Opioid-Sparing Anesthesia in Non-ERAS Surgical Patients:

An Educational Toolkit and Protocol for Certified

Registered Nurse Anesthetists to Reduce Barriers of its Utilization

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Table of Contents

Dedication and Acknowledgments

I would like to dedicate this project to my mom for all her love, encouragement, support, and instilling in me the confidence to continue to reach higher and push harder to achieve what I want in life. I also dedicate this to my wife for all her love and support and without her this would not have been possible.

I would also like to thank Dr. Linda Stone, Dr. Terry Wicks, Dr. Nancy Shedlick for granting me this opportunity and accepting me into the program. Also, a big thanks to Dr. Josh Borders for his support through this project.

Abstract

Background: Opioids are a useful medication during surgical procedures for pain relief and to decrease surgical stimulation but have many side effects as well as contribute to an epidemic causing 80,000 deaths per year. New alternatives to opioid have been utilized and researched and show improved outcomes, less side effects, and reduced opioid use after surgery but providers have been slow to adopt an opioid-sparing anesthetic into practice.

Purpose: The purpose of this project was to encourage the use of multimodal anesthesia practice among Certified Registered Nurse Anesthetists by reducing barriers to the implementation of opioid-sparing anesthesia.

Methods: By researching the most current evidence, an opioid-sparing protocol was developed along with an educational module, presentation, and quick reference guide. CRNAs were given a pre-education survey prior to the education session which measured barriers to opioid-sparing anesthesia practices. After the CRNAs attended the education session and were able to use the opioid-sparing protocol and quick reference guide, a post-intervention survey after the educational session which was given to compare the barriers to the pre-educational survey. A statistical analysis was then performed on the surveys to determine if there were any significant differences in barriers.

Results: Due to small sample size and high attrition rate there were no significant differences to barriers in providing opioid-sparing anesthesia with p-values ranging from .1538 - .9181 for the difference barriers studied (cost, drug availability, attitude, experience).

Recommendations and Conclusion: Additional research into costs could have been implemented and discussed in the presentation. In order to increase retention, providers could have been reached out to individually and to discuss current evidence-based practices and given the surveys. More studies need to be completed on comparing costs of opioid-sparing practices and include costs associated with operating room times, post-anesthesia care times and medication costs as well to determine the financial difference between the different practices. With trends in data showing improved patient outcomes, reduced pain, increased patient satisfaction, opioid-sparing anesthesia practices will become the standard of care.

Key Words: Opioid-sparing anesthesia, opioid-free anesthesia, multimodal analgesia and anesthesia, opioids, morphine, fentanyl, remifentanil, sufentanil, ketamine, dexmedetomidine, dexamethasone, non-steroid anti-inflammatory drugs, NSAIDs, acetaminophen, magnesium sulfate, lidocaine, celecoxib, ketorolac, regional anesthesia, confidence, quick-reference guide, addiction, substance-use disorder, opioid crisis.

Background and Significance

Opioids have been a primary analgesic in anesthesia for numerous years but have many well-known undesirable side effects. Opioid receptors are located in the central nervous system and when activated, lead to hyperpolarization and inhibit neuronal activity (Bajwa et al., 2017). Transmission of signals from the peripheral pain neurons is reduced as it travels to higher central nervous system centers providing a reduction in the sensation of pain. Unfortunately, opioid agonists also stimulate the chemoreceptor trigger zone leading to nausea and vomiting (Bajwa et al., 2017; Fawcett & Jones, 2018). Other unwanted effects include excessive sedation, ileus, respiratory depression, pruritus, urinary retention, and a large potential for abuse, misuse, and physical dependency (Brandal et al., 2017; Enten et al., 2019; Guinot et al., 2019; Jebaraj et al., 2017; Velasco et al., 2019). Newer evidence also indicates increasing reports of other concerning adverse reactions such hyperalgesia, immunosuppression, infection, and increased risk of tumor recurrence (Estebe et al., 2021; Guinot et al., 2019; Lavand'homme & Steyaert, 2017; Wilson, 2019). These adverse effects can increase times in the recovery/post anesthesia care unit (PACU), increase length of hospital stay, increase morbidity and mortality, and increase hospital costs (Guinot et al., 2019; Jebaraj et al., 2017; Velasco et al., 2019).

In addition to side effects, opioids are highly addictive. Opioid misuse has led to the opioid epidemic in the United States with 16,000 deaths per year attributed to prescription opioids (U.S. Department of Health and Human Services, 2023) and over 80,000 opioid related deaths occurred in the United States in 2021. An estimated 1 in 16 post-surgical patients become chronic opioid users (Brummett et al., 2017). These numbers have risen drastically in recent years and are expected to continue to increase.

Because of the risks associated with opioids, providers have been researching alternatives to combat the overuse of opioids. Multimodal analgesia is defined as the use of two or more different classes of medications to treat and relieve pain (Valesco et al., 2019). In the context of opioid sparing anesthesia, the term is often used interchangeably in literature. For the purposes of this project and manuscript, opioid-sparing anesthesia and multimodal anesthesia or multimodal analgesia will be used interchangeably. The use of opioid-sparing and opioid-free anesthesia has been shown to be beneficial to patients and improve outcomes including decreased nausea and vomiting, decreased time to extubation, comparable post-operative pain scores & opioid consumption, and decreased PACU length of stay (Enten et al. 2019; Guinot et al., 2019). The use of an educational toolkit was shown to be successful in implementation of multimodal analgesia (Sarin et al., 2020).

Purpose

The objective of this project is to encourage the use of multimodal opioid-sparing anesthesia among certified registered nurse anesthetists (CRNAs). This will be accomplished by providing education on opioid-sparing anesthesia and creating a toolkit for the implementation of an opioid-sparing anesthesia protocol using the most current evidence. The goal is to improve confidence and knowledge among CRNAs to facilitate the transition of this technique so that it can become standard practice.

Review of Current Evidence

To promote the most scientifically sound and best evidence-based practice, a thorough search of the literature was conducted. Several searches were conducted via CINAHL and PubMed. CINAHL searches included: "anesthesia AND opioid free anesthesia," "nonopioid or OFA or opioid sparing anesthesia)," "opioid free anesthesia AND systematic review". PubMed search terms included: “anesthesia AND educational toolkit”, “anesthesia AND opioid free AND opioid sparing”. Multiple queries used on both databases included the following search terms: “anesthesia AND opioid-free AND opioid-sparing”, “opioid-sparing anesthesia AND barriers”, “opioid-free anesthesia AND education”. Searching for intervention articles included the search terms “anesthesia AND pain control pathway OR pain management pathway”,” anesthesia OR opioid-sparing anesthesia AND postoperative pain OR pain score OR pain level”, “anesthesia AND opioid use OR opioid consumption”, “ketamine AND postoperative pain”, “magnesium AND postoperative pain”, “Ofirmev OR acetaminophen OR Tylenol AND postoperative pain”, “lidocaine AND postoperative pain”, “dexmedetomidine OR Precedex AND postoperative pain”, “gabapentin AND postoperative pain”, “Lyrica OR pregabalin AND postoperative pain”, “decadron AND postoperative paim” and “postoperative opioid use”. Any articles that did not have full-text available were excluded to ensure the study was able to be read in its entirety. To ensure stronger evidence, additional searches were limited to randomized control trials (RCTs) only. All searches were limited to the previous five years to ensure the newest available evidence. Any additional articles older than five years were obtained from cited sources within the resulting literature. This resulted in 178 articles.

Searches on CINAHL and PubMed showed no results on “badge buddy AND cognitive aid”. Therefore, these terms were searched on Google Scholar and yielded three more articles. An additional search on CINAHL and PubMed included the terms “quick reference guide,” “quick reference AND protocol,” “quick reference guide AND anesthesia” which found two additional relevant articles. This yielded a total of 183 articles. Statistics regarding opioid overdoses and deaths were obtained from the North Carolina Department of Health and Human Services and the Center for Disease Control and Prevention websites.

Benefits of Opioid-Sparing Anesthesia

For many patients, surgery is their first experience with opioids and is a critical time in the development of the opioid epidemic – even in opioid naïve patients (Velasco et al., 2019). Any patient exposed to opioids is at risk for long-term use of opioids and the development of substance use disorder with some opioid naïve patients even having reported taking them over a year after their procedure (Velasco et al., 2019, p.459). Opioid overdoses resulting from substance use disorder claim thousands of lives each year. Per the Centers for Disease Control and Prevention (2021), there were 100,306 drug overdose deaths in the United States during a 12 month period ending in April 2021 – 75,673 of those were from opioid overdoses. According to the North Carolina Department of Health and Human Services (2022), eight North Carolinians die from opioid overdoses each day, which translates into just over 2,900 deaths per year. Over a 20-year period from 2000 to 2020, over 28,000 North Carolinians died from drug overdoses (NCDHHS, 2022). With the multitude of adverse effects described, different evidence-based analgesic strategies that reduce or eliminate the requirements for intraoperative opioids are needed. Additionally, surgeons prescribing patterns of opioid medications upon patient discharge also need to be addressed, as this has also been associated with the increasing severity of the opioid epidemic (Brandal et al., 2017).

Opioid sparing anesthesia can reduce the frequency of adverse effects frequently associated with opioid use. A very well-known adverse effect of opioids is respiratory depression (Enten et al., 2019; Estebe et al., 2021; Guinot et al., 2019; Velasco et al., 2019). Omitting or substantially reducing opioid use in the anesthetic plan has been shown to reduce time to extubation as well as decreased length of stay in the intensive care unit (Guinot et al., 2019). Additionally, research has shown that these patients tend to have less nausea in the PACU when compared to patients that received an opioid-based anesthetic (Enten et al., 2019; Frauenknecht et al., 2019; Grape et al., 2019).

Other studies demonstrated additional benefits including faster return of function and mobility, decreased post-op morbidity and mortality, decreased episodes of hypotension, decreased episodes of shivering, and decreased length of hospital stay (Enten et al., Gabriel et al., 2019; Grape et al, 2019; Wilson, 2019). Post-operative pain score differences were not statistically significant (Enten et al., 2019) between opioid sparing anesthesia and opioid anesthesia, while opioid sparing anesthesia showed decreases in post-operative morphine consumption (Guinot et al., 2019), indicating analgesic equivalency. Post-operative nausea and vomiting (PONV) was found to be twice as frequent in patients with remifentanil infusions vs. dexmedetomidine infusions (Grape et al., 2019). This data shows strong evidence that it is possible to have the same benefits and analgesic effects of opioid-based anesthesia without the increased risk of adverse outcomes that are associated with opioids.

Multimodal Agents

The concept of intraoperative “pain” is controversial. In 1979, the International Association for the Study of Pain (IASP) defined pain as “[a]n unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.” (Cohen et al., 2018, p. 2; Treede, 2018, p. 2). Estebe et al. (2021) expands on this to infer that consciousness is a requirement to experience pain, and while a patient is specifically under general anesthesia (GA), the only evaluation of ‘pain’ is the stress induced response, such as the ensuing changes in the cardiovascular status such as tachycardia and hypertension (Estebe et al., 2021). This implies that patients may be exposed to opioids when they do not need them.

There are multiple receptor pathways that can be targeted to address "pain" rather than just opioid receptors. For example, Forget & Cata (2017) showed that both ketamine and magnesium caused less variability in patient hemodynamics during surgery. By targeting these multiple analgesic pathways, non-opioid medications can drastically reduce the amount of opioid exposure in the perioperative period (Clebone et al., 2020). Alternative medications to opioids during the intraoperative period include the n-methyl-D-aspartate (NMDA) antagonists ketamine & magnesium sulfate, the α-2 agonist dexmedetomidine (Precedex), lidocaine, gabapentinoids, acetaminophen, and non-steroidal anti-inflammatory drugs (NSAIDs) such as celecoxib (Celebrex) or ketorolac (Toradol) (Clebone et al., 2020; Enten et al., 2019; Forget & Cata, 2017; Frauenknecht et al., 2019; Jouguelet-Lacoste et al., 2015; Rich, 2005).

NMDA Antagonists – Ketamine and Magnesium Sulfate

The N-methyl-D-aspartate (NMDA) receptors are important receptors in the transmission of pain and are found on the terminal synapse of second-order afferent neurons in the dorsal horn of the spinal cord. It is a voltage dependent, ligand activated receptor, with a calcium channel, that has binding sites for glycine and glutamate and at rest is blocked by magnesium (Bajwa et al., 2017). This is important to note because during consistent nociceptor stimulation, the NMDA receptor will depolarize, opening the calcium channels and lead to increased membrane potential and therefore hyperexcitability which translates to hypersensitivity to pain and decreased opioid responsiveness. This makes this receptor an important target in opioid-sparing anesthesia.

Because of this receptor, ketamine has made a resurgence in anesthesia. It is a known NMDA antagonist and has been studied extensively in clinical settings and shown to reduce opioid requirements, attenuate opioid tolerance or hyperalgesia, reduce nausea and vomiting, and reduced overall pain intensity scores (Bell et al., 2006; Gabriel et al., 2019; Jouguelet-Lacoste et al., 2015; Hocking & Cousins, 2003; Kumar et al., 2017; [WILL ADD MORE CITATIONS]). It is also noted that it is a smooth-muscle relaxant which makes it an effective agent in preventing bronchospasm. Additionally, ketamine has been shown to interact with μ- and δ-opioid receptors (Kumar et al., 2017). As with all drugs, it is important to note that it is a myocardial depressant, which is masked by its stimulation of the sympathetic nervous system. The release of catecholamines leads to increased heart rate, cardiac output, and therefore blood pressure. This in turn may increase pulmonary artery pressures, cerebral blood flow, and cerebral metabolic rate of oxygen consumption as well as increased tracheobronchial secretions.

At a normal resting membrane state, magnesium blocks the NMDA calcium channel. A prolonged stimulus alters the membrane potential leading to the displacement of the magnesium ion block allowing the calcium to pass through the channel, raising the membrane potential and leading to hyperexcitability. In recent years, perioperative magnesium administration has been studied for this antinociceptive effect. Current studies and meta-analyses show that intraoperative magnesium administration may provide relief in that it reduces postoperative opioid consumption and increases time to first request for pain medicine (Jabbour et al., 2020; Dehkordy et al., 2020; Ng et al., 2020).

Dexmedetomidine

Dexmedetomidine, more commonly known by its trade name Precedex, is an α-2 adrenergic agonist that can be utilized as an anxiolytic, analgesic adjunct, and for conscious sedation (Shafer et al., 2015). Due to these properties, it has been researched as an adjuvant drug for use in operating room procedures. It has been found that intraoperative dexmedetomidine led to improved vitals (increased MAP and BP), reduced fentanyl and midazolam requirements with no differences in oxygenation, ventilation, respiratory parameters, and equally rapid extubation times (Aouad et al., 2019; Buckley et al., 2020; Elgebaly and Sabry,2018; Seif et al., 2016; Zhang et al., 2018).

Lidocaine

Lidocaine is an amide type local anesthetic and is frequently used for regional and neuraxial anesthesia. It can also be used systemically to produce analgesia as it suppresses sodium channels in neurons which respond to painful stimuli (Flood et al., 2021). A lidocaine intravenous infusion used perioperatively has been shown to significantly reduce post-operative opioid consumption (Lovett-Carter et al., 2021). It has also been shown to hasten gastrointestinal recovery and reduce nausea and vomiting (Beaussier et al., 2018). There is a concern for lidocaine toxicity but studies have shown blood concentrations below toxic levels with serum concentrations similar to slightly lower than prolonged epidural administration (Beaussier et al., 2018).

Gabapentinoids

Gabapentin and pregabalin have long been used for neuropathic pain and to prevent seizures. However, gabapentinoids have been shown to help treat perioperative hyperalgesia and are a recommendation of the American Pain Society (Joshi, 2021). Multiple studies have shown that the use of gabapentin perioperatively can reduce pain scores at 24 and 48 hours postoperatively, reduce nausea and vomiting, reduce dizziness, and reduce opioid consumption (Han, 2016; Zhai, 2016; Dong, 2016; Li, 2017).

While the mechanism of action for is not completely known, there are varying thoughts on precisely how gabapentinoids exhibit analgesic effects. Some theories posit that they primarily work on the alpha 2 delta 1 subunit of voltage gated calcium channels (Bajwa et al., 2017). These subunits are highly related to nociception and are increased when an injury occurs.

Others theorize that gabapentinoids inhibit neurotransmitter release onto those same alpha 2 delta receptors (Chincholkar, 2020).

Acetaminophen

Acetaminophen or paracetamol, more commonly known by its trade name Tylenol, is a common over-the-counter pain analgesic and antipyretic medication. Acetaminophen can be used intraoperatively as an adjunct analgesic agent. The exact analgesic mechanism of acetaminophen is not fully understood but may be related to inhibition of central cyclooxygenase (COX) activity or modulation of the endogenous cannabinoid system (Gabriel et al., 2019). Its use is limited by its hepatotoxicity; therefore, its dosage is limited to four grams total in a 24 hour period, typically one gram given every six hours. Acetaminophen can also be given preoperatively; there is currently no evidence that giving preoperatively or intraoperatively is superior nor a difference between oral and intravenous administration (Cain et al., 2021)

NSAIDs

Nonsteroidal anti-inflammatory drugs (NSAIDs) are either selective or nonselective cyclooxygenase (COX) inhibitors with both analgesic and anti-inflammatory properties (Flood et al., 2021). The COX pathway produces prostaglandins which are upregulated and released after tissue injury. This can cause hyperalgesia and allodynia. NSAIDs inhibit the synthesis of arachidonic acid and therefore prostaglandins. Ketorolac, a nonselective COX inhibitor, reduces pain and sensitization. In a meta-analysis, patients were received ketorolac had a 9-66% reduction in patient-controlled analgesia opioids and a 59% reduction in rescue medication (Martinez et al., 2019). Celecoxib, a COX-2 selective inhibitor, documented a decrease in 24-h opioid consumption, pain scores, and postoperative nausea and vomiting with preoperative celecoxib administration for non-cardiac surgery (Gabriel et al., 2019).

Post-operative Pain Scores

Several retrospective analyses (Enten et al., 2019; Estebe et al., 2021; Guinot et al., 2019; Hofer et al., 2017) showed that post-operative pain scores were not significantly different between patient groups that received multimodal analgesia compared to opioid-based anesthesia. Two randomized-control trials compared the efficacy of the α-2 agonist dexmedetomidine as the sole analgesic agent compared to fentanyl (Jebaraj et al., 2017) and remifentanil (Grape et al., 2019) and showed that it was equivalent in its analgesic properties. A literature review of low-dose or sub-anesthetic dose ketamine infusions demonstrated that post-operative opioid consumption was decreased by 40% and no major complications were reported (Jouguelet-Lacoste et al., 2015).

Barriers to Opioid-Sparing Anesthesia

Addressing practitioner opinion and perceived barriers to this paradigm shift of opioid-sparing anesthesia is of the utmost importance, and it should begin during formal training. A qualitative study by Valesco et al. (2019) consisted of a series of semi-structured telephone interviews with local certified registered nurse anesthetists (CRNAs) in the Chicago metropolitan area, who gave their opinions on what hinders them from using opioid-free anesthesia as well as facilitators to its use. Common barriers included limited experience, lack of resources, and preconceived beliefs such as superiority and predictability of an opioid (Valesco et al, 2019). Deep-rooted beliefs are difficult to address, as evidenced by an interviewee quote: “I don’t care what the research shows; I anecdotally see a very poor outcome [with opioid alternatives]” (Valesco et al., 2019, p. 464). Facilitators mentioned by interviewees included positive experiences with multimodal anesthesia, negative experiences with opioid medications, and institutional policy (Valesco et al., 2019). An additional survey among CRNAs showed younger anesthesia practitioners were more likely to use opioid-sparing anesthesia than more experienced providers likely due to deeply set beliefs and experiences by older providers (Morrow et al., 2021).

The literature shows high levels of quality evidence that opioid-sparing anesthesia is as effective as opioid-based anesthesia with much less risk of adverse outcomes (Frauenknecht et al., 2019; Gabriel et al., 2019) Provider behavior, opinion, and willingness to change practice need to be addressed to facilitate adoption at facilities that have not yet shifted toward multimodal anesthesia. The next step is to then make the evidence more well-known to anesthesia providers so it can become standard practice and provide an evidence-based tool to facilitate quicker change to the best and most current evidence-based practices. One method to achieve this goal is using cognitive aids.

Cognitive Aids

A cognitive aid is defined as a prompt designed to assist a worker complete a task or series of tasks – a checklist is a type of cognitive aid that lists sequential actions (Hall et al., 2020). Cognitive aids like these have been commonly used in aviation since the 1930s and, contrasted with guidelines, protocols, or standard operating procedures, are meant to be used while performing the task (Marshall, 2013). As anesthesia is commonly compared with aviation, the same concepts can easily be crossed over. Cognitive aids are particularly useful in emergencies and can reduce errors while increasing performance (Hall et al., 2020; Marshall, 2013; Sarin et al., 2020).

Visual cognitive aids are devices that help to facilitate clinician responses to certain situations, such as critical events, and are likely to be used when perceived to be easy to do so

(Clebone et al., 2020). Cognitive aids have also been shown to lead to a reduction in errors and increases in performance (Hall et al., 2020). A cognitive aid that healthcare workers may be familiar with is a quick reference guide also known as a "badge-buddy". Quick reference guides are a visual aid that usually sits behind a worker's ID badge and typically contains a protocol or checklist. An opioid-sparing protocol can easily be placed on one of these to utilize as a quick reference guide where a protocol for multimodal anesthesia can easily be referenced by clinicians. [Use articles (Miguel-Alvaro et al., 2021) and (Pain Management Guideline Panel, 1992) to discuss Quick Reference Guides.]

Conceptual Framework/Theoretical Model

This project utilized the Awareness to Adherence model which was developed to improve physician adherence to new guidelines after administering a survey on new vaccine recommendations (Pathman et al., 1996). This model consists of four steps: awareness, agreement, adoption, and adherence. In practice, the provider must become aware of the new guidelines, receive education, and decide if they agree with the guideline, adopt the guideline, and then continue to follow it.

In following this guideline, we educated CRNA's on recent evidence-based practice to adhere to awareness. The next step was for the providers to agree to the guidelines shown by the current evidence on opioid-sparing anesthesia. If they agreed with the evidence, CRNAs were then to adopt its use in their own practice. CRNAs would then continue to use the protocol in their practice to continue to adhere to the evidence-based practice protocol.

Methods

Design

For this project we performed a quantitative study involving a pre and post intervention of evidence-based practice education with the goal of advancing the CRNA provider's understanding of opioid-sparing anesthesia (OSA). The project included the creation of an educational module on current evidenced-based research with OSA, creation of an OSA protocol, a quick reference guide, and a pre- and post-intervention survey to evaluate the confidence, barriers, and understanding of OSA.

Translational Framework

The Plan-Do-Study-Act framework was used as a framework for this evidence-based educational project as it has been shown to be valuable as a problem-solving tool to improve processes and sustain change (Taylor et al., 2014). In the “plan” phase, an improvement is identified, and a plan is developed to create an improvement. This plan is then enacted in the “do” stage, then its implementation and effects are examined in the “study” phase. If the plan was effective, then it is continued in the “act” stage and will be recommended for future use.

Permissions

This project has been supported by the hospital and an application for approval by the Internal Review Board (IRB) will be completed through the University of North Carolina at Greensboro. All participants in this study were kept anonymous by utilizing unique IDs upon completing their surveys.

Setting

Project was completed in a suburban hospital in the southeast. They offer ten operating rooms, two procedure rooms, and a cystoscopy room. They also provide non-operating room anesthesia (NORA) such as lithotripsy and anesthesia for radiological procedures. This location can provide different types of surgical services from general surgeries to specialty services such as orthopedics, plastic surgeries, and cardiovascular.

Sample

For this project, a convenience sample was selected, with the hope of recruiting 30 practicing certified registered nurse anesthetists at the hospital. The only requirements for a CRNA to be included in the study is to be over the age of eighteen, currently practiced at the participating hospital, and consented to participate in the project. CRNAs have been selected as the sample group for this project, as they are providing most analgesics and anesthetics to patients in the perioperative period with a higher understanding of the pharmacologic effects of different medications. As an incentive to complete the project, a $20 Amazon gift card will be provided to each CRNA that completes both pre- and post- questionnaires.

Procedure

Our intervention will begin with an educational pre-recorded PowerPoint module provided via email. We will also offer an in-person lecture discussing opioid-sparing anesthesia and the protocol. The designed educational toolkit [Appendix E], quick reference guide [Appendix C], and questionnaires will be distributed to the CRNAs that are willing to participate. A copy of the consent form and recruitment form can be found in Appendix A and B. This project was implemented in September 2022 with the distribution of a recruitment e-mail and pre-interventional surveys. A repeat recruitment e-mail and pre-education survey was distributed in October 2022. The educational toolkit including the PowerPoint presentation and quick reference guide were distributed in November and December. An in-person presentation was given on February 3, 2023. Post-education surveys were distributed at the end of February in-person and e-mail and again in March 2023.

Instruments

A Likert-scale questionnaire will be used to collect data for this project. The Likert-scale questionnaire will present 31 questions on the pre-intervention survey and 34 questions on the post-survey to the participants with responses that range from "strongly disagree" to "neither agree nor disagree" to "strongly agree" as well as multiple short answer questions regarding the barriers such as cost, attitude, and experience in providing opioid-sparing anesthesia techniques. The Likert-scale has been selected as an appropriate instrument because it is a self-evaluation tool that allows the participants to answer questions in confidence and also allows the researchers to collect data anonymously as it was developed to measure attitudes on a five- or seven-point ordinal scale (Sullivan & Artino, 2013). The Likert-scale has been shown to be a reliable and valid tool for self-assessment data collection and is often used in healthcare settings; therefore, it is ideal for the data collection for this project (Joshi et al., 2015).

Data Collection

A pre-interventional survey (Appendix D) designed via Qualtrics will be emailed to the subjects along with the consent to participate in the project prior to the educational module. This will be used to collect data on the following barriers: costs, attitudes on OSA's effectiveness, training, and experience. After an interventional period of five months, the same survey will be distributed to the participants via email, a QR code at the end of the PowerPoint, and a printed QR code to be distributed after the in-person presentation. The data collected will be stored on private laptops with password protection and will be completely anonymous, with demographic data only being collected to track participation and incentivize participation via a gift card after completing both surveys.

Data Analysis

The data was analyzed via 2-sample and independent t-tests to determine statistically significant changes in mean scores of the Likert-scale survey and trends in the data from pre- to post-intervention. Significance was determined by $p<.05$. The optional comments will not be statistically analyzed, but some quotes were provided in this manuscript for completeness. The statistical consultant for the project was the biostatistics professor at UNC Greensboro.

Project Budget

No outside funding will be utilized. The estimated budget was $700 for gift card incentives for completion of the project. This was estimated by a predicted sample of 30 CRNAs receiving $20 gift cards plus costs for printing quick reference guides. A statistical analysis program was also budgeted for but was not needed.

Results

The pre-education survey was completed by 22 participants with a wide range of experience from less than 5 years to greater than 25 years (Table 1) with 10 male participants and 12 female participants. The pre-education survey questions regarding education level did not

	Pre-Education Demographics n=22	Post-Education Demographics n=10
Gender		
Male	10	5
Female	12	5
Years Experience		
<5	2	2
5-9	8	3
10-14	4	2
15-19	4	1
20-24	3	1
≥25	1	1

Table 1: Survey Demographics

record any responses therefore these demographics were not included. The post-education survey was completed by 10 of these participants for 47.6% retention rate. To determine if attitudes towards opioid-sparing anesthesia improved after the intervention, an analysis was completed on the question regarding if the respondent believed opioid-sparing anesthesia was practical. There was a shift toward more agreeing with it being practical (Figure 1), but it was not statistically significant with a p-value of 0.229. Cost was still a large barrier after the education session with

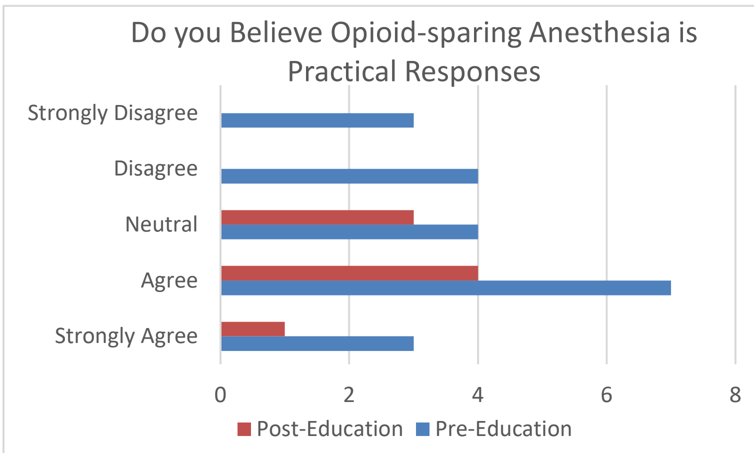

Figure 1: OSA Practicality According to Respondents

a p-value of 0.4913 as CRNA perception to costs of OSA did not change (Figure 2). For the barrier of training and education, most respondents seemed to disagree (Figure 3) that they needed more training or experience to utilize, and our intervention had no statistically significant effect on this barrier (p-value = 0.4613). Only one participant commented in the free-text box asking for addition comments on OSA which they noted "we don't do it consistently to truely

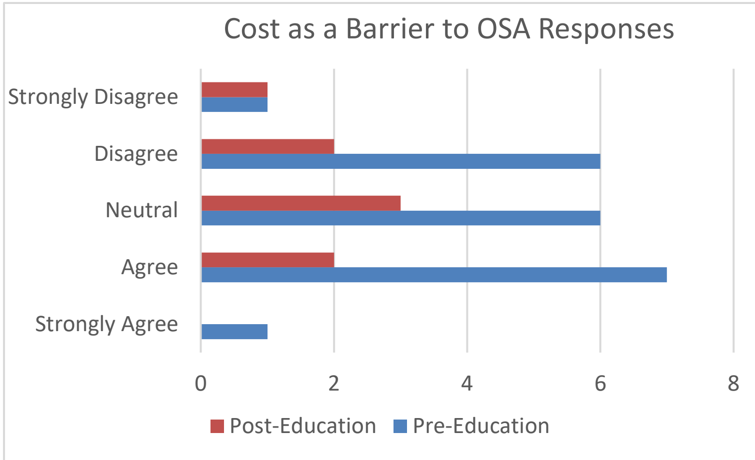

Figure 2: Cost as a Barrier to OSA

[sic] evaluate, nor do we follow up consistently for effects." Another participant during the educational session noted that "Unless there is a concern, we do not usually follow up with the patients in PACU" which means they were unable to evaluate the effectiveness of the different anesthetic protocols that were provided. Participants in the education session also noted that "the toolkit was very helpful and informative", "costs are a major concern", and "many of these medications are not readily available."

Discussion

The survey findings did not indicate any significant differences regarding the barriers studied after implementing our project. A small sample size and a low retention rate impacted the

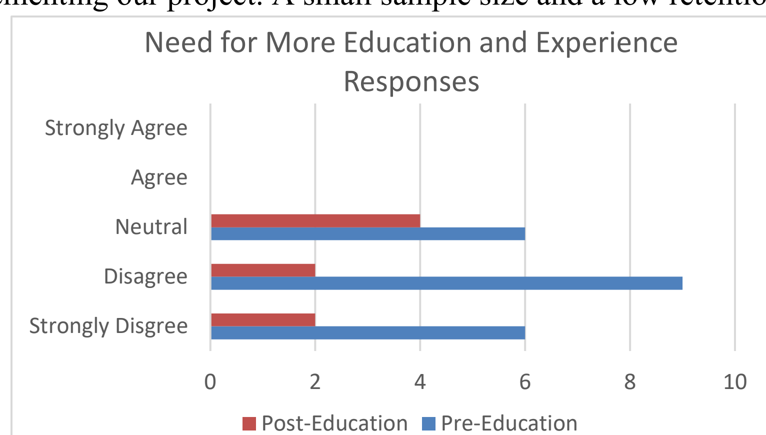

Figure 3: Need for More Education or Experience

project which required consistent recruitment e-mails to be sent out with minimal impact. During our implementation, the author of this project was informed there was a large turnover of employees at the facility which was detrimental to our project. Medication availability was a concern with the respondents and is a known barrier, but this project was not have been able to implement a change in medication locations and was not included in the project. With fast turnover times, it proves to be a time constraint to gather these medications from pharmacy or the central medication supply then to prepare them for use which does inhibit providers ability to utilize OSA.

The facility was very receptive to the protocol and the data reflected this as the attitudes towards opioid-sparing anesthesia were a small barrier. The larger barrier of cost was discussed with respondents during the presentation as it was noted the evidence showed reduced costs with decreased recovery times and rescue medication, but the respondents would have liked to have seen actual monetary data regarding this. Most providers disagreed with needing more training to provide OSA so this was a small barrier for the respondents and did not have a significant change after the intervention.

Limitations

Due to the number of students utilizing this site as their project site, this author was advised to combine the surveys with students implementing a similar project to prevent respondents from being overwhelmed due to the number of projects. This led to a lengthy survey to be included and may have contributed to reduced retention of respondents during the project. Therefore, the reduced retention with increased turnover led to a small sample size increasing the difficulty of receiving significant results.

Recommendations for Future Study

In a similar study, participation was increased by contacting the providers individually to recruit and encourage participation (Steele et al., 2022). This would increase participation and increase retention by creating a more personal feel to the project. Another recommendation would be to study the costs involved in OSA. The study should consider the costs of the medications utilized and compare it to the cost savings of reduced operating room times, reduced recovery times, and reduced pain medication given in recovery. This was to be included in the project but the literature regarding costs has yet to be studied.

Relevance and Recommendations for Clinical Practice

OSA has been shown to improve patient outcomes, patient satisfaction, reduce recovery time, while also reducing post-operative opioid consumption. Therefore, it should be considered for every patient. While it is not under CRNA control, another factor that contributes to the ongoing opioid epidemic is physician behavior regarding prescribing habits; two studies showed that surgeons often prescribe opioid medications at discharge even if the patient has required little to no opioid in the post-operative phase (Brandal et al., 2017; Estebe et al., 2021). Education therefore will eventually need to be extended to surgeons as well as educating the patients about the risks involved in utilizing opioids.

Conclusion

With all the benefits of utilizing OSA as well as its potential to help reduce the opioid epidemic, OSA should be utilized by every provider. While it may not eliminate the use of opioids, OSA can help attenuate many side effects of opioids while improving patient satisfaction and reduce the pain associated with surgery as well as reduce costs. Therefore, all providers should feel confident in its application and hospitals should continue researching OSA and reducing the barriers to its implementation.

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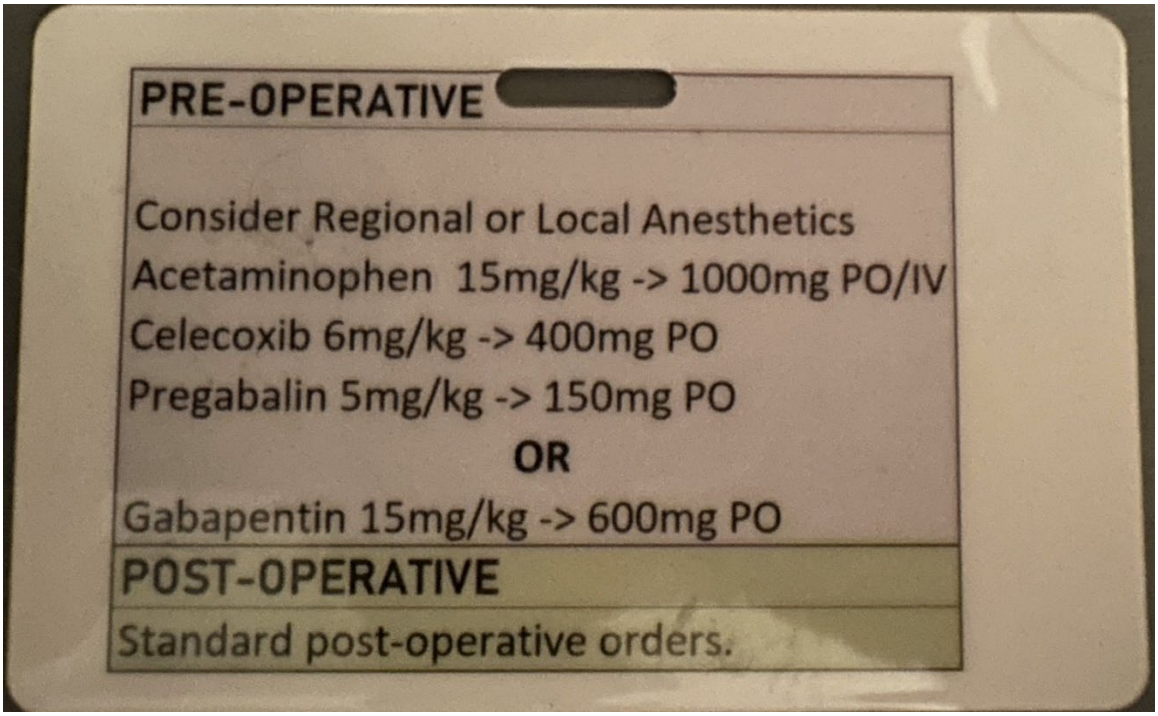
Appendices

Appendix A. Quick Reference Guide

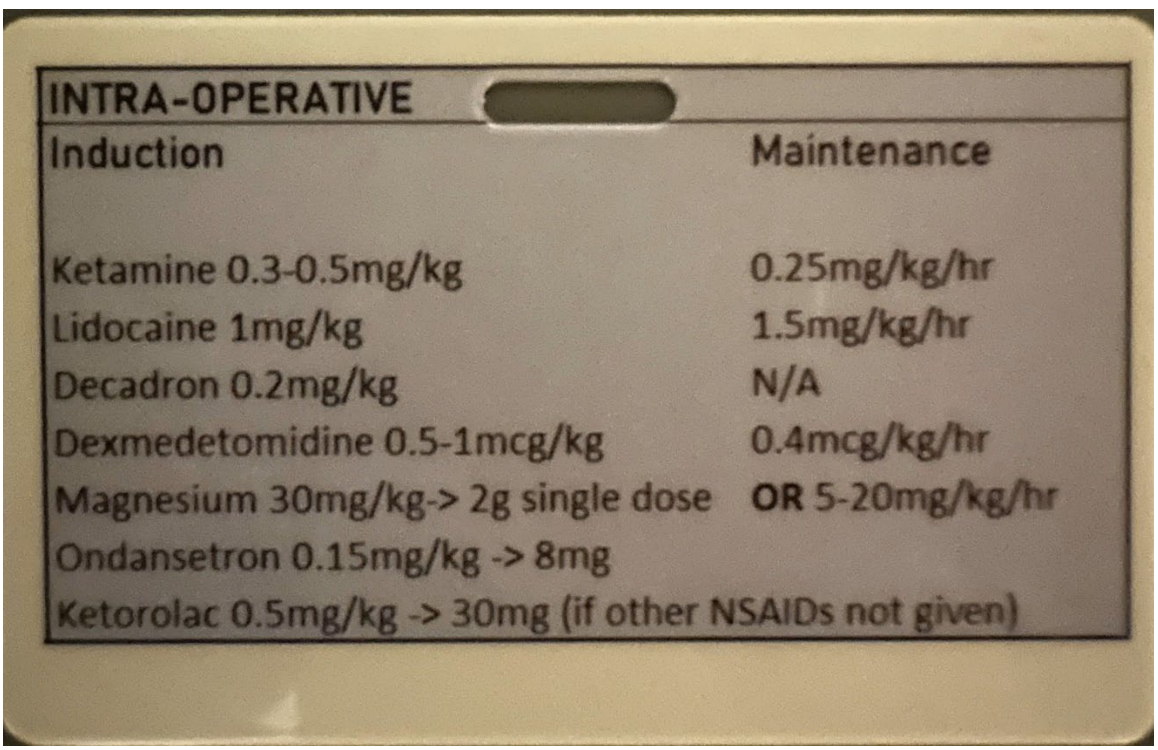


PRE-OPERATIVE

Consider Regional or Local Anesthetics
Acetaminophen 15mg/kg -> 1000mg PO/IV
Celecoxib 6mg/kg -> 400mg PO
Pregabalin 5mg/kg -> 150mg PO
OR
Gabapentin 15mg/kg -> 600mg PO

POST-OPERATIVE

Standard post-operative orders.



INTRA-OPERATIVE

Induction	Maintenance
Ketamine 0.3-0.5mg/kg	0.25mg/kg/hr
Lidocaine 1mg/kg	1.5mg/kg/hr
Decadron 0.2mg/kg	N/A
Dexmedetomidine 0.5-1mcg/kg	0.4mcg/kg/hr
Magnesium 30mg/kg-> 2g single dose	**OR** 5-20mg/kg/hr
Ondansetron 0.15mg/kg -> 8mg	
Ketorolac 0.5mg/kg -> 30mg (if other NSAIDs not given)	

Appendix B. Pre/Post-intervention Survey

Opioid-Free/Sparing Anesthesia Survey

Start of Block: Demograhics

Q1 What is your age?

- ○ 25-34 (1)
- ○ 35-44 (2)
- ○ 45-54 (3)
- ○ 55-64 (4)
- ○ 65 or older (5)

Q2 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Other (4) ____
- ○ Prefer not to say (5)

Q3 How long have you been a practicing CRNA?

- Less than 5 years (1)
- 5-9 years (2)
- 10-14 years (3)
- 15-19 years (4)
- 20-24 years (5)
- 25 years or longer (6)

Q4 Was your nurse anesthesia training a masters level or doctorate level?

- Masters Degree (1)
- Doctorate Degree (2)

Q5 If you do not have a doctoral degree, do you plan to obtain one in the future?

- Yes (1)
- No (2)
- N/A, I already have a doctoral degree. (3)

End of Block: Demograhics

Start of Block: Attitude/Barriers

Q6 I believe opioid-free/sparing anesthesia is impractical.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q7 Opioid-free/sparing anesthesia is of no interest to me.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q8 I do not plan to include opioid-sparing techniques in my practice in the future.

- ◯ Strongly disagree (1)
- ◯ Somewhat disagree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat agree (4)
- ◯ Strongly agree (5)

Q9 Learning opioid-free/sparing techniques is not worth the effort or the time.

- ◯ Strongly disagree (1)
- ◯ Somewhat disagree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat agree (4)
- ◯ Strongly agree (5)

Q10 I do not currently use opioid-free/sparing techniques in my practice whenever possible.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q11 I believe the opioid epidemic has been exaggerated.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q12 Opioid-free/sparing anesthesia is less effective than traditional anesthesia including opioids.

- ◯ Strongly disagree (1)
- ◯ Somewhat disagree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat agree (4)
- ◯ Strongly agree (5)

Q13 Opioid-free/sparing techniques lead to worsened pain control for patients.

- ◯ Strongly disagree (1)
- ◯ Somewhat disagree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat agree (4)
- ◯ Strongly agree (5)

Q14 Our facility culture is not supportive of opioid-free/sparing anesthesia techniques.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q15 I feel I need more training and experience to utilize opioid-sparing anesthesia.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q16 Cost may be a prohibitive barrier to implementing opioid-free/sparing techniques at my facility.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q17 I have access to a variety of anesthesia techniques and equipment such as ultrasound, nerve blocks, epidurals, and spinals.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q18 I have access to a variety of non-opioid medications such as NSAIDs, ketamine, dexmedetomidine, magnesium, acetaminophen, dexamethasone, and lidocaine.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

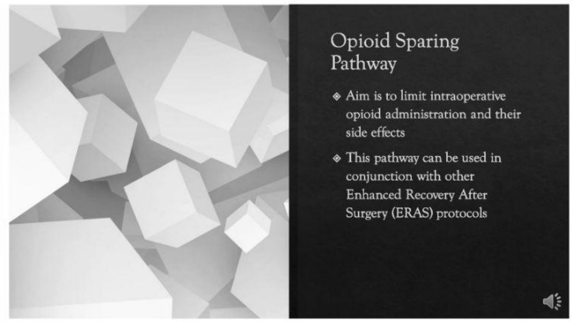
○ Somewhat agree (4)

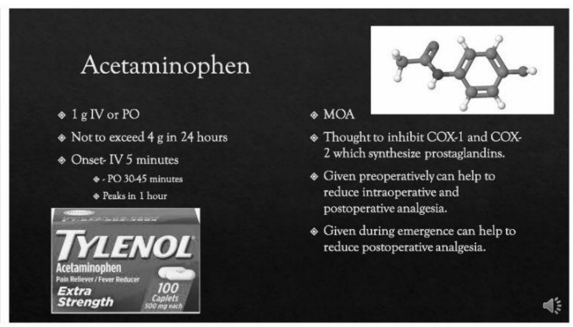
○ Strongly agree (5)

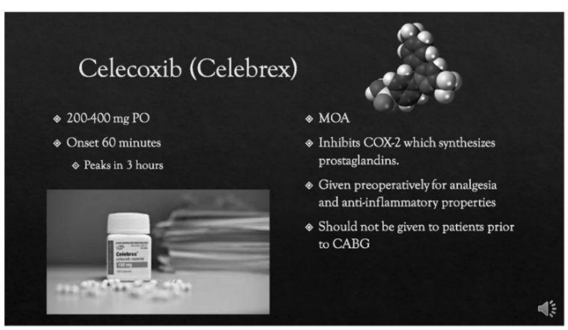
Q19 Please write any additional comments or thoughts about YOUR attitude or perception of opioid-sparing or opioid-free anesthesia.

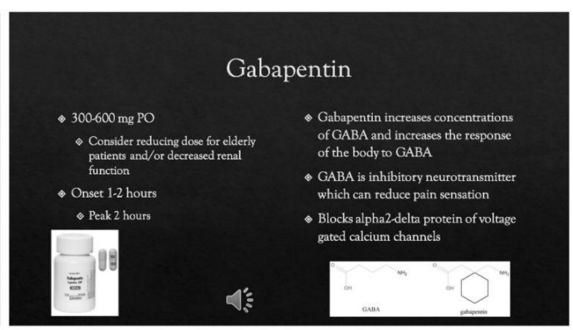
____

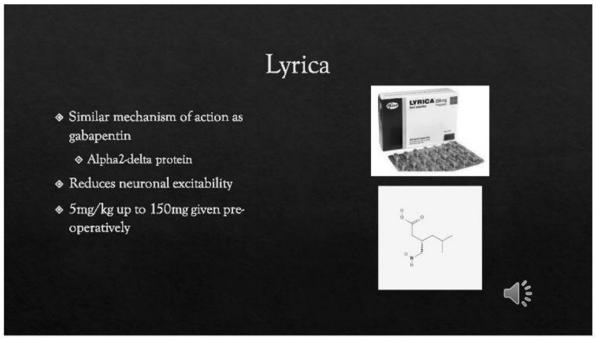
Appendix C. OSA Educational PowerPoint

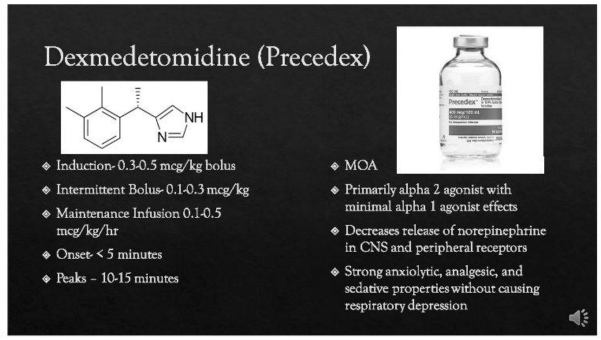


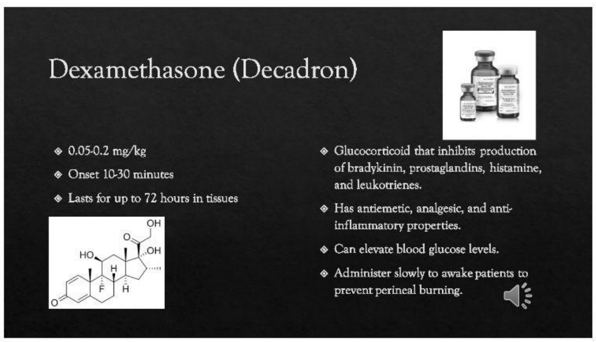


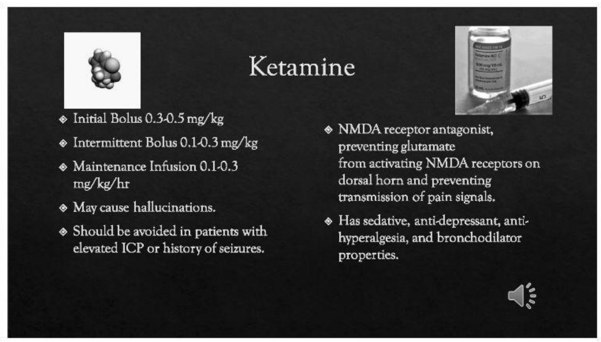


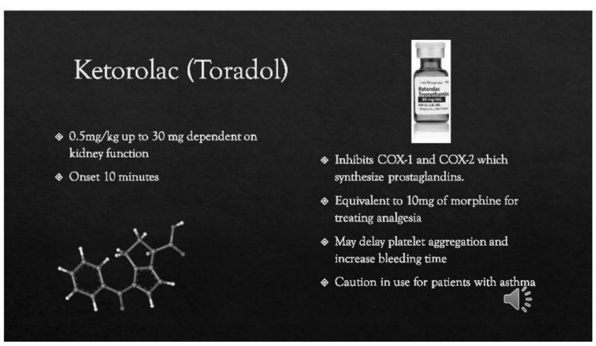


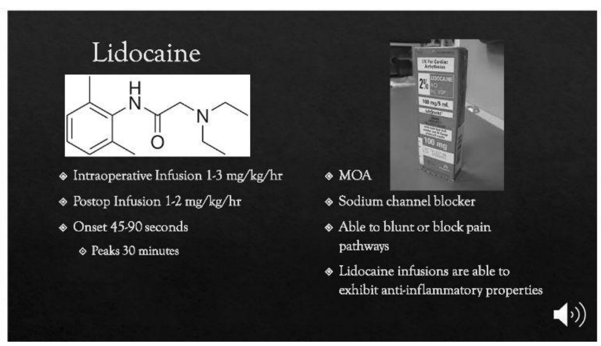

Lyrica
Similar mechanism of action as gabapentin
Alpha2-delta protein
Reduces neuronal excitability
5mg/kg up to 150mg given pre-operatively
LYRICA

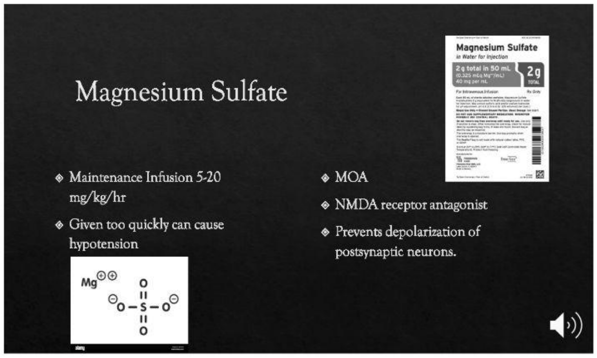

Dexmedetomidine (Precedex)
NH
N
Induction- 0.3-0.5 mcg/kg bolus
Intermittent Bolus- 0.1-0.3 mcg/kg
Maintenance Infusion 0.1-0.5 mcg/kg/hr
Onset- < 5 minutes
Peaks – 10-15 minutes
MOA
Primarily alpha 2 agonist with minimal alpha 1 agonist effects
Decreases release of norepinephrine in CNS and peripheral receptors
Strong anxiolytic, analgesic, and sedative properties without causing respiratory depression
Precedex

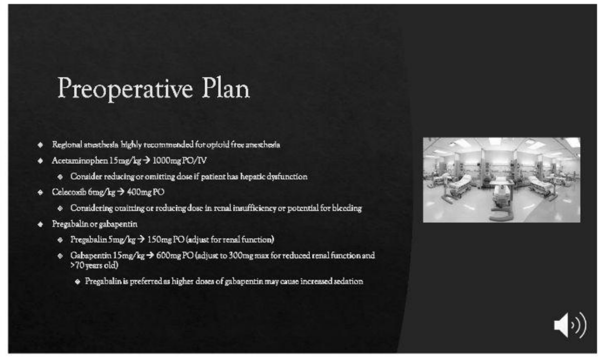

Dexamethasone (Decadron)
0.05-0.2 mg/kg
Onset 10-30 minutes
Lasts for up to 72 hours in tissues
OH
HO
OH
H
F
H
O
Glucocorticoid that inhibits production of bradykinin, prostaglandins, histamine, and leukotrienes.
Has antiemetic, analgesic, and anti-inflammatory properties.
Can elevate blood glucose levels.
Administer slowly to awake patients to prevent perineal burning.

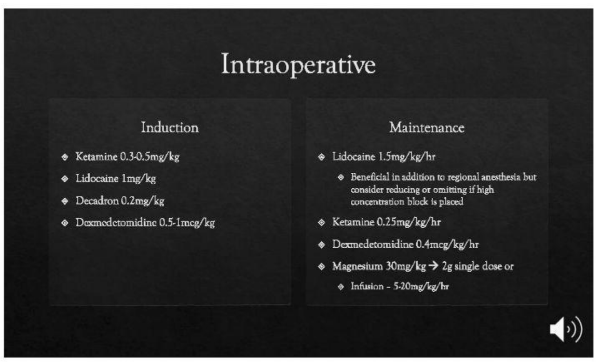

Ketamine
Initial Bolus 0.3-0.5 mg/kg
Intermittent Bolus 0.1-0.3 mg/kg
Maintenance Infusion 0.1-0.3 mg/kg/hr
May cause hallucinations.
Should be avoided in patients with elevated ICP or history of seizures.
NMDA receptor antagonist, preventing glutamate from activating NMDA receptors on dorsal horn and preventing transmission of pain signals.
Has sedative, anti-depressant, anti-hyperalgesia, and bronchodilator properties.

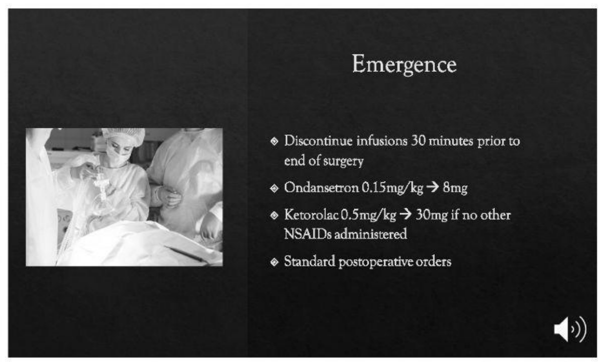

Ketorolac (Toradol)
0.5mg/kg up to 30 mg dependent on kidney function
Onset 10 minutes
Inhibits COX-1 and COX-2 which synthesize prostaglandins.
Equivalent to 10mg of morphine for treating analgesia
May delay platelet aggregation and increase bleeding time
Caution in use for patients with asthma
Ketorolac Tromethamine

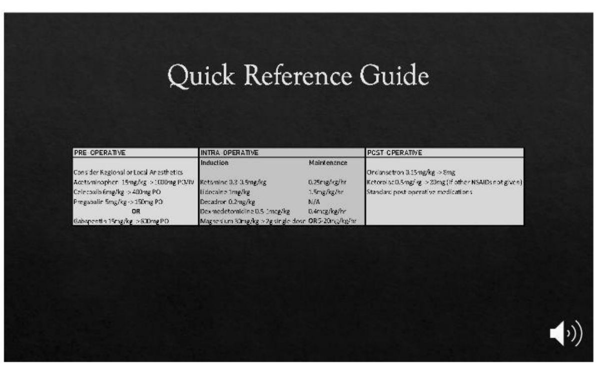

Lidocaine
H
N
O
N
Intraoperative Infusion 1-3 mg/kg/hr
Postop Infusion 1-2 mg/kg/hr
Onset 45-90 seconds
Peaks 30 minutes
MOA
Sodium channel blocker
Able to blunt or block pain pathways
Lidocaine infusions are able to exhibit anti-inflammatory properties

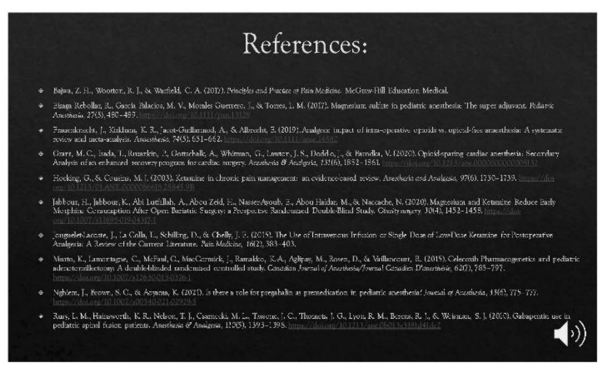

Magnesium Sulfate
Maintenance Infusion 5-20 mg/kg/hr
Given too quickly can cause hypotension
MOA
NMDA receptor antagonist
Prevents depolarization of postsynaptic neurons.
Magnesium Sulfate
in Water for Injection
2g total in 50 mL
2g


Preoperative Plan
Regional anesthesia highly recommended for opioid free anesthesia
Acetaminophen 15mg/kg → 1000mg PO/IV
Consider reducing or omitting dose if patient has hepatic dysfunction
Celecoxib 6mg/kg → 400mg PO
Considering omitting or reducing dose in renal insufficiency or potential for bleeding
Pregabalin or gabapentin
Pregabalin 5mg/kg → 150mg PO (adjust for renal function)
Gabapentin 15mg/kg → 600mg PO (adjust to 300mg max for reduced renal function and >70 years old)
Pregabalin is preferred as higher doses of gabapentin may cause increased sedation


Intraoperative
Induction
Ketamine 0.3-0.5mg/kg
Lidocaine 1mg/kg
Decadron 0.2mg/kg
Dexmedetomidine 0.5-1mcg/kg
Maintenance
Lidocaine 1.5mg/kg/hr
Beneficial in addition to regional anesthesia but consider reducing or omitting if high concentration block is placed
Ketamine 0.25mg/kg/hr
Dexmedetomidine 0.4mcg/kg/hr
Magnesium 30mg/kg → 2g single dose or
Infusion - 5-20mg/kg/hr


Emergence
Discontinue infusions 30 minutes prior to end of surgery
Ondansetron 0.15mg/kg → 8mg
Ketorolac 0.5mg/kg → 30mg if no other NSAIDs administered
Standard postoperative orders


Quick Reference Guide
PRE-OPERATIVE
Consider Regional or Local Anesthetics
Acetaminophen 15mg/kg -> 1000mg PO/IV
Celecoxib 6mg/kg -> 400mg PO
Pregabalin 5mg/kg -> 150mg PO
OR
Gabapentin 15mg/kg -> 600mg PO
INTRA-OPERATIVE
Induction
Ketamine 0.3-0.5mg/kg
Lidocaine 1mg/kg
Decadron 0.2mg/kg
Dexmedetomidine 0.5-1mcg/kg
Magnesium 30mg/kg -> 2g single dose
Maintenance
0.25mg/kg/hr
1.5mg/kg/hr
N/A
0.4mcg/kg/hr
OR 5-20mg/kg/hr
POST-OPERATIVE
Ondansetron 0.15mg/kg -> 8mg
Ketorolac 0.5mg/kg -> 30mg (If other NSAIDs not given)
Standard post-operative medications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