHI) (The Society of Anesthesia and Sleep Medicine, 2022). Apnea is the cessation of airflow for more than ten seconds, while hypopnea is considered a 50% reduction in airflow for ten seconds that occurs 15 or more times per hour of sleep while also being associated with snoring and 4% or more reduction in oxygen saturation (The Society of Anesthesia and Sleep Medicine, 2022). Obesity predisposes patients to having OSA because the presence of more adipose tissue in the neck and pharyngeal areas increases the likelihood that a patient's airway periodically collapses as the upper airway muscles relax during the respiratory cycle. Since polysomnography is an additional test requiring patients' time and medical resources, it is often not completed.

Respiratory failure is defined as the respiratory system failing to exchange one or both gas exchange functions required for the normal physiologic functions of cells in the body: the provision of oxygen and elimination of carbon dioxide (CO2) (Roussos & Koutsoukou, 2003). Through blood gas analysis, respiratory failure is technically defined as a partial pressure of arterial oxygenation less than 60 mmHg, a partial pressure of arterial CO2 greater than 45 mmHg, or both (Roussos & Koutsoukou, 2003). There are two mechanisms which must function

appropriately for adequate gas exchange to occur. The lung tissue must function appropriately to allow diffusion of oxygen and CO2 across the alveolar membranes to and from the capillaries in circulation. Furthermore, the body utilizes a pump which consists of the chest wall, diaphragm, respiratory muscles, and the respiratory control centers in the central nervous system which respond to changing levels of CO2 and oxygen in the blood (Roussos & Koutsoukou, 2003). Generally, failure of gas exchange in the lung is caused by pathologic processes such as pneumonia, emphysema, and interstitial lung disease while failure of the pump is caused by trauma, obstruction, and drug overdose (Roussos & Koutsoukou, 2003). Failure of the lung and hypoxemia is defined in the literature as type I respiratory failure, while failure of the pump resulting initially in hypercapnia is identified as type II respiratory failure (Roussos & Koutsoukou, 2003). With type II respiratory failure, although hypoxemia often accompanies hypercapnia, the hallmark of ventilatory failure is an increase of arterial CO2 greater than 45 mmHg (Roussos & Koutsoukou, 2003). In the context of OSA, the mechanism of respiratory compromise is type II respiratory failure, which left untreated ultimately leads to hypoxia, brain damage, and death. The most definitive intervention for respiratory compromise related to a failing pump consists of endotracheal tube intubation and mechanical ventilation which restores the functions of the failing pump. To detect hypercapnia which precedes hypoxemia in type II respiratory failure, monitoring of end tidal carbon dioxide (ETCO2) is beneficial for patients with OSA in the postoperative period for the early detection of respiratory compromise. ETCO2 readings are 2-5 mmHg less than arterial CO2 concentrations (Corn, 2000). It is important for healthcare providers to acknowledge this fact when monitoring patients for respiratory failure in the event an arterial blood sample is not easily obtainable.

Post-surgical respiratory failure is not limited to patients who are obese with suspected OSA or those who are diagnosed with OSA. Most literature focuses on all causes of postoperative respiratory failure, rather than instances where OSA is thought to be the sole cause. Postoperative respiratory failure can be caused by a myriad of complications such as, "hypoxemia, hypercarbia, hypoventilation, opioid administration, or a composite metric of postoperative pulmonary complications which include a wide variety of pathologies" (Rao & Khanna, 2018, p. 2). Rao and Khanna (2018) indicate obesity and OSA, among other comorbidities, are commonly seen in patients who require intensive care unit (ICU) admission because of postoperative respiratory failure. "Audits of ICU admissions suggest that 17-47% of unplanned ICU admissions have a respiratory indication, and that the rate of unplanned ICU admissions is up to 91% higher in patients with postoperative pulmonary complications" (Rao & Khanna, 2018, p. 4). The cost accrual from an admission due to postoperative respiratory failure does not stop once the patient is admitted. Depending on the severity of complications, patients with postoperative respiratory failure may spend days in the hospital, using resources and increasing costs.

One study focused on patients who underwent noncardiac procedures ranging from orthopedics to open abdominal procedures. In this study, Memtsoudis et al. (2011) found obese patients were five times more likely to have OSA than their nonobese counterparts. At the conclusion of the study, Memtsoudis et al. (2011) reported OSA increased the odds ratio for the need of tracheal intubation and mechanical ventilation by five-fold following orthopedic surgery, with the risk being even higher for patients undergoing abdominal procedures. It concluded OSA is an independent risk factor for pulmonary complications during and after surgical procedures requiring general anesthesia with mechanical ventilation (Memtsoudis et al., 2011). Additionally,

Mutter et al. (2014) completed a cohort study among patients with diagnosed OSA, undiagnosed OSA, and those without OSA. The results showed an increased risk of postoperative respiratory complications for patients with OSA, with a slight reduction in respiratory complications seen in patients with diagnosed OSA versus those with undiagnosed OSA (Mutter et al., 2014). These findings further emphasize the need for guidelines for postoperative care in patients with OSA, regardless of having a formal diagnosis.

Due to the prevalence of undiagnosed OSA, the STOP-Bang questionnaire has been adopted as a preoperative screening tool to help anesthesia providers determine a patient's risk for OSA. The table can be seen in Appendix C. Although there is variance in the OSA prescreening practices among hospitals and surgical facilities, the STOP-Bang questionnaire is utilized in many organizations as it can be completed quickly and has a high sensitivity for accurate diagnosis (Chung et al., 2016). Chung et al. (2016) suggests the reference standard for the diagnosis of OSA is an overnight polysomnogram to assess a patient's AHI. However, the completion of a polysomnogram is time consuming, labor intensive with a sleep study specialist, and expensive (Chung et al., 2016). Chung et al. (2016) found that there is a lack of resources for the completion of polysomnography studies in the general population, with patients in Canada waiting 11.6 months for the testing and initiation of continuous positive airway pressure (CPAP) in the event an OSA diagnosis is made. The STOP-Bang questionnaire was developed to provide a concise and user-friendly preoperative screening tool and has been well utilized with a sensitivity of 93% for predicting moderate to severe OSA and 100% for detecting severe sleep apnea (Chung et al., 2016). Although the STOP-Bang questionnaire is highly utilized among healthcare providers, the intraoperative and postoperative management of patients identified for being at risk for complications related to OSA varies greatly. Based on the knowledge and the

increased risk of complications patients with OSA have, the question arises as to why so much emphasis has been placed on determining patients at risk for OSA, but no concrete guidelines have been developed to care for patients following surgery as they recover from anesthesia.

As more awareness of OSA has developed over the years, more healthcare providers are trying to mitigate the risk factors following surgery which are associated with the disease process. The Society of Anesthesia and Sleep Medicine developed a committee titled The OSA Death and Near Miss Registry Committee with the goal of creating a database of critical patient events related to OSA (Bolden et al., 2020). The committee aims to provide a clearer understanding of why adverse events occur in patients with OSA and to determine interventions which have the potential to minimize these events (Bolden et al., 2020). The committee's study is very specific to OSA as the scenarios they review have complications directly related to OSA as determined by two of the three reviewing physicians on their team (Bolden et al., 2020). It is known that compounding effects of opioids and sedative medications decrease patients' respiratory drive, putting them at risk for respiratory compromise following surgery (Bolden et al., 2020). The results of one study showed 56% of the serious adverse events occurred while the patients were in the hospital, while 21% occurred after patients were discharged home (Bolden et al., 2020). Furthermore, the study showed all patients with critical adverse events following discharge were prescribed opioids to take at home. Incidentally, the article reports postoperative monitoring for the cases occurring in the inpatient setting consisting of intermittent and continuous pulse oximetry, but no utilization of ETCO2 monitoring.

Significance of the Problem to Nurse Anesthesia

Considering nurse anesthetists are referred to as "airway experts" by many healthcare providers, respiratory complications following surgery are of great concern for them. Nurse

anesthetists are specialized healthcare providers who are responsible for the management of a patient's airway to ensure adequate ventilation and systemic tissue oxygenation. The three main components of anesthetic plans are often considered as amnesia, analgesia, and akinesia. The medications which nurse anesthetists administer to successfully achieve adequate amnesia, analgesia, and akinesia can potentially hinder patients' physiologic respiratory mechanics.

Anesthesia providers have a significant responsibility to ensure patients with OSA have individualized anesthetic plans accounting for the disease process and ensuring full recovery from any hindrance in respiratory function caused during a surgical procedure.

Rao and Khanna (2018) found that postoperative respiratory failure is the fourth most common cause of postoperative complications which contributes significantly to patient morbidity and mortality. While many reviewed texts and articles provide different lists of factors contributing to postoperative respiratory failure, one common patient factor leading to respiratory complications following surgery is OSA (Rao & Khanna, 2018). The development of postoperative guidelines to care for patients with diagnosed or suspected OSA may decrease the incidence of postoperative respiratory failure and prevent prolonged stays following surgery. One meta-analysis discovered patients with suspected OSA had a nearly 2.5-fold increased risk for developing postoperative respiratory failure and an unplanned admission to an intensive care unit (ICU) (Hai et al., 2014). In a retrospective case-control study completed in a group of patients undergoing elective orthopedic surgery, unanticipated respiratory failure led to ICU admission in roughly 1% of the population (Melamed et al., 2016). The incidence of respiratory failure following thoracic and open abdominal procedures was higher than patients undergoing orthopedic procedures (Rao & Khanna, 2018). These events are associated with extreme complications, higher mortality, longer length of hospital stay, and significantly increased

hospital costs (Melamed et al., 2016). Branson (2013) suggests the cost of postoperative pulmonary complications is near $52,000 per patient. Noble (2018) similarly found the average cost of a respiratory failure event amounts to $53,502. While patient safety is the first and foremost priority when caring for patients with OSA undergoing surgery, complications that do arise place additional strain on healthcare systems and lead to the accrual of unnecessary costs.

The guidelines proposed with this project may improve patient safety following surgical procedures, decrease healthcare costs, and preserve resources for other critically ill patients. Improvements in postoperative care for patients with OSA and other populations at high risk for OSA may also allow more procedures to be completed on an outpatient basis, decreasing costs and the risk of complications. In patients with postoperative respiratory complications related to OSA, the common consensus is that they can be prevented if a combination of patient monitoring and treatments are implemented in the perioperative and postoperative periods.

PICOT Question

In patients diagnosed with obstructive sleep apnea (OSA) or suspected to have OSA with a STOP-Bang score greater than 3 undergoing anesthesia, how would the development and implementation of evidence-based practice (EBP) guidelines for OSA management versus a traditional approach, affect respiratory failure rates and patients' length of stay following surgery?

Project Objectives

- Develop EBP guidelines for the intraoperative and postoperative management of patients at risk for respiratory complications due to OSA.
- Develop a system to implement the EBP guidelines for the care of patients with OSA.

- Determine how to evaluate and adjust the EBP guidelines if initial outcomes do not show a decrease in the incidence of postoperative respiratory failure in patients with OSA.

Conceptual Framework

Conceptual frameworks are comparable to maps which define the steps required to connect all the different aspects of a scholarly project (Moran et al., 2019). They are also tools to help researchers interpret findings to determine the effectiveness of proposed practices, and whether adjustments can be made to produce the intended outcomes of the project. (Moran et al., 2019). The conceptual framework utilized to guide this scholarly project with the aim to improve postoperative patient outcomes related to OSA is the Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Health Care (IMR). The IMR is a framework presented in a simple diagram which asks a question at each step (Cullen et al., 2022). If the answer to a question is "yes", the researcher proceeds to the next step (Cullen et al., 2022). If the answer is "no", it provides instructions on what to do next to develop a legitimate EBP research project (Cullen et al., 2022). Permission to utilize the Iowa Model Revised framework for this scholarly project was requested and approved on June 21st, 2022. The outline can be seen in Appendix A. The remainder of this paper is broken down into the individual steps of this framework and descriptions are provided explaining how each step pertains to the project objectives.

Assemble, Appraise, and Synthesize the Body of Evidence

Literature Review

In this scholarly project, a key point is identifying the care practices which improve the safety of surgical procedures for patients with OSA. The first step of the IMR involves identifying an area or topic of interest in which a change in practice can impact patient outcomes (Cullen et al., 2022). Since many studies have been published reviewing all the different causes

of postoperative respiratory failure, this project aims to focus solely on the risk factors associated with OSA. Although only a portion of postoperative respiratory complications are linked to OSA, this scholarly project focuses on the postoperative outcomes for that specific population, ultimately working to decrease the incidence of respiratory complications following surgery.

The second decision point in the IMR involves finding evidence not only to confirm there is a problem, but also to support the guidelines which are being proposed within a scholarly project. In this step, the IMR asks, "Is there sufficient evidence?" (Cullen et al., 2022). The comprehensive research completed to answer the above questions involves critical evaluations of articles from the following databases: Medline with Full Text, Cochrane Database of Systematic Reviews (CDSR), the Cumulative Index of Nursing and Allied Health Literature (CINAHL), and PubMed. Initial searches regarding OSA and its role in causing postoperative respiratory complications returned thousands of articles with very few specific to the topic. While many sources cite OSA as possibly being a contributing factor, most sources study the broad topic of postoperative respiratory failure, failing to provide in-depth information regarding OSA. Consequently, 24 of the first articles returned within the initial searches including "postoperative respiratory failure" and "unplanned postoperative admissions" had to be omitted. The articles did not identify OSA as the primary cause contributing to patient's respiratory complications. Moving forward in the literature review, search phrases were adjusted, and articles were only included if they provided information identifying OSA as an independent risk factor for postoperative pulmonary complications.

To develop the proposed guidelines for the postoperative care of patients with OSA, 40 articles were reviewed which suggested varied interventions for the postoperative management of patients with OSA. Of the 40 articles, 12 were selected to guide the development of the

guidelines by identifying the most supported interventions to improve postoperative outcomes in patients with OSA. The time frame was adjusted to include documents from years between 2008 to 2022. The last recommendations for the postoperative care of patients with OSA were released in 2014. This literature review aims to develop the most recent and up to date guidelines for the care of patients with OSA. The articles selected from the following searches provide the basis for the rest of the literature review and the development of the evidence-based guidelines.

Capnography in the Postoperative Period

The first component of the EBP guidelines includes the implementation of capnography monitoring for patients diagnosed with OSA or who have a STOP-Bang score of 3 or higher during the entire postoperative period. The phrase “capnography monitoring and OSA” was utilized within PubMed’s database which returned 433 articles. Filters included full text articles with published dates ranging from 2010-2022. Richardson et al., (2016) conducted a systematic review which included other systematic reviews, meta-analyses, randomized controlled trials, clinical trials, and economic studies. Richardson et al. (2016) chose to perform full text reviews on 200 of the 2,753 documents returned with their initial literature search. Of the 200, 29 articles were selected to be utilized within the review. While the study did not find statistically significant data supporting the use of capnography in the postoperative arena for patients with known OSA due to the lack of sufficient articles, it did discover that capnography resulted in earlier detection of respiratory events and prevented hypoxemia in the population of patients undergoing procedural sedation (Richardson et al., 2016). Hence, ETCO2 monitoring is included as a guideline for this scholarly project.

While monitoring oxygenation via pulse oximetry is a tool utilized during every surgical procedure and frequently in the postoperative period, it is not as sensitive for the early detection

of hypoventilation as ETCO2 monitoring. This is especially prevalent with patients who are on supplemental oxygen. The study completed by Moradian et al., (2021) was a randomized clinical trial evaluating the use of capnography in patients who underwent coronary artery bypass grafting. While indicating the capnography may be an earlier indicator for respiratory failure than pulse oximetry, the study is limited by its sample size of 70 patients. Additionally, anesthetic medications and opioids decrease patients' normal respiratory efforts in response to elevated levels of carbon dioxide (CO2) in the blood (Moradian et al., 2021). ETCO2 monitoring can diagnose hypoventilation in the postoperative period sooner and may be more cost effective than performing arterial blood gasses to determine whether a patient meets extubation criteria (Moradian et al., 2021). Although a patient's pulse oximeter reading may not show a decline, the early phase of hypoventilation will lead to the accumulation of CO2 in the blood, which will prevent homeostasis and result in an acidotic state not compatible with normal cellular function (Bolden et al., 2020). If left untreated, the decrease in ventilation can result in arterial hypoxemia and progress to potentially life-threatening circumstances.

While another one of the guidelines proposed by this scholarly project is to prohibit patients with BMIs greater than 45 kg/m² from undergoing surgery at outpatient surgery centers and from receiving opioids postoperatively, there still will be patients with BMIs less than 45 kg/m² with OSA who may receive opioids. A case-controlled study completed over the course of five months found that nine of the 634 total patients who received patient-controlled analgesia developed respiratory depression (McCarter et al., 2008). The study was conducted within the Main Line Health system in Philadelphia, Pennsylvania which includes four acute care hospitals (McCarter et al., 2008). In all nine instances of patients who developed respiratory depression, the capnography monitoring system alerted nurses of respiratory compromise by detecting

decreases in respiratory rates, apneic events, and increased concentrations of ETCO2 before decreases in pulse oximetry readings occurred (McCarter et al., 2008). The study concluded that monitoring respiratory rate and ETCO2 concentrations was more effective than monitoring oxygen via pulse oximetry alone (McCarter et al., 2008). The guideline of implementing capnography following anesthesia for patients with OSA may provide insight to its effectiveness for preventing respiratory failure following surgery within this specific patient population.

The ASA currently has recommendations for the care of obese patients at risk for OSA which have not changed since 2014. However, these recommendations are often up to interpretation by the surgeons and the anesthesia providers on a case-to-case basis. A full list of recommendations is provided in Appendix B. Using these recommendations as a reference, some of the interventions relevant to this scholarly project include considering a regional nerve block when appropriate and using short acting opioids such as remifentanil during the intraoperative period (Nagelhout & Elisha, 2017). According to the recommendations, the use of CO2 monitoring is only recommended during the intraoperative period. It does include the recommendation to avoid the use of high-dose postoperative opioids but does not indicate changes in postoperative patient care in the event opioids are required following surgery (Chung et al., 2016). Despite the presence of the recommendations, postoperative respiratory complications in patients with OSA continue to occur.

BMI restrictions for outpatient surgeries

Within the ASA recommendations previously mentioned, there is not an area which addresses the body habitus of patients undergoing surgery. Formerly viewed solely by a patient's weight in pounds or kilograms, providers have adopted the Body Mass Index (BMI) as a better indicator of a patient's height to weight distribution. BMI is measured in kg/m^2. The safety of

performing outpatient surgery in patients at risk for having OSA is controversial. Some practitioners feel patients with OSA are not safe candidates for same day surgeries, while others feel same day surgery is appropriate in the OSA population if there are no unmanaged comorbidities present such as uncontrolled diabetes or hypertension. Considering the strong relationship between obesity and OSA, utilizing the BMI measurement and developing a cut off limit for outpatient surgeries may decrease the incidence of postoperative respiratory complications.

A literature review performed within the CINAHL Plus with full text database utilizing the terms "BMI and outpatient surgery" returned 71 results. One study sought to identify a BMI limit for patients undergoing open abdominal hernia repair in the outpatient setting. The study discovered the incidence of patient readmission within 30 days of the procedure increased by 6% for every 5-point increase in BMI (Vlessides, 2019). While the author suggests considering the type of procedure and patient factors other than BMI for determining the appropriateness of undergoing procedures on an outpatient basis, he recommends the BMI cutoff for outpatient procedures be 45 kg/m² (Vlessides, 2019). For the sake of this project and to eliminate provider judgment on a patient's health status, a BMI limit of 45 kg/m² has been selected as the limit for surgeries being completed on an outpatient basis.

A retrospective cohort study assessed the relationship between patient BMIs and same day hospital admissions following tonsillectomies performed at outpatient surgery centers**.** This study evaluated the likelihood of hospital admissions within three different BMI ranges: 40-50 kg/m², 50-60 kg/m², and greater than 60 kg/m². The results concluded that patients with BMIs between 40-50 kg/m² had a 1.3-fold increased risk of same day admission following tonsillectomy compared to patients with BMIs less than 40 kg/m² (Gabriel et el., 2021). The

results showed patients with BMIs 50-60 kg/m² had increased admission rates by 2-fold when compared to patients with BMIs less than 40 kg/m² (Gabriel et el., 2021). The study did not show statistically significant increases in same day admissions following tonsillectomies for patients with BMIs greater than 60 kg/m², but Gabriel et al. (2021) suggests that may be attributed to the small number of patients in this weight class undergoing the procedures on an outpatient basis. These findings further support the decision to set the BMI cutoff limit for outpatient procedures at 45 kg/m² as a part of the proposed guidelines.

Regional Anesthesia

With the onset and persistence of the opioid epidemic and the adverse effects of their use resulting in addiction and death, regional anesthesia and other methods of pain management are becoming more common. While opioids are still appropriate to use in certain scenarios and play a large role in many anesthetic plans, some patient populations are at higher risk for adverse outcomes following opioid administration. Opioids bind to receptors in the central nervous system and block pain impulses while also reducing the brain's responsiveness to increasing levels of CO2 in the blood, causing decreased respirations (Coczowicz & Memtsoudis, 2021). While patients with OSA already experience intermittent episodes of apnea with increasing levels of CO2 and decreasing levels of oxygen in the blood, it is evident patients with OSA are at an increased risk for adverse respiratory events following opioid administration.

A literature search was conducted within the PubMed database utilizing the search phrase "regional anesthesia and OSA." The search returned thirteen results, three of which were utilized for this study. The first source is a retrospective analysis which compared the complications seen in patients who underwent a total hip arthroplasty (THA) under general anesthesia with opioids to those who had the same procedure but with regional anesthesia. The analysis reviewed a total

of 349,008 patients who underwent THA surgery in Florida, New York, Maryland, and Kentucky between 2007 and 2014 (Golaz et al., 2021). Within this patient population, 18,063 of those patients also had a diagnosis of OSA (Golaz et al., 2021). Interestingly, the study saw an increase in the prevalence of OSA from 1.7% in 2007 to 7.1 % in 2014 (Golaz et al., 2021). Although the study did not find a statistically significant difference in morbidity and mortality associated with OSA in patients who underwent THA, it found that patients with OSA had a longer length of stay following surgery compared to patients who underwent the THA without OSA (Golaz et al., 2021). However, longer lengths of stay and increased 30-day readmission rates were seen in patients with OSA who underwent the procedure with general anesthesia and opioids compared to those who received regional anesthesia (Golaz et al., 2021). These articles provide solid support for the use of regional anesthesia techniques as opposed to general anesthesia with opioids.

Another idea to consider is that the increased accessibility and use of ultrasound in today's anesthesia practice has the potential to increase the number of providers qualified to incorporate peripheral nerve blocks for the management of perioperative and postoperative surgical pain. If more providers are trained to utilize ultrasound to place peripheral nerve blocks and they become skilled at providing regional anesthesia, the amount of opioid used for pain management may significantly decrease. An article previously cited indicated 21% of the patients with known OSA who experienced critical events were prescribed opioids to take at home following their procedures (Bolden et al., 2020). Chitnis et al. (2020) states the implementation of peripheral nerve block techniques significantly decreases the amount of opioid administration during the procedure and following the procedure. Peripheral nerve blocks therefore significantly decrease the risk of postoperative respiratory failure related to opioid

administration, especially in patients who have OSA and are predisposed to developing postoperative respiratory complications.

The third source discovered within the PubMed search was a cohort study which studied patients who underwent a total knee arthroplasty (TKA) at a hospital in Singapore. This cohort study indicated that patients who underwent a TKA under general anesthesia with opioids stayed in the hospital one day longer than patients who underwent the same procedure with regional anesthesia (Ji & Ke, 2021). While this article did not specifically indicate OSA as a contributing factor related to patients increased length of stay following general anesthesia, it has evidence supporting improved patient outcomes following a surgical procedure in which regional anesthesia was used. Considering OSA is associated with increased pulmonary complications following surgery and prolonged hospital stays, it can be concluded that the use of regional anesthesia opposed to general anesthesia with the primary pain management being provided with opioids is of benefit for patients with OSA who undergo TKA.

The same search (regional anesthesia and OSA) performed in the MEDLINE with Full Text database yielded 17 results, which one expert opinion was utilized for the sake of this literature review. Cozowicz and Memtsoudis (2021) reviewed many sources and indicated the use of neuraxial anesthesia and peripheral nerve blockade compared to general anesthesia in patients undergoing orthopedic surgery was associated with a decrease in pulmonary complications, mechanical ventilation, ICU admissions, lengths of stay, and hospital costs in the patient population with OSA. Their research also suggested that general anesthesia is a risk factor for hypoxemia in patients with OSA (Coczowicz & Memtsoudis, 2021). Furthermore, Cozowicz and Memtsoudis (2021) discovered general anesthesia with the use of opioids resulted in patients with OSA having an increased apnea hypopnea index in the postoperative period

associated with an exacerbation of nocturnal hypoxemia and hypercapnia. This expert opinion includes evidence from many other resources indicating the benefits of anesthesia techniques besides general anesthesia in patients with OSA.

Furthermore, the cost benefit of regional/neuraxial anesthesia versus general anesthesia must be considered. Anselmi et al. (2021) conducted a systematic review which discovered local or regional anesthesia accrued lower costs when compared to general anesthesia when performed at an ambulatory setting. The article suggests that reductions in operating time, post-anesthesia recovery time, and lengths of stay in the hospital following local or regional anesthesia could all contribute to the decrease in costs. (Anselmi et al., 2021). This is simply another example supporting the utilization of regional anesthesia to decrease the use of time and resources for both patients and hospital systems when compared to general anesthesia.

Summary of the Literature

The most strongly supported interventions in the literature with the greatest potential to decrease respiratory complications following surgery in patients with OSA include the utilization of postoperative ETCO2 monitoring, the implementation of a BMI cutoff limit for outpatient surgery centers, the use of regional anesthesia without opioids in obese patients, and the use of positive airway pressure (PAP) immediately following surgery. While the consensus of the articles reviewed indicates PAP therapy following surgery is beneficial for preventing postoperative respiratory compromise, some resources found its effects were negligible due to limits with patient compliance. While PAP is recommended in many publications, there is no guideline for the implementation in most patients with OSA because most patients are undiagnosed with the disease. Therefore, patients have never used a continuous positive airway pressure (CPAP) machine and are unfamiliar with them. Lee and Sundar (2021) state PAP is the

first line treatment for OSA, citing it as being “efficacious, cost-effective, and noninvasive” (p. 92). However, the article also reveals one third of people who have been diagnosed with OSA and have a CPAP machine at home are non-compliant and wear the machine less than seven hours per night (Lee & Sundar, 2021). There is room for improvement in the formal diagnosis for patients with OSA. While it sounds relatively easy to set up all patients at high risk for OSA with a CPAP machine in the immediate postoperative period, there are limitations to this practice. Patients can be disoriented following surgery as they are recovering, and the anesthetic medications continue to be removed from circulation. If they are not familiar with the use of a CPAP machine prior to surgery, it is highly unlikely they will tolerate it postoperatively as they are recovering from anesthesia (Lee & Sundar, 2021). Ways to improve patient compliance with CPAP include proper preoperative screening and formal testing for OSA, education regarding risk factors associated with OSA, and appropriate mask fitting for patients (Lee & Sundar, 2021). Unfortunately, this project does not allow the time and resources required to perform polysomnography studies for all patients with a STOP-Bang score greater than 3. For this EBP guideline implementation, the use of PAP will not be evaluated because of time constraints and additional costs. A separate study would need to be completed to fully understand the impact of a formal sleep apnea diagnosis, proper PAP mask fitment, and levels of compliance in the postoperative recovery of patients with OSA.

Design and Pilot the Practice Change

Determining and engaging the desired patient population

The proposed clinical site for implementation is a level one trauma center located in an inner city within the mid-west United States and its affiliated outpatient surgery centers. In addition to trauma services, the site routinely performs a multitude of inpatient and outpatient

surgery types including obstetrics. The patient population in focus includes all surgical patients previously diagnosed with OSA as well as those who are determined to be at risk of having obstructive sleep after scoring 3 or greater following completion of the STOP-Bang questionnaire prior to undergoing surgery.

Consider resources, constraints, and approval

To implement the proposed project, many stakeholders will be involved. Approval must be granted by the surgery, anesthesia, finance, nursing, and risk management departments within the facility. To identify the incidence of postoperative respiratory failure in patients with OSA prior to the implementation of the proposed guidelines, the Quality Improvement Department of the facility will need to evaluate the records of past patients. Constraints may involve the cost to acquire monitoring devices capable of obtaining capnography readings in all post anesthesia care units (PACUs), obtaining nasal cannulas equipped to monitor capnography, and time allotment for the education of staff about how to implement the guidelines. Issues with supply chain shortages due to the COVID-19 pandemic may present problems with obtaining the supplies needed to implement the proposed guidelines.

Develop a localized EBP guideline

The following guidelines are designed to be implemented at the level one trauma center and its affiliated outpatient surgery centers as previously discussed. They are written based on evidence found within the literature review. The guidelines have also been created with assistance from the framework provided in the IMR.

1) Patients undergoing surgery who have a formal diagnosis of OSA or who are suspected of having OSA with a STOP-Bang score greater than 3 must have the following practices implemented during and or following their surgery:

2) Patients with a BMI greater than 45 kg/m^² must have surgery completed at an inpatient facility with the ability to monitor patients overnight

3) Surgery must be performed with neuraxial or regional anesthesia without the use of opioids

4) Patients must undergo continuous capnography monitoring in the immediate postoperative period until they are discharged from the hospital building

Implementation

The second objective of this project is to develop an implementation plan for the use of the proposed guidelines in practice. After identifying adequate evidence in the literature to support the changes in practice, the IMR progresses to designing and piloting the practice change (Cullen et al., 2022). Cullen et al. (2022) suggests the implementation portion of developing EBP guidelines should be completed in four phases. The four phases include creating awareness and interest, building knowledge and commitment, promoting action and adoption, and pursuing integration and sustained use (Cullen et al., 2022). Cullen et al. (2022) provides many potential strategies to be utilized to assist with the development of each phase within the implementation process. There are strategies provided for two different categories within each of the four phases.

Phase 1: Creating Awareness and Interest to Promote Adoption

To create awareness and to connect with the stakeholders and staff at a selected level one trauma center, strategies which would be utilized from the IMR include forming staff meetings to highlight the advantages and anticipated impact of implementing the guidelines in the patient population effected with OSA. To spark interest, examples of past patients who developed postoperative respiratory failure related to OSA could be provided. While the occurrence may be relatively rare, the complications are often severe when respiratory failure occurs without

immediate intervention within this population. Information from Bolden et al. (2020) could be provided in this phase, which suggested death and brain damage are more likely to occur in patients with OSA following surgery when inadequate monitoring and other considerations are not acknowledged regarding the disease process. Considering the average cost of postoperative respiratory failure was near $52,000 per patient in 2013, it is likely staff and stakeholders will have an interest in preventing the adverse respiratory outcomes from occurring in high-risk patient populations such as those with OSA.

To build organizational support, designated members from several departments within the hospital would be included in each meeting. One representative from each of the following departments would need to be in attendance for the meetings: surgery, anesthesia, finance, quality improvement, and preoperative/postoperative nursing staff. Of the strategies provided by Cullen et al. (2022), highlighting the advantages and anticipated impact of the guidelines through meetings among stakeholders and clinicians would be the most effective strategies for the sake of this EBP project. The benefits of creating awareness and interest through the above strategies would be to motivate clinicians to promote the adoption of the guidelines, build a positive perception about the EBP project which would be implemented by the clinical team, and improve the social morale among the people who would put the proposed guidelines into action (Cullen et al., 2022). It is important to include members from all the different specialties involved so participants can be held accountable if results are not what was expected following the initial guideline implementation.

Phase 2: Building Knowledge and Commitment

There are many ways to build knowledge and commitment when trying to develop and implement an EBP project. Cullen et al. (2022) suggests the utilization of an EBP facilitator or

mentor to help guide the core groups and make appropriate adjustments as needed throughout the implementation process. The EBP facilitator serves as the project director and works to improve clinician knowledge, attitudes, skills, and confidence in the adoption of EBP changes (Cullen et al., 2022). During the meetings directed by the EBP facilitator, members of each discipline will have the opportunity to ask questions and provide feedback on ways the guidelines could be effectively implemented.

Although the representatives of the different disciplines have been mentioned, a more detailed synopsis must be provided as to why members of the different disciplines have been included in the meetings to represent the different core groups. Cullen et al. (2022) suggests a core group is a small group of clinicians who can represent all work shifts and be deemed responsible for the training, trouble shooting, and reinforcement of the proposed guidelines. A surgeon who is preferably the director of the surgery department who performs many cases within the facility must be present and willing to adopt regional or neuraxial anesthesia without the use of opioids as the sole modality of pain control during and following surgical procedures in patients at risk for OSA. The lead surgeon would represent the other surgeons within that core group who practice within the facility. It would be understood that some procedures cannot be completed with regional/neuraxial anesthesia such as traumas. However, those patients could still be monitored in the postoperative period with continuous capnography to aid in the early detection of respiratory failure. The core group of surgeons' input is vital to the development and implementation of the best neuraxial/regional management plan for patients when applicable.

The director of anesthesia services or the chief certified registered nurse anesthetist (CRNA) could be selected to represent the anesthesia department. This representative would be necessary because anesthesia providers would be the clinical staff responsible for the

administration of neuraxial/regional anesthesia and the prohibition of the use of opioids within the OSA patient population. The director of anesthesia or the chief CRNA would be the leader of the core group of anesthesia providers and would be responsible for reporting to the EBP facilitator during the designated meetings.

Another core group vital to the implementation of the guidelines would include the preoperative nursing staff. This core group would be responsible for implementing the STOP-Bang questionnaire for every patient who presents to the hospital for surgery. Without the participation of this core group, patients at risk for having OSA would not be able to be identified and the guidelines could not be effectively implemented. Although the STOP-Bang questionnaire is straightforward, the preoperative nursing staff would need training on how to conduct the survey with each patient who presents for surgery. A charge nurse for the preoperative nursing staff would be identified to represent this core group and would be included in the meetings conducted by the EBP facilitator.

Similarly, a charge nurse for the postoperative nursing staff would need to be designated to represent the core group of nurses who monitor patients while they recover from anesthesia. This core group is responsible for the implementation of capnography monitoring for the evaluation of patients' ETCO2 levels and the detection of apnea in patients at risk for respiratory complications related to OSA. The designated charge nurse would report concerns and barriers to the implementation of capnography monitoring to help the team determine the best way for postoperative nursing staff to effectively monitor patients with OSA.

One person from the quality improvement department would be designated to review cases and provide statistical analysis of the incidence of respiratory failure in patients affected by OSA prior to and following the implementation of the guidelines. He or she would attend the

designated meetings to report and discuss the findings. A member of the finance department would also need to be present to determine the most cost-effective strategy to implement the guidelines, including the cost/expense implications of acquiring the appropriate monitors and equipment for the guideline implementation.

Lastly, a team member from the facility's information technologies department would need to be involved to help implement the guidelines. This person would be responsible for incorporating the STOP-Bang questionnaire into the preoperative nursing staff's patient assessment tab. He/she would also need to create a flag which would populate when a patient's STOP-Bang score is 3 or higher. This would notify all the staff involved in the patient's care that the guidelines need to be implemented for the management of their OSA. This flag would need to be easily visible within each patient's EMR so that the surgery staff, anesthesia staff, and pre and postoperative nursing staff know the OSA guidelines are to be implemented during the hospital stay. This individual would need to attend the meetings scheduled by the EBP facilitator to receive feedback from all the core team representatives to develop the most effective way to ensure the guidelines are implemented.

To build knowledge and commitment among the stakeholders and staff within the facility, another strategy provided by Cullen et al. (2022) includes providing educational resources. Benefits of providing education are that it is inexpensive, and it can be delivered in different formats that would be most suitable to the clinicians who will be involved in the guideline implementation (Cullen et al., 2022). Cullen et al. (2022) proposes that in person meetings among the core group leaders promotes bidirectional communication and a solid understanding of the proposed practice change. These resources would be provided via information discovered through literature reviews and portrayed through PowerPoint

presentations. Educational videos would also be provided to help staff understand the pathology associated with OSA and the increased risks for postoperative respiratory failure within the patient population. Education would enable staff to understand how the implementation of the guidelines may decrease the incidence of postoperative respiratory failure in patients with OSA.

Phase 3: Promote Action and Adoption

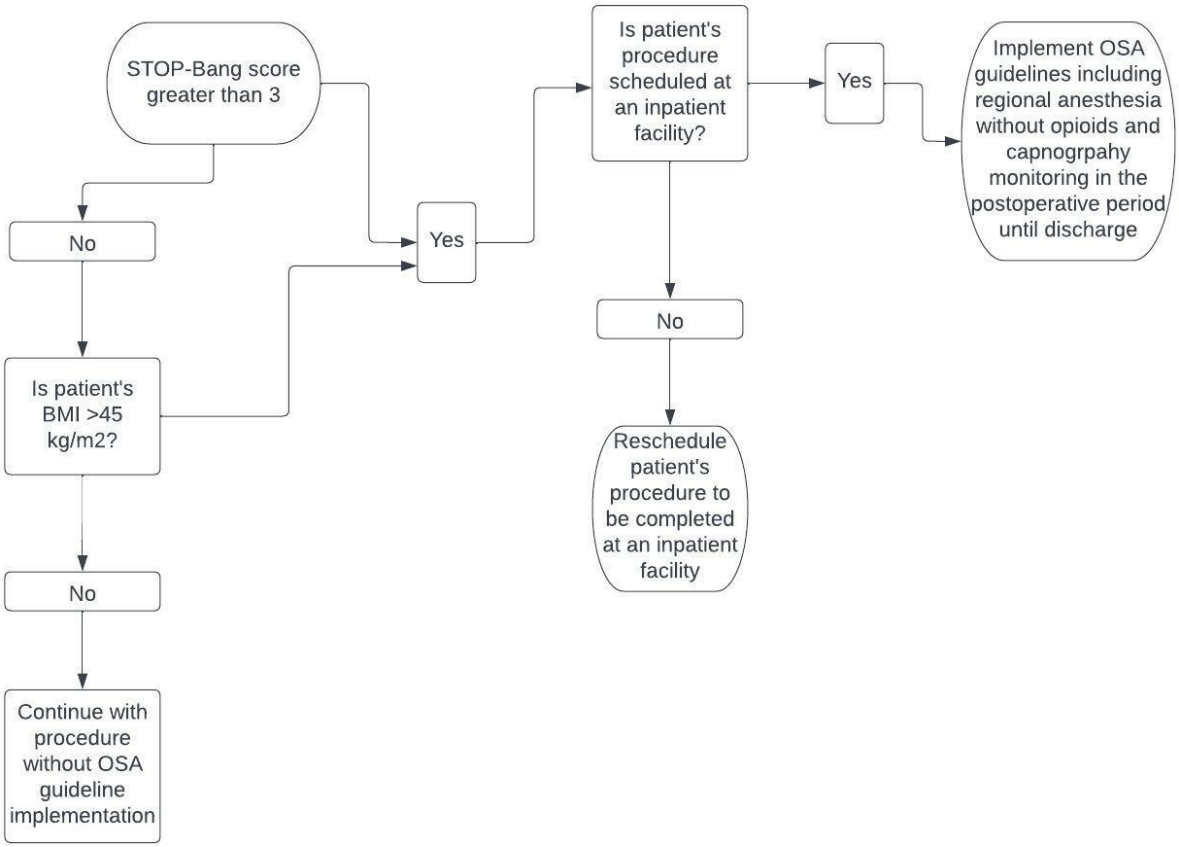
Phase 3 of the EBP practice in action model works to promote action and adoption from the clinicians involved in the implementation process. Strategies selected from Cullen et al. (2022) which would assist in promoting action and adoption of the EBP guidelines include creating reminders/practice prompts, developing a workflow algorithm, and creating standing orders. Cullen et al. (2022) identifies a reminder or practice prompt as a cue provided to clinicians at the point of care which reminds them to implement the EBP guidelines. The alert may be an electronic pop-up signal or alarm indicating a need for action, or an action to avoid while implementing a practice change (Cullen et al., 2022). Whenever a patient would present to a facility for the preoperative nurse to complete their initial assessment, a reminder would populate within the patient's electronic chart, prompting the nurse to complete the STOP-Bang questionnaire and obtain the patient's height and weight for the calculation of their BMI. Following a score of less than 3 and a BMI less than 45 kg/m^², no additional pop-ups would present within the patient's chart as the guidelines would not be implemented for this patient.

When previously identifying the IT department's role as a core group involved in the implementation process, one of the practice prompts was discussed. This practice prompt would involve a pop-up in a patient's electronic chart once a score of 3 or higher is obtained after the preoperative nurse completes the STOP-Bang questionnaire, or the patient's BMI is greater than 45 kg/m^². The pop-up would present as the following algorithm provided in Figure 1. Cullen et

al. (2022) states, “A decision algorithm is a flowchart to guide actions using patient data or risk to determine a course of action or interventions based on specific patient circumstances related to a clinical topic” (p. 211). For surgeons and anesthesia providers, this algorithm would populate once opening the patient’s chart, indicating the need for them to provide regional/neuraxial pain management without the use of opioids during the procedure. The pop-up would no longer appear once the provider has documented the provision of a regional or neuraxial nerve blockade. For postoperative nurses caring for patients following the procedure, this algorithm would prompt them to place a nasal cannula with the ability to monitor the patient’s ETCO2 values as well as apneic events. It would no longer appear once an ETCO2 reading has been obtained and documented within the patient’s chart.

Figure 1

Obstructive Sleep Apnea Care Algorithm



Additionally, another strategy to promote the action and adoption of the EBP guidelines involves creating standing orders. Cullen et al. (2022) indicates standing orders are usually generated by a clinical team which are built into the health record as an order set for decision support, including language such as the dosing of medications, route of administration, or specific monitoring which needs to be performed. For the sake of this EBP guideline implementation, the anesthesia and surgery teams would need to develop standard orders which would provide the types of regional/neuraxial anesthesia indicated for specific types of procedures. For all patients identified for being at risk of complications related to OSA, the

standard order for postoperative capnography monitoring would automatically be placed to ensure adequate monitoring following procedures.

Phase 4: Pursue Integration and Sustained Use

While creating guidelines and developing an initial plan to implement them is important, it is also important to make the implementation process sustainable to determine effectiveness. To pursue integration and sustained use of the EBP guidelines, strategies which would be utilized from Cullen et al. (2022) include celebrating local unit progress, performing audits, providing feedback to staff, and trending the results seen when the guidelines are implemented. In accordance with the evaluation meetings, meetings could be conducted by the EBP facilitator at three months, six months, one year, and two years following the implementation of the EBP guidelines. The meetings could be held in the proposed facility's auditorium before the beginning of many scheduled shifts. These meetings would involve providing coffee and bagels for staff to acknowledge the progress made regarding the impact and sustainability of the EBP guideline implementation. Members required to be in attendance would include all the previously identified core group representatives. Coffee and bagels would be provided to encourage additional staff members from within the different core groups to attend and be recognized for the role they play in the success and effectiveness of the guideline implementation. Celebrating progress within the facility where guidelines are implemented serves to demonstrate interest from the organizational leaders, focuses energy on achieving the goal of sustained practice change, and encourages clinicians to continue implementing the practice change with enthusiasm (Cullen et al., 2022). Acknowledging the impact which a group of people is making and rewarding them for it is a way to promote continued engagement.

During the meetings, audits and trends seen following the implementation of the EBP guidelines would be discussed among the core group representatives and all other staff members who are interested. Reviewing this information with all the people affected by the implementation of the guidelines improves clinician involvement, creates a learning culture, and helps sustain practice changes (Cullen et al., 2022). Viewing the trend of the incidence of respiratory failure related to OSA prior to implementing the guidelines at 3 months, six months, one year, and two years following implementation would show staff members the impact and importance of their roles regarding the implementation process. It could also bring light to any inefficiencies, allowing the interprofessional team of core group leaders to adjust and set future goals based on the results and feedback from the clinical staff members.

Budget

Materials

The supplies required to implement this project include bedside monitors capable of monitoring and recording ETCO2 levels, along with nasal cannulas equipped with side stream capnography monitoring abilities. With side stream capnography monitoring, the gas analyzer is located outside of the ventilator circuit and is considered an open system (Aminiahidashti et al., 2018). Closed system capnography monitors are utilized while someone is on a mechanical ventilator such as during surgery with general anesthesia (Aminiahidashti et al., 2018). The cost of nasal cannulas with side stream ETCO2 monitoring abilities ranges from $15.00 to $25.00, based on the supplier. Considering many facilities use the Phillips IntelliVue bedside monitoring systems, the cost of nasal cannulas compatible with those monitors are considered. Pacific West Medical (2022) sells nasal cannulas capable of monitoring ETCO2 which are compatible with the Philips IntelliVue monitors for $21.20 per nasal cannula.

Since the nasal cannulas are disposable and designed for single patient use, the total cost of utilizing these nasal cannulas depends on the number of patients who undergo surgery with the EBP guidelines implemented based on their risk of developing respiratory failure secondary to OSA. An inner-city medical center in the Midwest reports completing 22,125 surgical procedures last year (M. Carter, personal communication, September 15, 2022). Assuming the theoretical site for guideline implementation performs the same volume of surgeries, estimated costs will be calculated based on those numbers. Using Nagelhout and Elisha's (2017) estimation that 75% of adults are obese and that 71-77% of adults with a BMI greater than 35kg/m^² have OSA, the estimated number of nasal cannulas required has been calculated. 75% of 22,125 is equal to almost 16, 594 (16,593.75) surgeries. This means of the 22,125 surgeries performed at that specific clinical site, nearly 16,594 of them were completed in patients who had some degree of obesity. Using the estimation that 74% of obese adults have OSA, the number of patients needing to be monitored with capnography nasal cannulas was determined. (16,594 × 0.74 = 12,279.56). While the cost to implement the use of ETCO2 nasal cannulas may seem high, one must consider the budget which the facility already allocates for the purchase of traditional nasal cannulas, which would likely decrease with the implementation of the guidelines. Please see Table 1 for a cost breakdown.

Table 1

End Title Carbon Dioxide Nasal Cannula Costs

Cost of ETCO2 Nasal Cannula	Estimated # of patients requiring ETCO2 monitoring annually	Estimated time of guideline implementation	Total Cost
$21.20	12,280	2 years	$520,672.00

If these guidelines were implemented at a facility which does not have monitors capable of monitoring ETCO2, the cost of implementation would increase significantly. The facility would need to consider upgrading their current bedside monitors, also known as multiparameter monitors, to ones which can monitor ETCO2, or simply purchasing separate monitors for the sole purpose of recording ETCO2 levels. According to Noble (2018), refurbished multiparameter monitors can be purchased for $6,000. The total cost of a facility purchasing and upgrading its multiparameter monitors would depend on the number of post-anesthesia care beds present in their unit for recovering patients after surgery. However, a more economical option to monitor capnography for the guideline implementation would be to purchase two or three portable ETCO2 monitors. These monitors range from $3,750 to $5,400 and would be able to move from room to room to monitor the patients included in the population for the EBP guideline implementation (Noble, 2018). According to Noble (2018) Medtronic sold their portable capnography monitor for $4,650 in 2018. It can currently be purchased for $5,324 from Medical Device Depot (2022). Please see Table 2 for a concise cost breakdown.

Table 2

Portable Capnography Monitor Costs

Cost of portable capnography monitor	Estimated # of monitors required	Total Cost
$5324.00	5	$26,620.00

Staff Training

Another expense to consider when implementing the EBP guidelines for the management of patients with OSA pertains to training the nursing staff. While most staff members at the

facility of focus may be familiar with the STOP-Bang questionnaire and the use of ETCO2 monitoring, training must be provided to emphasize the importance of effectively incorporating the practices for the patient population in focus. The EBP facilitator would need to train the core group representatives for the pre-operative and postoperative nursing groups. The training would be able to be completed within 30 minutes, prior to the beginning of the nurses' scheduled shifts. Once the core group leaders are trained, they would provide the education to the members within their core groups in the same manner. All staff would be able to be trained within 1 week, assuming they arrive to work 30 minutes early on one of the days they are scheduled to work during that week. The nurses would be paid their hourly rate for the 30 minutes they spend in training. According to Incredible Health (2022) the average hourly rate for Registered Nurses in the Midwest United States is $34.44 per hour. Estimating the theoretical facility for guideline implementation has 45 beds available in both the preoperative and postoperative nursing units with a nurse: patient ratio of 1:3, roughly 10 pre-operative nurses and 10 postoperative nurses (20 nurses total) would receive training each day of the work week in which training is completed. The reason it would be 10 nurses per core group rather than 15 per day would be because the training only needs to be completed by each staff member one time. At an hourly rate of $34.44, the training of the preoperative and postoperative nursing staff would be estimated to amount to $344.40 per day (20×34.44×0.5). In total, the training of nursing staff would accrue an estimated cost of $1,722.00 ($344.40/day×5 days in the work week). Additional training would not need to be provided for surgeons or anesthesia providers because they are already trained on the provision of regional/neuraxial anesthesia techniques. A concise cost breakdown for staff training is provided in Table 3.

Table 3

Staff Training Costs

Nurses Trained/day	Hourly Rate	Time In Training	Cost per day	5 Day Total
20	$34.44	0.5 hour	$344.40	$1,722.00

Meeting Costs

The costs to hold the recognition and evaluation meetings at three months, six months, one year, and two years in the auditorium of the theoretical hospital facility would also need to be considered. The staff required to be in attendance include the representatives from each of the core groups. They would be compensated at their usual hourly rate for 2 hours of time. For the surgeon, this would amount to $400, considering the average surgeon hourly rate in the United States is $200 per hour (Salary.com, 2022). For the sake of this project model, the provider representing the core group of anesthesia providers would be a certified registered nurse anesthetist (CRNA) and the EBP facilitator. The average nurse anesthetist salary in the United States is $97 per hour. For two hours of time, the total would be $194. The next core group representatives to account for are the preoperative and postoperative nurse leaders. Their average hourly rate is $34.44 (Incredible Health, 2022). Since there is one representative from each core group, the total cost for them both to attend each meeting would be $137.76. Next, the cost to have a facility's finance manager present at the meetings would total $102, at an hourly rate of $51 per hour (Salary.com, 2022). The cost to have a clinical quality improvement specialist present would be $76 at an hourly rate of $38 (ZipRecruiter, 2022).

To encourage members of all the different core groups to attend the meetings, coffee and bagels would be provided during each of the 4 meetings. To estimate the cost of coffee and

bagels for each meeting, an estimated 30 people would be in attendance. Three packs of 13 bagels could be purchased from Panera Bread for roughly $53.97 (17.99/piece) (Panera Bread, 2022). Enough coffee to serve 30 people would cost around $50.97 (3 totes at $16.99 each) (Panera Bread, 2022). All the proposed meeting costs are provided in Table 4.

Table 4

Meeting Costs

Core Group Representative Hourly Rate	**Cost for 2 hours of time**
Surgeon: $200	$400
CRNA: $97	$194
Pre/Postoperative Nurses: $34.44	$137.76
Finance Manager: $51	$102
Quality Improvement Specialist: $38	$76
IT specialist: $15.43	$30.86
Bagels: $17.99 for 13 pack of bagels	$53.97 (3 packs to serve 30 people)
Coffee: $16.99 for a tote of coffee to serve 10	$50.97 (3 totes of coffee)

Total Cost of 1 Meeting	**$1,045.56**
Total Cost of all 4 Meetings	**$4,182.24**

Lastly, the time required for the IT department to incorporate the reminder practice prompts, algorithm, order sets, and follow up questionnaires into the preoperative, intraoperative, and postoperative phases of patients' electronic charts would need to be considered. According to a clinical informatics consultant, this would require nearly 52 hours of consulting time at a

rate of $200 per hour (S. Johanson, personal communication, September 15, 2022). Please see Table 5 for the IT costs of incorporating the practice prompts into patients' EMR. Following Table 5, Table 6 has been created to combine all the previous tables to show a total cost analysis for the implementation of the proposed guidelines.

Table 5

Information Technology Costs

IT Consulting Hourly Rate	# Hours	Total Cost
$200	52	$10,400.00

Table 6

Total Costs of Guideline Implementation

Category	**Cost**
Capnography Nasal Cannulas	$520, 672.00
Portable Capnography Monitors	$26,620.00
Staff Training	$1,722.00
Meetings	$4,182.24
IT Department Consulting	$10,400.00
Total Cost	**$563,596.24**

Evaluation Plan

Following guideline implementation, a process must be in place for assessing and determining how effective the guidelines are. Cullen et al. (2022) stresses the importance of performing baseline data collection prior to implementing any practice change. It is important to

have a baseline of data collected which can be used to evaluate the effectiveness of EBP guidelines after they are implemented into practice (Cullen et al., 2022). For the sake of this project, the quality improvement department of the facility chosen for implementation would need to be involved. Information would need to be obtained regarding the incidence of postoperative respiratory failure seen within the facility. Next, Cullen et al. (2022) states an important decision to make when planning for the evaluation of EBP guidelines would be to determine the sample size or population in focus. It is important to have a general idea of the number of patients the facility in focus typically treats with the medical condition under investigation (Cullen et al., 2022). The following questions are ones which could be considered when developing an evaluation plan.

Which patients should be included in the sample?

With the development of the PICOT question, the population in focus consists of patients who present for surgery who have previously been diagnosed with OSA, or those who score 3 or higher upon completion of the STOP-Bang questionnaire with the preoperative nursing staff. The chosen patient population includes patients scoring 3 or higher on the STOP-Bang questionnaire because 60-90% of people with OSA lack a formal diagnosis and are unaware that they have the disease (The Society of Anesthesia and Sleep Medicine, 2022). With the reported reliability of the STOP-Bang questionnaire indicating a sensitivity of 93% for predicting moderate to severe OSA and 100% for detecting severe sleep apnea, it has been chosen as the preoperative screening tool for this scholarly project (Chung et al., 2016). Utilizing the STOP-Bang questionnaire helps ensure the proposed guidelines are implemented for all patients at risk for respiratory complications following surgery which may be related to OSA, despite not having an official diagnosis.

What data or indicators are critical to collect?

It would be critical to collect the incidence of postoperative respiratory failure witnessed at the theoretical facility of implementation before the EBP guidelines are implemented and following implementation. It would also be critical to note instances when the EBP guidelines were not implemented when a patient at risk of having OSA undergoes surgery so that adjustments can be made to improve the effectiveness of the guidelines. To remove the practice prompt within a patient's chart during their care, the provider must indicate why the guidelines were not followed. Reasons could be due to the following:

- Did the patient's clinical condition prevent the use of neuraxial/regional anesthesia?
- Did the patient refuse neuraxial/regional anesthesia?
- Was the STOP-Bang questionnaire not completed in the preoperative phase of care?
- Was the surgery emergent?

How will the data be collected?

The data would be collected through a review of patient charts by the designated member of the quality improvement department. At each meeting, the member from the quality improvement department would provide data regarding the incidences in which patients diagnosed with or at risk for OSA develop respiratory failure requiring intervention. This includes periods of apnea, ETCO2 readings greater than 45 mmHg, or decreases in pulse oximetry readings below 90%. This period would encompass the immediate postoperative period up to 30 days following surgery, including patients who require readmission to the hospital within that period. Patients who require readmission following discharge would need to be evaluated by the admitting physician to determine if the complications are related to the patient

having OSA. The results obtained following the guideline implementation will be compared to the previous incidence of postoperative respiratory failure related to OSA within the facility.

Timeline

After the guidelines are implemented, the results would be evaluated over the period of 2 years, with meetings scheduled at the previously mentioned intervals.

How frequently will data be collected and reported back to the clinicians involved?

The data would be collected and presented by the representative from the quality improvement department at the meetings facilitated by the EBP facilitator at 3 months, 6 months, 1 year, and 2 years following the implementation of the guidelines.

What is the goal?

The goal is to evaluate the effectiveness of the EBP guidelines and to determine where changes can be made to improve the implementation process. The ultimate goal of the guideline development is to decrease the incidence of postoperative respiratory failure in patients diagnosed with OSA or patients at risk of having OSA but do not have a formal diagnosis.

At the beginning of each meeting, a clinician questionnaire (Table 7) developed by the quality improvement department could be presented to each person. The questionnaire would serve as an assessment of the involved clinicians' perceptions of the EBP guidelines, as well as an assessment of their behavior and practice regarding the implementation process. Evaluation of clinicians' attitudes and behaviors regarding the EBP guideline implementation would be useful in determining if the guidelines are being implemented as intended. The following questions could be included to evaluate the opinions of the clinicians involved in the implementation of the EBP Guidelines. Evaluating the answers to the questionnaire by the members of the core groups would allow them to make adjustments and improve the adoption of the guidelines into practice.

Table 7

Potential Questionnaire to Assess Staff Opinions Regarding Guideline Implementation

Clinical Position:		
Potential Questions	**Yes**	**No**
Do you feel the OSA EBP guidelines improve patient safety?		
I am doing my part in implementing the EBP guidelines.		
Implementing the guidelines takes too much time away from other tasks I am responsible for completing for patients under my care.		
What STOP-Bang score indicates the need to implement the EBP guidelines? (Answer with a number in the "yes" box)		
Are patients in which the EBP guidelines are being implemented for allowed to receive opioids?		

Conclusion

The proposed EBP guidelines may improve the safety of surgical procedures in patients who have OSA by acknowledging the risk factors associated with the disease process and taking steps to adjust the plan of care before a complication which could have been prevented results in respiratory failure. Respiratory complications seen in this population are usually preventable with the use of certain monitoring tools and treatments which are readily available in today's technologically advanced healthcare systems (Rao & Khanna, 2018). The implementation of a BMI cutoff limit for outpatient surgery centers, the use of regional/neuraxial anesthesia without opioids, and the utilization of postoperative ETCO2 monitoring are all practices which have the potential to decrease the incidence of respiratory failure following surgery in patients with OSA.

Decreasing or eliminating some of the risk factors which contribute to respiratory failure in patients with OSA may also improve patient outcomes by decreasing the amount of time a patient needs to be hospitalized following surgery. Decreasing a patient's length of stay in the hospital results in the use of less resources, ultimately saving the patient and the hospital system money.

References

Aminiahidashti, H., Kiasari, A., Sazgar, M., & Shafiee, S. (2018). Applications of end-tidal carbon dioxide monitoring in emergency department; a narrative review. *The Clinical Journal of Emergency Departments*, *6*(1). Retrieved September 10, 2022, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5827051/pdf/emerg-6-e5.pdf

Anselmi, L., Cafarotti, S., Gabutti, L., Graff, V., Mongelli, F., Pascale, M., Regina, D., Saporito, A., & Treglia, G. (2021). Perioperative costs of local or regional anesthesia versus general anesthesia in the outpatient setting. *Brazilian Journal of Anesthesiology*. Retrieved September 12, 2022, from https://doi.org/https://reader.elsevier.com/reader/sd/pii/S0104001421003663?token=20BF9F6D497E50085471801BB11A894FD65579A403341CE2FCC5A6B502DE24096C8D90C535BB939F8D65CBB9CE13FD14&originRegion=us-east-1&originCreation=20220912201803

Bolden, N., Posner, K. L., Domino, K. B., Auckley, D., Benumof, J. L., Herway, S. T., Hillman, D., Mincer, S. L., Overdyk, F., Samuels, D. J., Warner, L. L., Weingarten, T. N., & Chung, F. (2020). Postoperative critical events associated with obstructive sleep apnea: Results from the society of anesthesia and sleep medicine obstructive sleep apnea registry. *Anesthesia & Analgesia*, *131*(4), 1032–1041. https://doi.org/10.1213/ane.0000000000005005

Branson, R. D. (2013). The scientific basis for postoperative respiratory care. *Respiratory Care*, *58*(11), 1974–1984. Retrieved June 7, 2022, from https://doi.org/10.4187/respcare.02832

Chitnis, S., Tang, R., & Mariano, E. (2020). The role of regional analgesia in personalized postoperative pain management. *Korean Journal of Anesthesiology*. Retrieved July 20, 2022, from https://doi.org/10.4097/kja.20323

Chung, F., Abdullah, H., & Liao, P. (2016). STOP-Bang Questionnaire: A practical approach to screen for obstructive sleep apnea. *Chestnet*, (149), 631–638. Retrieved August 23, 2022, from https://doi.org/https://journal.chestnet.org/action/showPdf?pii=S0012-3692%2815%2900018-5

Corn, S. (2000). Understanding anesthesia equipment. *Anesthesiology*, *93*(4). Retrieved November 12, 2022, from https://doi.org/10.1097/00000542-200010000-00061

Cozowicz, C., & Memtsoudis, S. G. (2021). Perioperative management of the patient with obstructive sleep apnea: A narrative review. *Anesthesia & Analgesia*, *132*(5), 1231–1243. Retrieved August 22, 2022, from https://doi.org/10.1213/ane.0000000000005444

Cullen, L., Deberg, J., Farrington, M., Hanrahan, K., Kleiber, C., & Tucker, S. (2022). *Evidence-based practice in action: Comprehensive strategies, tools, and tips from the University of Iowa Hospitals and Clinics* (2nd ed.). Sigma Theta Tau International.

Elton B. Stephens Company. (n.d.-a). *Cinahl database | ebsco*. EBSCO Information Services, Inc. | www.ebsco.com. Retrieved June 9, 2021, from https://www.ebsco.com/products/research-databases/cinahl-database

Elton B. Stephens Company. (n.d.-b). *Medline with full text | ebsco*. EBSCO Information Services, Inc. | www.ebsco.com. Retrieved June 9, 2021, from https://www.ebsco.com/products/research-databases/medline-full-text

Gabriel, R. A., Burton, B. N., Du, A. L., Waterman, R. S., & Macias, A. (2021). Should there be a body mass index eligibility cutoff for elective airway cases in an ambulatory surgery

center? a retrospective analysis of adult patients undergoing outpatient tonsillectomy. *Journal of Clinical Anesthesia, 72*, 110306. Retrieved August 22, 2022, from https://doi.org/10.1016/j.jclinane.2021.110306

Golaz, R., Tangel, V. E., Lui, B., Albrecht, E., Pryor, K. O., & White, R. S. (2021). Post-operative outcomes and anesthesia type in total hip arthroplasty in patients with obstructive sleep apnea: A retrospective analysis of the state inpatient databases. *Journal of Clinical Anesthesia*, *69*, 110159. Retrieved August 22, 2022, from https://doi.org/10.1016/j.jclinane.2020.110159

Hai, F., Porhomayon, J., Vermont, L., Frydrych, L., Jaoude, P., & El-Solh, A. A. (2014). Postoperative complications in patients with obstructive sleep apnea: A meta-analysis. *Journal of Clinical Anesthesia, 26*(8), 591–600. Retrieved June 7, 2022, from https://doi.org/10.1016/j.jclinane.2014.05.010

Hallowell, P., Stellato, T., Schuster, M., Graf, K., Robinson, A., Crouse, C., & Jasper, J. (2007). Potentially life-threatening sleep apnea is unrecognized without aggressive evaluation. *American Journal of Surgery*, *193*(3), 364–367. Retrieved November 12, 2022, from https://doi.org/10.1016/j.amjsurg.2006.09.022

Incredible Health. (2022). *Average Registered Nurse Salary In Ohio*. Retrieved September 10, 2022, from https://www.incrediblehealth.com/salaries/rn/oh#:~:text=Registered%20nurses%20in%20Ohio%20earn,(or%20%2434.44%20per%20hour).

Indeed. (2021). *Health Information Technician Salary*. Retrieved September 10, 2022, from https://www.indeed.com/career/health-information-technician/salaries/OH

Inoue, Y., Qin, B., Poti, J., Sokol, R., & Gordon-Larsen, P. (2018). Epidemiology of obesity in adults: Latest trends. *Current Obesity Reports*, *7*(4), 276–288. Retrieved May 25, 2022, from https://doi.org/10.1007/s13679-018-0317-8

Ji, X., & Ke, W. (2021). Two types of anaesthesia and length of hospital stay in patients undergoing unilateral total knee arthroplasty (tka): A secondary analysis based on a single-centre retrospective cohort study in singapore. *BMC Anesthesiology*, *21*(1). Retrieved August 22, 2022, from https://doi.org/10.1186/s12871-021-01459-7

King, I. M. (1992). King's theory of goal attainment. *Nursing Science Quarterly*, *5*(1), 19–26. https://doi.org/10.1177/089431849200500107

Lee, J. J., & Sundar, K. M. (2021). Evaluation and management of adults with obstructive sleep apnea syndrome. *Lung*, (199), 87–101. Retrieved May 18, 2022, from https://doi.org/10.1007/s00408-021-00426-w

MacLehose, H., & Hilton, J. (2013, January 23). *Changes to The Cochrane Library during The Cochrane Collaboration's first 20 years*. Cochrane Library. Retrieved June 9, 2021, from

McCarter, T., Shaik, Z., Scarfo, K., & Thompson, L. (2008). Capnography monitoring enhances safety of postoperative patient-controlled analgesia. *AM Health Drug Benefits*, *5*, 28–35. Retrieved August 20, 2022, from https://doi.org/https://pubmed.ncbi.nlm.nih.gov/25126237/

Medical Device Depot. (2022). *Medtronic capnostream 35 capnograph*. Retrieved September 10, 2022, from https://www.medicaldevicedepot.com/Nellcor-Capnostream-35-Capnograph-p/PM35MN02.htm?dfw_tracker=3918-99697&gclid=Cj0KCQjw6_CYBhDjARIsABnuSzoajxKlj4vuJa2dGPRE8oODpZ6O2dFpRb17g2LhfqDTwkFJDGSfcuAaAvnCEALw_wcB

Melamed, R., Boland, L. L., Normington, J. P., Prenevost, R. M., Hur, L. Y., Maynard, L. F., McNaughton, M. A., Kinzy, T. G., Masood, A., Dastrange, M., & Huguelet, J. A. (2016). Postoperative respiratory failure necessitating transfer to the intensive care unit in orthopedic surgery patients: Risk factors, costs, and outcomes. *Perioperative Medicine*, *5*(1), n.p. Retrieved June 7, 2022, from https://doi.org/10.1186/s13741-016-0044-1

Memtsoudis, S., Liu, S. S., Ma, Y., Chiu, Y., Walz, J., Gaber-Baylis, L. K., & Mazumdar, M. (2011). Perioperative pulmonary outcomes in patients with sleep apnea after noncardiac surgery. *Anesthesia & Analgesia*, *112*(1), 113–121. Retrieved July 19, 2022, from https://doi.org/10.1213/ane.0b013e3182009abf

Moradian, S., Beitollahi, F., Ghiasi, M., & vahedian-azimi, A. (2021). Capnography and pulse oximetry. *National Library of Medicine*. Retrieved July 20, 2022, from https://doi.org/10.21203/rs.3.rs-496561/v1

Moran, K., Burson, R., & Conrad, D. (2019). *The doctor of nursing practice project* (3rd ed.). Jones & Bartlett Learning.

Mutter, T., Chateau, D., Moffatt, M., Ramsey, C., Roos, L., & Kryger, M. (2014). A matched cohort study of postoperative outcomes in obstructive sleep apnea: could preoperative diagnosis and treatment prevent complications? *Anesthesiology*, *121*. Retrieved May 26, 2022, from https://doi.org/https://pubs-asahq-org.ezproxy.otterbein.edu/anesthesiology/article/121/4/707/12159/A-Matched-Cohort-Study-of-Postoperative-Outcomes

Nagelhout, J., & Elisha, S. (2017). *Nurse anesthesia* (6th ed.). Saunders.

National Center for Biotechnology Information. (n.d.). *About - pubmed*. PubMed. Retrieved June 9, 2021, from https://pubmed.ncbi.nlm.nih.gov/about/

Noble, M. (2018). *How much does capnography monitoring cost*. Medtronic. Retrieved September 10, 2022, from https://hcpresources.medtronic.com/blog/is-capnography-monitoring-worth-the-cost

Pacific West Medical. (2022). *Philips-M2750A CO2/O2 Nasal Cannula- Adult Intellivue Sidestream*. Retrieved September 10, 2022, from https://www.pacificwestmedical.com/philips-healthcare/philips-medical-consumables/gas-monitoring/m2750a-co2-o2-nasal-cannula-adult-intellivue-sidestream-monitoring-supplies-disposable-non-intubated/

Panera Bread. (2022). *Bagels and Coffee*. Retrieved September 11, 2022, from https://www.panerabread.com/en-us/app/category/30.html

Rao, V. K., & Khanna, A. K. (2018). Postoperative respiratory impairment is a real risk for our patients: The intensivist's perspective. *Anesthesiology Research and Practice*, *2018*, 1–7. Retrieved June 7, 2022, from https://doi.org/10.1155/2018/3215923

Richardson, M., Moulton, K., Rabb, D., Kindopp, S., Pishe, T., Yan, C., Akpinar, I., Tsoi, B., & Chuck, A. (2016). *Capnography for monitoring end-tidal CO2 in hospital and pre-hospital settings: a health technology assessment* (1st ed.). Canadian Agency for Drugs and Technologies in Health. https://doi.org/https://pubmed.ncbi.nlm.nih.gov/27227208/

Roussos, C., & Koutsoukou, A. (2003). Respiratory failure. *European Respiratory Journal*, *22*(Supplement 47), 3s–14s. Retrieved August 28, 2022, from https://doi.org/10.1183/09031936.03.00038503

Salary.com. (2022, August 29). *Hourly wage for a surgeon in the United States*. Retrieved September 11, 2022, from https://www.salary.com/research/salary/benchmark/surgeon-hourly-wages

Shapiro, F. E., Punwani, N., Rosenberg, N., Valedon, A., Twersky, R., & Urman, R. (2014). Office-based anesthesia: safety and outcomes. *Anesthesia & Analgesia, 119*, 276–285. Retrieved February 18, 2023, from https://doi.org/10.1213/ANE.0000000000000313

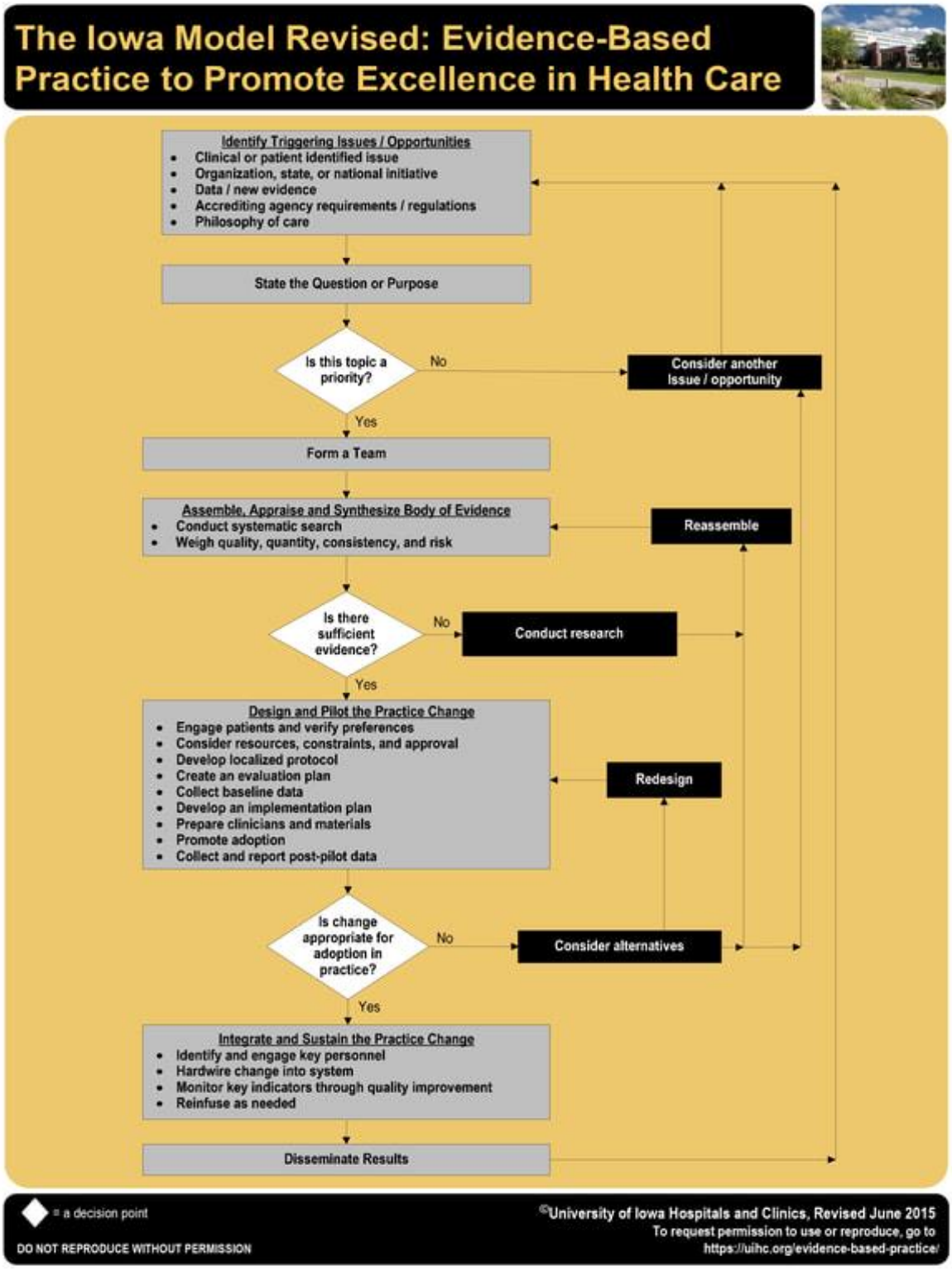
Spence, D., Han, T., McGuire, J., & Couture, D. (2015). Obstructive sleep apnea and the adult perioperative patient. *Journal of Perianesthesia Nursing*, *30*(6), 528–545. Retrieved November 12, 2022, from https://doi.org/10.1016/j.jopan.2014.07.014

The Society of Anesthesia and Sleep Medicine. (2022). *Sasm/samba/socca collaborative guideline announcement for postoperative management of patients with osa*. Society of anesthesia and sleep medicine. Retrieved May 25, 2022, from http://sasmhq.org/postop-mgmt-osa/

Vlessides, M. (2019). *Quantifying how big is too big for ambulatory surgery*. Anesthesia Experts. Retrieved July 20, 2022, from https://anesthesiaexperts.com/uncategorized/quantifying-big-big-ambulatory-surgery/#Documents

ZipRecruiter. (2022, September 4). *Clinical quality improvement specialist salary*. Retrieved September 11, 2022, from https://www.ziprecruiter.com/Salaries/Clinical-Quality-Improvement-Specialist-Salary--in-Ohio#:~:text=How%20much%20does%20a%20Clinical,be%20approximately%20%248.33%20an%20hour.

Appendix A


The Iowa Model Revised: Evidence-Based Practice to Promote Excellence in Health Care
Identify Triggering Issues / Opportunities
Clinical or patient identified issue
Organization, state, or national initiative
Data / new evidence
Accrediting agency requirements / regulations
Philosophy of care
State the Question or Purpose
Is this topic a priority?
No
Consider another issue / opportunity
Yes
Form a Team
Assemble, Appraise and Synthesize Body of Evidence
Conduct systematic search
Weigh quality, quantity, consistency, and risk
Reassemble
Is there sufficient evidence?
No
Conduct research
Yes
Design and Pilot the Practice Change
Engage patients and verify preferences
Consider resources, constraints, and approval
Develop localized protocol
Create an evaluation plan
Collect baseline data
Develop an implementation plan
Prepare clinicians and materials
Promote adoption
Collect and report post-pilot data
Redesign
Is change appropriate for adoption in practice?
No
Consider alternatives
Yes
Integrate and Sustain the Practice Change
Identify and engage key personnel
Hardwire change into system
Monitor key indicators through quality improvement
Reinfuse as needed
Disseminate Results
= a decision point
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Appendix B

Recommendations for the management of patients with OSA recreated from Nagelhout & Elisha (2017)

Phase	Anesthesia Concerns	Principles of Management
Preoperative	• Cardiac Arrhythmias • Comorbidities • Sedative Premedication • Risk stratification, evaluation, and optimization	• Use of positive airway pressure (PAP) to reduce arrhythmias • Individualized anesthetic plan for every patient • Minimal preop sedation. Dexmedetomidine before surgery may reduce intraop sedation requirements • In depth assessment to verify OSA diagnosis and other undiagnosed comorbidities
Intraoperative	• Regional Anesthesia • Difficult Intubation • Opioid-related respiratory depression • Excessive sedation in monitored anesthesia care cases	• Utilize nerve blocks • Ramp patient and use PAP during preoxygenation • Opioid minimization • Use of capnography for intraop monitoring
Anesthesia Reversal	• Post-extubation airway obstruction and desaturation	• Verify full reversal of neuromuscular blockade • Ensure patient is fully conscious prior to extubation • Head of bed elevated for recovery
Postoperative	• Respiratory • Suitability for outpatient surgery • Postop respiratory event in patient suspected to have OSA	• PAP and supplemental oxygen • Avoid Opioids • Intensive respiratory monitoring • Prophylaxis for venous thromboembolism • Longer monitoring time available in PACU • Transfer plan readily available to inpatient facility for outpatient procedures

Appendix C

STOP-Bang preoperative questionnaire for obstructive sleep apnea (OSA), recreated from Nagelhout & Elisha (2017)

Snoring: Do you snore loud enough to be heard through closed doors?	**Yes**	**No**
Tired: Do you frequently feel tired during the day?	**Yes**	**No**
Observed: Has anyone observed you stop breathing while you are asleep?	**Yes**	**No**
Pressure: Do you have or are you being treated for high blood pressure?	**Yes**	**No**
BMI >35 kg/m²?	**Yes**	**No**
Age > 50 years old?	**Yes**	**No**
Neck Circumference > 40 cm?	**Yes**	**No**
Gender: Male?	**Yes**	**No**

High Risk for OSA: Yes to ≥ 3 questions

Low Risk for OSA: Yes to < 3 questions

Appendix D

Literature Review Table

Authors	Type of Source	Purpose	Level of Evidence	Findings
Anselmi et al., (2021)	Journal Publication	Which costs less? Regional or general anesthesia.	Systematic Review	Local/Regional anesthesia costs less, regardless of surgical procedure being performed
Bolden et al., (2020)	Journal Publication	Identify contributing factors to postoperative respiratory events in patients with OSA	Systematic Review	Opioids and sedative medications increased the risk of respiratory complications in patients with OSA
Chitnis et al., (2020)	Journal Publication	Discuss the role of regional anesthesia in postoperative pain management	Expert Opinion	Regional anesthesia decreases patient requirements for oral and intravenous opioids following surgery
Cozowicz and Memtsoudis (2021)	Journal Publication	Reviews the best ways to manage postoperative pain in patients with OSA	Expert Opinion	Neuraxial anesthesia in patients with OSA is associated with a decrease in pulmonary issues

Authors	Type of Source	Purpose	Level of Evidence	Findings
Gabriel et el., (2021)	Journal Publication	Determine the relationship between BMI and same day admission rates in patients undergoing tonsillectomies in ambulatory surgery centers	Retrospective Cohort Study	Patients with BMI between 40-60 kg/m² had nearly 2 fold increase in admissions following tonsillectomy
Golaz et al., (2021)	Journal Publication	Compare complications seen in THA procedures under general anesthesia vs. those with regional anesthesia	Retrospective Cohort Analysis	Patients with OSA had less pulmonary complications following surgery when they received regional anesthesia
Hai et al., (2014)	Journal Publication	Identify the relationship between patients with OSA and ICU admission due to respiratory events postoperatively	Systematic Review: Meta-Analysis	Patients with OSA have a 2.5-fold higher risk for requiring ICU admission following surgery

Authors	Type of Source	Purpose	Level of Evidence	Findings
Inoue et al., (2018)	Journal Publication	Identify trends in obesity	Systematic Review	The prevalence of obesity continues to increase with time
Ji and Ke (2021)	Journal Publication	Determine the difference in length of stay for patients undergoing TKA under GA vs RA	Cohort Study	GA increased patients' length of stay compared to RA for TKA
McCarter et al., (2008)	Journal Publication	Assess the effectiveness of capnography in postoperative periods with patient-controlled analgesia	Case controlled study	Capnography is more effective than traditional methods with pulse oximetry in detecting respiratory depression
Memtsoudis et al., (2011)	Journal Publication	Assess adverse pulmonary events in patients with OSA following noncardiac surgery	Systematic Review	Patients with OSA developed pulmonary complications 1-4% more frequently than patients without OSA

Authors	Type of Source	Purpose	Level of Evidence	Findings
Moradian et al., (2021)	Journal Publication	To determine the sensitivity of capnography to assess respiratory status compared to arterial blood gasses	Single qualitative cohort study	Patients monitored with capnography were successfully extubated sooner compared to patients monitored via arterial blood gasses
Mutter et al., (2014)	Journal Publication	Risk reduction of postoperative respiratory complications in patients with OSA	Matched cohort study	The use of continuous positive airway pressure may decrease postoperative respiratory complications in patient with OSA
Richardson et al., (2016)	Systematic Review published as a book	Determine the clinical and cost-effectiveness of the use of capnography in varying patient populations	Systematic Review	Respiratory events were detected earlier and hypoxemia was prevented with the use of capnography. Cost effectiveness questionable

Authors	Type of Source	Purpose	Level of Evidence	Findings
Rao & Khanna (2018)	Review Article	Risk factors for postoperative respiratory depression	Systematic Review	OSA, among other comorbidities predisposes patients for developing respiratory depression postoperatively
Vlessides, M. (2019)	Journal Publication	Determine the relationship between 30-day readmission rates and patients BMI	Systematic Review	Readmission rates increased by 6% for every 5-point increase in BMI

Appendix E

Guideline

Hospital X	
Title: Evidence-Based Practice Guideline for the Surgical Patient with Obstructive Sleep Apnea (OSA)	**NUMBER:** 1-234
ISSUE DATE:	**EFFECTIVE DATE:**
DEVELOPED BY: Aaron McNeilan	
REVIEWED BY: Department of Anesthesia	
APPROVED BY:	

SCOPE:

This guideline is to be implemented within all surgery and operating room areas associated with Hospital X, including outpatient surgery centers affiliated with the institution.

STATEMENT OF PURPOSE:

The purpose of this guideline is to provide evidence-based practice recommendations for the preoperative, intraoperative, and postoperative care of patients who are at risk for having obstructive sleep apnea to decrease the incidence of respiratory failure following surgery in this patient population.

DEFINITIONS:

- **Respiratory Failure:** the respiratory system failing to exchange one or both gas exchange functions to maintain a partial pressure of arterial oxygenation greater than 60 mmHg or a partial pressure of arterial CO2 less than 45 mmHg
- **Obstructive Sleep Apnea:** episodes of apnea and hypopnea during sleep that are caused by partial or complete obstruction of the upper airway
- **Polysomnography Sleep Study:** study in which a patient sleeps under medical observation to assess his/her apnea-hypopnea index (AHI).
- **Apnea:** the cessation of airflow for more than ten seconds
- **Hypopnea:** is considered a 50% reduction in airflow for ten seconds that occurs 15 or more times per hour of sleep while also being associated with snoring and a 4% or more reduction in oxygen saturation

POLICY:

This guideline applies to the nurses, surgeons, and anesthesia providers who are directly involved in the care of patients undergoing surgical procedures who are at risk of having OSA. This guideline assists providers in determining patients' risk of having OSA and helps develop a care plan during surgery and immediately following surgery in patients who are determined to be at risk for developing adverse outcomes related to OSA. The preoperative assessment utilized in the guidelines to determine patient risk factors for OSA is not a substitute for a polysomnography study and cannot be used to officially diagnose OSA. The guideline is

intended to improve the safety of surgical procedures in patients with OSA but does not create legally enforceable responsibilities for healthcare professionals.

GUIDELINE:

1) **Recommended Preoperative Screening:**
   - **a.** Preoperative nursing staff will be trained on how to conduct the STOP-BANG questionnaire for every patient who presents for surgery, regardless of their Body Mass Index (BMI). This questionnaire will be prompted to be completed by nursing staff via an alert in each patient's EMR, which persists until the questionnaire is completed
   - **b.** A score of 3 or more on the STOP-BANG questionnaire indicates a high risk for having Obstructive Sleep Apnea (OSA), in which the recommended guidelines are designed to be implemented
   - **c.** Patients with a BMI greater than 45 kg/m^2 should not undergo surgery requiring general anesthesia in an outpatient setting due to the strong correlation between obesity, OSA, and respiratory failure. The inpatient setting allows for closer monitoring of patients following surgical procedures, with more resources readily available in the event a patient develops respiratory failure following surgery
   - **d.** With a BMI of greater than 40 kg/m^2 being considered Class III obesity, or "severe obesity", there may be instances where a patient may have a BMI equal to or greater than 40 kg/m^2 but may not have additional comorbidities. In this instance, the anesthesia provider and surgeon will need to use their judgement to determine the safety of patients in this group undergoing surgery in an outpatient setting
   - **e.** A BMI limit of 45 kg/m^2 is utilized to provide consistency for the proposed guideline implementation, considering the risk of 30-day readmission following surgery in obese patients increases by 6% for every 5-point increase in a patient's BMI
2) **Recommended practice changes for patients whose BMI is ≥ 45 kg/m^2 or whose STOP-BANG score is ≥ 3 who will undergo surgery at a hospital (inpatient setting).**
   - a. **Intraoperative:** Regional anesthesia without the use of opioids for pain control during and following surgery
     - i. Regional anesthesia can be provided in many forms including peripheral nerve blocks, spinals, and epidurals
     - ii. Regional anesthesia is implemented to allow patients to maintain a natural airway, preventing the innate drive to breathe from completely being inhibited or overridden due to anesthesia during a procedure
     - iii. The anesthetic plan will be created by the surgeon and the anesthesia provider, permitting them to incorporate the regional technique they feel most appropriate for each patient's individual needs and the type of procedure being completed
     - iv. Regional anesthesia has been shown to decrease costs by decreasing patients' lengths of stay following surgery
   - b. **Postoperative:** End Tidal Carbon Dioxide (ETCO2) monitoring following surgery up until discharge

i. According to the American Society of Anesthesiologists (ASA), their 2014 OSA recommendations include intraoperative ETCO2 monitoring, but do not include ETCO2 monitoring in the postoperative phase of care.
ii. Every patient at risk of having OSA will be provided with a nasal cannula with ETCO2 monitoring capabilities to be utilized following surgery until the patient is discharged home
iii. ETCO2 monitoring is more sensitive for early detection of respiratory failure than pulse oximetry monitoring
iv. In the event a patient does develop respiratory failure following surgery, treatment should be determined by the anesthesia provider assigned to the patient in the recovery area. If participating in the above guidelines, opioids should not be a contributing factor, so other factors to consider may be local anesthetic systemic toxicity, excess benzodiazepines, or severity of OSA. It will be the provider's responsibility to determine treatment moving forward and to decide if a patient needs to be intubated and admitted to the hospital until respiratory function returns to baseline

References

Golaz, R., Tangel, V. E., Lui, B., Albrecht, E., Pryor, K. O., & White, R. S. (2021). Post-operative outcomes and anesthesia type in total hip arthroplasty in patients with obstructive sleep apnea: A retrospective analysis of the state inpatient databases. *Journal of Clinical Anesthesia*, *69*, 110159. Retrieved August 22, 2022, from https://doi.org/10.1016/j.jclinane.2020.110159

Moradian, S., Beitollahi, F., Ghiasi, M., & vahedian-azimi, A. (2021). Capnography and pulse oximetry. *National Library of Medicine*. Retrieved July 20, 2022, from https://doi.org/10.21203/rs.3.rs-496561/v1

Nagelhout, J., & Elisha, S. (2017). *Nurse anesthesia* (6th ed.). Saunders.

Roussos, C., & Koutsoukou, A. (2003). Respiratory failure. *European Respiratory Journal*, *22*(Supplement 47), 3s–14s. Retrieved August 28, 2022, from https://doi.org/10.1183/09031936.03.00038503

Vlessides, M. (2019). *Quantifying how big is too big for ambulatory surgery*. Anesthesia Experts. Retrieved July 20, 2022, from https://anesthesiaexperts.com/uncategorized/quantifying-big-big-ambulatory-surgery/#Documents