OPTIMIZING ANALGESIA: OPIOID-SPARING ALTERNATIVES FOR OBSTRUCTIVE SLEEP APNEA

by

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As members of the DNP Project Committee, we certify that we have read the DNP project prepared by Garrett Saisho Park, titled Optimizing Perioperative Analgesia: Alternative Intravenous Agents for Opioid-Sparing in Obstructive Sleep Apnea, and recommend that it be accepted as fulfilling the DNP project requirement for the Degree of Doctor of Nursing Practice.

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Final approval and acceptance of this DNP project are contingent upon the candidate's submission of the final copies of the DNP project to the Graduate College.

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LAND ACKNOWLEDGEMENT

We respectfully acknowledge the University of Arizona is on the land and territories of Indigenous peoples. Today, Arizona is home to 22 federally recognized tribes, with Tucson being home to the O'odham and the Yaqui. The University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.

DEDICATION

I dedicate this work to various individuals who I hold dear to my heart. Firstly, to my amazing partner, Reece Bonilla. You supported me without limits during this challenging time in my doctoral studies, and your support has been pivotal in my ability to endure and persevere. You inspire me every day with your compassionate approach to the world, which you navigate with such grace.

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ABSTRACT

Purpose: The purpose of this quality improvement project was to educate anesthesia providers about use of four non-opioid intravenous (IV) agents—dexmedetomidine, ketamine, magnesium, and lidocaine—for opioid-sparing analgesia in patients with obstructive sleep apnea (OSA). Project aimed to evaluate changes in provider intent, perceptions, and attitudes toward implementing these agents in clinical practice.

Background: OSA is a prevalent sleep disorder characterized by recurrent airway collapse, increased perioperative risks such as respiratory depression and hypoxia, particularly with opioid use. American Society of Anesthesiologists recommends opioid-sparing techniques for OSA patients, yet specific guidance on pharmacological alternatives remains limited. Evidence from general surgical populations suggests four non-opioid agents of interest may effectively reduce opioid consumption and improve analgesic outcomes.

Methods: An educational session was developed and delivered virtually to anesthesia providers employed by anesthesia group at a single facility. Pre-survey assessed baseline provider intent, perceptions, and attitudes regarding opioid-sparing strategies. Following 15-minute video presentation, post-survey evaluated changes in these metrics and identified barriers to implementation. Data from paired pre- and post-survey responses were analyzed using Wilcoxon Signed-Rank Test for statistical significance. Open-ended responses were analyzed qualitatively to identify recurring themes.

Results: Ten anesthesia providers completed both pre- and post-surveys. A statistically significant increase in their confidence and intention to use non-opioid intravenous agents for opioid-sparing analgesia in patients with OSA, as evidenced by changes in post-survey

responses. Wilcoxon Signed-Rank Test revealed significant improvements in confidence in understanding of benefits of ketamine, dexmedetomidine, magnesium, and lidocaine for patients with OSA ($p = 0.035$), as well as increases in intent to use opioid-sparing techniques ($p = 0.02$). Providers also reported greater awareness of importance of minimizing opioid use in population ($p = 0.009$). Qualitative analysis revealed logistical barriers, 40% of participants reporting barriers to utilize interventions that included: limited access to agents in operating rooms and dosing issues, particularly with ketamine being supplied in impractical large vials.

Conclusions: Project demonstrated that educational session effectively increased anesthesia providers' confidence and willingness to implement opioid-sparing techniques for OSA patients. However, logistical barriers, such as limited access to certain agents, may impact widespread use of these techniques.

INTRODUCTION

Obstructive sleep apnea (OSA) is an increasingly prevalent disorder of sleep in the human population in which there are repetitive episodes of a reduction or total cessation of ventilatory flow, typically caused by various degrees of pharyngeal collapse (Chung et al., 2016). The perioperative patient with OSA presents unique anesthetic challenges, coupled with increased perioperative risk related to factors such as: aberrancies in the upper airway anatomy, increased pharyngeal collapsibility, and instabilities in responsive thresholds to hypoxemia and hypercarbia (Cozowicz & Memtsoudis, 2021).

Many anesthetic agents decrease upper airway function through inhibition of protective reflexes, worsening of airway collapsibility, and a decrease in central respiratory activity (Hillman & Chung, 2017). Of particular interest are the deleterious effects of opioids in patients with OSA, which are associated with increased rates of respiratory depression and postoperative apneic events (Gupta et al., 2018). The subsequent recommendations by the American Society of Anesthesiologists Task Force on Perioperative Management of Obstructive Sleep Apnea published guidelines to avoid or reduce the use of systemic opioids in high risk OSA patient populations (American Society of Anesthesiologists [ASA], 2014). Several alternative intravenous (IV) agents have been described that may serve as effective adjuncts to anesthesia and offer the potential for opioid-sparing effects. This project describes the efficacy of a multi-agent IV approach in providing adjunctive anesthesia intended to provide opioid-sparing for patients with OSA through the lens of quality improvement.

Background Knowledge and Significance

The prevalence of OSA worldwide has reached 1 billion people, and, accordingly, this increased prevalence is reflected proportionally in the surgical population (Cozowicz & Memtsoudis, 2021). Coupled with its known risk modification to perioperative outcomes, especially that of cardiopulmonary origin, the presence of OSA requires unique anesthetic considerations (ASA, 2014).

There exist two main changes that comprise the OSA disease process: dysfunctional passive mechanics of the airway and critical disruptions in the central respiratory center (McNicholas & Pevernagie, 2022). In the awake state, the upper airway is resistant to collapse via a reflex-mediated activation of the airway dilator muscles that include the tensor palatine, genioglossus, and hyoid muscles; conversely, this mechanism is inhibited in sleep states due to reduced neural inputs to the motor neurons of these muscles, which occurs in all humans (Subramani et al., 2017). This effect is pronounced in patients with OSA due to a narrower and more collapsible airway, leading to pathology (McNicholas & Pevernagie, 2022). Additionally, the loss of wakefulness leaves the regulation of central respiratory motor output mainly under the control of chemoreceptor feedback, and it is hypothesized that individuals with OSA possess instability in this complex cyclical feedback mechanism (McNicholas & Pevernagie, 2022).

The role of opioid receptor agonists in the perioperative management of acute pain has been well established and is utilized universally but not without significant and unique drawbacks. Alone, opioids have been shown to cause central, obstructive, and hypoxemic events during sleep and after anesthesia (Freire et al., 2022). The effect of opioid analgesic agents in patients with OSA is associated with exacerbations of the pathology by way of reductions in upper airway muscle tone and suppression of chemoreception, which lead to upper airway obstruction and ventilatory pattern aberrations (Freire et al., 2022). A closed claims analysis conducted by the American Society of Anesthesiologists (ASA) in 2015 examined 341 deaths or ischemic brain injuries in the setting of opioid administration in the postoperative period, and 40% of these cases had a preexisting diagnosis for OSA or were at otherwise high risk (Lam et al., 2016). Several other studies have corroborated this increased risk in the OSA patient population as elevated occurrences of postoperative hypoxia, respiratory failure, cardiac events, and transfers to the intensive care unit have been observed (Wolfe et al., 2016).

In addition to the implications for patient safety and improved outcomes, there exists an economic incentive for anesthesia providers to utilize opioid-sparing analgesic agents. Specifically, in one of the perioperative metrics, the Merit-Based Incentive Payment System (MIPS) outlines the use of two or more non-opioid analgesic interventions across a broad range of surgical procedures (ASA, 2023a). Effectively, reimbursement from the Centers for Medicare and Medicaid Services (CMS) is directly affected by the use or non-use of multimodal analgesic approaches in the perioperative setting (Latino & Kapoor, 2021). This particular MIPS quality metric, in addition to holding significant reimbursement implications, recognizes the evidence-based nature of multimodal analgesia and its relative importance in improving patient outcomes and further underscores the importance of this project.

The practice of multimodal analgesia, though not new, has gained significant attention with the implementation of the enhanced recovery after surgery (ERAS) program. This approach involves the administration of various non-opioid agents to achieve adequate pain relief, often surpassing the benefits of opioids alone while simultaneously minimizing the risks associated with opioid use (Simpson et al., 2019). Numerous non-opioid agents have been studied; however, this project will focus on the use of intravenous dexmedetomidine, ketamine, magnesium, and lidocaine in the perioperative setting to decrease opioid consumption in the OSA patient population. While studies directly examining the opioid-sparing effects of these agents in patients with OSA are limited, the evidence indicates their potential benefits through resounding findings of opioid-sparing effects across a wide range of surgical populations and various comorbidities (Wang et al., 2018). Studies investigating the opioid-sparing effects of these agents across diverse surgical populations have consistently demonstrated reductions in intraoperative and postoperative opioid requirements, in addition to improvements in subjective pain intensity scores compared to traditional opioid regimens. Furthermore, the safety profile of these agents when used in a multimodal context has been favorable in the literature, with no significant increase in adverse effects compared to opioid-based analgesia (Aguerreche et al., 2021). Specifically, the four intravenous agents of interest in this project were selected due to the practical nature of administration and general availability across many facilities. The combination of dexmedetomidine, ketamine, magnesium, and lidocaine is a common regimen administered by anesthesia providers to provide opioid-free or opioid-sparing anesthesia, being informally referred to as the “McLott Mixture” (McLott & Stahel, 2022).

The risk burden of opioid administration in patients with OSA has been acknowledged, and the ASA has published guidelines on perioperative anesthetic management in this patient population, recommending techniques that reduce or eliminate the need for opioid agents, such as regional techniques (ASA, 2014). However, there exists a lack of comprehensive discussion regarding specific pharmacological agents to achieve opioid-sparing, emphasizing the need for recommendations of suitable opioid-sparing agents for perioperative administration in patients with OSA (ASA, 2014). This project aimed to bridge this gap by exploring and recommending four suitable opioid-sparing agents through an anesthesia provider educational session in delivering adequate analgesia without the deleterious pulmonary effects associated with opioid agents in patients with OSA, thereby contributing to increased patient safety, reductions in morbidity and mortality, and alleviating the economic burden related to opioid-associated adverse events in the perioperative environment.

Local Problem

During clinical training at a 615-bed tertiary care medical center in a suburban area outside of Phoenix, Arizona, the principal investigator, a student registered nurse anesthetist (SRNA), observed an appreciable variability between anesthesia providers' management of perioperative analgesia in patients with OSA and that many of the anesthetics delivered did not incorporate opioid-sparing techniques. Adequate access to opioid-sparing agents was observed, and after conversations with numerous anesthesia providers, including site champion Jacob Thompson, DNP, CRNA, deficits in knowledge regarding the specific agents to be used to accomplish opioid-sparing in this patient population were perceived to be the root cause of the issue. Consequently, the opportunity existed to implement a quality improvement initiative via anesthesia provider education.

In addition to the facility-specific needs, a 2017 Behavioral Risk Factor Surveillance System (BRFSS) optional module was utilized to examine the prevalence of sleep disorder symptoms in eight states, including Arizona. In this survey, three out of four adults reported having sleep disorder symptoms, and respiratory symptom prevalence increased proportionally with BMI (Liu et al., 2021). In Maricopa County, there is a paucity of epidemiological data on OSA but an increasing prevalence of obesity, which is closely associated with the incidence of OSA (Ward et al., 2020). Consequently, the prevalence of OSA within the patient population at the previously mentioned tertiary care center is likely underreported or undiagnosed, emphasizing the need for perioperative opioid-sparing techniques.

Intended Improvement

Project Purpose

The purpose of this Doctor of Nursing Practice (DNP) quality improvement (QI) project was to provide education on the use of four non-opioid analgesic agents in achieving opioid-sparing techniques in patients with OSA undergoing anesthesia. The objective was to educate anesthesia providers, including anesthesiologists, certified registered nurse anesthetists (CRNAs), and student registered nurse anesthetists (SRNAs) through a concise and informative virtual session aimed at encouraging changes in practice at the facility. Site authorization was obtained and can be found in Appendix A.

Project Question

In anesthesia providers (P), will a structured educational session highlighting the benefits of four non-opioid analgesic agents for opioid-sparing (I) increase their intent to modify current anesthetic practices in patients with OSA (O)?

Project Objectives

The proposed project includes the following objectives:

1. Evaluate the current practices, perceptions, and intentions of anesthesia providers regarding opioid-sparing analgesia for patients with OSA and their awareness of the challenges associated with opioid use in this population.
2. Implement the educational presentation virtually to increase awareness and encourage positive perceptions of using four non-opioid intravenous analgesic agents to achieve opioid-sparing in patients with OSA.
3. Evaluate the overall effectiveness of the educational presentation through a pre- and post-survey to assess for changes in providers' perceptions, intent to adopt, and perceived barriers to using the four intravenous agents for opioid-sparing perioperative analgesia.

Theoretical Framework

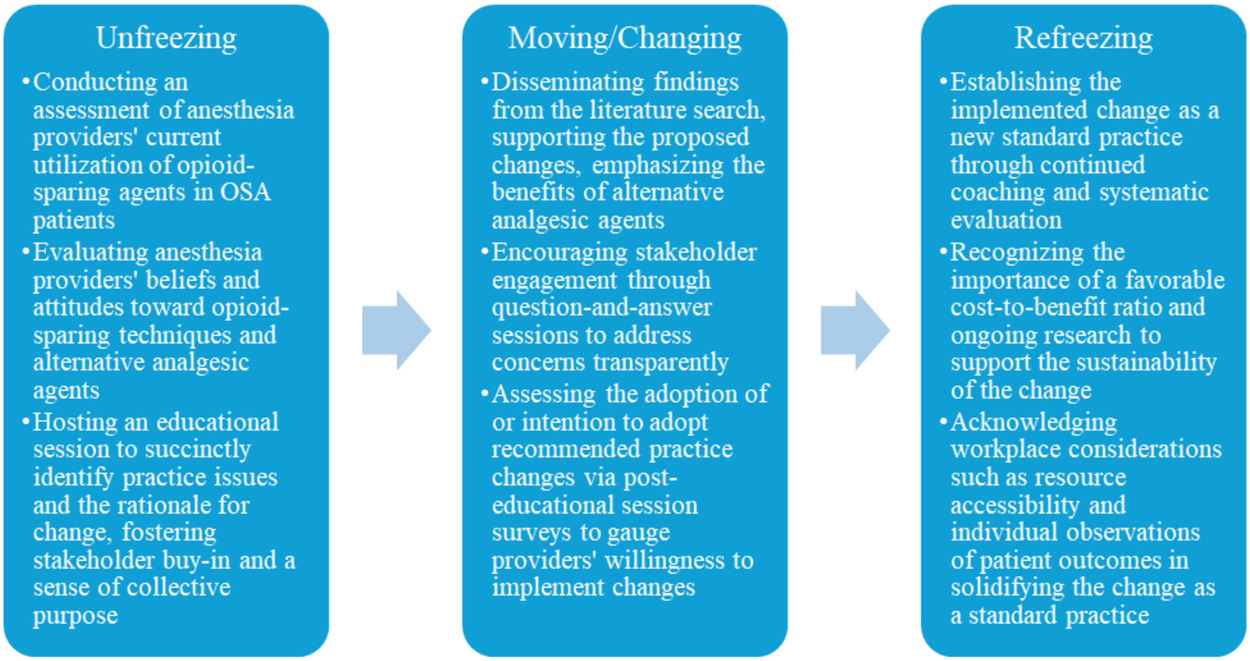
Implementation of evidence-based recommendations involves the appropriate application of a theoretical framework. Change theories are often appropriate as they provide a global perspective on the change process related to human behavior (Mitchell, 2013). Moreover, theoretical frameworks empower clinicians to discern patterns of health and illness and their respective implications, aid in formulating and arranging targeted interventions, and facilitate the assessment of intervention efficacy (Christenbery, 2011). Many theoretical frameworks exist, some focusing on learning and knowing, while others on equity or empowerment (Luft et al., 2022). Considering that the execution of this DNP project involves using educational measures to promote practice change amongst anesthesia providers, the chosen theory that provides the foundational underpinning to this DNP project is Lewin's change theory (LCT).

Lewin's Change Theory (LCT)

Although change is inevitable in healthcare, almost two-thirds of all change implementation projects fail due to a combination of poor planning, unmotivated staff, or poor communication (Barrow et al., 2024). Lewin's change theory (LCT) accurately depicts the stages of organizational change and describes them as three major phases: unfreezing, movement, and refreezing (Hussain et al., 2018). The underlying concept that underscores LCT is the concept that human behavior is an equilibrium created by opposing forces of driving and restraining factors; for instance, driving forces encourage change by inspiring people in a particular direction, and opposing forces halt this process or push them away from the direction of interest (Wojciechowski et al., 2016). Consequently, LCT's three-step model depicts a global perspective of how this equilibrium is disrupted, adjusted, and re-established, therefore subsequent use of this model is efficacious in understanding human behavior, and motivation for change, and the sustainability of such change, particularly within the context of quality improvement as relevant to this DNP project.

Figure 1

Adaptation of Lewin's Change Theory Model



Unfreezing Stage

The unfreezing stage involves creating problem awareness to facilitate the undoing of the current equilibrium (Wojciechowski et al., 2016). Practically and in the healthcare context, this stage typically results in clinicians identifying a potential discrepancy between practice and evidence-based guidelines. According to Tetef, (2017), a pivotal characteristic of this stage involves the critical appraisal of evidence-based practices juxtaposed with prevailing practice paradigms. The evaluation of the anesthesia providers' utilization of opioid-sparing agents in patients with obstructive sleep apnea (OSA) at the implementation site constitutes an element of the unfreezing phase. Furthermore, assessment of current beliefs or attitudes towards the importance of opioid-sparing and usage of alternative intravenous analgesic agents is beneficial in identifying barriers to unfreezing the existing practice paradigm. In accomplishing the assessment of overall perceptions of anesthesia providers, the likelihood of stakeholder buy-in increases and establishes a sense of common-cause comradery. A crucial component of this stage lies in the educational session; concise identification of the practice issue and indication for practice change is essential for a successful "unfreezing" of the equilibrium, leading to the potential for adaptation of the proposed change. Of particular important to this stage is a concise elucidation of the contextual backdrop, encompassing key elements such as the epidemiology of OSA, the inherent risk factors associated with opioid administration in individuals affected by this condition, and the current anesthetic trends in anesthetic management in this cohort.

Moving Stage

The moving stage, often referred to as the changing stage, aims to seek alternatives to the practice status quo and identifies the benefits and limitations of the proposed alternatives (Wojciechowski et al., 2016). In this stage of LCT, the change agent disseminates the findings of a thorough literature search that supports the proposed changes. For this project, the objective during this stage is to highlight the benefits of perioperative administration of intravenous dexmedetomidine, ketamine, magnesium, and lidocaine in regards to their opioid-sparing effects and discuss the theoretical benefit in patients with OSA through an educational session. Stakeholders will be invited to pose questions and articulate their concerns; the evidence-derived insights extrapolated from the literature will be utilized to elucidate these areas comprehensively, incorporating a transparent approach in identifying any lacunae or constraints within the existing body of research. Notably, if individual providers decide to utilize the recommended intravenous agents, the recommended practice change that follows the educational session functions as part of the moving stage; this process will be assessed through a post-educational session survey gauging providers' willingness or inclination to adopt the recommended practice changes.

Refreezing Stage

In the refreezing stage, the implemented change has been established into the new equilibrium as habit and resists further change (Wojciechowski et al., 2016). For this stage to occur, there must be the realization of a favorable cost-to-benefit ratio, continued coaching, and systematic evaluation of the implemented change (Wojciechowski et al., 2016). Many of this stage's elements fall beyond this project's scope, primarily due to time and resource limitations associated with the long-term maintenance aspect. Nonetheless, the success of this stage of LCT determines whether the change becomes ingrained as a standard practice, and potentiating factors include continued research validating the practice, individual observations of patient outcomes, and workplace considerations such as accessibility to resources (Shirey, 2013).

As part of the refreezing stage, it is essential to provide ongoing resources to ensure that the change remains sustainable and integrated into clinical practice. While the long-term aspects of maintaining the change fall outside the project's scope, several vital tools will be made available to support the refreezing process. The results of the project, including data on pre- and post-education assessments, will be shared with key stakeholders, including the project’s site champion and department heads, to demonstrate the effectiveness of the intervention. Additionally, a comprehensive reference list of the literature review will be provided to serve as a resource for further study and to support ongoing dialogue about best practices in opioid-sparing techniques for patients with OSA.

Literature Synthesis

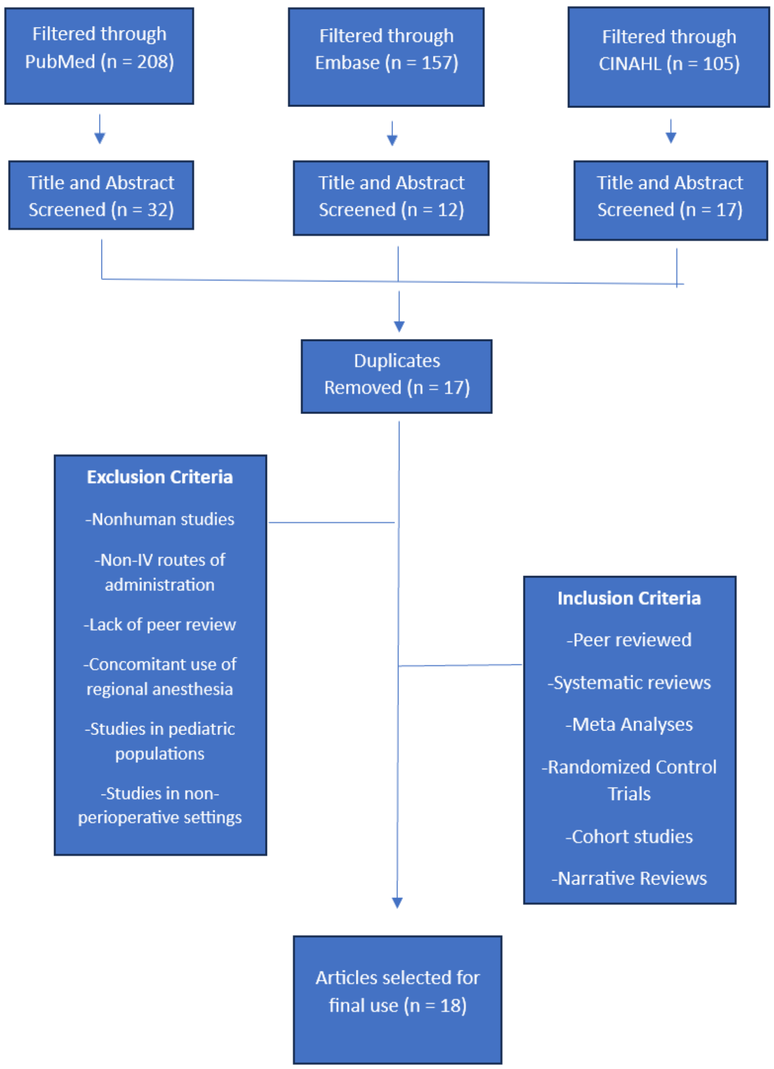
Evidence Search

There is a substantial amount of literature supporting the role of perioperative intravenous dexmedetomidine, ketamine, lidocaine, and magnesium in opioid-sparing effects when used conjunctively with general anesthesia. A literature review was conducted using multiple searches using PubMed, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and Embase electronic search engines, accessed via the Arizona Health Sciences Library. The search terms utilized for the initial literature search were “multimodal,” “ketamine,” “dexmedetomidine,” “lidocaine,” “magnesium,” “opioid-sparing,” and “obstructive sleep apnea.” It was immediately apparent that there exists a scarcity of studies specifically investigating the effects of the aforementioned intravenous agents on opioid-sparing in patients with OSA. Consequently, the literature search consisted of a two-arm approach, with one arm of the search aiming to elucidate the detrimental impact of opioid use in patients with OSA and the other arm investigating the opioid-sparing effects of the four specific agents proposed. Notably, the literature search strategy for the latter arm required the writer to conduct separate searches for each intravenous agent across all three electronic search engines. Search terms for the first arm of the approach included “effect of opioids,” “obstructive sleep apnea,” and search terms for the second arm included “dexmedetomidine,” “lidocaine,” “ketamine,” “magnesium,” “opioid-sparing,” and “perioperative.” For all three search engines, filters were applied to include articles published within the last ten years, full text, and English language. Given the global prevalence of OSA and its interventional applicability to patients in the United States, international studies were included.

Initial search results for the first arm of the query investigating the effect of opioid agents in patients with obstructive sleep apnea revealed seventy-four articles in PubMed, eighty-seven articles in Embase, and twenty-two articles in CINAHL. The initial search results for dexmedetomidine revealed forty articles in PubMed, twelve articles in Embase, and ten articles in CINAHL. For ketamine, initial search results revealed thirty-six articles in PubMed, nine in Embase, and forty-three in CINAHL. For lidocaine, initial search results revealed thirty-six articles in PubMed, six in Embase, and twenty-one in CINAHL. Lastly, regarding magnesium, initial search results revealed twenty-two articles in PubMed, forty-three articles in Embase, and nine in CINAHL. First, inclusion and exclusion criteria were utilized to narrow article quantity by reviewing article titles and abstracts. Inclusion criteria included specific study designs such as systematic reviews, meta-analyses, randomized control trials, narrative reviews, and retrospective cohort studies. Exclusion criteria included non-human studies, non-IV routes of administration, use of regional anesthesia, lack of peer review, studies in pediatric patients, and studies conducted in non-perioperative settings. With the respective criteria in mind, the eligibility of studies was assessed by screening titles and abstracts. After an exhaustive review, a total of three articles were included in the first arm of the search describing the risk burden of perioperative opioid use on the OSA disease process, and fifteen studies were included for review in the second arm of the search describing the opioid-sparing effects of the four intravenous agents of interest.

Figure 2

Flow Diagram for Literature Review



Opioid-Sparing in Patients with OSA

While there exists a paucity of literature investigating the direct opioid-sparing effects of perioperative intravenous dexmedetomidine, ketamine, lidocaine, and magnesium in patients with obstructive sleep apnea (OSA) specifically, it is reasonable to assume that individuals with OSA have been part of the total sample size in various studies, albeit not as the exclusive focus.

Consequently, the theoretical basis of this paper aims to discuss the opioid-sparing effect of the four non-opioid analgesic agents across multiple surgical populations, thereby implicating the extension of benefit and appropriate role in patients with OSA. The perioperative management of patients with OSA has been well-described in the literature, and a systematic review and meta-analyses by Gupta et al. (2018) associated the incidence of opioid-induced respiratory depression with factors such as pre-existing cardiac disease, pulmonary disease, and OSA. Additionally, a 2021 narrative review discussed the risk profile of utilizing opioid agents in patients with OSA and its associations with worsening of upper airway collapsibility, central respiratory depression, and increased risk for severe postoperative respiratory depression requiring naloxone administration, citing several well-designed observational studies (Cozowicz & Memtsoudis, 2021). Conversely, another narrative review published in 2022 discussed several studies with conflicting results regarding the association between opioid agents and airway obstructive events; however, the authors noticed considerable interindividual variability within the sample populations and variable study methodologies possibly accounting for these variable results (Freire et al., 2022). More importantly, however, the authors of this review discussed insightful pathophysiological mechanisms of opioid agents in the setting of OSA disease, many of which have been studied in vivo. For instance, several well-designed studies have demonstrated the suppressive effect of opioid agents in hypoglossal motoneuron function and genioglossal muscle activity, which are crucial in understanding the deleterious respiratory effects of opioid agents in patients with a pre-existing airway pathology such as OSA (Freire et al., 2022). The American Society of Anesthesiologists (ASA) has updated its practice guidelines regarding the management of patients with OSA, and opioid-sparing techniques are heavily encouraged, acknowledging the risk profile of systemic opioid administration in this setting (American Society of Anesthesiologists, 2014). These studies of interest offer a plausible case for the cautious approach toward opioid agents in patients with obstructive sleep apnea, underscoring the importance of pursuing opioid-sparing approaches.

Intravenous Agents: Mechanisms of Action

Dexmedetomidine acts at the α_2 adrenoreceptors, both centrally and peripherally, resulting in inhibition of adenylate cyclase and subsequent decreased calcium conduction intracellularly (Vuyk et al., 2021). Via these mechanisms in the CNS, the resulting effects include sympatholysis, sedation, and analgesia, with the analgesic effects of interest being mediated through stimulation of α_{2C} and α_{2A} receptors in the dorsal horn of the spinal cord, resulting in reductions in the release of the pronociceptive transmitters substance P and glutamate (Vuyk et al., 2021).

Magnesium acts as a non-competitive NMDA receptor antagonist and exerts its analgesic effects by inhibiting the intracellular influx of calcium, resulting in decreased neurotransmission of pronociceptive mediators (Jabbour et al., 2020). Similar to magnesium, ketamine exerts its primary mechanism of action via antagonism at the NMDA receptors at the cortical level as well as in the spinal cord (Vuyk et al., 2021). Additionally, ketamine inhibits central hypersensitization and attenuates acute tolerance to opioid administration such as the effects appreciated in opioid-induced hyperalgesia (Vuyk et al., 2021).

Lastly, lidocaine’s role as an analgesic agent involves mechanisms which are still unclear, but an increasing number of studies are showing that intravenous lidocaine has many desired effects, such as anti-inflammatory, anticancer, and organ-protective effects (Wang et al., 2024). It's mechanism of action is thought to be complex, as lidocaine is shown to act on the glycinergic system, ion channels, NMDA receptors, and serotonin receptors (Beaussier et al., 2018).

Comprehensive Appraisal of Evidence

Two meta-analyses appraised 45 randomized controlled trials (RCTs) cumulatively, evaluating the effect of dexmedetomidine on multiple postoperative endpoints, with pain evaluation scores and opioid consumption being the most pertinent (Tsaousi et al., 2018; Wang et al., 2018). A meta-analysis conducted by Tsaousi et al. (2018) found that the use of intraoperative dexmedetomidine as an adjunct to general anesthesia in patients undergoing spine surgery resulted in a statistically significant reduction of intraoperative and postoperative opioid consumption, as measured by morphine equivalents. Another meta-analysis, conducted by Wang et al. (2018), investigated the effects of intraoperative dexmedetomidine but included a variety of surgical populations, including general surgery, orthopedics, ear-nose-throat (ENT), neurosurgery, cardiothoracic surgery, gynecology, mixed type of surgeries, and maxillofacial surgery. This study, in addition to utilizing postoperative opioid consumption as an outcome measure, also utilized pain assessment scoring, unlike the previously mentioned meta-analysis. Both postoperative opioid consumption and pain assessment in the interventional arm revealed statistically significant reductions, albeit with high heterogeneity (Wang et al., 2018). Sensitivity analysis was performed by excluding individual studies sequentially, which continued to show statistical significance (Wang et al., 2018). Furthermore, the timing of dexmedetomidine administration in the intraoperative course and variability of administration (e.g., bolus injection or continuous infusion) did not contribute to the variability in results, and this lends itself to practical considerations of the use of the agent. Two additional RCTs involved the use of intraoperative conjunctive dexmedetomidine in patients undergoing ambulatory urology and ambulatory gynecologic laparoscopic surgery, respectively, and both RCTs found significant reductions in numerical and visual pain rating scores and a decreased overall need for rescue opioid analgesia in the postoperative phase (Hakim & Wabba, 2019; Shariffuddin et al., 2018).

The meta-analyses and RCTs studying the perioperative role of intravenous dexmedetomidine consistently demonstrate its opioid-sparing effect across a variety of surgical populations (Aguerreche et al., 2021; Hakim & Wabba, 2019; Sharriffudin et al., 2018; Wang et al., 2018). In parallel, the reductions in pain assessment scores in patients receiving this agent corroborate the opioid-sparing effect, although there is significant variability between studies regarding dosing and administration mechanisms (e.g., bolus or continuous infusion) (Aguerreche et al., 2021; Hakim & Wabba, 2019; Sharriffudin et al., 2018; Wang et al., 2018). However, the lack of variability among analgesic outcomes suggests the effective use of the agent regardless of the specific protocol used, thereby promoting its implementation into practice; this, along with its consistency among many surgical populations, including ambulatory surgical populations, highlights the potential applicability of this agent ubiquitously among surgical populations.

Similar to dexmedetomidine, the use of intraoperative intravenous magnesium sulfate as a conjunctive analgesic agent has been studied in a wide variety of surgical populations. Two RCTs studied the analgesic effect of intraoperative magnesium sulfate infusions in gynecological surgeries and found that the need for intraoperative and postoperative doses of opioids was significantly decreased in patients in the magnesium interventional group, and reductions in pain assessment scores were statistically significant (Gao et al., 2020; Sousa et al., 2016). In the RCT conducted by Gao et al. 2020, mean blood pressure in the magnesium group was significantly lower than in the placebo group, although hypotension was not observed in either group. Another RCT examined magnesium and ketamine together as part of an intraoperative analgesic regimen in patients undergoing breast surgery and found significantly less postoperative opioid consumption in the interventional group but with non-statistically significant differences in numerical pain scores and side effects related to opioid use (Hassan & Mahran, 2023). A three-arm RCT conducted by Jabbour et al. (2020) examined the effect of ketamine and magnesium infusions for opioid-sparing and analgesic outcomes in patients undergoing open bariatric surgery, a population of particular interest as obesity is a well-established risk factor for the prevalence of OSA (Erridge et al., 2021). In the study, patients who received magnesium and ketamine consumed significantly less morphine in the first 24-hour postoperative period, although this difference was not observed at the 48-hour mark, and no significant differences were seen in PONV, time to extubation or sedation metrics (Jabbour et al., 2020).

The use of ketamine as an adjunctive analgesic agent in the perioperative setting has been investigated both as a standalone treatment and part of combination therapy, as elucidated earlier. A recent meta-analysis by Zhou et al. (2022) analyzed 30 RCTs studying the analgesic effect of perioperative administration of low-dose ketamine in patients undergoing spine surgery and found that pain scores were significantly decreased in the interventional groups up to 48 hours postoperatively, and this was consistent with significantly reduced cumulative morphine equivalent requirements with no increase in ketamine-related adverse effects compared to those who only received opioids. However, considerable variations in dosing and timing of the agent were observed across all of the included RCTs (Zhou et al., 2022). An RCT by Jipa et al.(2022) studied the effect of ketamine and lidocaine when administered intraoperatively in patients undergoing open abdominal surgery and found significantly decreased pain intensity scores, intraoperative and postoperative opioid consumption, and no observed differences between groups concerning the incidence of PONV. Two additional studies, including a meta-analysis and a retrospective cohort study, demonstrated comparable opioid-sparing effects when investigating the impact of systemic lidocaine infusions in ambulatory surgery and laparoscopic surgery (Lovett-Carter et al., 2021; Thomas et al., 2023). Studies in the obese bariatric surgery populations also corroborated similar findings with the use of systemic lidocaine for perioperative analgesia, resulting in significant reductions in opioid consumption as well as significantly higher global Quality of Recovery-40 (QoR-40) scores in the postoperative period (De Oliveira et al., 2014; Tovikkai et al., 2020). As highlighted earlier, the observed opioid-sparing effects in the bariatric surgery population hold significant implications for the application of these findings to patients with OSA, given the high prevalence of this pathology in obese patients.

Similar to results observed in studies for dexmedetomidine, similar themes and implications were ascertained from the studies for ketamine, lidocaine, and magnesium. The recurring theme involved reductions in intraoperative and postoperative opioid requirements accompanied by improvements in subjective pain intensity scores, thereby highlighting the potential of these agents to provide opioid-sparing and enhance patient comfort across diverse surgical populations. Additionally, many of the studies examined the safety profile of these agents when used in the context of multimodal analgesia and found no significant increase in adverse effects compared to opioid-based analgesia, further promoting the feasibility of the use of the agents across diverse patient populations. In particular, the inclusion of studies in higher-risk populations, such as those undergoing cardiothoracic and bariatric surgery, yielded similar opioid-sparing effects and safety profiles, thus underscoring a strong rationale for the application of these agents in patients with OSA. Additionally, many of the studies explored the synergistic effects of these agents when utilized together for multimodal analgesia and serve to highlight the value of a combined agent approach to enhance opioid-sparing effects and improve overall perioperative pain management.

Table 1

Opioid-Sparing Intravenous Agents

Agent (Intravenous)	Common Dosages	Mechanism of Action	Timing	Side Effects
Dexmedetomidine	**Bolus:** Up to 0.5 mcg/kg **Infusion:** 0.3–0.8 mcg/kg/hr	Highly selective **α_2-adrenergic receptor agonist**. Reduces norepinephrine release, leading to sedation and analgesia without respiratory depression. **Inhibits nociceptive transmission at the dorsal horn of the spinal cord**, reducing pain signal propagation	Administered intraoperatively as a continuous infusion or bolus.	Hypotension, bradycardia, dry mouth, sedation, nausea.
Ketamine	**Bolus:** 0.5 mg/kg **Infusion:** 0.1–0.5 mg/kg/hr	**NMDA receptor antagonist**. Prevents central sensitization in dorsal horn neurons, interfering with pain transmission in the spinal cord	Administered intraoperatively as a bolus followed by continuous infusion.	Hallucinations, increased intracranial pressure, hypertension, dysphoria.
Magnesium	**Bolus:** 30–50 mg/kg (commonly 2–3 g) **Infusion:** 10–15 mg/kg/hr	**NMDA receptor antagonist**. Prevents central sensitization in dorsal horn neurons, interfering with pain transmission in the spinal cord.	Administered intraoperatively as a bolus followed by continuous infusion.	Hypotension, flushing, nausea, vomiting, respiratory depression (at high doses)

Table 1 - Continued

Agent (Intravenous)	Common Dosages	Mechanism of Action	Timing	Side Effects
Lidocaine	**Bolus:** 1–1.5 mg/kg **Infusion:** 1–2 mg/kg/hr	**Sodium channel blocker**. Inhibits neuronal signal conduction.	Administered intraoperatively as a bolus followed by continuous infusion	Hypotension, bradycardia, dizziness, seizures (at toxic doses)

Limitations of the Literature

There were common limitations within the literature reviewed. Many of the studies utilized pain assessment scales such as the VAS and NRS pain scoring tools to evaluate the effectiveness of the analgesic effects of the agents of interest, and pain scoring tools are very subjective, given the subjective nature of pain (Wideman et al., 2019). Consequently, this unavoidable limitation should be considered when appraising the literature. Perhaps more accurate is the use of postoperative opioid consumption often reported in morphine equivalents, as requirements of narcotic analgesia most often reflect the effectiveness of perioperative analgesic techniques (Nielsen et al., 2016). Secondly, the studies had considerable variability in the dose ranges and administration timing. For example, the definition of low-dose ketamine differed between studies, with doses ranging from 0.1 mg/kg to 1 mg/kg (Zhou et al., 2022). Furthermore, there was inconsistency in the timing of administration, with some studies administering the agents solely intraoperatively while others administered the agents in both intraoperative and postoperative periods (Zhou et al., 2022). Another limitation is the significant heterogeneity observed among the studies due to variations in study designs, multiple treatment arms, and variability in delivery doses and timing, as discussed. Many of the meta-analyses attempted to account for this by conducting subgroup analyses and meta-regression, which continued to show consistent results (Lovett-Carter et al., 2021; Wang et al., 2018; Zhou et al., 2022). Lastly, a significant limitation of the studies is the lack of data reporting on opioid-related side effects, particularly respiratory depression, although opioid-sparing effects logically correlate with relative reductions in deleterious opioid-related respiratory effects as these effects are known to be dose-dependent in nature (Dahan et al., 2010).

METHODS

Project Design

This quality improvement (QI) project targeted anesthesia providers with the purpose of enhancing their understanding and propensity to utilize perioperative opioid-sparing pharmacological techniques in patients with OSA. A descriptive, comparative design was employed in this project to determine the effectiveness of the virtual educational session by allowing for the direct comparison of pre- and post-intervention metrics, which demonstrated whether the implementation successfully influenced the providers' understanding and behavior. Pre- and post-survey questionnaires were administered to the participants using Qualtrics software and QR coding, which facilitated efficient data collection and ensured participant anonymity. Additionally, the use of Qualtrics software and QR coding served as a practical method for data collection, whereby participants scanned the QR code with their smartphone devices to quickly access the session questionnaires without the need for additional login steps or technical barriers.

To increase participation and accessibility to the educational session, a pre-recorded presentation was created and distributed by the CRNA Clinical Coordinator, to the clinical site's physician anesthesiologists and CRNAs via email with a link for easy access. The goal was to enable providers and residents to view the presentation at their convenience, ideally alleviating the logistical challenge of gathering all participants to convene at a single time and location, thus increasing participation. Approximately one week before the session, a notification was sent via email to all anesthesia providers and residents at the clinical site to encourage participation. At the beginning of the presentation, the purposes of the DNP project and the right to refuse participation were explained, followed by a QR link to the pre-presentation survey (Appendix D). Subsequently, the recorded PowerPoint presentation detailed information about the increased sensitivity to opioid agents in patients with OSA, the benefits of opioid-sparing approaches in this patient population, brief pharmacology of the proposed four intravenous agents, and the evidence-based research findings pertaining to these agents. A QR link was displayed at the end of the presentation, providing access to the post-presentation survey. The pre-recorded portion of the presentation, excluding the time for completing the questionnaires, was approximately fifteen minutes.

Model for Implementation

Quality improvement projects are differentiated from research in that the former involves creating strategic processes derived from existing data and generally does not generate new knowledge (Faiman, 2021). While both QI and research are intended to improve clinical practice and benefit patient outcomes, QI tends to focus on improving internal processes or streamlining clinical workflow in a specific setting (Faiman, 2021). The Model for Improvement (MFI) framework may be utilized to conceptualize and accelerate improvement processes in a simple but effective manner (Institute for Healthcare Improvement [IHI], 2023).

The MFI consists of two main components: answering three key questions and utilizing the Plan-Do-Study-Act (PDSA) cycle (IHI, 2023). The three questions (Figure 3) are fundamental and utilized in an iterative process, as changes in thinking in one question throughout the change process may result in changes in thinking in another (IHI, 2023). Addressing the three questions of the MFI is as follows: the project investigator (PI) intended to increase awareness of the benefits of opioid-sparing in patients with OSA and the likelihood of utilizing one or more of the proposed non-opioid intravenous agents through an educational presentation. With the educational presentation serving as the change of interest, the effectiveness of this change as an improvement was evaluated via pre- and post-educational surveys to measure the baseline understanding and intentions of anesthesia providers regarding opioid-sparing techniques and their willingness to adopt the proposed changes after the educational presentation.

Plan-Do-Study-Act (PDSA) Cycle

Plan

The Plan-Do-Study-Act (PDSA) model is a cyclical component of the MFI that tracks the progress of a QI initiative in real time and involves developing a plan to test a change, carrying out the test, observing and learning from the consequences, and determining what modifications should be made (IHI, 2023). The PDSA model is an iterative process and provides a systematic blueprint for making real-time adjustments to a QI initiative, a benefit enjoyed in QI but not research (IHI, 2023). Consequently, real-time feedback utilizing the PDSA model increases the likelihood of project success (IHI, 2023).

The PDSA model provided a simple but effective groundwork for implementing the educational initiative and allowed this process to be continually evaluated to ensure that the project objectives were met. In the planning stage of the model, the PI consulted with the Chief

Anesthesiologist and Chief CRNA at the facility to solidify the need for the QI initiative. An exhaustive literature review was conducted, and the results and themes were extrapolated. A short video presentation was created utilizing Canva, and pre- and post-session surveys were created utilizing Qualtrics software.

Do

In the second step of the PDSA model, the video presentation was sent to the participants, and the subsequent data collection from the pre- and post-session surveys was completed.

Study

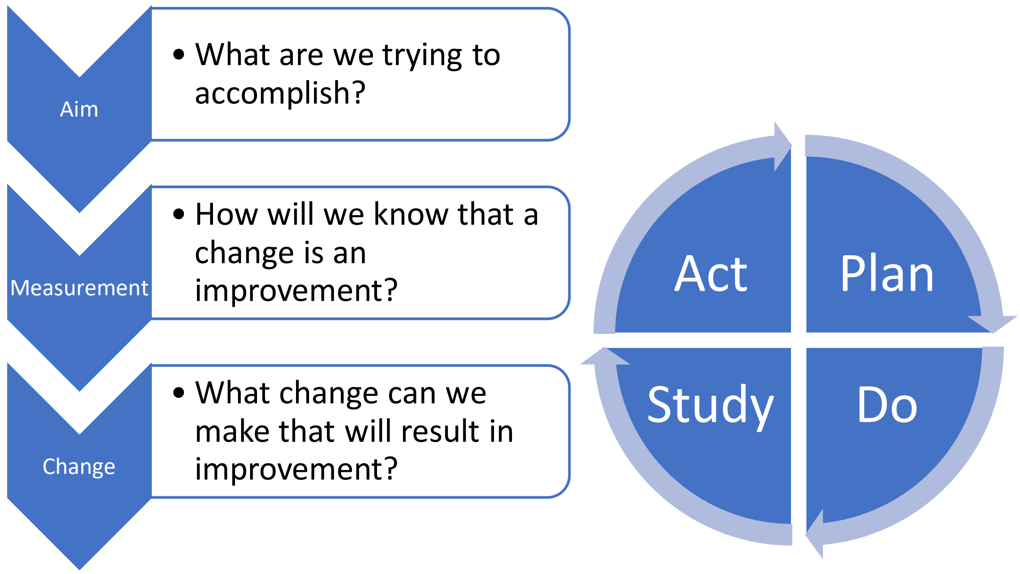
During the third phase, the data was critically analyzed to determine the impact of the educational intervention on achieving the project objectives. Critical appraisal of the data, in addition to assessing the effectiveness of the intervention, also identified factors that may have influenced the results (IHI, 2023).

Act

In the final stage of the PDSA cycle, the PI consulted with the project committee to discuss the necessity of modification to the intervention and strategies to increase sustainability. If the project successfully met the previously discussed objectives, the PI and project committee discussed the potential for more definitive implementation efforts. If the project did not meet the objectives, the PI collaborated with the project committee to identify opportunities for improvement to the educational initiative. At this point, a new PDSA cycle was instituted.

Figure 3

The Model for Improvement and PDSA Cycle



(Adapted from *Model for Improvement*, by the Institute for Healthcare Improvement, retrieved from http://www.ihi.org/resources/how-to-improve, Copyright 2023).

Setting and Stakeholders

The video presentation was disseminated to the anesthesia providers employed by NPH at a level I trauma, 615-bed acute care medical center in Mesa, Arizona. Mesa is a suburb of Phoenix with a population of 512,498 as of the 2022 census (United States Census Bureau, 2023). Of note, implementation involved solely the providers employed by the anesthesia group, and not personnel employed by the facility itself. There were many stakeholders involved in this initiative. Pertinent stakeholders included: certified registered nurse anesthetists (CRNAs) and physician anesthesiologists who worked in the main OR on a full-time and as-needed basis. The anesthesia providers were directly responsible for administering anesthesia and managing perioperative analgesia. These providers benefited from evidence-based education to enhance their clinical practice, particularly in implementing opioid-sparing techniques for patients with obstructive sleep apnea (OSA). Additional stakeholders included the patients, surgeons, perioperative nurses, and hospital administrators. The benefits of this QI project for the stakeholders involved being updated on current literature and evidence-based practice in the area of perioperative analgesia for patients with OSA. The risks associated with participation in this project were related to the time spent viewing the educational session and answering survey questions.

Planning the Intervention

Before beginning the session, participants were informed of their right to voluntary participation and that they could withdraw from the project at any time without any repercussions. Additionally, participants were informed that proceeding beyond this point would signify their consent to participate in the project. The educational presentation began with a pre-session survey accessible via QR code, consisting of four demographic questions to assess anesthesia providers' titles, years of experience, their encounters with OSA incidence, and their current methods of analgesia for patients with OSA.

The pre-session survey also included seven additional questions addressing their perceptions, intent to modify practice, and understanding of opioid effects and alternative intravenous analgesic agents. After completing the pre-session survey, participants viewed a-minute video presentation. The presentation discussed the pathophysiology behind OSA, the deleterious effects of opioid administration in this patient population, and the proven benefits of four non-opioid intravenous analgesic agents in achieving opioid-sparing analgesia.

At the conclusion of the presentation, a post-session survey included the same seven questions from the pre-session survey to evaluate changes in perceptions and intent to modify practice, along with four additional questions specifically addressing the effectiveness of the educational session and perceived barriers to implementing the four non-opioid intravenous agents. Unpaired items between the pre- and post-surveys were analyzed separately for qualitative analyses.

Participants and Recruitment

Participants for this DNP project included anesthesiologists and certified registered nurse anesthetists (CRNAs) employed by National Partners in Healthcare (NPH). There were a total of 38 anesthesia providers within the facility, including 24 anesthesiologists and 14 CRNAs. The participating anesthesia providers worked full-time or part-time in the operating room. It is important to note that the implementation of this project involved only NPH anesthesia providers and no other employees of the facility.

To encourage participation and minimize attrition, the PI offered an incentive in the form of a self-funded twenty dollar Starbucks gift card, which was awarded to one participant through a random drawing. Eligibility for the drawing required participants to complete both the pre- and post-survey as well as view the presentation. This incentive aimed to motivate participants to fully engage in the project while ensuring anonymity and fairness in the selection process. Recruitment was achieved through word of mouth during the PI's clinical rotation and via email notifications (Appendix C).

Consent and Ethical Considerations

Participation in the educational session and questionnaire was voluntary, and participants were informed of their ability to withdraw from participating at any time. A disclosure form (Appendix B) detailing the project's purpose, extent of involvement, and anonymity of the survey responses was presented to all participants before the session. By reviewing the disclosure form and continuing with the pre-session survey and subsequent video presentation (Appendices D & E, respectively), participants acknowledged their consent to participate in the QI project and data collection. Additionally, the University of Arizona Institutional Review Board (IRB) approved the implementation of this QI project, determining that this QI project was not research and did not involve human subjects (Appendix A). Finally, written approval was obtained from the co-chief certified registered nurse anesthetist (CRNA) employed by NPH at this facility (Appendix A). Several ethical considerations will be adhered to in order to protect participants' rights.

Informed Consent

As stated before, participation in the educational session and questionnaire was entirely voluntary. Before the educational content was delivered, participants viewed a form that detailed the purpose of the project, their involvement, and the confidentiality of their responses. Additionally, they were informed that continuing past the consent screen for the pre-session survey would imply their agreement to participate. Finally, they were made aware of their right to withdraw participation from the project at any time without repercussions.

Anonymity and Confidentiality

The anonymity of participants was maintained throughout the duration of the project. Survey responses did not contain any personally identifiable information, effectively ensuring that answers could not be tracked back to any specific participant. Additionally, the Qualtrics software ensured the anonymity of responses.

Data Privacy

The data collected was kept confidential and used only for the purposes of the project. The data extrapolated from the Qualtrics surveys was stored on a password-protected hard drive only accessible by the PI.

Institutional Approval

The University of Arizona Institutional Review Board (IRB) reviewed and approved this QI project, confirming that it was free of human subjects testing and did not thereby constitute research (Appendix A). Additionally, written approval was obtained by National Partners in Healthcare, the anesthesiology group associated with the medical facility, to support and approve the implementation of the QI project (Appendix A).

Data Collection

The data collection for this QI project included the results of the pre- and post-session surveys (Appendix D). The questionnaires were created by the writer and reviewed by the three DNP project committee members. Participants were provided access to the questionnaires via QR code links that were accessible prior to the start of the presentation and at the conclusion. The items on the questionnaire incorporated multiple-choice, open-ended, and Likert formats, and Qualtrics software was utilized for data collection. As discussed earlier, the surveys included general data such as years of experience and the type of anesthesia provider, along with questions aimed at evaluating perceptions and attitudes toward opioid-sparing analgesia in patients with OSA, assessment of the current use of these agents for opioid-sparing purposes, and intent to use these agents for such purposes in patients with OSA.

The pre-session survey included questions regarding demographics, current practice, perceptions, and attitudes toward opioid-sparing analgesia. The post-questionnaire included identical questions except for the demographic items and added four follow-up questions: questions eight and nine were paired to assess perceptions of opioid-sparing analgesia both before and after the educational session, while questions ten and eleven evaluated barriers to utilizing the intravenous agents of interest and were analyzed qualitatively to extrapolate themes.

Data Analysis

The data collected from the pre- and post-session questionnaires was analyzed using descriptive statistics, with particular emphasis placed on the participants' intent to implement opioid-sparing analgesia with any number of the four intravenous agents of interest in patients with OSA, as well as their perceptions and attitudes toward these practices. Qualtrics securely stored the data in an anonymous fashion, ensuring participant confidentiality. The statistical analysis for this quality improvement project utilized IBM SPSS software and the Wilcoxon Signed-Rank Test to compare pre- and post-intervention survey responses from the anesthesia providers regarding their understanding and utilization of opioid-sparing techniques in patients with OSA. This non-parametric test was appropriate given the anticipated small sample size (10-30 participants) and the ordinal nature of the survey data, which included Likert scale responses. By using the Wilcoxon Signed-Rank Test, the PI could effectively assess whether there were significant differences in the providers' perceptions and confidence levels before and after the educational intervention. The Wilcoxon signed-rank test critical values table (Table 3) was used to determine statistical significance because it provides the threshold test statistic (W) required for significance based on the sample size. If the calculated test statistic (W) exceeded this threshold, the change from pre- to post-survey responses was deemed statistically significant. This approach ensured that results were appropriately interpreted within the constraints of the small sample.

To address potential attrition, only paired data—where participants had completed both the pre- and post-surveys—was included in the statistical analysis. Any unpaired responses were excluded from paired analyses but may still have contributed to qualitative insights, such as demographic trends or open-ended survey responses. This ensured that the quantitative findings accurately reflected the intended comparisons. To minimize attrition, participants were incentivized with a self-funded Starbucks gift card, offered in a random draw to those who completed both surveys and the educational session. Additionally, email reminders and clear instructions on accessing and completing both surveys were provided to encourage full participation.

In addition to statistical comparisons, qualitative analysis focused on theme extrapolation from open-ended survey responses. This allowed for a richer understanding of the providers' perspectives and any barriers they may have faced in implementing opioid-sparing practices. Identifying these themes not only enhanced the interpretability of the quantitative findings but also informed potential strategies for improving perioperative care in patients with OSA.

RESULTS

Sample Size and Demographics

The survey participants consisted of a total of 10 anesthesia providers, including 3 anesthesiologists and 7 certified registered nurse anesthetists (CRNAs), and all of them completed both the pre- and post-session surveys. The majority of participants had extensive clinical experience, with 5 participants reporting between 5-10 years of practice and 2 participants with more than 10 years of experience. Of the remaining participants, 1 reported 0-2 years and 2 reported 2-5 years of experience. The breakdown of anesthesia providers included 30% anesthesiologists (n=3) and 70% CRNAs (n=7) (Figure 4). The average years of anesthesia practice experience among participants was 6.95 ± 3.9 years (Table 1). The distribution of experience levels provided a comprehensive representation of both early and seasoned anesthesia providers.

Figure 4

Type of Provider

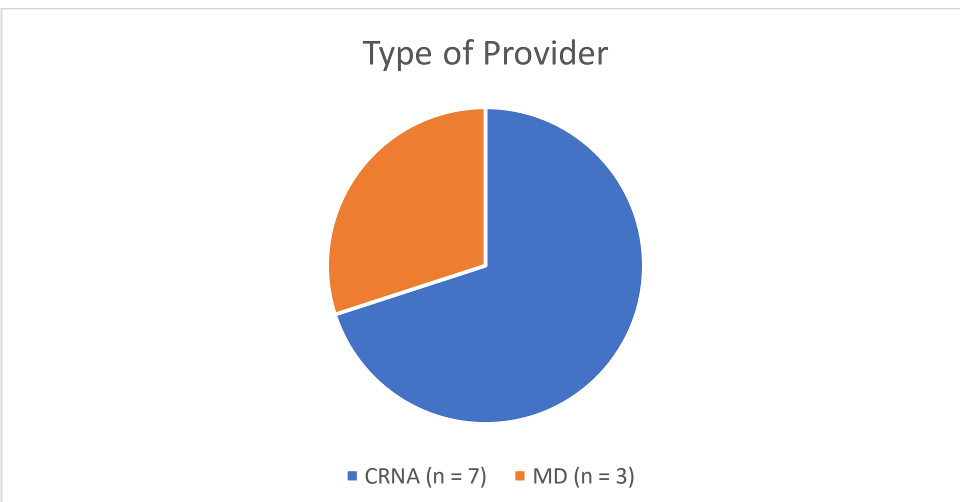


Table 2

Years in Practice

Type of Provider	Mean of Years in Practice	N (Number of Participants	Standard Deviation (SD)
Anesthesiologist	2.67	3	1.53
CRNA	8.79	7	9.3

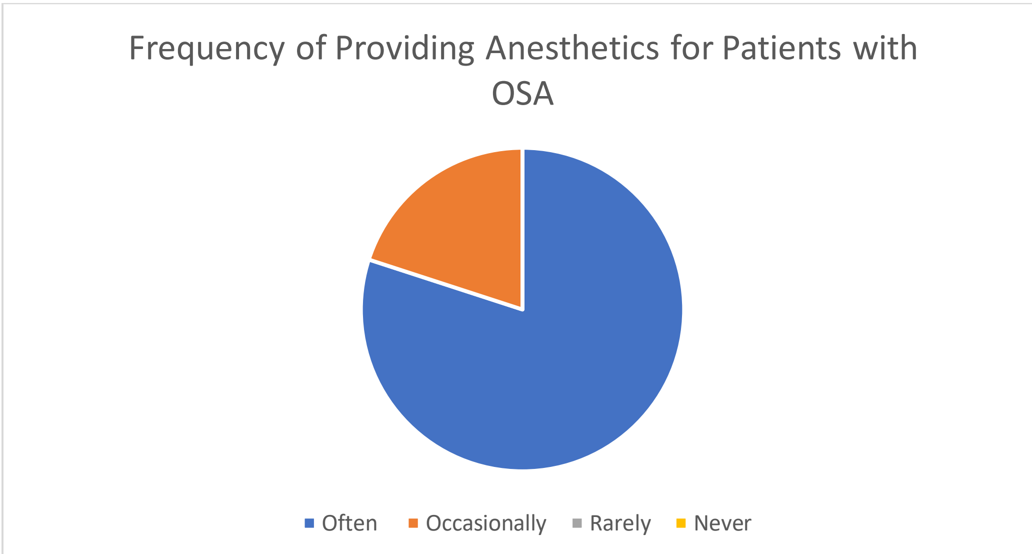
Current Practices and Frequency of Anesthesia Provision for OSA Patients

The pre-survey included questions regarding the frequency of anesthesia providers' exposure to obstructive sleep apnea (OSA) patients and their current analgesic regimen for OSA management. In pre-survey question 3, participants were asked how often they reported caring for patients with OSA on an average week. The majority, 80% (n=8), reported managing OSA patients "Often" during a given week, while 20% (n=2) reported "Occasionally" (Figure 5). This indicates that most anesthesia providers in the survey frequently care for OSA patients, suggesting a strong familiarity with this patient population.

Pre-survey question 4 focused on anesthesia providers' current analgesic regimen for OSA patients. 40% of the respondents (n=4), indicated that they use opioid-sparing analgesia with multimodal modalities (e.g., NSAIDs, ketamine, dexmedetomidine, magnesium, and/or lidocaine). In contrast, 40% (n=4) still rely on opioid agonists as the primary or sole analgesic agent, while 20% (n=2) reported that the presence of OSA does not influence their analgesic approach. These findings highlight a diverse range of practices among anesthesia providers, with some still relying on opioids despite the potential risks for OSA patients.

Figure 5

Frequency of Providing Anesthetics for Patients with OSA

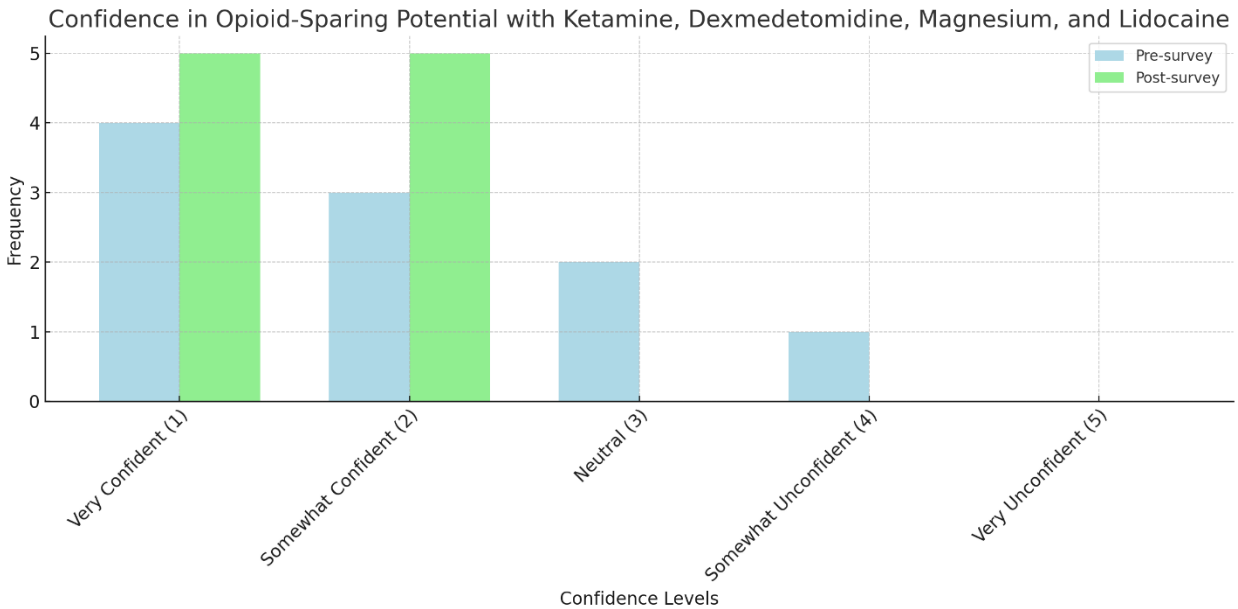


Changes in Confidence and Attitudes

The results of the Wilcoxon Signed-Rank Test revealed a significant improvement in participants' confidence regarding the use of opioid-sparing agents in OSA patients. For instance, Question 1 asked participants how confident they were that utilizing intravenous agents such as ketamine, dexmedetomidine, magnesium, and lidocaine were effective in reducing opioid consumption perioperatively. The median confidence score increased, with more providers indicating greater confidence in using these agents post-education (Figure 6). This suggests that the educational session had a positive effect on providers' willingness to utilize non-opioid intravenous agents for pain management in OSA patients. The test statistic (W) was 28 (Table 3), which is above the threshold of 8 for a sample size of 10 participants, indicating statistical significance at $p = 0.014$ (Table 4). The effect size (r) for this comparison was 0.78, which reflects a large effect size, suggesting a strong shift in confidence levels following the educational intervention.

Figure 6

Q1 - Confidence in Opioid-Sparing Potential with Ketamine, Dexmedetomidine, Magnesium, and Lidocaine

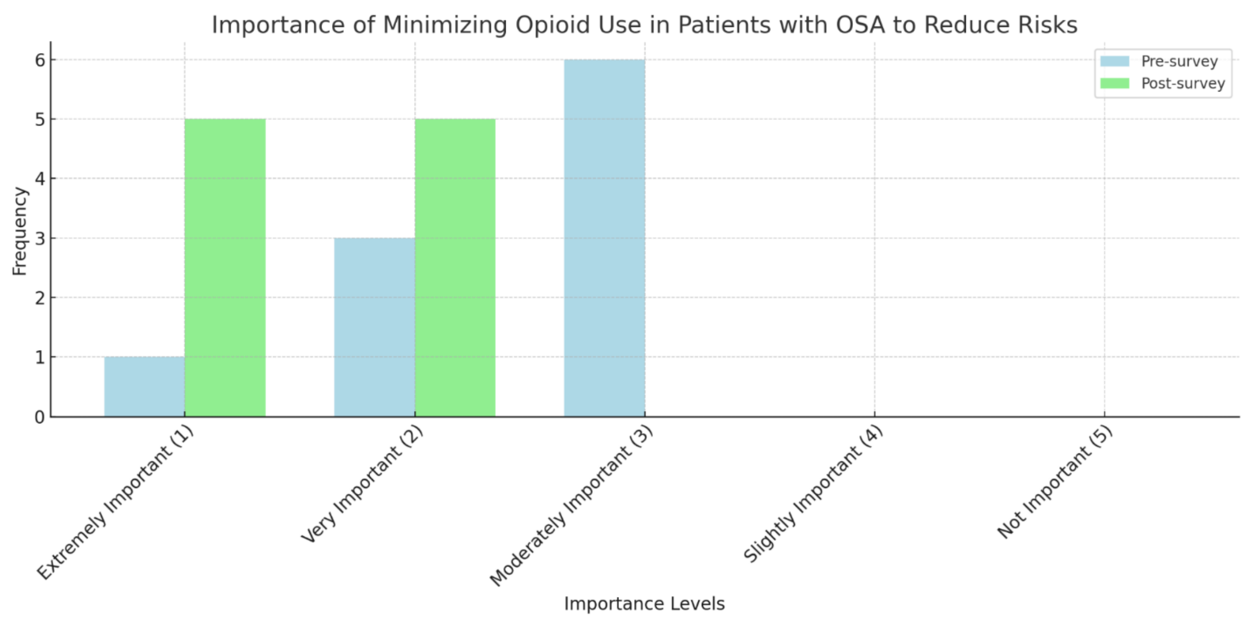


Additionally, participants reported a significant change in their attitudes toward the importance of minimizing opioid use in OSA patients. Question 2 assessed how important it was for providers to minimize opioid use in this population. The frequency of responses indicating that minimizing opioid use was "Extremely Important" (1) and "Very Important" (2) increased substantially in the post-survey compared to the pre-survey. Specifically, the number of participants marking "Extremely Important" and "Very Important" increased after the educational session, with a significant shift from the pre-survey to the post-survey results (Figure 7). This change was reflected in the Wilcoxon Signed-Rank Test. The test statistic (W) was 36

(Table 3), which is greater than the critical value of 8, confirming statistical significance at $p = 0.009$. The effect size (r) was 0.82, indicating a very large effect, showing a substantial change in participants' perceptions of the importance of opioid minimization. These results indicate that the educational session effectively emphasized the importance of reducing opioid consumption in OSA patients, significantly shifting participants' perspectives toward prioritizing opioid-sparing practices.

Figure 7

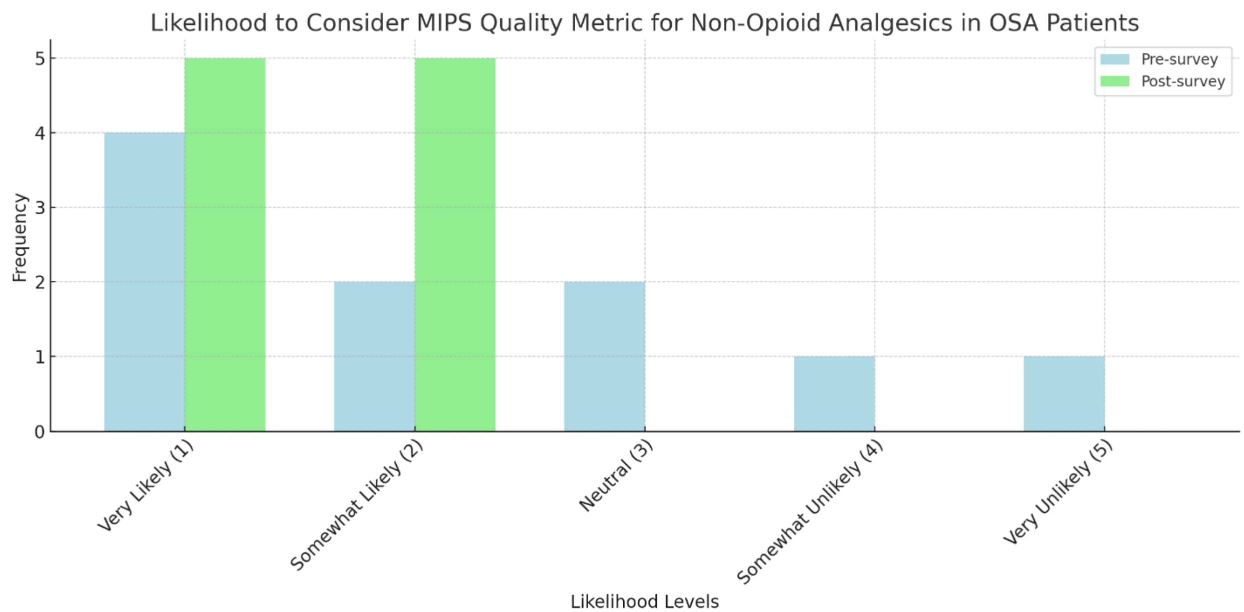
Q2 – Importance of Minimizing Opioid Use in Patients with OSA to Reduce Pulmonary Risk



The results also demonstrated a significant increase in participants' willingness to consider the Merit-Based Incentive Payment System (MIPS) quality metrics for non-opioid analgesia. Question 3 evaluated how likely providers were to integrate MIPS quality metrics into their opioid-sparing practices for OSA patients. The test statistic (W) was 36 (Table 3), which exceeds the critical value of 8, indicating statistical significance at a p level of 0.011. The effect size (r) was 0.81 (Table 4), indicating a large effect and suggesting that the educational session effectively helped participants recognize the importance of incorporating MIPS quality metrics into their practice (Figure 8). There was an appreciable shift in responses from pre-survey to post-survey. In the pre-survey, most participants indicated a "Somewhat Likely" response (2), whereas, post-survey, a substantial number of participants moved to "Very Likely" (1), indicating a greater likelihood of considering MIPS quality metrics in their practice (Figure 8). This shift suggests that the educational intervention helped participants better recognize the value of MIPS in promoting evidence-based practices for OSA management.

Figure 8

Q3 – Likelihood to Consider MIPS Quality Metric for Non-Opioid Analgesics in OSA Patients



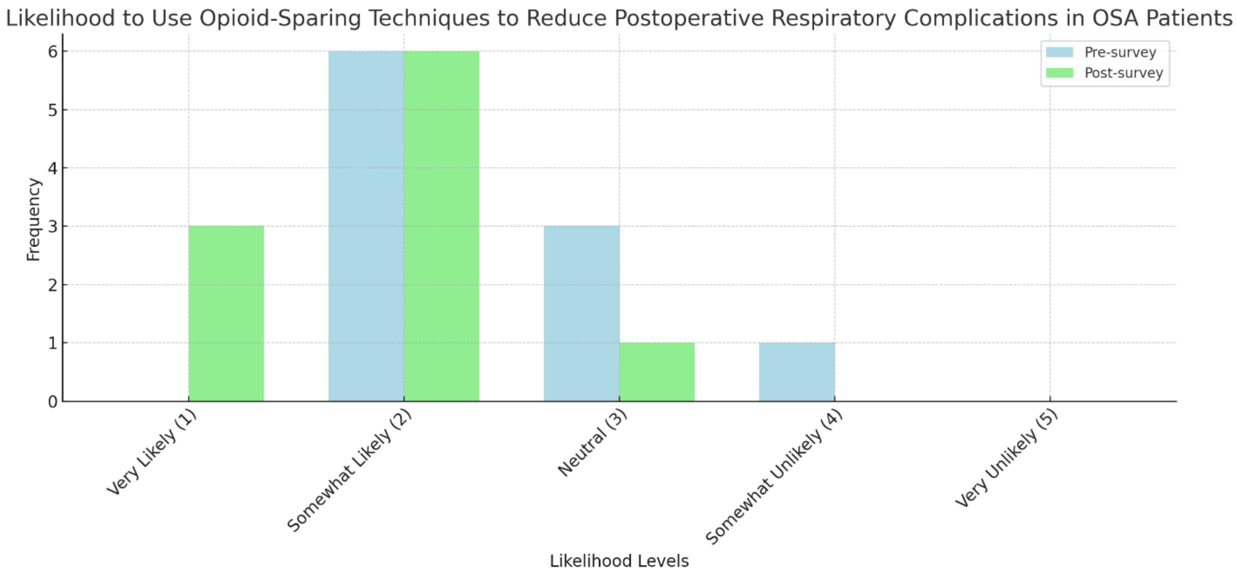
Question 4 assessed participants' confidence in their understanding of the benefits of ketamine, dexmedetomidine, magnesium, and lidocaine for patients with OSA. The Wilcoxon Signed-Rank Test revealed a significant increase in confidence post-intervention ($p < 0.05$). The test statistic (W) was 32 (Table 3), which is above the critical value of 8, showing statistical significance at $p = 0.035$ (Table 4). The effect size (r) was 0.67, reflecting a large effect size, suggesting a noticeable improvement in understanding. The median confidence score increased, with more participants reporting that they felt more knowledgeable about these agents' benefits for OSA patients after the teaching session.

Question 5 examined how likely providers were to implement opioid-sparing techniques, such as using the four intravenous agents, in patients with OSA. The results indicated a clear trend toward increased willingness after the educational session, with the p-value showing statistical significance ($p = 0.02$) (Figure 9). These findings suggest that the educational intervention not only increased confidence in understanding but also enhanced the likelihood that providers would incorporate these techniques into their clinical practice. The test statistic (W) was 21 (Table 3), which is above the critical value level of 8, indicating that the shift from pre-survey to post-survey responses was statistically significant. The effect size (r) was 0.74 (Table 4), suggesting a large effect and highlighting the impact of the educational session on increasing participants' likelihood of using opioid-sparing techniques.

Although participants expressed greater confidence and willingness to implement opioid-sparing techniques, question 6 explored the potential concerns about side effects when using non-opioid agents. The p-value for this comparison was 0.054, indicating a trend toward reduced concerns but not reaching statistical significance. The test statistic (W) was 7 (Table 3), which is below the critical value of 8, meaning it did not meet the threshold for statistical significance.

Figure 9

Q5 – Likelihood to Use Opioid-Sparing Agents in Patients with OSA



Finally, question 7 focused on the impact of practical limitations, such as lack of in-OR access to certain agents or the unavailability of prefilled syringes, on providers' willingness to use non-opioid agents. The results showed a significant shift in providers' willingness to use these agents in the face of logistical challenges, with a p-value of 0.011. This finding highlights that practical barriers were a significant concern prior to the educational session, but after the intervention, providers became more confident in overcoming these challenges. The test statistic (W) was 36 (Table 3), which is greater than the critical value of 8, indicating statistical significance. The effect size (r) was 0.81 (Table 4), showing a very large effect and suggesting that, after the educational session, participants were more confident in overcoming practical limitations.

Question 8 assessed how likely participants were to utilize non-opioid intravenous analgesic agents such as ketamine, dexmedetomidine, lidocaine, and magnesium as adjuncts to opioid agents for perioperative analgesia in patients with OSA, prior to the educational intervention. The pre-survey responses showed a mean score of 2.60 (SD = 0.70), indicating that, on average, participants were somewhat likely to use these agents (with the most common responses being "Somewhat Likely" or "Neutral"). The range of responses spanned from 2 to 4, with a significant portion of the participants marking "Somewhat Likely" (2) and "Neutral" (3), indicating some hesitation to integrate these agents into clinical practice before the educational session.

Question 9, on the other hand, assessed participants' likelihood to utilize these same agents following the educational session. The results from the post-survey revealed a marked increase in willingness, with a mean score of 1.60 (SD = 0.52). This suggests that participants were more likely to use non-opioid agents, with the majority indicating "Strongly Agree" (1) or "Agree" (2). The range of responses was from 1 to 2, demonstrating a strong shift in participants' attitudes post-intervention, indicating a positive change in their willingness to incorporate opioid-sparing strategies into their clinical practice. Although Questions 8 and 9 were not technically paired, a Wilcoxon Signed-Rank Test was applied due to the "pre" and "post" wording of the questions, which assessed the same topic before and after the educational intervention, and this revealed statistical significance ($p = 0.04$). The test statistic was 45, which is greater than the threshold of 8, indicating statistical significance. The effect size (r) was 0.9, indicating a very large effect size.

These findings highlight that the educational intervention effectively increased the participants' confidence in utilizing non-opioid agents for OSA patients, shifting their likelihood from neutral or somewhat likely to more likely in utilizing the non-opioid agents of interest for

OSA patients. This suggests that the intervention was successful in altering providers' attitudes and behaviors toward opioid-sparing techniques, reinforcing the importance of education in influencing clinical practices.

Table 3

Wilcoxon Signed-Rank Test: Critical Value Table

Critical Values of the Wilcoxon Signed Ranks Test

n	Two-Tailed Test		One-Tailed Test	
	α = .05	α = .01	α = .05	α = .01
5	--	--	0	--
6	0	--	2	--
7	2	--	3	0
8	3	0	5	1
9	5	1	8	3
10	8	3	10	5
11	10	5	13	7
12	13	7	17	9
13	17	9	21	12
14	21	12	25	15
15	25	15	30	19
16	29	19	35	23
17	34	23	41	27
18	40	27	47	32
19	46	32	53	37
20	52	37	60	43
21	58	42	67	49
22	65	48	75	55
23	73	54	83	62
24	81	61	91	69
25	89	68	100	76
26	98	75	110	84
27	107	83	119	92
28	116	91	130	101
29	126	100	140	110
30	137	109	151	120

(University of Florida, n.d.)

Table 4

Statistical Analyses

Question	Test Statistic (W)	Standardized Test Statistic (z)	Pre-Survey Mean	Post-Survey Mean	Effect Size (R)	Significance (P)
Q1: Confidence in effectiveness of opioid-sparing agents	28	2.46	2.4	1.5	0.78	0.014
Q2: Perceived importance of opioid-sparing in OSA	36	2.598	2.7	1.6	0.82	0.009
Q3: Likelihood to consider MIPS quality metrics	36	2.558	3.1	1.7	0.81	0.011
Q4: Understanding the benefits of non-opioid agents for OSA	32	2.111	2.2	1.5	0.67	0.035
Q5: Likelihood to utilize agents in OSA	21	2.333	2.5	1.8	0.74	0.02
Q6: Concern for side effects with agents	7	1.93	2.5	3.4	0.61	0.54
Q7: Perceived barriers on using agents	36	2.539	2.3	4.7	0.81	0.011

Barriers to Non-Opioid Intravenous Agent Use in OSA Cases

In question 10 on the post-survey, anesthesia providers were asked if they perceived any potential barriers to implementing the four non-opioid intravenous agents (ketamine, dexmedetomidine, lidocaine, magnesium) into their anesthetic plan for patients with OSA. Of the 10 participants, 60% (n=6) responded "no," while 40% (n=4) responded "yes". Participants who responded "yes" were asked to provide further explanation in free text response in question 11. The barriers mentioned in the responses all involved a lack of in-room access to the agents, particularly in regard to practical dosages, which increased the workload required to retrieve and dilute the agents to usable amounts. A total of 75% (n=3) of the participants who reported barriers cited access issues, particularly related to the limited availability of some agents in the operating room or the need to retrieve them from central storage. Another common barrier mentioned by 50% (n=2) of respondents was dosing and waste management, especially in relation to ketamine's large 500 mg vials, which led to significant waste when smaller doses were required. Finally, 25% (n=1) of participants noted the limited supply of agents such as dexmedetomidine and magnesium, which were available only in specific locations, making them less accessible during routine practice. These barriers highlight the logistical challenges anesthesia providers face in integrating non-opioid intravenous agents into their practice for OSA patients.

DISCUSSION

Summary

The results of this quality improvement project indicate that the educational intervention significantly increased anesthesia providers' confidence and willingness to incorporate opioid-sparing techniques for patients with obstructive sleep apnea (OSA). In addition to participants reporting a high frequency of caring for patients with OSA in the perioperative setting, participants demonstrated a clear improvement in their confidence levels regarding the use of non-opioid intravenous agents such as ketamine, dexmedetomidine, lidocaine, and magnesium, as well as a clear improvement in intention to use these agents in perioperative pain management. The participants also demonstrated a statistically significant increase in their perceived importance of minimizing opioid use in patients with OSA due to significant perioperative respiratory morbidity. The frequency of responses indicating that minimizing opioid use was "Extremely Important" and "Very Important" significantly increased post-intervention, with a p-value of 0.009.

Furthermore, the analysis revealed a notable increase in providers' willingness to consider the Merit-Based Incentive Payment System (MIPS) quality metrics for non-opioid analgesia. A shift from "Somewhat Likely" to "Very Likely" was observed post-education, with a p-value of 0.011, indicating that the educational session increased participants' recognition of the value of MIPS in guiding evidence-based practices. In terms of barriers, logistical limitations and concerns about side effects were mentioned, with lack of in-OR access to the agents and the impracticality of some dosages as the primary challenges. Although concerns about side effects showed a trend toward reduction, they did not reach statistical significance ($p = 0.054$), and this may be attributed to multiple factors. Firstly, the relatively small sample size (10 participants) may have limited the power of the statistical analysis, making it harder to detect a significant effect. Additionally, the low baseline levels of concern about side effects may have resulted in a ceiling effect, thereby leaving less room for improvement. Lastly, the scope of the educational intervention may not have been sufficient to address deeply rooted concerns about side effects. Overall, the data suggests that the educational session was effective in improving perceptions of opioid-sparing techniques in OSA patients using dexmedetomidine, ketamine, magnesium, and lidocaine, as well as participants' confidence and intentions to utilize these agents perioperatively.

Strengths and Limitations

A key strength of this quality improvement project was the successful completion of both the pre- and post-surveys by all participants, with no attrition. This ensures that the data gathered accurately reflects the changes in attitudes and confidence levels before and after the educational intervention. Additionally, the use of an asynchronous, pre-recorded video for the educational session was beneficial, as it allowed participants to watch the presentation at their own convenience, reducing the need to attend a live session at a specific time. This flexibility may have helped increase participation, as providers could engage with the content on their own schedule.

However, there were several limitations to consider. The sample size was relatively small, with only 10 out of 38 anesthesia providers participating. This low participation rate may have been due to recruitment challenges, such as the lack of a central location, such as an anesthesia lounge, to display flyers and inform providers about the study. Furthermore, the facility where these anesthesia providers are employed was undergoing significant structural changes within the personnel due to a tumultuous anesthesia landscape, which may have contributed to staff distractions and heightened stress levels. These factors may have influenced providers' ability or willingness to participate in the project. Additionally, while the asynchronous nature of the presentation offered flexibility, it also presented a potential weakness. Providers may have been less inclined to view the presentation during their free time, and the home environment could have introduced distractions, potentially reducing engagement with the educational content.

Implications (Practice, Education, Research and Policy)

This quality improvement (QI) project highlighted the positive impact of an educational intervention aimed at enhancing anesthesia providers' confidence and willingness to utilize non-opioid intravenous agents, such as ketamine, dexmedetomidine, magnesium, and lidocaine, in the perioperative management of obstructive sleep apnea (OSA) patients. The findings suggest that providing anesthesia providers with targeted education can lead to improved perceptions of opioid-sparing practices. These changes in attitude may be critical for reducing opioid consumption and improving patient outcomes in the OSA population, underscoring the value of educational interventions in clinical practice.

In regard to clinical practice, the results indicate that anesthesia providers are more likely to consider incorporating these agents into their anesthetic plans post-education. However, the low participation rate in the project, with only 10 of 38 anesthesia providers involved, limits the ability to draw definitive conclusions about the full impact on practice. This low participation could be addressed by refining recruitment strategies, such as displaying flyers in high-traffic areas and offering increased incentives, such as gift cards for all participants. By improving recruitment efforts, future projects may reach a larger sample size, enhancing the statistical power and the generalizability of the findings.

While the educational session was effective in improving knowledge and confidence, its reach was limited due to low participation. To maximize the effectiveness of similar future initiatives, it may be more beneficial to consider offering in-person presentations rather than relying on providers to view the material outside of work hours in their free time. An in-person presentation would provide an opportunity for real-time interaction, immediate clarification of any questions, and a more engaging environment, which could potentially increase participation and retention. Additionally, repeated educational sessions or refresher courses may be necessary to reinforce learning and ensure that these changes are sustained over time. To further enhance the impact, increasing participation through additional incentives or offering a variety of learning formats, such as offering the option of participating in a live presentation or virtual format, could be beneficial.

One significant limitation was the absence of studies directly linking the use of these non-opioid agents to OSA patients. Much of the existing literature pertains to patient populations with conditions comorbid with OSA, such as bariatric patients, who are more likely to experience sleep apnea. Future research should focus on OSA-specific patient populations to establish a stronger evidence base for the use of these agents. Randomized controlled trials or large cohort studies that specifically examine the efficacy of non-opioid agents in OSA patients would strengthen the foundation for clinical practice.

Finally, from a policy perspective, it may be beneficial to develop institutional policies or guidelines that encourage the use of opioid-sparing techniques, particularly in populations at high risk for opioid-related complications, such as OSA patients. Policies that promote the inclusion of non-opioid agents in perioperative care plans could support broader adoption of these practices, particularly if they are integrated into quality improvement initiatives, such as the Merit-Based Incentive Payment System (MIPS) for anesthesia providers. By aligning educational interventions with policy initiatives, it would be possible to create a more systemic approach to reducing opioid use and improving patient safety.

DNP Essentials Addressed

The DNP essentials are a set of eight competencies designed to prepare the DNP advanced practice nurse for their role in healthcare leadership and practice (AACN, 2006). This DNP project addressed three essential competencies. The first essential incorporated into this project is DNP Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice. In this project, a literature review was conducted to evaluate existing evidence on opioid-sparing techniques for obstructive sleep apnea (OSA) patients, particularly the use of intravenous agents like ketamine, dexmedetomidine, magnesium, and lidocaine. The literature review informed the creation of an educational presentation aimed at increasing anesthesia providers’ knowledge and confidence in using these non-opioid agents.

The second essential addressed was DNP Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care. This essential emphasizes the use of technology to support and improve patient care. This project aligned with this essential by utilizing an electronic, asynchronous PowerPoint presentation to deliver the educational content. Additionally, IBM SPSS Statistics (Version 26) was employed for data analysis to assess the effectiveness of the educational intervention in improving provider knowledge, confidence, and attitudes toward using opioid-sparing agents in OSA patients.

The final essential incorporated into this project was DNP Essential VII: Clinical Prevention and Population Health. DNP Essential VII emphasizes the role of clinical prevention in promoting health and wellness (AACN, 2006). This project aimed to reduce the risks associated with perioperative opioid use in OSA patients by increasing anesthesia providers’ knowledge and willingness to use opioid-sparing agents. By enhancing providers’ understanding of these agents and promoting their use, this project contributes to the broader goal of improving patient outcomes and addressing the ongoing opioid epidemic.

Conclusions

The purpose of this quality improvement project was to educate anesthesia providers about the use of four non-opioid intravenous agents—dexmedetomidine, ketamine, magnesium, and lidocaine—for opioid-sparing analgesia in patients with obstructive sleep apnea (OSA). The results indicate that the educational session had a positive impact on anesthesia providers' confidence, perceptions, and willingness to utilize these agents in clinical practice. Participants showed a significant increase in their confidence levels and intent to use opioid-sparing agents for pain management in OSA patients, reflecting a shift toward prioritizing opioid reduction strategies.

However, despite the improvements in knowledge and attitudes, the project was limited by low participation, with only 10 out of 38 providers engaging in the intervention. This low participation rate reduced the statistical power of the analysis and made it difficult to assess the broader impact of the educational session on clinical practice. Future studies should aim to increase participation, possibly through enhanced recruitment strategies, such as offering additional incentives or conducting in-person presentations rather than relying solely on asynchronous learning formats.

Another limitation of this project is the lack of direct evidence regarding the use of these non-opioid agents specifically in OSA patients, which made it challenging to provide a robust evidence base for their implementation. Much of the evidence supporting the use of these agents comes from broader surgical populations, such as bariatric patients with comorbid sleep apnea, rather than from OSA-specific studies. Further research is needed to examine the effectiveness of these agents in OSA patients to strengthen the evidence supporting their use in this population.

In conclusion, while the educational intervention was successful in improving providers' knowledge, confidence, and intentions to use opioid-sparing agents, further research and adjustments to the educational approach are needed to reach a larger audience and assess long-term practice changes. Future initiatives should also aim to address the gap in OSA-specific evidence, which will be critical in guiding clinical decisions and reducing opioid use in this high-risk population.

Plan for Dissemination

This QI project was presented via a poster at the Arizona Association of Nurse Anesthesiology Sun & Fun 2025 conference. The event was held from April 4-April 6, 2025, and was attended by CRNAs and RRNAs from around the country.

APPENDIX A

SITE APPROVAL/THE UNIVERSITY OF ARIZONA INSTITUTIONAL REVIEW BOARD AUTHORIZATION LETTER

National Partners in Healthcare
2221 Lakeside Blvd. #600
Richardson, TX, USA 75082

April 29, 2024

University of Arizona Institutional Review Board
c/o Office of Human Subjects
1618 E. Helen St.
Tucson, AZ 85721

Please note that Mr. Garrett Park, UA Doctor of Nursing Practice student, has the permission of National Partners in Healthcare to conduct a quality improvement project at this facility for his project, “Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea.”

Mr. Park will conduct a virtual teaching session for anesthesia providers employed by National Partners in Healthcare that provide anesthesia services at Banner Desert Medical Center in Mesa, AZ. Within this session, a pre- and post-session survey will be conducted. Mr. Park will recruit providers through word of mouth at the clinical site, as well as through email notifications and flyers. Recruitment efforts will provide a description of the project, the extent of their participation, the means to access the teaching session, and the date of the session. Mr. Park’s activities will be completed by February 30, 2025.

Mr. Park has agreed to provide to my office a copy of the University of Arizona Determination before he recruits participants and implements this quality improvement project. Additionally, he will provide follow-up and project results with me to disseminate among the anesthesia department.

If there are any questions, please contact my office.

Signed,

Andrew Istok, CRNA
Clinical Coordinator
2221 Lakeside Blvd. #600
Richardson, TX, USA 75082
Phone: (568)-484-8312

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University of Arizona IRB
845 N Park Ave., Suite 537A
Tucson, AZ 85719
Fax: 520-621-9810
VPR-IRB@arizona.edu

NOT HUMAN RESEARCH

December 9, 2024

Garrett Park

Dear Garrett Park:

On 12/9/2024, the IRB reviewed the following submission:

Type of Review:	Initial Study
Title:	Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea
Investigator:	Garrett Park
IRB Submission ID:	STUDY00005699
Sponsor:	None
Prime Sponsor:	None
IND, IDE, or HDE:	None
Documents Reviewed:	• Actual pre- and post- survey questions.docx, Category: Data Collection Tool; • Advisor Attestation.pdf, Category: Other; • DNP - Consent to participate form.docx, Category: Consent Form; • DNP Project Implementation PPT.pptx, Category: Participant Material; • DNP Project Recuitment Email.docx, Category: Recruitment Materials; • IRB-Protocol-for-Determination-of-Human-Research-v2023-12.docx, Category: IRB Protocol; • NPH Permission Letter.docx, Category: External Site Authorization;

The IRB determined that the proposed activity is not research involving human subjects as defined by DHHS and FDA regulations.

IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any

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changes be made. If changes are made and there are questions about whether these activities are research involving humans in which the organization is engaged, please submit a new request to the IRB for a determination.

All Covered Individuals must disclose all sponsored and non-sponsored Research Projects to the Office for Responsible Outside Interests (OROI) prior to Conducting Research if the individual is an Investigator. Please visit the OROI website for more information.

We value your feedback and would appreciate you taking the time to complete our survey about your experience with the IRB staff: https://uarizona.co1.qualtrics.com/jfe/form/SV_ehQ04WxNA06b42i.

If questions arise at any time during your study, please email the general IRB inbox at VPR-IRB@arizona.edu.

APPENDIX B

CONSENT DOCUMENT (DISCLOSURE AND CONSENT FORM)

Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea

Disclosure Statement for Consent to Participate

Principal Investigator: Garrett S. Park, RN, BSN, DNP Candidate

This quality improvement project is intended to deliver educational content to anesthesia providers and students regarding current literature on the benefits of opioid-sparing analgesia in patients with obstructive sleep apnea, focusing on four pharmacological agents associated with benefit in this area. The overarching goal of this initiative is to support the anesthesia providers employed by National Partners in Healthcare (NPH) that provide anesthesia services at Banner Desert Medical Center in optimizing their practice in an increasingly prevalent patient population.

If you choose to participate in this project, you will be asked to view a 20-minute virtual educational session. The session will be pre-recorded and will not be live, so learners may view the presentation at their leisure. During the session, you will be asked to complete a pre-survey, view the presentation, and answer post-survey questions. All survey responses are anonymous. Participation in this session is voluntary, with no known or foreseeable risks associated with participation. You will receive no immediate benefit from participation. Those who complete both the pre- and post-survey questionnaires will be automatically entered into a drawing to receive a $20 Starbucks gift card, personally funded by me.

Participation is voluntary, and refusal to participate will involve no loss of benefits or penalty to which you are otherwise entitled. You may withdraw participation at any time. Furthermore, you may skip any survey questions that you wish not to answer.

If you have any questions or concerns, please contact Garrett Park at garrettspark@arizona.edu

APPENDIX C

RECRUITMENT MATERIAL (RECRUITMENT EMAIL)

Dear Participant,

You are invited to participate in an education session entitled: **Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea.** This quality improvement project is intended to deliver educational content to anesthesia providers and students regarding current literature on the benefits of opioid-sparing analgesia in patients with obstructive sleep apnea, focusing on four pharmacological agents associated with benefit in this area. This educational session was created by Garrett Park, a student nurse anesthetist, as part of his Doctor of Nursing Practice project.

If you choose to participate in this project, you will be asked to view a 20-minute virtual educational session. The session will be pre-recorded and will not be live, so learners may view the presentation at their leisure. During the session, you will be asked to complete a pre-survey, view the presentation, and answer post-survey questions. All survey responses are anonymous. Participation in this session is voluntary, with no known or foreseeable risks associated with participation. Those who complete both the pre- and post-survey questionnaires will be automatically entered into a drawing to receive a $20 Starbucks gift card, personally funded by me.

Participation is voluntary, and refusal to participate will involve no loss of benefits or penalty to which you are otherwise entitled. You may withdraw participation at any time. Furthermore, you may skip any survey questions that you wish not to answer.

Please use the link below to access the presentation at your earliest convenience. **Please view the presentation and complete the survey between January 7- February 7, 2024.**

If you have any questions or concerns, please contact Garrett Park at garrettspark@arizona.edu

APPENDIX D

EVALUATION INSTRUMENTS (PRE-SURVEY, DEMOGRAPHIC QUESTIONNAIRE – QUESTIONS D1-D4, PRESURVEY QUESTIONS – Q1-Q7, POST-SURVEY INSTRUCTIONS – QUESTIONS Q1-Q11)

Pre-Survey

Dear Participant,

Thank you for taking time out of your busy schedule to participate in my DNP project. Your insight is crucial to the success of this project. Before you begin the presentation, please take a few moments to complete the pre-survey. Your responses will help us understand your perspectives, experiences, and current understanding of opioid-sparing analgesia in patients with obstructive sleep apnea and the associated pharmacological agents.

Your participation is voluntary, and your responses are entirely anonymous. Please answer as openly and honestly as possible as this will facilitate the success of this project and future initiatives.

If you have any questions or concerns, please feel free to contact Garrett Park at garrettspark@arizona.edu. Thank you again for your invaluable insight and participation!

Warmly,
Garrett Saisho Park, RN, BSN, CCRN-CSC
DNP Candidate

Pre-Survey Demographic Questionnaire

D1 Please select role within this facility

- Anesthesiologist (MD, DO)
- Certified Registered Nurse Anesthetist (CRNA)
- Student Registered Nurse Anesthetist (SRNA)
- Other (Please Specify)

D2 How many years of experience do you have in your role as an anesthesia provider?

- 0-2 years
- 2-5 years
- 5-10 years
- >10 years

D3 On an average week, how often do you provide anesthesia for patients with a listed diagnosis of obstructive sleep apnea (OSA) or those at high suspicion for having it?

- Never
- Rarely
- Occasionally
- Often

D4 What is your current intraoperative analgesic approach in patients with OSA, when regional techniques are contraindicated or otherwise unavailable?

- Opioid agonists as the primary or sole analgesic agent
- Opioid-sparing analgesia with multimodal modalities (e.g. NSAIDs, nonopioid agents such as ketamine, dexmedetomidine, magnesium, and/or lidocaine)
- Opioid-free analgesia
- The presence of OSA does not affect my analgesic plan

Pre-Survey Questions

Demographic Questions (D1-D4)

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Please select role within this facility

- ○ Anesthesiologist (MD, DO)
- ○ Certified Registered Nurse Anesthetist (CRNA)
- ○ Student Registered Nurse Anesthetist (SRNA)
- ○ Other (Please Specify)

How many years of experience do you have in your role as an anesthesia provider?

- ○ 0-2 years
- ○ 2-5 years
- ○ 5-10 years
- ○ >10 years

On an average week, how often do you provide anesthesia for patients with a listed diagnosis of obstructive sleep apnea (OSA) or those at high suspicion for having it?

- Never
- Rarely
- Occasionally
- Often

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What is your current intraoperative analgesic approach in patients with OSA, when regional techniques are contraindicated or otherwise unavailable?

- Opioid agonists as the primary or sole analgesic agent
- Opioid-sparing analgesia with multimodal modalities (e.g. NSAIDs, nonopioid agents such as ketamine, dexmedetomidine, magnesium, and/or lidocaine)
- Opioid-free analgesia
- The presence of OSA does not affect my analgesic plan

Presurvey questions (Q1-Q7)

Q1 & Q2

	Very confident	Somewhat confident	Neutral	Somewhat unconfident	Very unconfident
How confident are you that the use of intraoperative ketamine, dexmedetomidine, magnesium, and lidocaine can contribute to effective analgesia and reduce opioid consumption postoperatively?	○	○	○	○	○

	Extremely important	Very important	Moderately important	Slightly important	Not important
In your opinion, how important is it to minimize opioid use in patients with OSA to reduce risks such as hypoventilation and airway obstruction?	○	○	○	○	○

Q3 & Q4

	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
How likely are you to consider the Merit-Based Incentive Payment System (MIPS) quality metric involving non-opioid analgesic interventions when planning anesthesia for OSA patients?	○	○	○	○	○

	Very confident	Somewhat confident	Neutral	Somewhat unconfident	Very unconfident
How confident are you in your understanding of the benefits of non-opioid intravenous analgesic agents (i.e. ketamine, dexmedetomidine, lidocaine, magnesium) for patients with OSA?	○	○	○	○	○

Q5 & Q6

	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
How likely are you to use opioid-sparing techniques to reduce the risk of postoperative respiratory complications in patients with OSA?	○	○	○	○	○

	Great extent	Moderate extent	Small extent	Very little	Not at all
To what extent do concerns about potential side effects affect your willingness to use the four non-opioid intravenous agents of interest (dexmedetomidine, ketamine, magnesium, lidocaine) for OSA patients?	○	○	○	○	○

Q7

	Great extent	Moderate extent	Small extent	Very little	Strongly Disagree
To what extent do practical limitations (e.g. lack of in-OR pyxis access, unavailability of prefilled syringes) affect your likelihood of using the four non opioid intravenous agents of interest (dexmedetomidine, ketamine, magnesium, lidocaine) in OSA cases?	○	○	○	○	○

Post-Survey Instructions

Dear Participant,

Congratulations! You have successfully completed the pre-survey and PowerPoint educational presentation. I greatly appreciate your time and effort. Please take a few moments to complete the post-survey, reflecting on any changes you may consider in your practice.

Your participation remains voluntary, and your responses are confidential. I encourage you to be open and honest as your feedback will contribute significantly to the outcomes of this project.

If you have any further questions or comments, please do not hesitate to contact me via email at garrettspark@arizona.edu. Thank you again for your continued support and participation.

Best regards,

Garrett Saisho Park, RN, BSN, CCRN-CSC

DNP Candidate

Post-Survey Questions

Q1 & Q2

	Very confident	Somewhat confident	Neutral	Somewhat unconfident	Very unconfident
How confident are you that the use of intraoperative ketamine, dexmedetomidine, magnesium, and lidocaine can contribute to effective analgesia and reduce opioid consumption postoperatively?	○	○	○	○	○

	Extremely important	Very important	Moderately important	Slightly important	Not important
In your opinion, how important is it to minimize opioid use in patients with OSA to reduce risks such as hypoventilation and airway obstruction?	○	○	○	○	○

Q3 & Q4

	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
How likely are you to consider the Merit-Based Incentive Payment System (MIPS) quality metric involving non-opioid analgesic interventions when planning anesthesia for OSA patients?	○	○	○	○	○

	Very confident	Somewhat confident	Neutral	Somewhat unconfident	Very unconfident
How confident are you in your understanding of the benefits of non-opioid intravenous analgesic agents (i.e. ketamine, dexmedetomidine, lidocaine, magnesium) for patients with OSA?	○	○	○	○	○

Q5 & Q6

	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
How likely are you to use opioid-sparing techniques to reduce the risk of postoperative respiratory complications in patients with OSA?	○	○	○	○	○

	Great extent	Moderate extent	Small extent	Very little	Not at all
To what extent do concerns about potential side effects affect your willingness to use the four non-opioid intravenous agents of interest (dexmedetomidine, ketamine, magnesium, lidocaine) for OSA patients?	○	○	○	○	○

Q7

	Great extent	Moderate extent	Small extent	Very little	Strongly Disagree
To what extent do practical limitations (e.g. lack of in-OR pyxis access, unavailability of prefilled syringes) affect your likelihood of using the four non opioid intravenous agents of interest (dexmedetomidine, ketamine, magnesium, lidocaine) in OSA cases?	○	○	○	○	○

Q8 & Q9

	Very likely	Somewhat likely	Neutral	Somewhat unlikely	Very unlikely
Before this presentation, how likely were you to utilize non-opioid intravenous analgesic agents such as ketamine, dexmedetomidine, lidocaine, and/or magnesium as adjuncts to opioid agents for perioperative analgesia in patients with obstructive sleep apnea (OSA)?	○	○	○	○	○

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
As a result of this presentation, I am more likely to utilize non-opioid intravenous analgesic agents such as ketamine, dexmedetomidine, lidocaine, and/or magnesium as adjuncts to opioid agents for perioperative analgesia in patients with obstructive sleep apnea (OSA).	○	○	○	○	○

Q10 & Q11

Do you see any potential barriers to implementing any of the four agents pharmacological agents of interest (ketamine, dexmedetomidine, lidocaine, magnesium) into your anesthetic plan in patients with OSA?

- ◯ No
- ◯ Yes
- ◯ Uncertain

If you answered yes to the question above, please explain below.

APPENDIX E

PARTICIPANT MATERIAL (TRAINING PRESENTATION POWERPOINT; DNP PROJECT PROPOSAL PRESENTATION)

TRAINING PRESENTATION POWERPOINT

Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea

By: Garrett Saisho Park, Student Registered Nurse Anesthetist (SRNA), DNP Candidate

University of Arizona

THE UNIVERSITY OF ARIZONA
College of Nursing

Objectives

https://www.appostgradtraining.com/2016/07/19/accreditation-standard-2-curriculum-learning-objectives/

- Review the unique pathophysiology of obstructive sleep apnea (OSA) that increase the perioperative risk for respiratory complications, particularly when opioids are administered.
- Explore the pharmacological mechanisms and benefits of four non-opioid intravenous agents (dexmedetomidine, ketamine, magnesium, and lidocaine) that can be used to achieve opioid-sparing analgesia in patients with OSA.
- Discuss the limitations in utilizing the four non-opioid intravenous agents of interest for the purposes of opioid-sparing analgesia.

2

NOT Objectives

This presentation will NOT:

- Advocate for or promote opioid-free anesthesia
- Imply that appropriate utilization of perioperative opioids is poor practice.
- Discuss in-depth pharmacology with the selected agents

3

Overview of Presentation

Pre-Survey → Presentation → Post-Survey

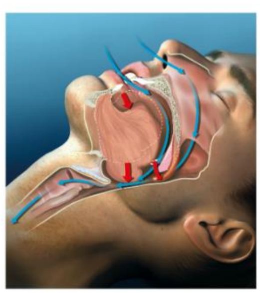
4

But First…Pre-Session Survey

- If QR code doesn't work, use this link
- https://uarizona.co1.qualtrics.com/jfe/form/SV_ewUBVjAp3RxtOV8
- This survey is completely anonymous and voluntary.
- Your participation is much appreciated!

5

Background/Significance



- **OSA Pathophysiology**: Repeated airway collapse due to reductions in upper airway muscle tone during sleep⍰leads to hypoxemia and hypercarbia (Cozowicz & Memtsoudis, 2021)
- **Prevalence is** ↑↑↑ (Chung et al., 2016).
- **Anesthetic challenges**: Anesthetic agents, especially opioids exacerbate OSA⍰ morbidity and mortality
  - Increased rates of postoperative hypoxia, respiratory failure, cardiac events, ICU admissions→increased costs (Wolfe et al., 2016).

6

Significance

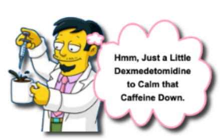
- **ASA Recommendations**: Guidelines advise reducing or eliminating opioids in OSA patients to minimize respiratory risks (American Society of Anesthesiologists, 2023).
- **MIPS Incentives**: Medicare promotes multimodal analgesia via quality metrics, directly impacting reimbursement (Latino & Kapoor, 2021).
  - **Requires 2 or more non-opioid analgesic agents utilized**
- **Why It Matters**: Aligning with these practices improves patient safety and has financial implications for providers (American Society of Anesthesiologists, 2023).

Dexmedetomidine

- **Mechanism**: Agonist at alpha-2 adrenoreceptors, resulting in SNS depression→sedation, anxiolysis, analgesia, antishivering (Vuyk et al., 2021).
- Findings: As an adjunctive agent, results in **reduced intra- and post-operative opioid consumption and pain scores across diverse surgical populations** (Tsaousi et al., 2018; Wang et al., 2018).
- **Wide Applicability**: Demonstrated efficacy in various surgeries, including GYN, ENT, spine, and urology (Hakim & Wabba, 2019; Shariffuddin et al., 2018; Wang et al., 2018).
- **OSA-Specific Data Gap**: Limited studies specifically target OSA patients, but findings suggest potential applicability based on shared pathophysiology.

Dexmedetomidine: Dosing

- **Variability in Studies**: Both bolus and infusion methodologies were used, with effective outcomes across diverse protocols.
- **Bolus Dosing**: Studies varied between 2–8 mcg boluses; average: 0.5 mcg/kg.
- **Infusion Dosing**: Ranges from 0.3–0.8 mcg/kg/hr, depending on surgical context.
- **Key Takeaway**: Flexibility in dosing allows for tailoring to specific patient and procedural nee



Dexmedetomidine: Concerns

- **Concern: Postoperative sedation with dexmedetomidine might worsen airway obstruction in OSA patients**.

- RCT compared dexmedetomidine vs. propofol sedation in patients with OSA.
- **Findings:**
  - Significantly lower incidence of airway obstruction with dexmedetomidine (11.5% vs. 41.7%).
  - Fewer airway interventions required in the dexmedetomidine group.
- **Conclusion:**
  - Dexmedetomidine is less likely to cause upper airway obstruction compared to propofol.

10

Ketamine

- **Mechanism of Action**: Non-competitive NMDA receptor antagonist; reduces central hypersensitization (Vuyk et al., 2021). Attenuates opioid-induced hyperalgesia and acute opioid tolerance.
- **Findings**: Meta-analysis of 30 RCTs: Reduced pain scores and opioid consumption up to 48 hours postoperatively in spine surgery patients (Zhou et al., 2022).
- Effective as part of multimodal regimens, with **significant opioid-sparing effects in bariatric, abdominal, and breast surgeries** (Jabbour et al., 2020; Hassan & Mahran, 2023).
- No significant increase in ketamine-related adverse effects across studies (Zhou et al., 2022).

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Ketamine: Dosing

Bolus Dosing: Typical range: 0.3–0.5 mg/kg, usually given at surgical incision.

Infusion Dosing: Average: 0.15 mg/kg/hr, often administered as IV pushes during surgery.

Variability Across Studies: Effective outcomes observed with both bolus and infusion methodologies.

Key Takeaway: Flexibility allows for tailoring based on patient needs and procedure type.

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Magnesium

Mechanism of Action: Non-competitive NMDA receptor antagonist; inhibits calcium influx to reduce pronociceptive transmission (Jabbour et al., 2020).

Findings:

Gynecologic surgeries: Decreased intra- and postoperative opioid use and pain scores (Gao et al., 2020; Sousa et al., 2016).

Bariatric surgery: Reduced 24-hour postoperative morphine consumption (Jabbour et al., 2020).

Breast surgery: Significant opioid-sparing effects when combined with ketamine (Hassan & Mahran, 2023).

No significant increase in side effects across studies.

13

Magnesium: Dosing

- **Bolus Dosing**: Typical range: 30–50 mg/kg in 50-100 ml of NS over 15-30 min, depending on surgical context.
- **Infusion Dosing**: Most studies: 3–8 mg/kg/hr during surgery.
- **Effective Across Protocols**: Both bolus and infusion methods yielded opioid-sparing effects.
- **Key Takeaway**: Dosing flexibility allows for tailored use based on patient and procedural needs.

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Lidocaine

- **Mechanism of Action**: Complex and not fully understood. Acts on glycinergic system, ion channels, NMDA, and serotonin receptors (Beaussier et al., 2018).
- Demonstrates anti-inflammatory, anticancer, and organ-protective effects (Wang et al., 2024).
- Findings:
  - **Bariatric surgery**: Reduced opioid use and improved recovery scores (De Oliveira et al., 2014; Tovikkai et al., 2020).
  - Abdominal surgery: Lower pain intensity and opioid consumption (Jipa et al., 2022).
- Safe profile with minimal adverse effects across studies.

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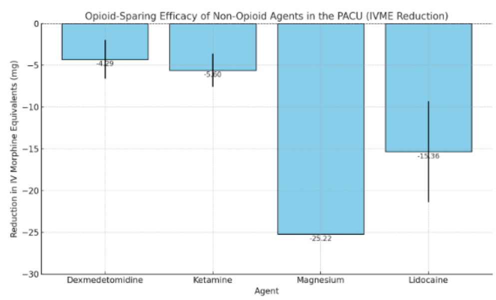
Lidocaine: Dosing

- **Induction Dosing**: Typically 1–1.5 mg/kg bolus at the start of surgery.
- **Infusion Dosing**: Maintained at 1–2 mg/kg/hr during surgery.
- **Key Takeaway**: Flexible dosing supports individualized approaches for patient and procedural needs.

16

Opioid Sparing: How Much?



Data from:
(Bi et al., 2020; Hung et al., 2024; Zhang et al., 2022; Zhou et al., 2022)

17

Limitations and Significance

- **Limited OSA-Specific Evidence**: Most studies focus on general surgical patients. Lack of direct data in confirmed OSA patients.
- **Relevance of Obesity and Bariatric Populations**:High prevalence of OSA in these groups supports their inclusion as proxies. Findings suggest potential applicability to OSA patients.
- **Reasonable Extrapolation**: Strong opioid-sparing evidence in general surgery supports use in high-risk OSA patients. Aligns with ASA recommendations for opioid-sparing in OSA populations.
- **Need for Further Research**: Direct studies in OSA patients are needed to validate findings and refine practice.

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Post Session Survey

- If QR code doesn't work, use this link
- https://uarizona.co1.qualtrics.com/jfe/form/SV_4TrElQMuUtyDdoq
- This survey is completely anonymous and voluntary.
- Your participation is much appreciated!

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IMAGE CAPTION

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DNP PROJECT PROPOSAL PRESENTATION

Optimizing Analgesia: Opioid-Sparing Alternatives for Obstructive Sleep Apnea

Garrett Saisho Park, RN, BSN, CCRN-CSC, RRNA
2025 DNP Project Defense
Project Committee:
James R. Reed, DNP, MSNA, CRNA, FAANA
Kristie Hoch, DNP, CRNA, MS, RRT, FAANA
Charles Elam, Ph.D, DNAP, CRNA
THE UNIVERSITY OF ARIZONA
College of Nursing

Background: Opioids and Obstructive Sleep Apnea

- **Significance** – The effect of opioids in patients with OSA has been shown to exacerbate the pathology with reductions in upper airway muscle tone and suppression of chemoreceptor, leading to upper airway obstruction and ventilatory pattern aberrations (Freire et al., 2022).
- Closed claims analyses have corroborated these pathological findings and have revealed significantly elevated occurrences of postoperative cardiopulmonary complications, including: hypoxia, respiratory failure, ICU admissions, and the need for postoperative mechanical ventilation (Wolfe, et al., 2016).
- The deleterious safety profile of opioid use in patients with OSA is well described, so appropriate modifications to the anesthetic plan are implicated (American Society of Anesthesiologists [ASA], 2023).

2

Background: Opioid-Sparing Analgesia

- There exist many modalities for opioid-sparing, and these include: regional techniques such as neuraxial anesthesia and peripheral nerve blocks, and various multimodal pharmacological techniques (Simpson et al., 2019).
- **This project focuses on four intravenous non-opioid agents as part of a multimodal approach with general anesthesia**. These agents include: intravenous dexmedetomidine, ketamine, magnesium, and lidocaine.
- With the recent emphasis on enhanced recovery after surgery (ERAS) pathways, opioid-sparing analgesic techniques have become increasingly popular; the goal is not to eliminate opioids as an analgesic modality, but to administer opioids judiciously alongside nonopioid agents in order to maximize the analgesic benefit of opioids while simultaneously minimizing the associated risks (Simpson, et al., 2019).

3

Local Problem

- National Partners in Healthcare (NPH) is an anesthesia management group that partners with healthcare facilities, surgeons, and other payors to provide quality practices in anesthesiology (National Partners in Healthcare, 2023).
- Observed variability in perioperative analgesia management for OSA patients at a 615-bed tertiary care center near Phoenix, Arizona; limited use of opioid-sparing techniques despite available resources.
- Conversations with anesthesia providers highlighted knowledge gaps regarding specific opioid-sparing agents for this population.
- 2017 BRFSS survey: 75% of adults in Arizona reported sleep disorder symptoms, with respiratory symptoms rising with BMI (Liu et al., 2021).
- Maricopa County's rising obesity rates suggest potential underdiagnosis of OSA, underscoring the need for opioid-sparing perioperative management (Liu et al., 2021).

4

Description of Project

- **Project question**: In anesthesia providers, will a structured educational session highlighting the benefits of four non-opioid analgesic agents for opioid-sparing increase their intent to modify current anesthetic practices in patients with OSA?
- **Objectives:**

1. Evaluate the current practices, perceptions, and intentions of anesthesia providers regarding opioid-sparing analgesia for patients with OSA and their awareness of the challenges associated with opioid use in this population.
2. Implement the educational presentation virtually to increase awareness and encourage positive perceptions of using four non-opioid intravenous analgesic agents to achieve opioid-sparing in patients with OSA.
3. Evaluate the overall effectiveness of the educational presentation through a pre- and post-survey to assess for changes in providers' perceptions, intent to adopt, and perceived barriers to using the four intravenous agents for opioid-sparing perioperative analgesia.

5

Project Goals

- 50% participation among the pool of anesthesia providers invited to participate
- 60% of participants will report an increase in knowledge attained

6

Theoretical Framework

- Change theories, such as Lewin's Change Theory (LCT), offer a global view on behavioral change, critical for guiding evidence-based implementations in healthcare (Mitchell, 2013).
- Frameworks help clinicians recognize health patterns, structure interventions, and evaluate outcomes (Christenbery, 2011).
- Lewin's Change Theory (LCT) is selected for this project due to its three-phase model—unfreezing, movement, refreezing—which effectively supports organizational change (Hussain et al., 2018).
- LCT emphasizes the balance of driving and restraining forces to initiate and sustain change, aligning well with the project's goal of promoting opioid-sparing techniques among anesthesia providers (Wojciechowski et al., 2016).

7

Theoretical Framework Cont.

Unfreezing

- Conducting an assessment of anesthesia providers' current utilization of opioid-sparing agents in OSA patients
- Evaluating anesthesia providers' beliefs and attitudes toward opioid-sparing techniques and alternative analgesic agents
- Hosting an educational session to succinctly identify practice issues and the rationale for change, fostering stakeholder buy-in and a sense of collective purpose

Moving/Changing

- Disseminating findings from the literature search, supporting the proposed changes, emphasizing the benefits of alternative analgesic agents
- Encouraging stakeholder engagement through question-and-answer sessions to address concerns transparently
- Assessing the adoption of or intention to adopt recommended practice changes via post-educational session surveys to gauge providers' willingness to implement changes

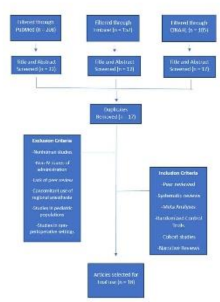
Refreezing

- Establishing the implemented change as a new standard practice through continued coaching and systematic evaluation
- Recognizing the importance of a favorable cost-to-benefit ratio and ongoing research to support the sustainability of the change
- Acknowledging workplace considerations such as resource accessibility and individual observations of patient outcomes in solidifying the change as a standard practice

8

Literature Synthesis

- **Databases Searched**: PubMed, CINAHL, Embase.
- **Keywords**: "multimodal," "opioid-sparing," "OSA," and specific agent names.
- **Two-Arm Approach**:
  - Examined opioid risks in OSA.
  - Investigated individual and combined effects of selected agents on opioid reduction.



9

Literature Synthesis Cont.

Scope of Literature:

•Significant support exists for dexmedetomidine, ketamine, lidocaine, and magnesium as opioid-sparing agents in general anesthesia.

•Few studies specifically focus on OSA patients; however, general findings indicate similar benefits in related populations, including those with comorbidities such as patients undergoing open bariatric surgery—a group particularly relevant given obesity's strong link to OSA prevalence (Erridge et al., 2021).

Key Findings

•All four agents show opioid-sparing benefits across varied surgical populations, potentially applicable to OSA patients.

•Agents such as dexmedetomidine, ketamine, and lidocaine reduce pain scores and opioid requirements consistently.

• Safety profiles are favorable, with no increase in adverse effects compared to opioids alone.

10

Literature Synthesis Cont.

Common Limitations:

•High variability in dosage and timing of administration across studies.

•Use of subjective pain scales (VAS/NRS) impacts consistency.

•Studies varied in the number and combination of agents used (e.g., dexmedetomidine alone vs. combined with ketamine), resulting in inconsistent effect sizes and complicating comparisons of efficacy.

11

Methodology

Project Design

- This is a Quality Improvement (QI) project that involves a comprehensive review of recent literature, a pre-recorded educational presentation utilizing PowerPoint, and pre- and post-surveys to measure the effectiveness of the teaching.
- Data will be collected and stored in an anonymous fashion using Qualtrics software. Pre- and post-surveys will be accessed utilizing QR codes visible during the presentation
- A qualitative approach will be utilized to measure the effectiveness of the presentation via statistical analysis of the pre- and post-survey results

12

Methodology: Model for Implementation

Plan Do Study Act (PDSA) Cycle: model is a cyclical component of the MFI that tracks the progress of a QI initiative in real time and involves developing a plan to test a change, carrying out the test, observing and learning from the consequences, and determining what modifications should be made (IHI, 2023).

- **Plan:** Identify the need for intervention with NPH and facility, literature synthesis conducted, educational presentation created
- **Do:** Educational presentation distributed via email from chief CRNA at facility. Pre- and post-surveys completed.
- **Study:** Data analysis to determine effectiveness of intervention
- **Act:** Data taken from survey results drive the need for modifications and/or sustainability of the intervention

13

Methodology: Setting and Participants

- The video presentation will be provided to NPH anesthesia providers at a 615-bed level I trauma center in Mesa, Arizona. This facility serves Mesa, a Phoenix suburb with a population of 512,498 (2022 census).
- Participants will consist of NPH providers – certified registered nurse anesthetists (CRNAs) and physician anesthesiologists working in the main OR on both full-time and per-diem bases.
- N = 38 - 38 NPH providers (24 anesthesiologists and 14 CRNAs) at this facility will be contacted through recruitment email.
- n = 10-15 (expected number of anesthesia providers who participate)
- Participation will be voluntary, with chief CRNA Andrew Istok emailing all NPH providers approximately one week before the implementation date. On the implementation date, Andrew will send another email to all providers, including a link to access the video presentation.
- Local site champion Jacob Thompson, DNP, CRNA will assist with recruitment via word-of-mouth reminders on site.
- Participants will be informed that by proceeding with the presentation, they provide implied consent to participate.

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Site Authorization

National Partners in Healthcare
2221 Lakeside Blvd. #600
Richardson, TX, USA 75082

April 29, 2024

University of Arizona Institutional Review Board
c/o Office of Human Subjects
1618 E. Helen St.
Tucson, AZ 85721

Please note that Mr. Garrett Park, UA Doctor of Nursing Practice student, has the permission of National Partners in Healthcare to conduct a quality improvement project at this facility for his project, "Optimizing Perioperative Analgesia: Alternative Intravenous Agents for Opioid-Sparing in Obstructive Sleep Apnea."

Mr. Park will conduct a virtual teaching session for anesthesia providers employed by National Partners in Healthcare that provide anesthesia services at Banner Desert Medical Center in Mesa, AZ. Within this session, a pre- and post-session survey will be conducted. Mr. Park will recruit providers through word of mouth at the clinical site, as well as through email notifications and flyers. Recruitment efforts will provide a description of the project, the extent of their participation, the means to access the teaching session, and the date of the session. Mr. Park's activities will be completed by January 30, 2025.

Mr. Park has agreed to provide to my office a copy of the University of Arizona Determination before he recruits participants and implements this quality improvement project. Additionally, he will provide follow-up and project results with me to disseminate among the anesthesia department.

If there are any questions, please contact my office.

Signed,

Andrew Istok, CRNA
Clinical Coordinator
2221 Lakeside Blvd. #600
Richardson, TX, USA 75082
Phone: (968)-484-8312

Methodology: Intervention

- **Educational Presentation**: A pre-recorded, approximately 10-15 minute presentation distributed via email by chief CRNA at NPH, allowing anesthesia providers to view it at their convenience.
- **Presentation Focus**: Emphasizes the importance of opioid-sparing techniques for OSA patients, covering their increased sensitivity to opioids, benefits of opioid-sparing approaches, a brief pharmacology overview of four IV agents, and evidence-based research.
- **Survey Assessment**: Pre- and post-surveys, consisting of 10 questions (administered through Qualtrics via QR codes present on screen during recorded presentation) will assess participants' knowledge, potential/intention for changes in clinical practice, and the barriers to doing so.

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Methodology: Plan for Data Collection and Analysis

Data Collection

- Electronic, anonymous data collection via Qualtrics
- Pre- and post-survey metrics

Data Analysis

- After initial data collection, the PI will transfer data from Qualtrics software into a Google Excel spreadsheet, and the results of the Qualtrics surveys will be electronically destroyed
- **The Wilcoxon Signed-Rank Test** will be useful in anticipation of a relatively small sample size. This test is useful for paired observations (pre- and post- format), and also useful for ordinal data, such as the likert scale responses.

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Methodology: Plans for Consent and Ethical Considerations

Plan for Consent

- Participation is voluntary
- Implied consent
  - Continuation in viewing the presentation and/or answering survey questions will imply consent
  - Participants can decline or withdraw participation and thus consent at any time

Ethical Considerations

- Anonymity and Confidentiality: Participant anonymity is maintained, with survey responses free from personally identifiable information, ensuring responses cannot be traced back to individuals.
- Data Privacy: Collected data will remain confidential and used solely for project purposes, stored on a password-protected hard drive accessible only by the principal investigator (PI).
- Institutional Approval: The project will be reviewed and approved by the University of Arizona IRB, confirming it does not involve human subjects. Written approval will also be obtained from National Partners in Healthcare to support implementation.

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Recruitment Material

- Flyers will not be distributed due to lack of anesthesia lounge/gathering area
- Recruitment email will be sent by Andrew Istok CRNA
- On-site champion CRNA will verbally recruit NPH providers.

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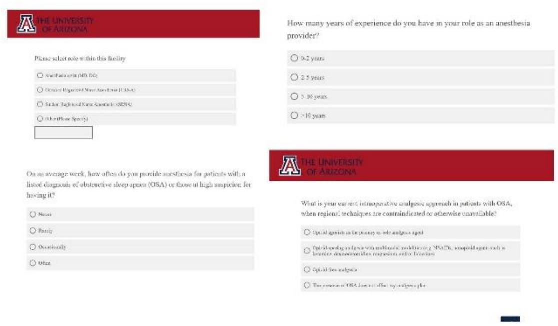
Qualtrics Survey



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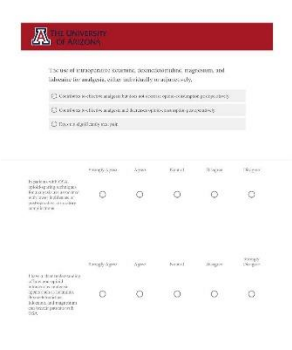
Qualtrics Survey



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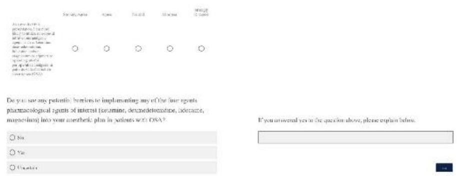
Qualtrics Survey



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APPENDIX F

PROJECT TIMELINE

Completion Date	Planning	Pre-implementation	Implementation	Evaluation
02/2024	Formal literature review			
04/2024	Meet with NPH stakeholders to discuss feasibility of project			
04/2024	Obtain implementation site authorization letter			
10/2024	Meet with DNP project committee chair to review manuscript			
11/05/2024		DNP project defense with project committee		
12/05/2024		Submit IRB application to the University of Arizona IRB		
01/07/2025			Link to the recorded educational session sent to NPH anesthesia providers by Andrew Istok CRNA via email	Collect survey data
02/07/25-2/18/25				Analyze survey data
2/21/25	DNP project defense submitted to committee chair			

APPENDIX G

LITERATURE REVIEW GRID

Project Question: *In anesthesia providers, will a structured educational session highlighting the benefits of four non-opioid analgesic agents for opioid-sparing increase their intent to modify current anesthetic practices in patients with OSA?*

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
Cozowicz, C., & Memtsoudis, S. G. (2021). Perioperative Management of the Patient With Obstructive Sleep Apnea: A Narrative Review. *Anesth Analg, 132(5)*, 1231-1243. https://doi.org/10.1213/ANE.0000000000005444 (Cozowicz & Memtsoudis, 2021)	Perioperative management of the patient with obstructive sleep apnea: A narrative review	Narrative review	• Outlines the increasing prevalence of obstructive sleep apnea (OSA) and the associated perioperative risk factors for exacerbation and sequelae, including airway and respiratory complications. • Discusses the risk profile of opioid agents in patients with OSA, including the worsening of upper airway collapsibility and central respiratory depression, as well as the increased sensitivity to these effects in this patient population.	• Provides a detailed background on the prevalence of OSA and the associated perioperative consequences, thus implicating the importance of this issue. • Highlights the increased risk of using opioid agents in this patient population, providing a strong rationale to utilize opioid sparing techniques.
Gupta, K., Nagappa, M., Prasad, A., Abrahamyan, L., Wong, J., Weingarten, T. N., & Chung, F. (2018). Risk factors for opioid-induced respiratory depression in surgical patients: a systematic review and meta-analyses. *BMJ Open, 8(12)*, e024086. https://doi.org/10.1136/bmjopen-2018-024086 (Gupta et al., 2018)	Risk factors for opioid-induced respiratory depression in surgical patients: a systematic review and meta-analyses	Systematic review with meta-analyses	• The risk for postoperative respiratory depression was associated with pre-existing cardiac disease (OIRD vs control: 42.8% vs 29.6%), pulmonary disease (OIRD vs control: 17.8% vs 10.3%), and OSA	• Underscores the risk factors associated with postoperative respiratory depression, one of which is OSA. • These findings support the rationale for achieving opioid sparing in this patient population in order to prevent adverse respiratory complications as discussed in this article.

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
			(OIRD vs control: 17.9% vs 16.5%) • The incidence of OIRD was found to be 5 cases per 1,000 anesthetics administered, and 85% of incidents occurring within the first 24 hours postoperatively.	
Bellon, M., Le Bot, A., Michelet, D., Hilly, J., Maesani, M., Brasher, C., & Dahmani, S. (2016). Efficacy of intraoperative dexmedetomidine compared with placebo for postoperative pain management: A meta-analysis of published studies. *Pain and Therapy*, *5(1)*, 63–80. https://doi.org/10.1007/s40122-016-0045 (Bellon et al., 2016)	Efficacy of intraoperative dexmedetomidine compared with placebo for postoperative pain management: A meta-analysis of published studies	Meta-analyses	• 14 RCTs were analyzed, with postoperative opioid consumption as the primary outcome measure and postoperative pain intensity and PONV as the secondary outcome measures. • Intraoperative administration of dexmedetomidine was associated with statistically significant reductions in postoperative opioid consumption and pain intensity in the postoperative period. • There was no effect on PONV incidence.	• The results of the meta-analysis demonstrate a positive effect in the use of dexmedetomidine to reduce opioid consumption and providing analgesia in the perioperative setting. • The findings support the concept and plausibility for opioid sparing approaches in patients with OSA.
Hakim, K. Y. K., & Wahba, W. Z. B. (2019). Opioid-free total intravenous anesthesia improves postoperative quality of recovery after ambulatory gynecologic laparoscopy.	Opioid-free total intravenous anesthesia improves	Randomized control trial	• This study evaluated the impact of an opioid-free TIVA regiment utilizing	• Dexmedetomidine in an opioid-free approach demonstrated significant analgesic effects and reduced reliance on rescue

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
Anesthesia, Essays and Researches, 13(2), 199–203. https://doi.org/10.4103/aer.AER_74_19 (Hakim & Wahba, 2019)	postoperative quality of recovery after ambulatory gynecologic laparoscopy		dexmedetomidine and propofol vs a standard TIVA regiment utilizing fentanyl and propofol. • The dexmedetomidine group resulted in a statistically significant improvement in QOR-40 scores vs the standard TIVA group in addition to lower times to first rescue analgesia, reduction in numerical rating pain scores, and a decreased overall need for rescue opioid and PONV agent compared to the opioid-based TIVA group.	analgesia in comparison with an opioid regiment, implicating its feasibility in an opioid-sparing approach.
Hwang, W., Lee, J., Park, J., & Joo, J. (2015). Dexmedetomidine versus remifentanil in postoperative pain control after spinal surgery: a randomized controlled study. *BMC Anesthesiology*, 15, 21. https://doi.org/10.1186/s12871-015-0004-1 (Hwang et al., 2015)	Dexmedetomidine versus remifentanil in postoperative pain control after spinal surgery: a randomized controlled study	Randomized control trial	• This RCT compared the effects of intraoperative remifentanil vs dexmedetomidine infusions on postoperative analgesia in patients undergoing spinal surgery. • The dexmedetomidine group had significantly lower Visual Analog Scale (VAS) scores at the immediate and late postoperative periods.	• Dexmedetomidine's significant impact in analgesia and decreased PCA requirements implicate its role in opioid sparing, and provide a potential opportunity for benefit in patients with OSA.

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
			• Patients in the dexmedetomidine group had a statistically significant lower patient controlled analgesia (PCA) requirement.	
Shariffuddin, I. I., Teoh, W. H., Wahab, S., & Wang, C. Y. (2018). Effect of single-dose dexmedetomidine on postoperative recovery after ambulatory ureteroscopy and ureteric stenting: a double-blind randomized controlled study. *BMC Anesthesiology, 18(1),* 3. https://doi.org/10.1186/s12871-017-0464-6 (Shariffuddin et al., 2018)	Effect of single-dose dexmedetomidine on postoperative recovery after ambulatory ureteroscopy and ureteric stenting: a double-blind randomized controlled study	Randomized control trial	• Patients were randomized to receive 0.5 mcg/kg IV dexmedetomidine with sevoflurane or saline (control). • The dexmedetomidine group resulted in a significant reduction in minimum alveolar concentration, and experienced lower postoperative resting and movement-related pain. • 1 hr postoperative VAS was significantly reduced in the dexmedetomidine group, with no patients requiring rescue narcotic (in contrast to the non-dex group).	• Dexmedetomidine's impact on intraoperative anesthetic requirements and postoperative pain demonstrate its potential for use as an adjunct to an opioid sparing regimen.
Gao, P. F., Lin, J. Y., Wang, S., Zhang, Y. F., Wang, G. Q., Xu, Q., & Guo, X. (2020). Antinociceptive effects of magnesium sulfate for monitored anesthesia care during hysteroscopy: a randomized controlled study. *BMC*	Antinociceptive effects of magnesium sulfate for monitored anesthesia care during	Randomized control trial	• In the magnesium group, the total amount of intraoperative and postoperative analgesic agents was significantly decreased.	• The findings support the use of magnesium sulfate as a beneficial adjuvant to reduce the need for intraoperative and postoperative opioid agents

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
Anesthesiology, 20(1), 240. https://doi.org/10.1186/s12871-020-01158 (Gao et al., 2020)	hysteroscopy: a randomized controlled study		• There was stable magnesium serum concentrations in the interventional group, and the incidence of hypotension was comparable between both magnesium and control groups. • Patients in the magnesium group required a significantly lower total dose of fentanyl.	without causing cardiovascular side effects.
Hassan, M. E., & Mahran, E. (2023). Effect of magnesium sulfate with ketamine infusions on intraoperative and postoperative analgesia in cancer breast surgeries: a randomized double-blind trial. *Brazilian Journal of Anesthesiology (Elsevier), 73(2)*, 165–170. https://doi.org/10.1016/j.bjane.2021.07.015	Effect of magnesium sulfate with ketamine infusions on intraoperative and postoperative analgesia in cancer breast surgeries: a randomized double-blind trial	Randomized Control Trial	• Compared the effects of a ketamine vs ketamine + magnesium adjuvant regiment during general anesthesia. • The ketamine with magnesium (KM) group had significantly less postoperative opioid consumption compared to the ketamine group. • Both groups showed similar NRS scores, side effects related to opioids, and chronic neuropathic pain metrics.	• Adding magnesium to a ketamine infusion was found to safely decrease the need for opioid agents, thus implicating its role in an opioid-sparing regimen for patients with OSA.
Jabbour, H., Jabbour, K., Abi Lutfallah, A., Abou Zeid, H., Nasser-Ayoub, E., Abou Haidar, M., & Naccache, N. (2020). Magnesium and ketamine reduce early morphine consumption	Magnesium and ketamine reduce early morphine consumption after	Randomized control trial	• This study demonstrated a significant reduction in morphine consumption	• Emphasizes the safety and efficacy of multimodal therapy using magnesium and ketamine

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
after open bariatric surgery: A prospective randomized double-blind study. *Obesity Surgery, 30(4)*, 1452–1458. https://doi.org/10.1007/s11695-019-04317-1 (Jabbour et al., 2020)	open bariatric surgery: A prospective randomized double-blind study		in patients who received a combination of magnesium and ketamine during open bariatric surgery compared to those who received ketamine alone or a placebo. • The magnesium and ketamine combination group showed an 87% relative reduction in morphine requirements, while the ketamine-only group showed a 21% relative reduction in morphine requirements compared to the placebo group, respectively.	in opioid-sparing during the first 24 hours postoperatively. • Provides a strong rationale for utilizing combination multimodal techniques for opioid-sparing using ketamine and magnesium. • Additionally, the bariatric patient population has significantly higher occurrences of obstructive sleep apnea, making this study sample particularly applicable to this project's target population
Sousa, A. M., Rosado, G. M., Neto, J.deS., Guimarães, G. M., & Ashmawi, H. A. (2016). Magnesium sulfate improves postoperative analgesia in laparoscopic gynecologic surgeries: a double-blind randomized controlled trial. *Journal of Clinical Anesthesia, 34*, 379–384. https://doi.org/10.1016/j.jclinane.2016.05.006 (Sousa et al., 2016)	Magnesium sulfate improves postoperative analgesia in laparoscopic gynecologic surgeries: a double-blind randomized controlled trial.	Randomized control trial	• Intraoperative magnesium sulfate infusions demonstrated a comparable reduction in postoperative pain when compared to a bolus of intravenous ketorolac during laparoscopic gynecologic oncology surgeries. • The magnesium sulfate group showed significantly decreased opioid consumption in	• Provides evidence for the efficacy of intraoperative magnesium sulfate in improving postoperative analgesia. • Provides evidence that magnesium sulfate plays a role as an opioid-sparing agent, thus implicating its potential for use in the context of opioid-sparing anesthesia in patients with OSA.

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
			the postoperative period. • During the initial 60 minutes postoperatively, pain intensity was lower in the magnesium group than in the ketorolac or placebo groups.	
De Oliveira, G. S., Jr, Duncan, K., Fitzgerald, P., Nader, A., Gould, R. W., & McCarthy, R. J. (2014). Systemic lidocaine to improve quality of recovery after laparoscopic bariatric surgery: a randomized double-blinded placebo-controlled trial. *Obesity Surgery*, *24(2)*, 212–218. https://doi.org/10.1007/s11695-013-1077-x (De Oliveira et al., 2014)	Systemic lidocaine to improve quality of recovery after laparoscopic bariatric surgery: a randomized double-blinded placebo-controlled trial	Randomized control trial	• Patients receiving systemic intraoperative lidocaine infusions during laparoscopic bariatric surgery demonstrated significantly higher global Quality of Recovery-40 (QoR-40) scores at 24 hours compared to the placebo group. • The lidocaine infusion group exhibited a lower total 24-hour opioid consumption compared to the placebo group.	• This study displays the potential benefits of utilizing systemic intraoperative lidocaine infusions in regards to its positive impact on postoperative quality of recovery in obese patients. • Provides evidence supporting the use of lidocaine as an opioid-sparing agent in this surgical population, in which a considerable amount suffer from comorbid OSA.
Jipa, M., Isac, S., Klimko, A., Simion-Cotorogea, M., Martac, C., Cobilinschi, C., & Droc, G. (2022). Opioid-sparing analgesia impacts the perioperative anesthetic management in major abdominal surgery. *Medicina (Kaunas, Lithuania)*, *58(4)*, 487. https://doi.org/10.3390/medicina58040487 (Jipa et al., 2022)	Opioid-sparing analgesia impacts the perioperative anesthetic management in major abdominal surgery	Randomized control trial	• The interventional group that involved the use of ketamine and lidocaine, as well as the epidural group, demonstrated a significant decrease in postoperative pain intensity.	• Demonstrates the role and capacity for opioid-sparing in infusions of ketamine and lidocaine intraoperatively.

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
			• There was a statistically significant decrease in postoperative opioid requirements in both interventional groups compared to the control group.	
Lovett-Carter, D., Kendall, M. C., Park, J., Ibrahim-Hamdan, A., Crepet, S., & De Oliveira, G. (2021). The effect of systemic lidocaine on post-operative opioid consumption in ambulatory surgical patients: a meta-analysis of randomized controlled trials. *Perioperative Medicine (London, England), 10(1)*, 11. https://doi.org/10.1186/s13741-021-00181-9 (Lovett-Carter et al., 2021)	The effect of systemic lidocaine on post-operative opioid consumption in ambulatory surgical patients: a meta-analysis of randomized controlled trials	Meta-analysis	• This study was a meta-analysis of five randomized control trials that studied the effect of systemic lidocaine on postoperative analgesic outcomes in the ambulatory surgery setting. • Systemic lidocaine demonstrated a statistically significant opioid-sparing effect, although postoperative pain control, PONV, an time to discharge did not show significant differences between the groups.	• Emphasizes the opioid-sparing effect of systemic lidocaine in the immediate postoperative period for ambulatory surgery patients. • The opioid-sparing effect is limited at 24 hours postoperatively, the study shows a potential short-term analgesic benefit for the purposes of opioid-sparing.
Thomas, G. J., Bauman, J. C., Bergeron, S., Wasvary, H. J., & Ziegler, M. A. (2023). Perioperative lidocaine infusion reduces opioid use in enhanced recovery after surgery patients undergoing laparoscopic colectomy. *The American Surgeon, 89(11)*, 4806–4810. https://doi.org/10.1177/00031348221135785	Perioperative lidocaine infusion reduces opioid use in enhanced recovery after surgery patients undergoing laparoscopic colectomy	Retrospective cohort study	• This study consisted of a retrospective review of patients who had undergone laparoscopic colon surgery with intraoperative infusions of lidocaine, and compared the morphine	• Demonstration that an intraoperative lidocaine infusion may lead to a substantial reduction in postoperative opioid consumption after laparoscopic colon surgery.

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
(Thomas et al., 2023)			milligram equivalents at the 48 hour postoperative mark to patients who had not received this agent. • The group who had received the lidocaine infusion showed a significant 52% reduction in median MME compared to the group without lidocaine.	• The findings support the use of intraoperative lidocaine for opioid-sparing effects.
Tovikkai, P., Rogers, S. J., Cello, J. P., & Mckay, R. E. (2020). Intraoperative lidocaine infusion and 24-hour postoperative opioid consumption in obese patients undergoing laparoscopic bariatric surgery. *Surgery for Obesity and Related Diseases : Official Journal of the American Society for Bariatric Surgery, 16(8)*, 1124–1132. https://doi.org/10.1016/j.soard.2020.04.026 (Tovikkai et al., 2020)	Intraoperative lidocaine infusion and 24-hour postoperative opioid consumption in obese patients undergoing laparoscopic bariatric surgery	Retrospective cohort study	• The 24-hour postoperative opioid consumption was significantly lower in the group receiving intraoperative lidocaine infusion, but non-significantly lower in the multivariate model. • Subgroup analysis, particularly among opioid-naive patients, showed a significantly reduced opioid consumption in the lidocaine group.	• Findings show a potential benefit for opioid-naive patients in regards to opioid-sparing. • This study implicates a role for lidocaine infusions to decrease postoperative opioid consumption in the setting of laparoscopic bariatric surgery.
Zhou, L., Yang, H., Hai, Y., & Cheng, Y. (2022). Perioperative low-dose ketamine for postoperative pain management in spine surgery: A systematic review and meta-analysis of randomized controlled trials. *Pain Research & Management*, *2022*, 1507097. https://doi.org/10.1155/2022/1507097	Perioperative low-dose ketamine for postoperative pain management in spine surgery: A systematic review and meta-analysis	Systematic review and meta-analyses	• This study included 30 RCTs involving patients undergoing elective spine surgery. • Patients who received perioperative ketamine	• The findings support the analgesic and opioid-sparing effects of perioperative low-dose ketamine administration. • The study also provides an analysis of the effectiveness and

Pub. Year; Author's Last Name	Title of Publication	Type of Study	Main Outcomes of Findings	Support for and or Link to Project
(Zhou et al., 2022)	of randomized controlled trials		infusions exhibited significantly lower pain intensity compared to the control group. • The ketamine group showed a reduction in opioid consumption at multiple postoperative time points.	safety profile of perioperative ketamine infusion.

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