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Development of Evidence-Based Practice Guidelines for Perioperative Multimodal Analgesia during Spine Surgery

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Final Scholarly Project: Development of Evidence-Based Practice Guidelines for Perioperative Multimodal Analgesia during Spine Surgery

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Abstract

The most common cause of adult disability is chronic back pain. As medication maintenance therapy becomes ineffective, surgical intervention is the last resort for treatment. Patients with chronic pain often rely on pain medication such as opioids for relief. The exposure and dependency of opioids can create unique challenges for anesthesia providers to deliver safe and adequate anesthesia for surgery. Patient's dependent on chronic opioids develops many adverse effects including sleep disordered breathing, suppression of the immune system, and higher risk of developing cardiovascular events under stress. There is a lack of consistent perioperative guidelines for patients undergoing spinal surgery with or without opioid exposure. This doctoral project seeks to develop evidence-based practice guidelines for perioperative management for patients undergoing spinal surgery. The Johns Hopkins evidence-based practice model was utilized to develop this doctoral project and to analyze the impact of non-opioid analgesia on visual analogue scale (VAS) scores, postoperative opioid consumption, and length of stay in the hospital (LOS). The non-opioid perioperative analgesic medications include ketamine, lidocaine, and dexmedetomidine. The project includes a plan for implementing the evidence-based practice guidelines, preparation and training staff, measuring outcomes, and potential revisions to the guidelines if there are undesirable effects.

Keywords: Ketamine, dexmedetomidine, lidocaine, non-opioid analgesia, pain, spine surgery

Introduction

Patients complaining of back pain are prescribed opioids to help tolerate the discomfort. Deyo et al., suggests that opioids are the most prescribed class of medication for back pain (2015). Approximately 4.5 million people in the United States depend on opioid medications to tolerate chronic pain (Kane & Hedrick, 2021). According to the National Institute of Health (NIH), approximately 220 people died daily in 2021 from opioid overdose (2023). The prevalence of opioid-exposed patients is increasing every year, so it is imperative to develop an anesthetic plan to minimize the development of opioid dependence postoperatively in patients undergoing spinal surgery.

There are challenges addressing acute pain in patients with chronic opioid management during surgery. Preoperative opioid exposure is linked with increased surgical complications, increased need to revision surgery, and longer hospital stays (Dunn et al., 2018). Opioids are the first line treatment for acute pain in surgery, but a patient with opioid exposure may require a higher dose for a desired clinical effect. The higher dose of medication may increase the risk of adverse effects. Side effects of over-administration of opioids include constipation, oversedation, nausea and vomiting (Deyo et al., 2015). High doses of opioids intraoperatively can lead to hemodynamic instability, including hypotension and bradycardia.

Chronic pain can be managed in different ways including opioids, physical therapy, muscle relaxants, non-steroidal anti-inflammatory (NSAIDs) medications, or yoga. As medications and other modalities become ineffective, surgery is the last resort. Using multi-modal analgesia perioperatively will help improve pain postoperatively and reduce the unwanted side effects of increased opioid administration. The proposed guidelines recommend

intraoperative ketamine, dexmedetomidine, or lidocaine based on a patient's hemodynamic status to assist postoperative pain control.

Background

Patients who exhibit chronic pain may have limited functionality for activities of daily living. According to the CDC (2023), chronic pain is defined as pain that lasts longer than 3 months, and approximately 21% of adults will experience chronic pain in the United States. Back pain is the most common reason for lost hours of productivity and worker's compensation (Casiano et al., 2023). Chronic back pain leads to a decrease in functional capacity and impacts the ability to perform activities of daily living. Studies indicate that 28% of adults have experienced back pain for at least a day within the last three months (Deyo et al., 2015), and 84% of the adult population will experience back pain in their lifetime (Casiano et al., 2023). Approximately 200 billion dollars is spent each year to manage back pain. The prevalence of chronic back pain highlights the significance of the societal impact.

Patients may experience progressive back pain for several years before surgery is considered as an intervention. According to the American Society of Anesthesiologists (ASA), surgery is not indicated for most types of low back pain; instead, medical management is recommended (2023). Nearly 20-40% of back surgeries fail to provide relief to the patient (ASA, 2023). Surgery is often only considered after exhausting medications and other resources, such as physical therapy, hot and cold therapy, or a nerve stimulator. When surgery does occur, it is most commonly due to herniated or ruptured discs, spinal stenosis, degenerative disc disease, spondylolisthesis, or vertebral fractures (ASA, 2023). Spinal decompression and fusions are the most common spinal surgery; spinal fusion rates increased by nearly 42% between 2004 and 2009 (Pannell et al., 2015). As spinal surgery is becoming more common it is important to

develop perioperative guidelines to minimize opioid requirements following surgery and reduce the incidence of chronic pain syndrome.

Patients who rely on opioids to relieve discomfort to perform activities of daily living may become dependent or addicted to the medications. Chronic opioid consumption influences the body's hemostasis, and dependence on opioids often develops (Coluzzi et al., 2017). The body will go through withdrawal if the opioid is discontinued abruptly. Opioid exposure decreases the pain threshold, resulting in higher sensitivity to discomfort, or hyperalgesia (Roeckel et al., 2016). Administering medications such as ketamine or dexmedetomidine may blunt this heightened response.

Opioid exposure increases the difficulty in managing acute pain during spine surgery. Patients exposed to opioids will be less tolerant of surgical pain and may require opioids longer than patients receiving non-opioid pain medications perioperatively (Nielson et al., 2018). Opioid use may lead to addiction when patients continue to use the drug despite harmful consequences and potentially illegal behavior to obtain the medication. A study found that nearly 60% of patients misused opioids before spine surgery (Ferari et al., 2020). The opioid misuse behavior led to poor follow up with the surgeon and increased the rate of infection, resulting in more surgeries to debride the surgical site. Patients who take opioids prior to surgery have higher incidents of postoperative complications, prolonged recovery, and higher pain control needs compared to opioid-naïve patients (Soffin et al., 2019). Performing a comprehensive assessment will aid the anesthetist to develop an individualized anesthesia plan.

Significance to the Profession

The goal of spinal surgery for patients with chronic back pain is to reduce the discomfort enough to improve daily living and minimize the need for opioids postoperatively. Patients with

chronic back pain account for more than 50% of the patients prescribed opioids in the United States (Deyo et al., 2015). However, approximately 52% of chronic opioid users continued to use opioids a year after spine surgery is performed (Dunn et al., 2018). Additionally, 18% of opioid-naïve patients developed opioid dependence a year after spinal surgery (Dunn et al., 2018). Only 6% of patients consistently use non-opioid medications with breakthrough morphine to help control postoperative pain within a month following spinal surgery (Bicket et al., 2019). Provider education regarding appropriate pain management using more than opioids to tolerate postoperative pain may improve these numbers.

Opioids, such as fentanyl, are very common during surgery to provide analgesia for surgical stimulation. During surgery, anesthesia providers may deliver the patient's first opioid medication (Soffin et al., 2018). Anesthesia providers have multiple opportunities to limit the delivered volume of opioids during spine surgery. Patients with opioid exposure are at an increased risk of developing tolerance, hyperalgesia, and addiction (Coluzzi et al., 2017). Patients who develop a tolerance of opioids require a higher medication dosage to elicit the same desired response, such as decreasing the nociceptive response during incision. Patients with opioid exposure are at a greater risk for inadequate pain control during and after surgery (Edwards et al., 2019). Anesthesia providers who undertreat pain intraoperatively are associated with patients experiencing increased length of hospital stay, higher morbidity, and higher incidents of complications such as chronic pain syndrome following surgery (Dunn et al., 2018). Perioperative pain control is essential to prevent a patient from developing complications or delay recovery following spine surgery.

The number of patients dependent on opioids for chronic pain makes perioperative pain management challenging for anesthesia providers. Approximately 25% of patients admitted for

surgery use opioids for pain management (Kane & Hedrick, 2021). Patients undergoing surgery may encounter perioperative risks that jeopardize hemodynamic stability, and anesthesia providers must respond appropriately. Increasing the dose of opioids during surgery is associated with risks, including respiratory depression, higher incidence of infection, compromised wound healing, and potential ileus (McAnally, 2017). Non-opioid medications must be considered for perioperative pain management of the patient having spinal surgery to minimize the adverse consequences of opioids. Intraoperative ketamine, lidocaine, or dexmedetomidine will assist in pain control by occupying other receptors beyond opioid receptors. Administration of these non-opioid medications lead to improved pain scores, reduced opioid requirements, and improved recovery time.

Problem Statement

Opioid medications are relevant in analgesia for patients with acute and chronic pain. The prescription of opioids increased from 43.8 million to 89.2 million between 2000 and 2010 (Soffin et al., 2018). There is a problem of overprescribing opioids after surgery; a study found that at a month follow-up, 46% of patients had over 20 tablets of morphine still available for pain (Bicket et al., 2019). Additionally, 47% of patients failed to dispose of morphine safely after six months, and 92% stored morphine insecurely after surgery. Due to overprescribing and lack of patient education, opioids following surgery can be easily misused and be a source of diversion.

The lack of specific perioperative guidelines or recommendations for patients with chronic back pain. Most anesthesia providers administer higher doses of opioids for patients who use opioids to address surgical pain perioperatively and postoperatively (Edwards et al., 2019). Postoperative pain control aims to make the discomfort tolerable, not pain-free (Soffin et al.,

2019). Patient education is essential to assist patients have realistic expectations and goals following spinal surgery.

PICO(T) Question

Research on multimodal analgesia is available to address intraoperative pain during spinal surgery, but data is limited in comparing interventions. Using multimodal analgesia with opioids will reduce the opioids needed and decrease the incidence of adverse effects of opioids. Developing perioperative guidelines for non-opioid pain medication is vital to protect this high-risk patient population from developing opioid dependence and addiction following surgery.

In the adult patient experiencing chronic pain undergoing spinal fusion, how does the development and implementation of EBP guidelines on intraoperative use of non-opioid pain medication, compared to opioid-based anesthesia, influence breakthrough opioid consumption 24 hours following surgery, postoperative nausea and vomiting (PONV), and length of stay in the hospital?

Objectives

Standardizing intraoperative guidelines for patients undergoing spinal surgery is imperative to reduce the risk of developing opioid dependence postoperatively. Efficient pain control is associated with improved surgical outcomes, reduced length of hospital stays, and lower rates of chronic pain development (Dunn et al., 2016). The goal of the Doctor of Nursing (DNP) project aims to use evidence-based practice research to develop guidelines for perioperative management of patients having spine surgery. The objectives of the doctoral project are as follows:

1. Identify evidence-based practice guidelines from the literature for intraoperative management using multimodal analgesia administration for spinal surgery for patients with opioid dependency.
2. Develop a comprehensive plan to implement non-opioid analgesia perioperatively for spinal surgery.
3. Develop a comprehensive plan to monitor opioid administration postoperatively and measure the hospital length of stay.
4. Develop a comprehensive plan to adjust the evidence-based practice non-opioid intraoperative guidelines as needed.

These objectives will direct the DNP project to develop guidelines for non-opioid analgesia during spine surgery, including medication parameters, opioid-dependent risk factors, and associated costs of implementing the guidelines.

Literature Synthesis

A literature review was conducted using keywords from the PICO question and submitted to multiple research databases. Research databases included Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, and Cochrane Library. Search terms include perioperative ketamine, perioperative lidocaine, perioperative dexmedetomidine, multimodal analgesia, and spine surgery. The initial result had thousands of articles. Further filtering was required using the following criteria: full text, peer-reviewed, published between 2015-2023, randomized control trial, and meta-analysis. The results of the new search were 38 articles. There are 15 articles involving spinal surgery and patients over 18, and they are in the literature review.

Literature Analysis

The literature review highlights the benefits of using perioperative non-opioid medications with opioids for pain control. Research suggests an opioid-sparing effect while also improving pain scores postoperatively. Using intraoperative ketamine, lidocaine, and dexmedetomidine can impact opioid consumption, postoperative pain scores, and LOS following spinal surgery.

Ketamine

Ketamine was previously used as an anesthetic, but due to more efficient medications being produced, became less utilized. Today, with higher incidence of opioid dependency, ketamine is gaining popularity again. Ketamine is classified as a N-Methyl-D-Aspartate (NMDA) receptor antagonist (Mion & Villevielle, 2013). The blocking of the NMDA receptor prevents the release of glutamate, an excitatory neurotransmitter. Ketamine disrupts the pain pathway in the dorsal horn to prevent communication to the brain (Gorlin et al., 2016). Ketamine depresses the reticular activating and limbic systems, referred to as "dissociative anesthesia" (Mion & Villevielle, 2013). Ketamine offers some cardiovascular stability because ketamine causes CNS stimulation, resulting in the release of indigenous catecholamines. However, in patients who are catecholamine depleted, ketamine may result in hypotension (Gorlin et al., 2016).

Research indicates ketamine possesses a unique property to help prevent hyperalgesia in patients dependent on opioids for chronic pain (Barreveld et al., 2013). However, other studies illustrate ketamine is less effective in the opioid-naïve patient population (Boenigk et al., 2019). Different RCTs discovered the effect of improved visual analog scale (VAS) scores with ketamine may last from 24 hours postoperatively up to a year after spinal surgery (Nielson et al.,

2018). The administration of perioperative ketamine can reduce postoperative opioid requirements by nearly 40% (Loftus et al., 2010).

Nielson et al., found that perioperative ketamine improved pain during mobilization (2018). The pain relief ketamine offers during movement suggests ketamine may improve physical therapy and rehab following surgery and potentially improve LOS. However, only one study concluded that perioperative ketamine could improve LOS in patients with opioid dependence (Boenigk et al., 2019). The administration of ketamine reduced pain scores and opioid consumption without an increase in any side effects (Barreveld et al., 2013). The administration of perioperative ketamine can minimize opioid requirements during and after surgery and potentially improve recovery times.

Dexmedetomidine

Dexmedetomidine is an alpha-2 adrenoreceptor agonist (Weerink et al., 2017). Dexmedetomidine is associated with sedative, anxiolytic, and analgesic effects without depressing the respiratory center of the brain. Dexmedetomidine inhibit C-fibers and Aa-fibers in the peripheral nervous system, and inhibit neurotransmission through the dorsal horn, preventing pain messages from reaching the brain (Tang & Xia., 2017). Alpha-2 receptor stimulation causes a negative feedback loop on the presynaptic membrane, causing a reduction in the release of norepinephrine, manifesting as bradycardia and hypotension.

There is mixed evidence of perioperative dexmedetomidine's impact on pain control and opioid consumption following surgery. Most of the studies determined that perioperative dexmedetomidine can improve pain scores and reduce the administration of opioids following surgery (Schnabel et al., 2013). However, a study showed no difference between dexmedetomidine and placebo for VAS scores or opioid administration (Naik et al., 2016).

According to Hwang et al. (2015), dexmedetomidine offers better analgesia than remifentanil and reduced incidents of PONV.

The administration of perioperative dexmedetomidine does cause side effects during and after surgery. According to Schnabel et al. (2013), patients receiving perioperative dexmedetomidine experienced prolonged LOS following surgery. In other studies, dexmedetomidine caused significant bradycardia and hypotension, requiring more phenylephrine perioperatively compared to the placebo group (Naik et al., 2016). The studies with increased rates of bradycardia and hypotension administered higher doses and boluses of dexmedetomidine. The suggested EBP guidelines took this into consideration, and reduced the dose to be efficient without increasing the risk of unwanted side effects. Dexmedetomidine is the preferred medication for a patient with high blood pressure and tachycardia.

Lidocaine

Kim et al., found that perioperative lidocaine is associated with improved pain scores postoperatively up to 48 hours following surgery (2014). Additionally, lidocaine provided an opioid-sparing effect and led to reduced opioid administration during and after surgery (Licina et al., 2022). Perioperative lidocaine did not have any significant side effects associated with administration during surgery. PONV was more evident in patients receiving fentanyl postoperatively than in the lidocaine group (Kim et al., 2014).

Multiple randomized control trials (RCTs) included that perioperative lidocaine reduced the average LOS in the hospital by uplk to 2 days after spinal surgery (Ibrahim et al., 2018; Kim et al., 2014). Reducing hospital LOS is associated with improved patient outcomes, including reduced rate of infection and better quality of life (Baek et al., 2018). Implementing perioperative non-opioid analgesics to assist in patient management undergoing spinal surgery

will significantly improve patient outcomes. Patients may express a reduction of pain scores, consume fewer opioids, and experience a shorter LOS. Patients will recover better and improve quality of life following extensive surgery. The incidence of hospital infections and complications will decrease with a reduction in the time a patient spends in the hospital after surgery (Yadla et al., 2015). Approximately 12% of all spine surgeries result in a surgical infection and require antibiotics and debridement (Schimmel et al., 2010). Careful consideration is necessary when determining which non-opioid analgesic to administer during a case to minimize side effects and prevent hemodynamic instability.

Johns Hopkins Evidence-Based Practice Model

The John Hopkins EBP model for nurses and healthcare professionals utilizes a clinical decision-making tool to improve patient care and patient outcomes (Dang et al., 2022). The tool uses EBP research to provide the most up-to-date data to deliver the best care to patients. John Hopkins University Hospital granted permission to utilize the John Hopkins evidence-based practice model on June 7, 2023; Appendix B shows approval from John Hopkins Nursing. This project is designed on and follows the John Hopkins Model. The first step using the EBP model is inquiry, evidence which includes practice and learning, followed by best practice, and finally, practice improvements and reflection (Dang et al., 2022). The last step is reflecting on the outcomes and assessing for improvements in clinical practice. Appendix C depicts the Johns Hopkins EBP model tool.

Methods and Designs

Inquiry

The first step of the John Hopkins EBP model is inquiry (Dang et al., 2022). Inquiry is asking questions or looking for ways to improve an idea or practice. In anesthesia, the goal is to

provide analgesia, amnesia, and akinesia safely and effectively. The goal of this project is to produce EBP guidelines that improve pain and LOS following spine surgery. Anesthesia providers must continually learn and adapt practice based on new EBP research and data. The inquiry step of this doctoral project is the PICO question, in the adult patient undergoing spinal surgery, how does the development and implementation of EBP guidelines on intraoperative use of non-opioid pain medication, compared to opioid-based anesthesia, influence breakthrough opioid consumption 24 hours following surgery and length of stay in the hospital?

Evidence

The John Hopkins EBP model's second step is data collection. Following the question, evidence and research are gathered to find trends in the data. Research articles included comparing perioperative ketamine, lidocaine, and dexmedetomidine with pain control and length of stay in the hospital following spinal surgery. The literature review includes meta-analysis studies and RCTs. The literature review data indicates a significant improvement in pain control and opioid consumption when utilizing multi-modal analgesia.

Best Practice

The next step is implementing the research to determine if the results are repeatable with positive outcomes. A patient undergoing spinal surgery will receive either ketamine, dexmedetomidine, or lidocaine perioperatively depending on their co-morbidities and hemodynamic profile during surgery. Refer to Appendix D for the proposed EBP guidelines. Patients vital sign trends, recovery period, and pain levels will be monitored closely to determine a statistical significance for pain control, PONV, and LOS following spinal surgery.

Practice Improvement & Reflection

Evaluating perioperative non-opioid analgesics for perioperative management will determine the effectiveness of practice. Considerations include benefit-to-risk ratio, cost, and measurable outcomes, including opioid consumption and LOS. Success of the project will be determined by the reduction of postoperative opioid requirements and improved LOS after surgery. Failure of the project will include unchanged or increased requirements of postoperative opioids, or prolonged LOS following spinal surgery. Using the John Hopkins EBP model will encourage best practices for anesthetic care and continue to change practice as more research is conducted.

Implementation

Inquiry

The first step is identifying stakeholders and determining current practices for patients undergoing spinal surgery. The stakeholders crucial to the implementation and data collection include anesthesia providers, pharmacy, and post anesthesia care unit (PACU) nursing staff. The EBP research will guide anesthesia leaders in developing appropriate perioperative multimodal analgesia order sets. Other stakeholders include billing, purchasing, and technical support.

The next step is establishing current practice trends. An application has been submitted to the institutional review board (IRB) at Otterbein University to support the DNP research project. Data can be collected after IRB approval. A team of CRNAs will review case reports of patients having spine surgery over the last three months. The team will compare the intraoperative medications given and the patients' PACU VAS score and opioid consumption 24 hours following surgery.

Evidence

Current literature supports the administration of multimodal analgesia for patients undergoing spinal surgery (Dunn et al., 2018). The CRNA team will compare the previous case reports to the current EBP recommendations. Identifying trends based on patient co-morbidities and opioid exposure will assist in appropriate guidelines. Inclusion criteria include patients over the age of 18, patients undergoing spinal surgery, hospital length of stay greater than 24 hours, and patients who received non-opioid medication perioperatively to assist in analgesia. Exclusion criteria includes patients under the age of 18, pregnant patients, and patients who received regional anesthesia.

Best Practice

Collaboration between the stakeholders is necessary to determine the feasibility, cost, and steps required to implement the EBP guidelines. The next step is identifying essential resources, education needs, and measurable outcomes. Education will be delivered to anesthesia providers via PowerPoint presentation, handouts will be available in the breakroom, and a flyer will be sent by email. The PACU nursing staff responsible for documenting VAS scores and administering medication following surgery will receive a small presentation during a staff meeting. Alghadir et al., found that VAS scores are the most reliable method of assessing acute pain in adults (2018). Information regarding the new perioperative management for spinal surgery will be posted in their breakroom and emails sent. All nursing and anesthesia staff involved will be required to sign a form confirming they received and understand the education. The form staff will sign, stating the new information is understood, is found in Appendix E. The amount of time for the anesthesia providers to review the content will be 15 minutes. Education will begin one month before the implementation of the guidelines.

Practice Improvement & Reflection

Implementation of the guidelines is subsequent. During this period, all spine surgery patients who qualify for the new guidelines will receive either perioperative ketamine, dexmedetomidine, or lidocaine. Postoperative VAS scores and PONV will be monitored, as well as the impact of these medications on their LOS in the hospital. The data will be collected for two months to evaluate the efficacy of the medications. After evaluation, the recommendations can be accepted, modified, or dismissed.

Timeline

The amount of time to collect data and formulate guidelines for perioperative management for patients experiencing spine surgery is one month. Information preparation and staff education will take a month to disseminate the changes for perioperative guidelines going forward. The time period to rule out the new guidelines and collect data including opioid consumption, VAS scores, and length of stay following surgery will be two months. The evaluation of the new perioperative guidelines will take a month. During this time the guidelines can be accepted, revised, or dismissed. The total timeline for the perioperative guidelines is five months.

Budget

The team of CRNAs that will perform data collection regarding the previous three months of spinal surgeries will be comprised of three CRNA's. The budgeted time is six hours of pay for each CRNA resulting in a total of $1,620. The development of the presentation is budgeted for three hours, with a cost of $270. The staff education for CRNAs will be included during a staff meeting and be assigned fifteen minutes for the presentation. Staff education is already built into the budget so that will save time and money to disseminate the new guidelines.

The supplies for handouts and posters in the breakroom are budgeted for $30. The total budget for the education and implementation of the guidelines is $1,920. Appendix F details the budget. There is a minor difference in cost between fentanyl and non-opioid analgesic medications. The cost of the medications will be charged to either the patient or insurance company. However, with the reductions in overall LOS in the hospital, this may result in the savings of thousands of dollars for both the patient and the hospital.

Outcome & Analysis Plan

The team of CRNA's that performed data collection to develop baseline information will gather the new statistics from the implemented guidelines. The VAS scores will be collected for 24 hours following surgery and an average will be calculated. This numerical value will be compared to the previously collected information to evaluate the efficacy of the proposed guidelines. The LOS will be determined starting the day of surgery until discharge. Patients who are admitted for other comorbidities or traumas that undergo spinal surgery will be excluded from data comparison due to complexity of overall care not involved with spinal surgery.

The number of days following spinal fusion surgery will be compared between the original statistics and the new numerical value from the implemented guidelines. Patients undergoing spinal fusion will be stratified based on the number of levels receiving operation. One or two levels will be considered mild spinal fusion, three or four levels will be considered intermediate invasive, and five levels or more will be considered severe spinal fusion surgery.

The rate of PONV will be monitored for 24 hours following spinal fusion. PONV will be monitored by the number of antiemetic doses after surgery, and the number of episodes of emesis. Data suggests patients will be less likely to experience PONV using multi-modal analgesia compared to opioid-based anesthesia.

The evidence suggests there will be a reduction in opioid administration and improved pain scores 24 hours following spine surgery with the implementations of the guidelines. A future project could perform a cost analysis to determine if the administration of dexmedetomidine is worth the price to improve LOS. However, if the length of stay is equivalent between dexmedetomidine and lidocaine infusions, the guidelines may be modified to preferentially suggest lidocaine. The data analysis will provide objective feedback regarding the efficacy of the perioperative guidelines.

Barriers

The greatest barrier to the intraoperative guideline implementation for spine surgery is adherence from staff. Anesthesia providers need to assess each patient to determine the most appropriate non-opioid analgesic to assist in pain control following spinal surgery. Giving dexmedetomidine when a blood pressure or heart rate is low may produce significant hypotension or bradycardia. Anesthesia providers who have been practicing for decades without utilizing non-opioid medications to assist anesthesia may find the process annoying or cumbersome. PACU nursing staff must document timely VAS scores postoperatively and give PONV medications when appropriate. The CRNA team collecting the data need to be diligent to make sure the documentation and comparison is accurate. Buy-in from all staff is necessary for the success of the intraoperative guidelines.

Conclusion

The lack of specific perioperative guidelines for patients with substance use disorder undergoing spinal fusion prompted this DNP project. Evidence suggests patients with opioid exposure are harder to manage during and after spine surgery (Kane & Hendrick, 2021). Using multi-modal analgesia intraoperative guidelines results in improved pain scores, reduced LOS

and PONV following major spine surgery (Kim et al., 2013). The purpose of this DNP project was to identify patients at high risk of experiencing severe postoperative pain, and initiating EBP guidelines to minimize the risk and improve postoperative outcomes. Using EBP information will improve patient outcomes and continue to guide the future direction of anesthesia.

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Appendix A

Evidence Review Worksheet

Citation	Conceptual Framework	Design/Method	Sample/Setting	Major Variables Studied	Outcome Measurement	Data Analysis	Findings	Level of Evidence	Quality of Evidence
Article 1									
Barreveld, A. M., Correll, D. J., Liu, X., Max, B., McGowan, J. A., Shovel, L., Wasan, A. D., & Nedeljkovic, S. S. (2013). Ketamine decreases postoperative pain scores in patients taking opioids for chronic pain: Results of a prospective, randomized, double-blind study. *Pain Medicine, 14*(6), 925–934. https://doi.org/10.1111/pme.12086	Measure pain scores with IV ketamine continuous infusion in addition to opioid-based PCA versus opioid-PCA alone for 24 hours postoperatively in patients with chronic opioid use	Prospective, randomized, double blind study	64 patients total Ketamine (N=32) Placebo (N=32) Exclusion criteria: discharge POD1	IV1= Continuous ketamine infusion DV1= Pain scores	Wilcoxon rank sum test and categorial outcomes were compared using chi-squared test	Average pain was less in ketamine group (P=0.024)	Patients who received ketamine infusion with PCA had better "average pain" score, but did not affect LOS or opioid consumption	2	Limitations: 1. Broad spectrum of types of surgeries included 2. Pain scores were no longer monitored for the study after ketamine or placebo were discontinued 24 hours after surgery
Annotated Bibliography The objective of the RCT was to determine the impact of a ketamine infusion with an opioid-PCA postoperatively in patients with opioid-dependence. The patients with the ketamine infusion experienced better pain scores without any increase in side effects from the ketamine infusion. The study did not find any statistical significance in opioid consumption or length of stay in the hospital between either group.									
Thematic Analysis: 1. Perioperative ketamine improves pain scores after surgery without significant risk of side effects 2. There is no difference in opioid consumption postoperatively or improved length of stay									
Article 2									
Boenigk, K., Echevarria, G. C., Nisimov, E., von Bergen Granell, A. E., Cuff, G. E., Wang, J., & Atchabahian, A. (2019). Low-dose ketamine infusion reduces postoperative hydromorphone requirements in opioid-tolerant patients following spinal fusion: A randomized controlled trial. *European journal of anesthesiology, 36*(1), 8–15. https://doi.org/10.1097/EJA.0000000000000877	Study to compare ketamine infusion with opioid-dependent and opioid naïve patients perioperatively and compare opioid consumption and pain scores	Randomized, double-blind study	129 patients total Naïve placebo (n=38) Naïve ketamine (n=30) Tolerant placebo (n=32) Tolerant ketamine (n=29)	IV1= ketamine infusion DV1= opioid consumption 24 hours after surgery DV2= numerical pain scores	Shapiro-Wilk test and Q-Q plots	Significantly reduced opioid consumption in ketamine tolerant group compared to placebo tolerant group (p <0.001)	Opioid-tolerant patients with ketamine infusion exhibited reduced opioid needs 24-hours postoperatively compared to tolerant placebo group. There was no statistical significance between either opioid-naïve groups and opioid consumption. Pain scores were similar in all groups, but this could be due to PCA and patients maintaining a similar level of comfort	2	Limitations: Patients in opioid-naïve groups were significantly younger, since they did not have chronic pain
Annotated Bibliography									

The goal of the RCT was to assess the role of perioperative ketamine in both opioid tolerant and opioid naïve patients having spinal fusion surgery. The results indicated significant decrease in opioid consumption between the ketamine tolerant group and tolerant control group. There was not statistical difference between either group with pain scores. The ketamine tolerant group experienced a 1-day decrease in length of stay compared to the tolerant placebo group (p=0.09).									
Thematic Analysis: 1. Perioperative ketamine can reduce postoperative opioids in opioid tolerant patients 2. Perioperative ketamine did not influence postoperative opioid consumption or pain scores in opioid naïve patients 3. Perioperative ketamine can reduce the LOS postoperatively in patients with opioid dependence									
Article 3									
Loftus, R. W., Yeager, M. P., Clark, J. A., Brown, J. R., Abdu, W. A., Sengupta, D. K., & Beach, M. L. (2010). Intraoperative ketamine reduces perioperative opiate consumption in opiate-dependent patients with chronic back pain undergoing back surgery. *Anesthesiology, 113*(3), 639–646. https://doi.org/10.1097/ALN.0b013e3181e90914	Perioperative ketamine infusion will reduce postoperative opioid consumption in patients with opioid dependence	Randomized, double-blind study	102 patients total Ketamine (n=52) Placebo (n=50)	IV1= continuous ketamine infusion DV1= opioid consumption postoperatively DV2= numerical pain scores	Unpaired t-test and Fisher exact test	Ketamine group received 37% less opioids within 48-hours after surgery (p=0.029)	Patients in the ketamine group had reduced opioid consumption and improved pain scores up to 6 weeks following surgery in comparison to the placebo group	2	Strength: Daily dose of opioids was equivalent in both ketamine and placebo group prior to surgery
Annotated Bibliography The objective of the RCT was to evaluate perioperative ketamine in patients with opioid dependence and chronic pain. The ketamine group experienced significant decrease in postoperative opioid use up to 48-hours following surgery and had improved pain scores compared to the control group. The average pain score was reduced up to 6 weeks following surgery in the ketamine group. There were no side effects from the ketamine or opioids during the study. There was no difference between groups with PACU stay or hospital stay.									
Thematic Analysis: 1. Perioperative ketamine improved pain scores postoperatively up to 6 weeks 2. Perioperative ketamine reduced postoperative opioid requirements by 37% 3. Perioperative ketamine did not improve LOS or PACU recovery time									
Article 4									
Meyer-Frießem, C. H., Lipke, E., Weibel, S., Kranke, P., Reichl, S., Pogatzki-Zahn, E. M., Zahn, P. K., & Schnabel, A. (2022). Perioperative ketamine for postoperative pain management in patients with preoperative opioid intake: A systematic review and meta-analysis. *Journal of Clinical Anesthesia* (78*),* 110652. https://doi.org/10.1016/j.jclinane.2022.110652	Perioperative ketamine infusion will reduce opioid consumption postoperatively in patients with opioid dependence	Systematic Review and Meta-Analysis	9 RCTs 802 patients	IV1= Continuous ketamine infusion perioperatively DV1= pain at rest and with movement DV2= morphine consumption	VAS scale	Ketamine shows anti-hyperalgesia effect up to 48-hours following surgery	Patients in the ketamine group consumed less opioids postoperatively up to 48 hours following surgery	1	The studies used showed low quality of evidence, but consistent opioid-sparing effect of ketamine for patients with opioid dependence
Annotated Bibliography This systematic review assessed the benefits of perioperative ketamine in patients with opioid dependence. The results revealed an opioid sparing effect postoperatively up to 48 hours following surgery. This information insinuates prevention of opioid induced hyperalgesia, and is shown to be a beneficial adjunct to perioperative pain management. There was no impact on length of stay between either group									
Thematic Analysis: 1. Perioperative ketamine reduced opioid administration up to 48 hours after surgery 2. Perioperative ketamine did not influence length of stay at the hospital									
Article 5									
Nielsen, R. V., Fomsgaard, J. S., Nikolajsen, L., Dahl, J. B., & Mathiesen, O. (2018). Intraoperative S-ketamine for the reduction of opioid consumption and pain one year after spine surgery: A randomized clinical trial of opioid-dependent patients*. European journal of pain, 23*(3), 455–460. https://doi.org/10.1002/ejp.1317	A study to compare perioperative ketamine during spinal surgery to placebo one year after surgery	Randomized control trial	147 patients total Ketamine group (n=74) Placebo group (n=73)	IV1= Perioperative ketamine bolus and infusion DV1=daily use of morphine consumption DV2=pain score at rest	The Dane Spine questionnaire including patient-reported analgesics, Visual	Fewer patients in the ketamine group used less morphine daily than the placebo group one year after surgery (p=0.02)	Morphine consumption was less in the ketamine group, and had improved pain scores at rest (p=0.01). Ketamine could improve hyperalgesia up to one year after spinal surgery in	2	Limitations: Only 67% of the original participants responded to the one-year follow up questionnaire

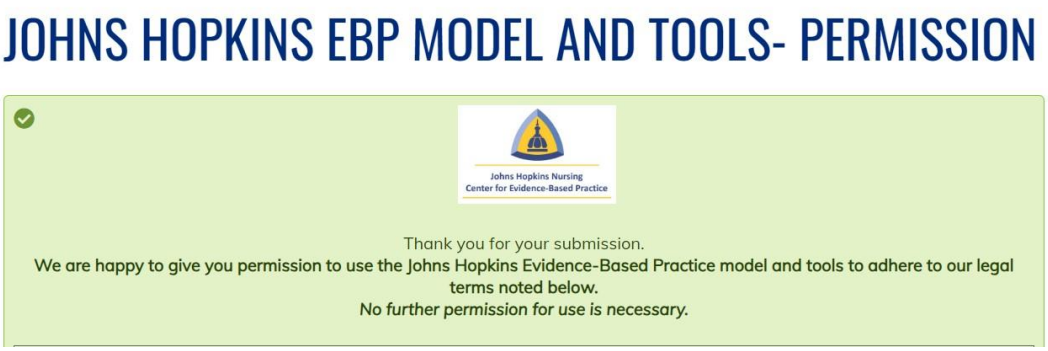
					Analogue Scale (VAS)		patients with chronic pain and opioid-dependence		
Annotated Bibliography This study evaluated the effects of perioperative ketamine up to a year following spinal surgery in patients with pre-operative opioid dependence. The ketamine group consumed less opioids daily, compared to the placebo group and had lower pain scores. Mobilization pain was improved in the ketamine group a year after surgery compared to the control group.									
Thematic Analysis: 1. Opioid consumption is reduced with perioperative ketamine up to a year following spine surgery 2. Perioperative ketamine improved pain without moving and with mobilization following surgery									
Article 6									
Dahi-Taleghani, M., Fazli, B., Ghasemi, M., Vosoughian, M., & Dabbagh, A. (2014). Effect of intravenous patient-controlled ketamine analgesia on postoperative pain in opium abusers. *Anesthesiology and pain medicine, 4(*1), e14129. https://doi.org/10.5812/aapm.14129	A study added ketamine into morphine for PCA versus placebo postoperatively for patients with opioid dependence	Randomized, double-blind study	140 patients total Ketamine group (n=70) Placebo group (n=70)	IV1= ketamine added to postoperative morphine PCA DV1= Postoperative pain scores DV2= PCA requirements	VAS score to rate pain, and T-Test was used for data analysis	The ketamine group experienced better pain scores up to 24 hours following surgery (p=0.02)	Patients used less morphine postoperatively with ketamine added to PCA. However, there was an increased rate of nausea and vomiting in the ketamine group too (p=0.02)	2	Limitations: Only involved males and orthopedic surgeries in the study
Annotated Bibliography This study compared a PCA with ketamine and morphine to a PCA with morphine for males following orthopedic surgery. The results showed a reduced accumulation of morphine consumption and improved pain scores in the ketamine group following surgery. The ketamine group experienced higher incidents of PONV compared to morphine PCA group.									
Thematic Analysis: 1. Postoperative ketamine and morphine PCA had better pain scores and reduced need for opioids following surgery compared to opioid PCA 2. Postoperative ketamine and morphine PCA significantly increased the incidence of PONV compared to morphine PCA									
Article 7									
Wang, X., Lin, C., Lan, L., & Liu, J. (2021). Perioperative intravenous S-ketamine for acute postoperative pain in adults: A systematic review and meta-analysis. *Journal of clinical anesthesia, 68*, 110071. https://doi.org/10.1016/j.jclinane.2020.110071	A review to measure ketamine's influence on postoperative morphine consumption	Systematic Review and Meta-analysis	12 RCTs 905 patients total Ketamine group (n=504) placebo group (n=401)	IV1= Perioperative ketamine infusion DV1= Pain score DV2= morphine consumption	VAS score and morphine consumption	Improved pain scores and morphine consumption in ketamine group versus placebo (p<0.001)	Ketamine infusion significantly improved postoperative pain and morphine use 12-hours after surgery, but did not provide statistical significance beyond 12 hours	1	Limitations: Some studies included small sample size and may overestimate the benefit of ketamine infusions
Annotated Bibliography The objective of this systematic review is to evaluate the effects of perioperative ketamine compared to placebo postoperatively. There was significant improvement in pain scores up to 24 hours following surgery in the ketamine group. Morphine consumption was reduced up to 12 hours after surgery in the ketamine group, but not after 24 hours. There was no difference on PONV between groups.									
Thematic Analyses: 1. Perioperative ketamine reduces opioid consumption up to 12 hours following surgery 2. Perioperative ketamine improves pain score up to 24 hours following surgery									
Article 8									
Hwang, W., Lee, J., Park, J. et al. Dexmedetomidine versus remifentanil in postoperative pain control after spinal surgery: a randomized controlled study. *BMC Anesthesiology 15,* 21 (2015). https://doi.org/10.1186/s12871-015-0004-1	A study to compare perioperative precedex versus remifentanil for postoperative pain	Randomized control trial	40 patients total Precedex group (n=20) remifentanil group (n=20)	IV1= Perioperative precede IV2= Perioperative remifentanil DIV1= pain score DIV2= PCA dose	VAS score, PCA amount	Improved VAS score and reduced PCA usage in precedex group (p<0.05)	Perioperative Precedex appears superior to remifentanil for pain control up to discharge from PACU. Patients receiving remifentanil exhibited more PONV.	2	Limitations: Small sample size

Annotated Bibliography This RCT compared precedex and remifentanil perioperatively for pain control during total intravenous anesthesia (TIVA). The precedex group exhibited better pain scores and had lower PCA dosages postoperatively. The remifentanil group experienced higher incidents of PONV.									
Thematic Analysis: 1. Patients receiving perioperative precedex had reduced VAS scores postoperatively 2. The total amount of PCA dosages was significantly less in the precedex group 3. Remifentanil exhibited more instances of PONV									
Article 9									
Naik, B. I., Nemergut, E. C., Kazemi, A., Fernández, L., Cederholm, S. K., McMurry, T. L., & Durieux, M. E. (2016). The effect of dexmedetomidine on postoperative opioid consumption and pain after major spine Surgery. *Anesthesia and analgesia, 122(*5), 1646–1653. https://doi.org/10.1213/ANE.0000000000001226	Perioperative precedex could reduce postoperative opioid use and improve pain scores	Randomized control trial	142 patients total Precedex group (n=71) Placebo group (n=71)	IV1= Perioperative precede infusion DV1= Pain score DV2= Opioid use postoperatively	VAS score, PCA amount	Minimal improvement in opioid consumption postoperatively (p=0.65) and pain scores (p=0.12)	This study showed precedex does not significantly improve pain scores or cause an opioid-sparing effect	2	Limitations: The study was terminated early, and postoperative analgesia was not strictly standardized
Annotated Bibliography This RCT compared perioperative precedex and normal saline for pain control. The precedex group required less rescue opioids during surgery (p=0.04), but not statistically significant beyond 24 hours. VAS scores were similar between groups. The precedex group exhibited more bradycardia and required more phenylephrine perioperatively.									
Thematic Analysis: 1. Perioperative precedex did not influence opioid consumption postoperatively 2. The precedex group experienced significantly higher rates of bradycardia and required more phenylephrine 3. VAS scores were similar between precedex and placebo group									
Article 10									
Schnabel, A., Meyer-Frießem, C. H., Reichl, S. U., Zahn, P. K., & Pogatzki-Zahn, E. M. (2013). Is intraoperative dexmedetomidine a new option for postoperative pain treatment? A meta-analysis of randomized controlled trials. *Pain, 154*(7), 1140–1149. https://doi.org/10.1016/j.pain.2013.03.029	Research of perioperative dexmedetomidine versus placebo to measure opioid consumption and pain postoperatively	Systematic Review and Meta-Analysis	28 RCTs 1,420 patients total	IV1= perioperative Dexmedetomidine DV1= pain score DV2= Opioid Consumption	VAS score, Postoperative opioid administration	Improved pain score and opioid consumption in the dexmedetomidine group (p=0.00001)	The research indicate dexmedetomidine can greatly improve pain scores and decrease opioid consumption postoperatively	1	Limitations: Large fluctuation of dexmedetomidine doses among trials
Annotated Bibliography In this systematic review, patients received perioperative precedex compared to placebo for pain management. The precedex group had significantly reduced pain scores following surgery compared to placebo group. Morphine consumption was reduced in the precedex group up to 48-hours following surgery. The precedex group exhibited higher incidents of bradycardia. The LOS in the PACU was prolonged in the precedex group compared to placebo.									
Thematic Analysis: 1. Perioperative precedex improves pain scores following surgery 2. Perioperative precedex reduces the amount of opioids postoperatively 3. LOS was prolonged with perioperative precedex									
Article 11									
Janatmakan, F., Nassajian, N., Jarirahmadi, S., Tabatabaee, K., & Zafari, M. (2021). Comparison of the effect of dexmedetomidine and remifentanil on pain control after spinal surgery: A double-blind, randomized clinical trial. *Anesthesiology and pain medicine, 11*(2): e111533. https://doi.org/10.5812/aapm.111533	Comparison of dexmedetomidine and remifentanil postoperatively for pain control	Randomized, double-blind study	60 patients total Dexmedetomidine group (n=30 Remifentanil group (n=30)	IV1= dexmedetomidine infusion IV2= remifentanil infusion DV1= Pain score DV2= PONV	VAS score, incidents of PONV	The average pain score in the dexmedetomidine group was significantly lower (p<0.001)	Dexmedetomidine offered significantly better pain control and less PONV than remifentanil	2	N/A
Annotated Bibliography This RCT compared perioperative precedex and remifentanil for pain management in spinal surgery. The precedex group experienced reduced opioid requirements following surgery. The mean pain intensity score was improved in the precedex group compared to remifentanil. The remifentanil group experienced higher rates of PONV.									
Thematic Analysis:									

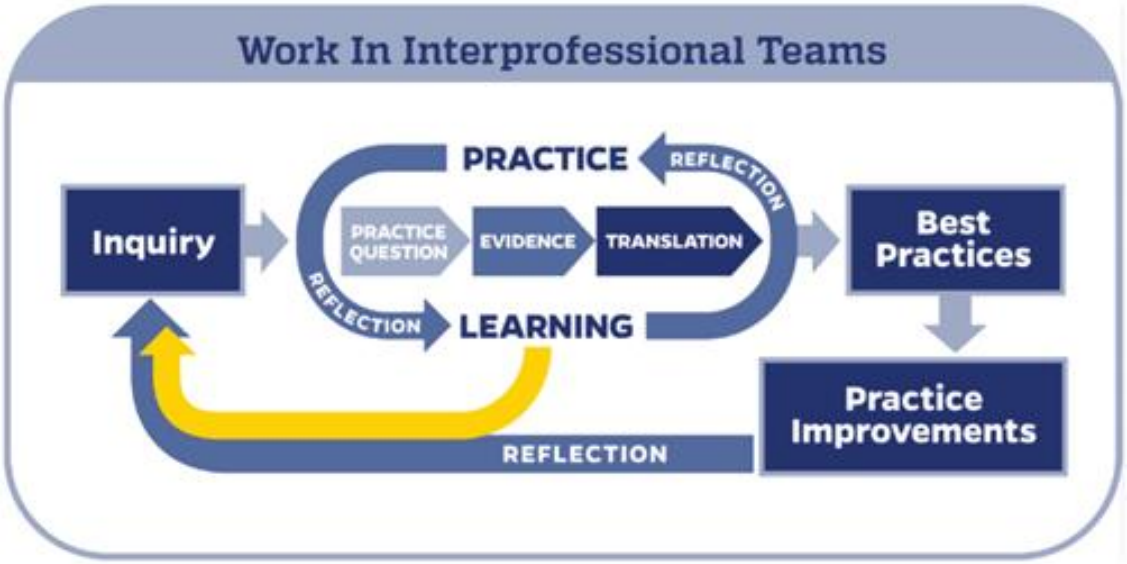
1. Perioperative precedex improved pain scores up to 24-hours following surgery 2. Perioperative remifentanil increased the rate of PONV 3. Perioperative precedex offered more hemodynamic stability during surgery compared to remifentanil									
Article 12									
Licina, A., & Silvers, A. (2022). Perioperative intravenous lidocaine infusion for postoperative analgesia in patients undergoing surgery of the spine: Systematic review and meta-analysis. *Pain medicine, 23(*1), 45-56. https://doi.org/10.1093/pm/pnab210	Examine effects of perioperative lidocaine for postoperative pain control, opioid consumption, and length of stay	Systematic Review and Meta-Analysis	8 RCTs Lidocaine group (n=349) Placebo group (n=343)	IV1= Perioperative lidocaine DV1= Pain score DV2= Opioid consumption DV3= Length of Stay (LOS)	VAS Score, opioids were converted to morphine equivalents	Average pain score was lower with lidocaine infusion 24 hours following surgery (p=0.0001), with reduced opioid consumption (p=0.005) and LOS (p=0.0007)	Perioperative lidocaine can minimize opioid demands and improve pain and LOS following surgery	1	Limitations: Inconsistent range of lidocaine bolus and infusion dose among RCTs
Annotated Bibliography This systematic review analyzed perioperative lidocaine versus placebo. The lidocaine group experienced significantly reduced pain scores up to 24-hours following surgery. Perioperative lidocaine decreased the amount of rescue opioids following surgery, and reduced the length of stay in the hospital.									
Thematic Analyses: 1. Perioperative lidocaine improves pain scores following surgery 2. Perioperative lidocaine reduces rescue opioid needs 3. LOS is reduced with the use of perioperative lidocaine									
Article 13									
Kim, K., Cho, D., Sung, J., Kim, Y., Kang, H., Song, K., & Choi, G. (2014). Intraoperative systemic infusion of lidocaine reduces postoperative pain after lumbar surgery: A double-blinded, randomized, placebo-controlled clinical trial. *The Spine Journal, 14*(8), 1559-1566. https://doi.org/10.1016/j.spinee.2013.09.031	Evaluate the effects of perioperative lidocaine on pain management and LOS postoperatively	Randomized, double-blind study	51 patients total Lidocaine group (n=25) Placebo group (n=26)	IV1= Perioperative lidocaine bolus and infusion DV1= Pain score DV2= opioid consumption DV3= LOS	VAS score	Lidocaine group had lower pain scores (p<0.05), opioid use (p<0.001) and LOS (p=0.039)	Lidocaine infusion helped minimize the doses of opioids and improved pain scores and LOS postoperatively	2	Limitations: Plasma level of lidocaine was not monitored, and none of the patients had underlying medical issues
Annotated Bibliography This RCT assessed the benefits of perioperative lidocaine versus placebo in lumbar surgery. Average pain scores were reduced in the lidocaine group up to 48-hours following surgery. Total fentanyl consumption was decreased in the lidocaine group compared to placebo. The lidocaine group averaged a day shorter stay in the hospital.									
Thematic Analysis: 1. Perioperative lidocaine improved pain scores after surgery 2. Fentanyl administration is decreased with perioperative lidocaine 3. Perioperative lidocaine can reduce the LOS following surgery									
Article 14									
Ibrahim, A., Aly, M., & Farrag, W. (2018). Effect of intravenous lidocaine infusion on long-term postoperative pain after spinal fusion surgery. *Medicine, 97*(13). https://doi.org/10.1097/MD.0000000000010229	To measure the effect of perioperative lidocaine up to 3 months postoperative	Randomized, double-blind study	40 patients total Lidocaine group (n=20) Placebo group (n=20)	IV1= Perioperative lidocaine DV1= Pain score DV2= opioid consumption DV3= LOS	VAS score, Morphine consumption	The lidocaine group exhibited lower pain (p<0.05) and opioid use (p<0.001) with improved LOS (p=0.001)	Patients who received perioperative lidocaine experienced better pain control postoperatively and decreased LOS	2	Limitations: Small sample size, and serum level of lidocaine was not monitored
Annotated Bibliography This RCT analyzed perioperative lidocaine compared to placebo during lumbar surgery. The lidocaine group experienced improved pain scores compared to placebo up to 48-hours following surgery. Total morphine consumption was significantly reduced in the lidocaine group following surgery. The lidocaine group averaged 2 days less in the hospital compared to the placebo group.									
Thematic Analysis:									

1. Perioperative lidocaine significantly reduces average pain following surgery 2. Opioid consumption can be improved using perioperative lidocaine 3. LOS can be significantly reduced using perioperative lidocaine during lumbar surgery									
Article 15									
Bi, Y., Ye, Y., Ma, J., Tian, Z., Zhang, X., & Liu, B. (2020). Effect of perioperative intravenous lidocaine for patients undergoing spine surgery: A meta-analysis and systematic review. *Medicine, 99*(48). https://doi.org/10.1097/MD.0000000000023332	Examine the effect of perioperative lidocaine versus placebo in spinal surgery	Systematic review and Meta-Analysis	4 RCTs 275 patients total	IV1= Lidocaine bolus and infusion DV1= Pain score DV2=opioid consumption DV3= LOS	VAS Score, measure morphine equivalents for opioid consumption	The lidocaine group experienced improved pain score (<0.001) and opioid use (p<0.001), but LOS was not statistically significant (p=0.65)	Perioperative lidocaine can decrease the need for opioids postoperatively and improve pain scores	1	Limitations: Sample sizes were small
Annotated Bibliography This systematic review investigated how perioperative lidocaine compared to placebo influenced postoperative management following spine surgery. The lidocaine group experienced significantly reduced pain scores up to 48-hours following surgery. Opioid consumption following surgery was reduced in the lidocaine control group. LOS was similar between the lidocaine and control group.									
Thematic Analysis: 1. Perioperative lidocaine improves pain scores following spinal surgery 2. Opioid consumption is improved postoperatively with perioperative lidocaine 3. Perioperative lidocaine did not influence a change in LOS									

Appendix B


JOHNS HOPKINS EBP MODEL AND TOOLS- PERMISSION
Johns Hopkins Nursing
Center for Evidence-Based Practice
Thank you for your submission.
We are happy to give you permission to use the Johns Hopkins Evidence-Based Practice model and tools to adhere to our legal terms noted below.
No further permission for use is necessary.

Appendix C



John Hopkins Evidence-Based Practice Model

Appendix D

Recommendation

Statement of Purpose:

The purpose of this recommendation is to deliver evidence-based practice guidelines regarding perioperative multimodal analgesia compared to standard practice during spinal surgery.

Policy:

This recommendation applies to anyone undergoing spinal surgery who qualifies according to the guidelines and who do not refuse. The anesthesia provider must carefully assess each patient individually to determine the most appropriate non-opioid analgesic medication to add to their anesthetic plan.

Medications:

Ketamine
Indications: Opioid exposure
Exclusion Criteria: Uncontrolled hypertension, pregnancy, heart or valve disease
Dosage: 0.5 mcg/kg bolus followed by 10 mcg/kg/min infusion until closure

Dexmedetomidine
Indications: Hypertension, tachycardia
Exclusion Criteria: Hypotension, bradycardia, heart block, pregnancy
Dosage: 0.5 mcg/kg bolus followed by 0.2 mcg/kg/hr until closure

Lidocaine
Indication: Age >18 years old
Exclusion Criteria: Pregnancy
Dosage: 1.5 mg/kg bolus followed by 2 mg/kg/hr infusion until closure

Recommendations:

1. Recommendation 1
    a. Patients undergoing spine surgery will be evaluated for administration of perioperative non-opioid medication to assist in reducing VAS scores and LOS
2. Recommendation 2
    a. Any patient undergoing spine surgery shall receive perioperative non-opioid medication if the inclusion criteria is met and the patient does not refuse
3. Recommendation 3
    a. Patients VAS scores will be recorded in the EMR thirty minutes for the first 6 hours, and then every 2 hours until discharge

Appendix E

Acknowledgement of New Perioperative Guidelines

I hereby acknowledge I have read and understand the new perioperative guidelines for patients undergoing spine surgery. I will assess a patients' VAS score every 15 minutes for 2 hours following spine surgery.

Name: **Signature:** **Work ID:**

Appendix F

Budget Plan

Research Team (3 CRNAs)	3 CRNAs x 6 hours (90/hour) = $1,620
Presentation Development	1 CRNA x 3 hours (90/hour) = $270
Handout and Poster Supplies	$30
Total Cost of Budget	$1,920