Distribution Statement

Distribution A: Public Release.

The views presented here are those of the author and are not to be construed as official or reflecting the views of the Uniformed Services University of the Health Sciences, the Department of Defense or the U.S. Government.

Multimodal Anesthetic Recommendations for Patients Identified with Chronic Pain Undergoing Major Joint or Neuro-Spine Surgery

Maj Aria Klein, Maj Edson Charles, Capt Joshua Boyle, Capt Mathew Thompson

Daniel K. Inouye Graduate School of Nursing

Uniformed Services University of the Health Sciences

Wright Patterson Air Force Base Medical Center

Copyright Acknowledgement Statement

"The author(s) hereby certify that the use of any original work by another author or copyrighted material used in the DNP project entitled:
Multimodal Anesthetic Recommendations for Patients Identified with Chronic Pain Undergoing Major Joint or Neuro-Spine Surgery
is either appropriately cited within the manuscript or used with formal written permission of copyright release by the owner of the original work."

Maj Aria A. Klein
Daniel K. Inouye Graduate School of Nursing
Uniformed Services University

Maj Edson W. Charles
Daniel K. Inouye Graduate School of Nursing
Uniformed Services University

Capt Joshua W. Boyle
Daniel K. Inouye Graduate School of Nursing
Uniformed Services University

Capt Mathew R. Thompson
Daniel K. Inouye Graduate School of Nursing
Uniformed Services University

Table of Contents

Appendices

Disclaimer

The opinions and assertions expressed herein are those of the author(s) and do not necessarily reflect the official policy or position of the Uniformed Services University nor the Department of Defense. Neither the members of this project team nor our family members have a financial interest in any commercial product, service, or organization providing financial support for this evidence-based project, deemed exempt by the Defense Health Agency Institutional Review Board in accordance with federal regulations.

Multimodal Anesthetic Recommendations for Patients Identified with Chronic Pain Undergoing Major Joint or Neuro-Spine Surgery

Abstract

Phase II Site: Wright Patterson Air Force Base Medical Center (WPMC), Dayton, Ohio

Project Title: Multimodal Anesthetic Recommendations for Patients with Chronic Pain Undergoing Major Joint or Neuro-Spine Surgery

Authors: Maj Aria Klein, Maj Edson Charles, Capt Joshua Boyle, Capt Mathew Thompson

Background or Problem/Issue: Chronic pain affects approximately 100 million Americans at the cost of $600 billion annually. This MTF lacks identification and evidence-based recommendations for chronic pain patients presenting for surgery.

Clinical Question or Purpose: The purpose of this project was to preoperatively identify chronic pain patients and provide evidence-based perioperative recommendations to enhance surgical outcomes. Will early identification and knowledge of the current state of the evidence lead to a measurable effect for this patient population?

Project Design: Phase 1 consisted of the implementation of an early identification pain tool for all patients presenting for surgery over a 60-day period. Phase 2 involved dissemination of evidence-based recommendations for adult chronic pain patients undergoing major joint or neuro-spine surgeries. Additionally, over the following two months data on time to first opioid, total opioid consumption, and hospital length of stay was analyzed and compared to retrospective data.

Analysis of the Results: Perioperative recommendations for major joints resulted in a 54% increase in time to first opioid and a 38.5% decrease in length of stay. However, a 121% increase in morphine equivalent in 24-hours was noted. The neuro-spine population demonstrated similar results with a 71% increase in time to first opioid, a 36.3% reduction in length of stay, and a 75% increased morphine equivalent.

Organizational Impact/Implications for Practice: This institution showed that greater than 30% of all surgical patients reported chronic pain, which is consistent with the national average. Furthermore, chronic pain was demonstrated in other unexpected surgical subspecialties. This highlights the need for early identification and knowledge of the current state of the evidence to effectively care for chronic pain at this institution.

Introduction

The Centers for Disease Control and Prevention (2020) states that patients who present for major joint or neuro-spine surgeries have a higher incidence of chronic pain. Opioid requirements for chronic pain patients are approximately 30% higher intraoperatively, which can lead to hemodynamic instability, somnolence, respiratory depression and persistent postoperative pain (Deng et al., 2017, Jackman, 2019; Nielsen et al., 2017). Approximately 8% - 15% of patients presenting for surgery are prescribed high dose opioids, which indicates a need for preoperative screening (Gulur et al., 2014). Unidentified chronic pain can lead to decreased time to first opioid, increased total opioid consumption and increased hospital length of stay (LOS) (Tsaousi et al., 2018; Westrich et al., 2019). The anesthesia department at the military training facility (MTF) lacked a screening tool for the early identification of patients with chronic pain as well as evidence-based multimodal perioperative recommendations.

Problem Synthesis

Chronic pain is a pandemic in America affecting nearly 100 million Americans. It is defined as a sensory and emotional experience that lasts greater than three months (Aronoff, 2016; Kopf et al., 2005). Annually the United States performs 48.3 million surgeries, of these one in four patients meet criteria for chronic pain (Hall et al., 2017; Jackman, 2019). The medical treatment for pain costs approximately $600 billion annually, which is greater than heart disease, cancer, and diabetes combined (Institute of Medicine, 2011). The development of chronic pain is a complex pathophysiological process that can lead to central sensitization.

Central sensitization is characterized by generalized and widespread hypersensitivity and hyperreactivity of the ascending and descending pain pathways (Nijs et al., 2011). Overloaded pain receptors in the dorsal horn change the transmission of pain, leading to an

exaggerated response (Barash et al., 2017). This patient population may present with a lower threshold for pain response, allodynia, hyperalgesia, and receptor field expansion (Yam et al., 2018). Their untreated pain can lead to complications such as increased pain scores, oversedation, delayed ambulation, and cardiopulmonary complications (Deng et al., 2017; Jackman, 2019; Nielsen et al., 2017). Chronic pain can also manifest with a host of psychological, emotional, cognitive and sensory comorbidities (Bushnell et al., 2013). Opioid analgesics have been the first-line agents for pain management, yet they can lead to many adverse effects (Devine & McGirt, 2015).

Effective pain management enhances patient and provider experience, overall population health, and reduced health care costs (Bodenheimer & Sinsky, 2014). "Notably, studies evaluating opioid therapy for chronic pain have found little evidence of efficacy in improving patients' functional status, but the risk of negative health consequences is considerable" (Sherry et al., 2021). Common side effects of opioids include delayed gastric emptying, pruritus, urinary retention, nausea, vomiting, and constipation (Gunther et al., 2018). Contrary to popular belief, intraoperative administration of high dose opioids demonstrated an increase in postoperative pain scores and morphine consumption (Rafiq et al., 2014). Incorporation of a multimodal perioperative plan can help manage postoperative pain while reducing total opioid consumption (Devin & McGirt, 2015). White et al. (2007), stated multimodal treatments correlate to a decreased time to a regular diet, bowel function, and return to normal activity as compared to opioids alone.

Early identification of chronic pain patients may help anesthesia providers tailor anesthetic plans that best suit the needs of this population. Will education of best practices from the literature review and the pharmaceuticals available at the MTF lead to increased

multimodal utilization? The overarching questions are, what is the best way to identify patients with chronic pain at the MTF, and how to treat them with best practices per current state of the evidence?

Relevance to Military Nursing

The Department of Defense (DOD) surgical population is not immune to the large incidence of chronic pain. This MTF is the second largest Air Force medical treatment facility that provides surgical care to active duty, retirees, veterans and dependents. In the military, chronic pain may be attributed to training injuries, high-demand occupations, and combat-related trauma (Gauntlett-Gilbert & Wilson., 2013). In the veteran's community there is a 66% prevalence of reported chronic pain (Liberto, 2021). In the active-duty community approximately 40% experience chronic pain, which accounts for over $1.6 billion in annual disability (U.S. Department of Veterans Affairs, 2020). Furthermore, these figures do not include the loss of productivity which is impactful to the mission but difficult to quantify (U.S. Department of Veterans Affairs, 2020).

While trying to maintain a readily deployable force, members are prescribed high dose or long-term opioids, increasing the risk for developing opioid dependence, misuse, or addiction (Sherry et al., 2021). Opioid prescriptions provide limited improvement in functional status with potentially negative consequences, including depression, anxiety and suicide (Sherry et al., 2021). Preoperative pain that goes unidentified, or a less than optimal perioperative experience could exacerbate this already existing issue. Additionally, the Defense Health Agency (DHA) could be adversely affected by increased readmission rates, decreased pain satisfaction, and outsourced specialty care, thus rendering monetary losses. Undertreated

pain fosters decreased productivity, disability, and severely impacts the mission of the armed forces and the dedicated population who serve within it.

Clinical Question

Does implementing a preoperative screening tool to identify chronic pain patients along with multimodal anesthetic recommendations increase time to first opioid, decrease 24-hour opioid consumption and decrease hospital length of stay in the MTF?

Search Strategy & Results

Phase 1

PubMed and PowerSearch were used to collect articles to review the current literature on chronic pain screening tools. Search keywords for all databases were “chronic” AND “pain” AND “anesthesia” AND “pre-operative” OR “chronic widespread pain” AND “perioperative” OR “chronic pain patient” AND “neuropathic pain” OR “McGill” OR “CPAQ8” OR “Chronic Pain Acceptance” OR “poorly controlled postoperative pain” AND “pathophysiology of chronic pain” OR “relieving pain” AND “quality of life” OR “geriatrics” AND “inflammatory” OR “noncancer pain” OR “United States chronic pain” AND “perioperative analgesia” AND “neuropathic pain” AND “nociceptive pain” OR “chronic pain pathophysiology” AND “peripheral nerve injury” AND “surgery” OR “pain assessment screening tool” AND “outcome registry” OR “perioperative analgesia” OR “acceptance based treatment” AND “chronic pain” OR “chronic pain physiology” AND “acceptance questionnaire.” Results were limited to the past twenty years, English language, and peer-reviewed journals.

The search process for phase 1 is shown in the PRISMA (Appendix A). As of October 2020, results yielded 34 articles that met the inclusion/exclusion criteria. Titles and abstracts

were screened, leaving four articles reviewed. The phase 1 review resulted in three level IIIB and one IIIA articles (Appendix C).

Phase 2

PubMed and PowerSearch electronic databases were searched for peer reviewed articles published in English within the last ten years that studied adult (human) subjects on multimodal analgesia for chronic pain patients by examining the following index terms. Search terms included the following: “perioperative AND multimodal analgesia AND spine surgery,” “safety AND multimodal AND chronic postop pain,” “major spine surgery AND chronic postoperative opioid,” “opioids AND post-operative pain OR addiction, abuser,” “multimodal analgesia AND postoperative pain management AND lumbar fusion surgery,” “dexmedetomidine AND monitored anesthesia care,” “intraoperative ketamine AND reduced perioperative opiate consumption AND opiate-dependent patients with chronic back pain,” “spinal surgery AND perioperative nonopioid,” “spine surgery AND perioperative ketamine,” “total knee arthroplasty AND dexmedetomidine,” “analgesia AND spine surgery AND dexmedetomidine,” “dexmedetomidine and surgical spine surgeries,” “hip arthroplasty AND acetaminophen AND multimodal analgesia,” and “postoperative pain control AND oral AND intravenous AND acetaminophen.”

The search process for phase 2 is shown in the PRISMA diagram (Appendix B). Results as of October 2020, yielded a total of 330 articles that met the inclusion/exclusion criteria. Title and abstracts were screened, leaving 18 articles reviewed (Appendix D). Review for phase 2 yielded two level IA articles, eight level IB articles, one level IIB, one level IIIA articles, and six level IIIB articles (Appendix D).

Solution Synthesis

Unidentified chronic pain can lead to decreased time to first opioid, increased total opioid consumption and increased hospital LOS. Identification of patients with pain greater than three months required a reliable and valid pain assessment tool. (Tsaousi et al., 2018; Westrich et al., 2019). A literature search identified three pain assessment tools of interest. The Pain Assessment Screening Tool and Outcome Registry (PASTOR) was developed by The Defense and Veterans Center for Integrated Pain Management (n.d.). This evidence-based computer adaptive test encompassing multiple pain assessment questionnaires, was excluded due to its cumbersome design. The McGill Pain Questionnaire (MPQ) is a 20-minute evaluation indicated for only fibromyalgia and rheumatoid arthritis and was excluded (Bruce et al., 2004). The Chronic Pain Acceptance Questionnaire 8 (CPAQ8) consisted of eight questions used to clarify data regarding a patient's chronic pain. Being a short questionnaire, it was not burdensome to complete preoperatively. CPAQ8 showed reliability and validity to evaluate activity engagement - "the degree to which one engages in life activities regardless of pain" and pain willingness - "willingness to experience pain" (Fish et al, 2013). CPAQ8 was chosen to be incorporated into the preoperative pain screening tool to quantify the patient's experience (Appendix E). A preoperative screening tool was developed which identified if a patient had experienced pain greater than three months, as well as their demographics, surgical service, and current treatment (Appendix F).

Preoperative Management

A steadily growing subset of the population on high dose opioids for chronic pain leads to the development of opioid tolerance further complicating perioperative pain control (Dunn et al., 2018; Puvanesarajah et al., 2015). High dose opioids can lead to depression, anxiety and

higher levels of postoperative pain (Jackman, 2019). Multimodal regimens that incorporate home opioids have shown an overall reduction in pain perception, decreased complication rates, and lowered visual analog scores (Coluzzi et al., 2017; Kim et al., 2016; Weingarten et al., 2015). Patients should remain on their prescribed doses of opioids throughout the perioperative period. Maintenance of baseline opioids keeps plasma concentrations at analgesic levels, preventing withdrawal symptoms (Coluzzi et al., 2017; Kim et al., 2016). In addition, transdermal fentanyl patches should remain in place for the surgical procedure, while monitoring its placement and keeping it away from heating elements (Coluzzi et al., 2017; Kim et al., 2016). Chronic pain patients present unique challenges for achieving postoperative pain control. Tolerance to opioid medications makes opioids less effective in treatment.

Acetaminophen, a non-steroidal anti-inflammatory drug, is widely used for pain management (Sun et al., 2018). It is a para-aminophenol derivative, providing excellent analgesia by blocking pain impulse generation (Sun et al., 2018; Westrich et al., 2019). It also works on cyclooxygenase within the central nervous system reducing opioid demand (Sun et al., 2018; Westrich et al., 2019). Intravenous (IV) acetaminophen has higher bioavailability both in the cerebrospinal fluid and plasma, compared to the oral concentration of the same dosage, while also allowing patients to maintain nil per os (NPO) status. The rapid onset of IV acetaminophen also makes it more attractive than cheaper oral formulations. However, the literature review revealed no change in total opioid consumption between IV and oral routes; therefore, it is suitable to administer 1-gram acetaminophen via either technique. Acetaminophen has shown to be beneficial in treating chronic pain through its indirect action on the cannabinoid (CB1) receptors, modulation of serotoninergic and opioid pathways,

inhibition of nitric oxide production, and hyperalgesia induced by substance P (Rivkin & Rivkin, 2014).

Intraoperative Management

Ketamine's anesthetic properties occur through binding preferentially to N-Methyl-D-Aspartate (NMDA) receptors, decreasing the presynaptic release of glutamate, potentiating the release of gamma aminobutyric acid (GABA) (Devine & McGrit, 2015). Analgesic properties occur by preventing nociceptive pathway sensitization within the central nervous system (Devine & McGrit, 2015). NMDA receptor antagonism is responsible for the majority of its clinical effects. Opioid receptors mediate clinical effects at central and spinal cord sites, as well as muscarinic cholinergic receptors, nicotinic receptors, noradrenergic, and voltage-sensitive L-type calcium ion channels (Barash et al., 2017; Rivkin & Rivkin, 2014). A safe hemodynamic and ventilation profile makes ketamine an excellent agent to help mitigate postoperative pain in chronic pain patients (Devine & McGrit, 2015). Evidence indicated that ketamine, given as a bolus 0.15-0.5 milligram per kilogram (mg/kg) followed by an infusion of 1-10 microgram per kilogram per minute (mcg/kg/min), decreased central sensitization and hyperalgesia, leading to a 33% decrease in total opioid consumption within the first 48-hours postoperatively (Devine & McGrit, 2015; Loftus et al., 2010; Pendi et al., 2018; Rivkin & Rivkin, 2014). Preemptive administration of ketamine has been shown to prevent the development of chronic pain by preventing the sensitization of neuronal circuits (Rivkin & Rivkin, 2014).

Dexmedetomidine is a potent and highly selective transmembrane a2-receptor agonist (Chan et al., 2016; Tsaousi et al., 2018). Activation of G protein-coupled receptors in the brainstem causes inhibition of norepinephrine release, decreases central nervous system

sympathetic outflow, provides sedation, anxiolysis, and analgesia without the risk of respiratory depression (Chan et al., 2016; Tsaousi et al., 2018). When administered in a multimodal pharmacological approach, morphine requirements were decreased at 24-hours by a mean difference of 32 milligrams (mg) and a delay in the first analgesic with a mean difference of 74 minutes (Chan et al., 2016). When given as a bolus 0.2-1 mcg/kg over 10-15 minutes followed by an infusion of 0.3-0.6 micrograms per kilogram per hour (mcg/kg/hr), total opioid consumption at 24-hours decreased by an average of 4.36 mg (Chan et al., 2016; Gandhi et al., 2017; Tsaousi et al., 2018). While acting on different receptors, dexmedetomidine can promote opioid sparing and potentiate opioid effects without increasing their hyperalgesic properties and side effects, thus helping treat patients with chronic pain (Tsaousi et al., 2018).

Regional anesthesia provides preemptive analgesia and improves pain control while allowing effective opioid sparing techniques (Kaye et al., 2019). This benefit has been shown to last through postoperative day three (Kaye et al., 2019; Rafiq et al., 2014). Regional anesthesia techniques in major joint surgeries have shown to be beneficial in several categories: earlier ambulation and rehabilitation, decreased 30-day mortality rate, decreased risks of thrombus formation, decreased LOS, decreased opioid consumption, decreased numerical pain scores and improved overall patient satisfaction (Kumar et al., 2017). Addressing pain management of major joint surgeries through incorporating regional anesthesia can effectively reduce pain compared with opioid regimes alone (Devine & McGrit, 2015; Kumar et al., 2017). When feasible, regional anesthesia is recommended for chronic pain patients undergoing major joint or neuro-spine surgery (Kaye et al., 2019; Rafiq et al., 2014).

In summary, substantial evidence supports multimodal medication approaches for chronic pain patients undergoing major joint and neuro-spine surgery, but it is difficult to determine which adjuncts will have the greatest impact. The literature review supports the effectiveness of multimodal approaches which target different signaling pain pathways, and results in synergistic pain relief that is superior to a single modality of pain control (Gritsenko et al., 2014; Kim et al., 2016; Rajpal et al., 2010; Vadivelu et al., 2019; Zhou et al., 2017). The recommendations allow the provider to customize anesthetic management to meet the specific needs of each patient. Regional techniques in conjunction with evidence-based adjunct dosing are recommended. See badge reference card for a summary of adjunct doses (Appendix G).

Focus Areas

1. Conducted a retrospective chart review to collect baseline data.
2. Identified patients scheduled for surgery with pain greater than three months.
3. Collected the frequency and severity of pain in adult patients scheduled for major joint or neuro-spine surgery.
4. Educated on evidence-based perioperative multimodal anesthetic recommendations.
5. Assessed implementation of recommendations over a 60-day period.
6. Compared retrospective outcomes to phase 2 outcomes and determined the impact of anesthetic interventions.
7. Assessed anesthesia provider feedback and perceived project usefulness.
8. Reported results to department leadership and anesthesia staff.
9. Incorporated a sustainment plan with recommendations for the MTF.

Business Case Analysis

Perioperative anesthetic recommendations for chronic pain patients undergoing major joint or neuro-spine surgery were disseminated. The macro-objectives included identification of patients with pain greater than three months and cost-effective multimodal treatments. Micro-objectives included increased time to first opioid, decreased total 24-hour opioid consumption and decreased hospital length of stay. The current cost of 1000mg IV acetaminophen is $40 per vial. The proposed switch to oral acetaminophen, 975mg (325mg tablets x 3), costs $0.21 per dose; multiplying the single dose times 594 annual cases, the yearly total cost of $124.74 was calculated. The MTF performs 594 major joint and neuro-spine surgeries yearly. Switching from IV to oral acetaminophen resulted in a total cost savings of $23,635 ($39.79 x 594 patients). Ketamine (200mg/single use vial) cost per single use vial was $168, for an average cost of $99,792 per year. Dexmedetomidine (4mg/vial) cost per single use vial was $228, for an average cost of $135,432 per year. Total multimodal anesthetic recommendation annual costs equated to $137,285 for 594 major joint or neuro-spine surgeries. One night in the medical surgical unit average cost is $3,814. A decreased hospital LOS in 20% of our patients, approximately 119 patients, resulted in a yearly savings of $453,866. Successful utilization of the recommendations rendered $477,501 annual savings for the MTF (Appendix H).

Organizing Framework

The John Hopkins Nursing Evidence-Based Practice model (JHNEBP) was the framework of this project (Appendix I). Widely utilized in nursing practice, it incorporates a culture of best evidence with one's clinical expertise resulting in enhanced learning, clinical knowledge and operational practice (Fineout-Overholt, 2019). This projects goals were best met by applying the model's framework, methods and tools.

The JHNEBP model helped guide clinical decisions by examining best practices related to a specific problem and provided simple guidelines with its three-step process: the practice question, evidence, and translation into usage. The JHNEBP started with a practice question that used the population, intervention, comparison, and outcome (PICO) to determine recommendations for the MTF. Secondly, evidence was synthesized with appropriate level appraisal and quality, resulting in the development of practice recommendations. In order to answer the practice question, extensive literature reviews were completed and yielded 22 articles. A pre-admission screening tool was developed to identify chronic pain patients. Then a thorough retrospective chart review was completed to measure baseline data which included time to first opioid, length of stay, and total opioid consumption within the first 24-hours. The phase 2 data was collected to determine the project's impact on chronic pain management. Third, recommendations are translated into practice by developing action and implementation plans. The evidence was then translated to improve awareness of chronic pain and educate anesthesia staff on optimal dosing available at the MTF.

Project Design

General approach

This evidence-based project (EBP) incorporated two phases that compared and contrasted outcomes pre and post intervention. Phase 1 implemented the pain pre-admissions screening tool for all patients presenting for surgery over a 60-day period. A retrospective chart review was included in phase 1 on time to first opioid, total opioid consumption and length of hospital stay for all major joint and neuro-spine patients from January to March 2020. Data from phase 1 was collected and presented to anesthesia and surgical providers at the beginning of phase 2. Evidence-based anesthetic recommendations (Appendix G) were disseminated to

providers prior to care on all major joints and neuro-spine surgeries from May to July 2021. This was accomplished with a presentation and badge reference card. Key data metrics listed above were again collected from May to July of 2021 and compared to phase 1 data.

Setting and Population

The MTF, located in Dayton, Ohio, provides comprehensive care to 37,000 beneficiaries and 58,000 eligible members including active duty, retirees, veterans and dependents. There are 12 Operating Room (OR) suites, 27 anesthesia staff and six pre-admission nurses. Annually, there are 2,608 surgical cases, of which 480 are major joints and 114 are neuro-spine surgeries (Wright Patterson Tricare Office, 2020).

Procedural Steps

See Appendix J for more details on our Procedural Steps.

Phase 1

The first step developed a clinical question that addressed the problem at the MTF. Pre-admission nurses received training on the Pain Pre-Admission Screening Tool (Appendix F), CPAQ8 (Appendix E) and completed a Pre-Admission Nurse Knowledge Check Back Quiz (Appendix K). Project approval was routed to the Institutional Review Board (IRB) at the MTF for an evidence-based project with research exemption.

Implementation of phase 1 began with the Pain Pre-Admissions Screening Tool and CPAQ8 questionnaire for all patients who presented to the MTF preadmissions clinic. Patients with pain greater than three months had documentation placed in their electronic health record (EHR) under the “review of systems: other comments” section. Information collected included demographics per the screening tool (Appendix F). Retrospective chart reviews for all major joint and neuro-spine patients were conducted to capture demographic data, CPAQ8 scores and

EBP outcomes. This information developed a baseline for the three outcomes measured in phase 2.

Phase 2

The Anesthesia department and leadership were presented with phase 1 findings and phase 2 recommendations. Anesthesia providers were encouraged to incorporate anesthetic recommendations for patients receiving major joint or neuro-spine surgery. All staff received a badge reference card (Appendix G), and recommendations were posted in operating rooms 4, 6 and 7 for quick reference. Chart review of all major joint and neuro-spine surgeries was done throughout phase 2 on the measurable outcomes. Following the completion of the EBP, the outcome findings were presented to the anesthesia department and leadership. The collected data was used to determine improvements and recommendations for future sustainability.

Data Analysis Plan

Phase 1

Data analysis was compiled from EHR and Pain Pre-Admission Questionnaire. The retrospective data collected assessed the outcomes of patients who received major joint or neuro-spine surgery. The pain pre-admissions questionnaire assessed the need for pre-admissions screening. Descriptive statistics were used to analyze collected data (Appendix L).

Phase 2

Phase 2 post-anesthetic interventions were collected, analyzed, and compared to phase 1 retrospective chart reviews. The utilization of a T-Test evaluated the data between the two independent arms. The determination of statistical significance was a p-value < 0.05. The pre- and post- data analysis was collected to determine the recommendations' significance (Appendix M).

Sustainment and Dissemination Plan

The MTF perioperative staff will receive annual training on the pre-admissions screening tool for its continual utilization. The anesthesia staff will receive reinforcement of the multimodal anesthetic recommendations for major joint and neuro-spine surgical patients via annual training and the badge reference card. Additionally, the anesthesia provider unit orientation will include the current recommendations.

Further assessment of the validity and reliability of the pain pre-admissions screening tool to capture the chronic pain population should be considered. Further integration with EHR systems would be ideal and could be considered at other MTFs. The findings will be disseminated via PowerPoint and poster board presentation at this MTF and during research week at the Uniformed Services University of Health Sciences.

HIPAA Concerns/Ethical Considerations

This evidence-based project contained no research. Therefore, the MTF did not require an IRB review (Appendix L). Although outcomes were related to individual patients, no personally identifiable information was collected. All paper questionnaires were maintained in a secured drawer in a locked office within the anesthesia department. Electronic databases protected by a common access card (CAC) enabled government computers to store the retrospective chart review data.

Project Results

Phase 1 Data Collection

Demographics

Data collection on chronic pain encompassed all patients receiving surgical care at the MTF via CPAQ8 questionnaire from January to March 2021. 23% (n=804) of patients self-

identified as having pain greater than three months. Of these 191 patients, there were 104 males and 87 females. Ages ranged from 18 to 91, with the majority of the patients aged 60 to 69.

Patients Identified with Chronic Pain		
Age years	**Male**	**Female**
>20	0	2
20-29	7	6
30-39	9	11
40-49	11	10
50-59	15	18
60-69	38	22
70-79	23	14
80-89	1	3
90+	1	0

Surgical Service Chronic Pain	
Surgical Service	**% Patients Experiencing Chronic Pain**
Ophthalmology	25% (n=2)
OFMS	34% (n=3)
ENT	38% (n=24)
General Surgery	38% (n=24)
Unknown Service	62% (n=39)
Pulmonary	67% (n=3)
Orthopedics	81% (n=62)
Podiatry	100% (n=2)
Neuro-spine	100% (n=8)

Patients reporting pain greater than three months based on surgical service: Ophthalmology 25% (n=12), OFMS 34% (n=3), ENT 38% (n=8), General Surgery 38% (n=24), Unknown Service 62% (n=39), Pulmonary 67% (n=3), Orthopedics 81% (n=62), Podiatry 100% (n=2), Neuro-spine 100% (n=8). Based on duty status, those identified with pain greater than three months; ad 50% (n=12), ret 52% (n=67), dep 64% (n=94), vet 72% (n=25). Based on findings, orthopedics, podiatry, and neuro-spine were found to have the

highest incidence of reported chronic pain. Podiatry was excluded due to the limited population.

Home Treatment Regimes

Different treatment(s) modalities were identified based on a patient's completed pain pre-admissions screening tool. Adjustments addressing clarifying treatment questions were made after incomplete responses, i.e. “unknown treatments” were identified. A total of 55% (n=191) of patients reported receiving treatment(s) for their chronic pain. Of those receiving treatment(s), 73% (n=77) took medications and 27% (n=28) took no medications. Reported modalities of treatment(s) included: eye drops (n=1), injections (n=2), physical therapy (n=4), none (n=10), surgery (n=13), pain specialist (n=20), unknown (n=27).

CPAQ8

The CPAQ8 results showed that 80.6% of major joint patients (n=57) reported pain greater than three months. On a scale of 0 to 48, an average pain score of 33 was reported (range 10 - 43). 100% of neuro-spine patients (n=2) reported pain greater than three months, with an average score of 31.7 (range 23 - 42). This indicated that neuro-spine patients had low acceptance of chronic pain and low pain willingness which impacted their daily activities. Without ongoing CPAQ8 questionnaires, there is no impact on the anesthetic plan.

Retrospective Chart Review

A retrospective chart review of the previous year’s EHR was completed on all patients who underwent major joint or neuro-spine surgery from January to March 2020. Dates were chosen to reflect pre-SARS-CoV-2 (COVID) operating room tempo. A total of 57 major joint procedures and 20 neuro-spine procedures were identified. Of these, 43 were TKA and 14 were THA. Five major joints were excluded due to the anesthetic being completed under GETA.

The major joint patients included for TKA received spinal anesthesia with an adductor canal block (ACB). All THA patients received spinal anesthesia. Of these, 45% (n=57) received one or more anesthetic recommendations. The average time to first opioid was 251.6 minutes (min) (range: 0 min - 1380 min). The morphine equivalent of the opioid received in the first 24-hours averaged 20.67 mg (range: 0 mg - 96 mg). Total hospital LOS averaged 1.48 days (range: 0.83 days - 4.17 days).

The neuro-spine patients received GETA. 40% (n=20) of the patients received one or more anesthetic recommendations from this EBP project. The average time to first opioid was 70.3 min (range: 0 min - 307 min). The morphine equivalent of opioids received in the first 24-hours averaged 33.9 mg (range: 0 mg - 117 mg). Total hospital LOS averaged 1.24 days (range: 0.42 days - 3.13 days).

Phase 2 Data Collection

Data was collected on all patients who received major joint or neuro-spine surgery at the MTF from May to July 2021. Of these 64 patients, major joint surgeries had a total of 47 patients, encompassing 35 TKA and 12 THA, while neuro-spine had a total of 17 patients. Three procedures (2 TKA, 1 THA) were excluded from the study due to GETA and one patient coding postoperatively.

The major joint patients received spinal anesthesia with an ACB for TKA. Of these, 100% (n=47) received one or more anesthetic recommendations showing a 55% increase post-implementation. The average time to first opioid was 387 min (range: 0 min - 1380 min), demonstrating a 54% increase in time compared to retrospective data. The morphine equivalent of opioids received in the first 24-hours averaged 45.77 mg (range: 0 mg - 471 mg), an increase

of 121%. Total hospital length of stay (LOS) for all patients averaged 0.91 days (range: 0.06 days - 2.19 days hrs.), a reduction of 38.5%.

All neuro-spine patients received GETA. Of these, 100% (n=17) received one or more anesthetic recommendations, marking a 150% increase post-implementation. The average time to first opioid was 120 min (range: 10 min - 553 min), an increase of 71%. The morphine equivalent of opioids received in the first 24-hours averaged 59.12 mg (range: 0 mg - 249.5 mg), demonstrating an increase of 75%. Total hospital length of stay averaged 0.79 days (range: 0.05 days - 1.77 days), a 36.3% reduction.

Analysis of Results

Analysis of results was completed with the utilization of the T-test. This data was found to be statistically insignificant with p-values > 0.05. The increase in total opioid consumption amongst both groups may be due to the small sample size. However, the length of stay for major joint patients was reduced by 38.5% and was statistically significant with a p-value of 0.0125 (Appendix O).

Major joint	Retrospective	Phase 2	% Change	P-value
Time to First Opioid	251.6 min (0 min - 1380 min)	387 min (0 min - 1380 min)	54% increase	0.35
Morphine equivalents	20.67 mg (0 mg - 96 mg)	45.77 mg (0 mg - 471 mg)	121% increase	0.26
Length of stay	1.48 days (0.83 days - 4.17 days)	0.91 days (0.06 days - 2.19 days)	38.5% reduction	**0.0125**

Neuro-spine	Retrospective	Phase 2	% Change	P-value
Time to First Opioid	70.3 min (0 min - 307 min)	120 min (10 min - 553 min)	71% increase	0.12
Morphine equivalents	33.9 mg (0 mg - 117 mg)	59.12 mg (0 mg - 249.5 mg)	75% increase	0.5
Length of stay	1.24 days (0.42 days - 3.13 days)	0.79 days (0.05 days - 1.77 days)	36.3% reduction	0.14

Barriers

During this project, multiple barriers were assumed and encountered. The initial limitation of the EBP project was COVID, which limited the number of surgical cases performed at the MTF. This impacted the sample size and affected the significance of the three-month observation period. Additionally, pre-admission interviews switched from in-person to telephone consults, increasing the burden on pre-admissions nurses to remember to incorporate the pain screening tool.

Another significant barrier was anesthesia providers' resistance to change in practice. Resistance can take on many forms to include knowledge deficit, lack of awareness, lack of agreement with regards to the evidence, lack of motivation, and low expectations the intervention will translate into favorable outcomes (Henderson et al., 2019; Tappen et al., 2017). Many anesthesia providers have different opinions on the best pain management options for their patients based on clinical expertise and may have been unwilling to change their current clinical practice.

Unanticipated high staff turnover, to include both anesthesia staff and pre-admission nursing staff, was another major barrier. A significant number of anesthesia providers that had received the initial briefing were relocated to other MTF facilities, while others had not

received it at all. This made post-implementation anesthesia questionnaires unobtainable for a large majority of anesthesia staff who initially received the recommendations but did not participate in phase 2 of the project. The turnover of pre-admission nurses, combined with the switch to telephone consults, may have led to incomplete pain assessment questionnaires and incomplete documentation in the EHR. The turnover of anesthesia staff resulted in missed awareness of the chronic pain assessment in the EHR and a culture that favored more opioid use for their patients.

Regional anesthesia techniques were not controlled in this EBP. The spinal doses used for TKA's were left to the provider's discretion to use hyperbaric, isobaric, or additives. ACB's for TKA's were left to provider's discretion. The EBP did not incorporate block training on specific techniques, dosing of medications or additives. This led to variability in block density and duration, both of which could have affected the project's three outcomes.

Organizational Impact/Implications to Practice

The incorporation of a pre-admissions screening tool for early detection of pain greater than three months impacted how the perioperative care team was alerted and then reacted on the day of surgery. Education to anesthesia staff on perioperative recommendations can increase awareness of multimodal anesthetic approaches. Additionally, the tool gave the organization data on the patient population it serves. This data suggests that greater than 30% of the surgical population had experienced pain greater than three months. This data point is consistent with the national average. Surprisingly, the findings alerted other unexpected subspecialties that chronic pain is ever-present within their surgical services as well. This reinforces the need for early identification and knowledge of the current evidence to effectively care for chronic pain at this institution.

Future Directions for Research and Practice

A major outcome of the project was a 36-38% reduction in time to patient discharge. This hints at the possibility for a future MTF Enhanced Recovery After Surgery (ERAS) protocol. Treating pain with minimal side effects is a key feature of any ERAS protocol as well as decreasing time in the PACU and averting overnight stays that impact costs and resources.

Conclusion

In conclusion, this EBP created an identification of surgical patients experiencing pain greater than three months. A translation of the most up to date evidence on the perioperative care for chronic pain patients was compressed into usable treatment options for providers. An evaluation was performed to determine if dissemination of the evidence and early identification of pain greater than three months led to a statistical significance in the measurable outcomes: time to first opioid, total opioid consumption, and LOS.

Though a decrease in length of stay for the total joint population was the only metric of statistical significance, the data suggests further benefit in relation to retrospective data, such as a reduction of 36.3% in LOS for the neuro-spine population. Also noted major joints and neuro-spine patients resulted in a 54% and 71% increase in time to first opioid, respectively. Unexpectedly, total opioid consumption increased in both patient populations; this may be due to providers' increased awareness of chronic pain diagnosis. The results reinforce the need for a constant evaluation and dissemination of the latest evidence regarding large subsets within the surgical population, such as chronic pain patients.

References

American Association of Nurse Anesthetists (2014). *Chronic pain management guidelines.* https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/chronic-pain-management-guidelines.pdf?sfvrsn=d40049b1_2

Anderson, A. B., Balazs, G. C., Brooks, D. I., Dickens, J. F., & Potter, B. K. (2020). Total joint arthroplasty volume in the military health system. *Military Medicine (00)*. https://doi.org/10.1093/milmed/usz401

Aronoff G. M. (2016). What Do We Know About the Pathophysiology of Chronic Pain? Implications for Treatment Considerations. *The Medical clinics of North America*, *100*(1), 31–42. https://doi.org/10.1016/j.mcna.2015.08.004

Barash, P. G., Cullen, B. F., Stoelting, R. L., Cahalan, M. K., Stock, M. C., Ortega, R., Sharar, S. S., & Holt, N.F. (2017). *Clinical Anesthesia* (8th ed.). Lippincott.

Banerjee, G., Edelman, J. E., Barry, D. T., Crystal, S., Gordon, K, S., Gordon, A. J., Gaither, J. R., Green, T. C., Kerns, R. D., Manhapra, A., Moorie, B., Fiellin, D., & Marshal, D. DL. (2019). High-dose prescribed opioids are associated with increased risk of heroin use among US military veterans. *Pain, 160*(9); 2126-2135. https://doi.org/10.1097/j.pain.0000000000001606

Bodenheimer, T., & Sinsky, C. (2014). From triple to quadruple aim: Care of the patient requires care of the provider. *Annals of Family Medicine, 12*(6), 573-576. https://doi.org/10.1370/afm.1713

Bruce, J., Poobalan, A. S., Smith, W. C. S., & Chambers, W. A. (2004). Quantitative assessment of chronic postsurgical pain using the McGill Pain Questionnaire. *The Clinical Journal of Pain, 20*(2), 70-75. https://doi.org/10.1097/00002508-200403000-00002

Bushnell, M. C., Čeko, M., & Low, L. A. (2013). Cognitive and emotional control of pain and its disruption in chronic pain. *Nature Reviews Neuroscience, 14*(7), 502–511. https://doi.org/10.1038/nrn3516

Candiotti, K. A., Bergese, S. D., Bokesch, P. M., Feldman, M. A., Wisemandle, W., & Bekker, A. Y. (2010). Monitored anesthesia care with dexmedetomidine: A prospective, randomized, double-blind, multicenter trial. *Anesthesia & Analgesia*, *110*(1), 47–56. https://doi.org/10.1213/ane.0b013e3181ae0856

Center for Disease Control and Prevention. (2020, May). *Pain and Arthritis*. Division of Public Health. https://www.cdc.gov/arthritis/pain/index.htm

Chan, I. A., Maslany, J. G., Gorman, K. J., O'Brien, J. M., & McKay, W. P. (2016). Dexmedetomidine during total knee arthroplasty performed under spinal anesthesia decreases opioid use: A randomized-controlled trial. *Canadian Journal of Anesthesia/Journal Canadien d'Anesthésie, 63*(5), 569-576. https://doi.org/10.1007/s12630-016-0597-y

Chi, D., Mariano, E., Memtsoudis, S., Baker, L., & Sun, E. (2019). Regional Anesthesia and readmission rates after total knee arthroplasty. *Anesthesia & Analgesia, 128*(6), 1319-1327. https://doi.org/10.1213/ANE.0000000000003830

Ciummo, F., Cheon, E., Samide, J. Habib, H., Abraham, T., & Tischler, H. (2016). Multimodal pain management in total knee placement with or without intravenous acetaminophen. *Critical Care Medicine, 44*(12), 468. https://doi.org/10.1097/01.ccm.0000510243.49282.2d

Coluzzi, F., Bifulco, F., Cuomo, A., Dauri, M., Leonardi, C., Melotti, R. M., Natoli, S., Romualdi, P., Savoia, G., & Corcione, A. (2017). The challenge of perioperative pain management in opioid-tolerant patients. *Therapeutics and Clinical Risk Management, Volume 2017*(13), 1163–1173. https://doi.org/10.2147/tcrm.s141332

Cook, L., Kallen, M., Buckenmaier, C., Flynn, D., Hanling, S., Collins, T., Jolts, K., Kwon, K., Medina-Torne, S., Nahavandi, P., Suen, J., & Gershon, R. (2017). Evaluation of the Validity and Response Burden of Patient Self-Report Measures of the Pain Assessment Screening Tool and Outcomes Registry (PASTOR). *Military Medicine, 187*(7), e1851-e1861. https://doi-org.usu01.idm.oclc.org/10.7205/MILMED-D-16-00285

Dahmen, K. G., & Albrecht, D. M. (2014). An approach to quality management in anesthesia: a focus on perioperative care and outcome. *European Journal of Anaesthesiology, 18*(s23), 4-9. https://doi.org/10.1046.j.1365-2346.2001.00003.x

Dang, D., & Dearholt, S.L. (2019). *Johns Hopkins Nursing Evidence-based Practice: Model and Guidelines (3rd ed.).* Sigma Theta Tau International.

Defense Health Agency. (2019, February). *Quadruple Aim Performance Process: Transforming Performance Improvement*.

file:///Users/ariaklein/Downloads/Quadruple%20Aim%20Performance%20Process%20Transforming%20Performance%20Improvement%20(4).pdf

Defense and Veterans Center for Integrated Pain Management. (n.d.) *Pain Assessment Screening tool and Outcomes Registry.* *Pain Assessment Screening Tool and Outcomes Registry (PASTOR) (dvcipm.org)*

Deng, F., Horn, S. D., Smout, R. J., Hickey, J. V., & Naples, J. J. (2017). Intravenous acetaminophen for perioperative pain control in adult elective neuro-spine surgical patients: A retrospective case-control study. *AANA Journal, 85*(3), 181-188. https://pdfs.semanticscholar.org/23ea/3996a01af7b86eb49c4010e07f09e7ea0071.pdf

Devin, C. J., & McGrit, M. J. (2015). Best evidence in multimodal pain management in spine surgery and means of assessing postoperative pain and functional outcomes. Journal of Clinical Neuroscience, 22(2015); 930-938. https://doi.org/10.1016/j.jocn.2015.01.003.

Duncan, C. M., Long, K. H., Warner, D. O., & Hebl, J. R. (2009). The economic implications of a multimodal analgesic regimen for patients undergoing major orthopedic surgery A comparative study of direct costs. *Regional Anesthesia and Pain Medicine*, *34*(4), 301-307. https://doi.org/10.1097/AAP.0b013e3181ac7f86

Dunn, L. K., Yerra, S., Fang, S., Hanak, M. F. , Leibowitz, M. K., Tsang, S. , Durieux, M. E. , Nemergut, E. C. & Naik, B. I. (2018). Incidence and risk factors for chronic postoperative opioid use after major spine surgery. *Anesthesia & Analgesia, 127*(1), 247–254. https://doi.org/ 10.1213/ANE.0000000000003338

Echeverria-Villalobos, M., Stoicea, N., Todeschini, A., Fiorda-Diaz, J., Alberto, A., Weaver, T., & Bergese, S. (2020). Enhanced recovery after surgery: A perspective review of postoperative pain management under ERAS pathways and its role on opioid crisis in the United States. *The Clinical Journal of Pain, 36*(3), 219-226. https://doi.org/10.1097/AJP.0000000000000792

Fillingim, R. B., Loeser, J. D., Baron, R., & Edwards, R. R. (2016). Assessment of chronic pain: Domains, methods, and mechanisms. *The Clinical Journal of Pain, 17*(9), 70-75. https://doi.org/10/1016/j.jpain.2015.08.010

Fish, R. A., Hogan, M. J., Morrison, T. G., Stewart, I., & McGuire, B. E. (2013). Willing and able: A closer look at pain willingness and activity engagement on the Chronic Pain Acceptance Questionnaire (CPAQ8). *Journal of Pain, 14*(3), 233–245

Gan, T. J. (2017). Poorly controlled postoperative pain: prevalence, consequences, and prevention. *Journal of Pain Research, 10*, 2287-2298 https://doi.org/10.2147/TPR.S144066

Gandhi, K. A., Panda, N. B., Vellaichamy, A., Mathew, P. J., Sahni, N., & Batra, Y. K. (2017). Intraoperative and postoperative administration of dexmedetomidine reduces anesthetic and postoperative analgesic requirements in patients undergoing cervical spine surgeries. *Journal of Neurosurgical Anesthesiology, 29*(3), 258–263. https://doi.org/10.1097/ana.0000000000000301

Gauntlett-Gilbert, J., & Wilson, S. (2013). Veterans and chronic pain. *British Journal of Pain, 7*(2), 79-84. https://doi.org/10.1177/2049463713482082

Giannitrapani, K. F., Ahluwalia, S. C., McCaa, M., Pisciotta, M., Dobscha, S., & Lorenz, K. A. (2018). Barriers to using nonpharmacologic approaches and reducing opioid use in primary care. *Pain Medicine Journal, 19*(7), 1357-1362. https://doi.org/10.1093/pm/pnx220

Gulur, P., Williams, L., Chaudhary S., Koury, K., & Jaff, M. (2014). Opioid tolerance - A predictor of increased length of stay and higher readmission rates. *Pain Physician Journal, 17*(4), E503-507. https://www.painphysicianjournal.com/current/pdf?article=MjEzMA%3D%3D&journal=83

Günther, T., Dasgupta, P., Mann, A., Miess, E., Kliewer, A., Fritzwanker, S., Steinborn, R., & Schulz, S. (2018). Targeting multiple opioid receptors - improved analgesics with reduced side effects?. *British Journal of Pharmacology*, *175*(14), 2857–2868. https://doi.org/10.1111/bph.13809

Hall, M. J., Schwartzman, A., Zhang, J., & Liu, X. (2017). Ambulatory surgery data from hospitals and ambulatory surgery centers: United States, 2010. *National Health Statistics Reports*, *10*(2), 1-15. https://www.ncbi.nlm.nih.gov/pubmed/28256998

Hamp, T., Stefaniak, B., Krammel, M., Reiter, B., Langauer, A., Stimpfl, T., & Plochl, W. (2018). Effect of intravenous s-ketamine on the MAC of sevoflurane: A randomized, placebo-controlled, double-blind clinical trial. *British Journal of Anaesthesia*, *121*(6), 1242-1248. https://doi.org/10.1016/j.bja.2018.08.023

Hudson, A. E., & Hemmings, H. C. (2011). Are anaesthetics toxic to the brain? *British Journal of Anaesthesia, 107*(1), 30-37. https://doi.org/10.1093/bja/aer122

Henderson, K., Coppens, E., Burns. (2021). Addressing barriers to implementing problem-based learning. *American Academy of Nurse Anesthesists, 89(*2). www.aana.com/aanajournalonline.

Harsoor, S. S., Rani, D. D., Rani, Lathashree, S., Nethra, S. S., & Sudheesh, K. (2014). Effect of intraoperative dexmedetomidine infusion on sevoflurane requirement and blood glucose levels during entropy-guided general anesthesia. *Journal of Anaesthesiology, Clinical Pharmacology, 30*(1), 25-30. https://doi.org/10.4103/0970-9185.125693

Hickman, S. R., Mathieson, K. M., Bradford, L. M., Garman, C. D., Gregg, R. W., & Lukens, D. W. (2018). Randomized trial of oral versus intravenous acetaminophen for postoperative pain control. *American Journal of Health-System Pharmacy*, *75*(6), 367-375. https://doi:10.2146/ajhp170064

Institute of Medicine. (2011). Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research. *Washington, DC: The National Academies Press.* https://doi.org/10.17226/13172

Jackman, C. (2019). Perioperative pain management for the chronic pain patient with long-term opioid use. *Orthopaedic Nursing*, *38*(2), 159-163. https://doi.org/10.1097/nor.0000000000000526

Kahokehr, A., Sammour, T., Zargar-Shoshtari, K., Thompson, L., & Hill, A. G. (2008). Implementation of ERAS and how to overcome the barriers. *International Journal of Surgery, 7*(1), 16-19. https://doi.org/10.1016/j.ijsu.2008.11.004

Kaye, A. D., Urman, R. D., Rappaport, Y., Siddaiah, H., Cornett, E. M., Belani, K., Salinas, O. J., & Fox, C. J. (2019). Multimodal analgesia as an essential part of enhanced recovery protocols in the ambulatory settings. *Journal of Anaesthesiology Clinical Pharmacology, 35*(5), S40-S45. https://doi.org/10.4103/joacp.JOACP_51_18

Kim, S., Ha, K., & Oh, I. (2015). Preemptive multimodal analgesia for postoperative pain management after lumbar fusion surgery: A randomized controlled trial. *European Spine Journal*, *25*(5), 1614-1619. https://doi.org/10.1007/s00586-015-4216-3

Kopf, A., Banzhaf, A., & Stein, C. (2005). Perioperative management of the chronic pain patient. Best Practice & Research. *Clinical Anaesthesiology*, *19*(1), 59-76. https://doi.org/10.1016/s1521-6896(04)00069-2

Kumar, K., Kirksey, M. A., Duong, S., & Wu, C. L. (2017). A review of opioid-sparing modalities in perioperative pain management: Methods to decrease opioid use postoperatively. *Anesthesia and Analgesia*, *125*(5), 1749-1760. https://doi.org/10.1213/ANE.0000000000002497

Lacasse, A. C., Charest, E. C., Dault, R. C., Cloutier, A.M. C., Choinière, M.C., Blais, L.C., & Vanasse, A. (2020). Validity of algorithms for identification of individuals suffering from chronic noncancer pain in administrative databases: A systematic review. *Pain Medicine*, *21*(9), 1825-1839. https://doi.org/10.1093/pm/pnaa004

Leotsakos, A., Zhen, H., Croteay, R., Loed, J. M., Sherman, H., Hoffman, C., Morganstein, L., O'Leary, D., Brunette, C., Peter, L., Duguid, M., Thomeczek, C., Van der Schrieck-De Loos, E., & Munier, B. (2014). Standardization in patient safety: the WHO High 5S Project. *International Journal for Quality in Health Care*, *26*(2), 109-116. https://doi.org/10.1093/intqhc/mzu010

Liberto, J. G. *The opioid crisis: treating our nation's veterans*. [PowerPoint Slide]. U.S. Department of Veterans Affairs VA Maryland Health Care System. (n.d.). https://www.nursing.umaryland.edu/media/son/academics/professional-education/The Opioid-Crisis-Treating-Our-Nations-Veterans-pdf.pdf

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

McLaughlin, D. C., Cheah, J. W., Aleshi, P., Zhnag, C., Ma, Benjamin, M., & Feeley, B. T. (2018). Multimodal analgesia decreases opioid consumption after shoulder arthroplasty: a prospective cohort study. *Journal of Shoulder and Elbow Surgery*, *27*(4); 686-691. https://doi.org/10.1016/j.jse.2017.11.015

Melnyl Fineout-Overholt, E. (2019). A guide to critical appraisal of evidence. *Nursing Critical Care*, *14*(3), 24-30. https://doi.org/10.1097/01.CCN.0000554830.12833.2

Nielsen, R. V., Fomsgaard, J. S., Siegel, H., Martusevicius, R., Nikolajsen, L., Dahl, J. B., & Mathiesen, O. (2017). Intraoperative ketamine reduces immediate postoperative opioid

consumption after spinal fusion surgery in chronic pain patients with opioid dependency: A randomized, blinded trial. *Pain, 158*(3), 463-470. https://doi.org/10.1097/j.pain.0000000000000782

Nijs, J., Goubert, D., & Ickmans, K. (2016). Recognition and treatment of central sensitization in chronic pain patients: Not limited to specialized care. *Journal of Orthopaedic & Sports Physical Therapy*, *46*(12), 1024–1028. https://doi.org/10.2519/jospt.2016.0612

Patil, S., Cornett, E. M., Jesunathadas, J., Belani, K., Fox, C. J., Kaye, A. D., Lambert, L. A., & Urman, R. D. (2019). Implementing enhanced recovery pathways to improve surgical outcomes. *Journal of Anaesthesiology Clinical Pharmacology*, *35*(5), 24-28. https://doi.org/10.4103/joacp.JOACP_36_18

Pendi, A., Field, R., Farhan, S.-D., Eichler, M., & Bederman, S. S. (2018). Perioperative ketamine for analgesia in spine surgery. *SPINE, 43*(5), E299–E307. https://doi.org/10.1097/brs.0000000000002318

Puvanesarajah, V., Liauw, J. A., Lo, S., Lina, I. A., Witham, T. F., & Gottschalk, A. (2015). Analgesic therapy for major spine surgery. *Neurosurgical Review*, *38*(3), 407-419. https://doi.org/10.1007/s10143-015-0605-7

Rawal, N. (2016). Current issues in postoperative pain management. *European Journal of Anaesthesiology*, *33*(3), 160-171. https://doi.org/10.1097/EJA.0000000000000366

Rafiq, S., Steinbrüchel, D. A., Wanscher, M. J., Andersen, L. W., Navne, A., Lilleoer, N. B., & Olsen, P. S. (2014). Multimodal analgesia versus traditional opiate based analgesia after

cardiac surgery, a randomized controlled trial. *Journal of Cardiothoracic Surgery, 9(*1), 13-19. https://doi.org/10.1186/1749-8090-9-52

Rajpal, S., Gordon, D. B., Pellino, T. A., Strayer, A. L., Brost D., Trost, G. R., & Zdeblick, T. A., & Resnick, D. K. (2010). Comparison of perioperative oral multimodal analgesia versus IV PCA for spine surgery. *Journal Spinal Disorder & Techniques*, *23*(2), 139-145. https://doi.org/10.1097/BSD.0b013e3181cf07ee

Rivkin, A., & Rivkin, M. A. (2014). Perioperative nonopioid agents for pain control in spinal surgery. *American Journal of Health-System Pharmacy*, *71*(21), 1845–1857. https://doi.org/10.2146/ajhp130688

Schwenk, E. S., & Mariano, E. R., (2018). Designing the ideal perioperative pain management plan starts with multimodal analgesia. *Korean Journal of Anesthesiology*, *71*(5), 345-352. https://doi.org/10.4097/kja.d.18.00217

Shea, R. A., Brooks, J.A., Dayhoff, N.E., & Keck, J. (2002). Pain intensity and postoperative pulmonary complications among the elderly after abdominal surgery. *Heart & Lung, 31*(6), 440-449. https://doi.org/10.1067/mhl.2002.129449

Sherry, T. B., Roth, C. P., Bhandarkar, M., & Hepner, K. A. (2021). Chronic pain among service members: Using administrative data to strengthen research and quality improvement. *Rand Corporation*. https://doi.org/10.7249/RRA1160-1

Sun, L., Zhu, X., Zou, J., Li, Y., & Han, W. (2018). Comparison of intravenous and oral acetaminophen for pain control after total knee and hip arthroplasty: A systematic

review and meta-analysis. *Medicine, 97*(6), e9751. https://doi.org/10.1097/MD.0000000000009751

Tappen, R., Lynn, C., Wolf, D., Rahemi, Z., Engstrom, G., Rojido, C., Shutes, J., & Ouslander, J. (2017). Barriers and facilitators to implementing a change initiative in long-term care utilizing the INTERACT quality improvement program. *Health care management, 36*(3), 219-230. https://doi.org/10.1097/HCM.0000000000000168

Tsaousi, G. G., Pourzitaki, C., Aloisio, S., & Bilotta, F. (2018). Dexmedetomidine as a sedative and analgesic adjuvant in spine surgery: a systematic review and meta-analysis of randomized controlled trials. *European Journal of Clinical Pharmacology, 74*(11), 1377–1389. https://doi.org/10.1007/s00228-018-2520-7

U.S. Department of Veterans Affairs. (2020 September). *Pain Management.* https://www.research.va.gov/topics/pain.cfm#research3

Vadivelu, N., Kai, A. M., Dai, F., & Dabu-Bondoc, S. (2019). Analysis of multiple routes of analgesic administration in the immediate postoperative period: A 10-year experience. *Current Pain and Headache Reports*, *23*(3), 1-8. https://doi.org/10.1007/s11916-019-0754-4

Weingarten, T. N., Jacob, A. K., Njathi, C. W., Wilson, G. A., & Sprung, J. (2015). Multimodal analgesic protocol and post anesthesia respiratory depression during phase 1 recovery after total joint arthroplasty. *American Society of Regional Anesthesia and Pain Medicine, 40*(4), 330-336. https://doi.org/10.1097/AAP.0000000000000257

Westrich, G. H., Birch, G. A., Muskat, A. R., Padgett, D. E., Goytizolo, E. A., Bostrom, M. P., Mayman, D. J., Lin, Y., & YaDeau, J. T. (2019). Intravenous vs oral acetaminophen as a component of multimodal analgesia after total hip arthroplasty: A randomized, blinded trial. *The Journal of Arthroplasty*, *34*(7), S215-S220. https://doi.org/10.1016/j.arth.2019.02.030

White, P., Sacan, O., Tufanogullari, E., Nuangchamnong, N., & Ogunnaike, B. (2007). Effect of short-term postoperative celecoxib administration on patient outcome after outpatient laparoscopic surgery. *Canadian Journal of Anesthesia*, *5*(4), 678 - 679.

Woolf, C.J. (2011). Central sensitization: Implications for the diagnosis and treatment of pain. *Pain*, *152*(3), S2-15. https://doi.org/10.1016/j.pain.2010.09.030

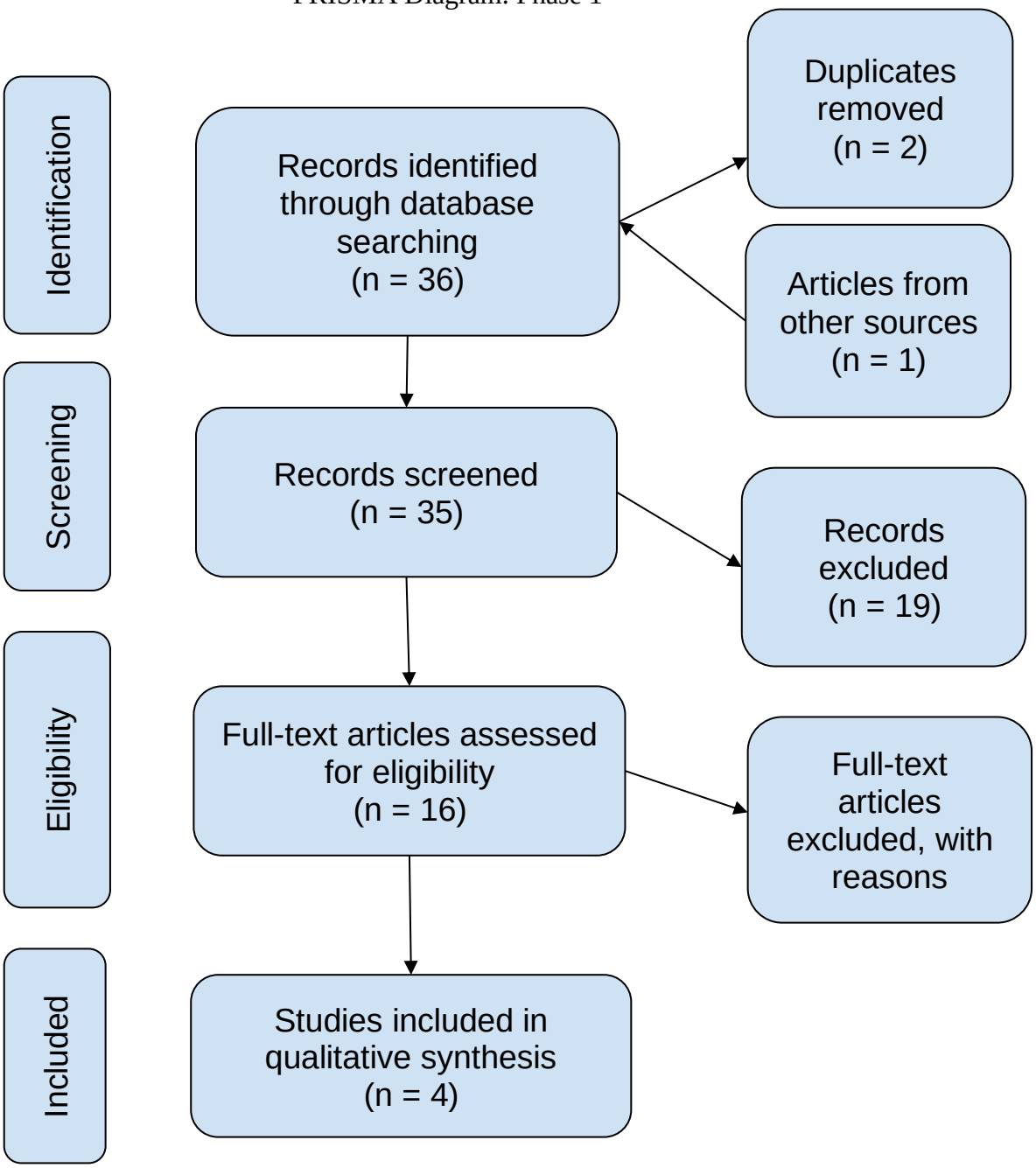
Yam, M. F., Loh, Y. C., Tan, C. S., Khadijah Adam, S., Abdul Manan, N., & Basir, R. (2018). General Pathways of Pain Sensation and the Major Neurotransmitters Involved in Pain Regulation. *International journal of molecular sciences*, *19*(8), 2164. https://doi.org/10.3390/ijms19082164

Yang, S., & Chang, M. C. (2019). Chronic Pain: Structural and Functional Changes in Brain Structures and Associated Negative Affective States. *International journal of molecular sciences*, *20*(13), 3130. https://doi.org/10.3390/ijms20133130

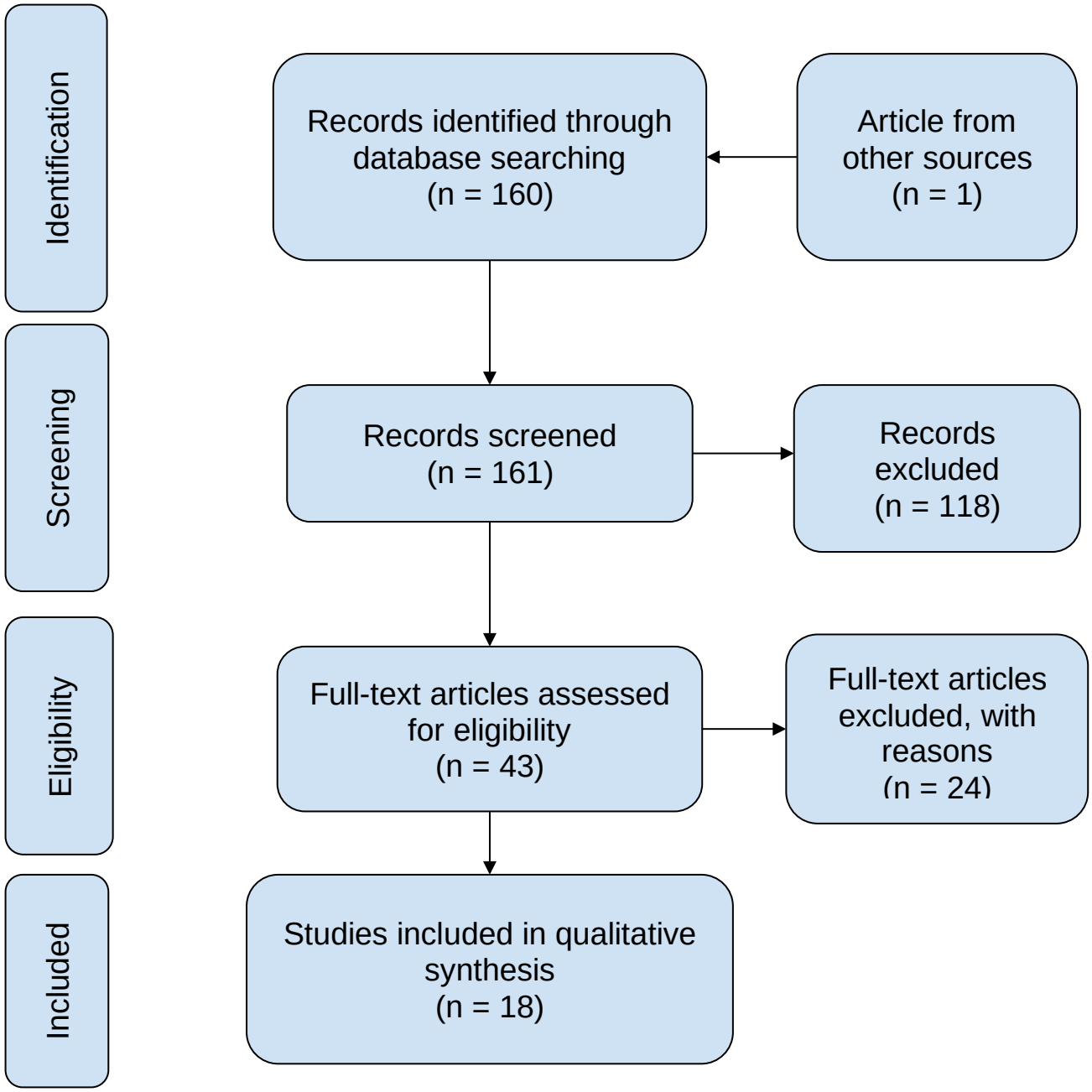
Zhou, J., Fan, Y., Zhong, J., Wen, X., & Chen, H. (2017). Efficacy and safety of multimodal analgesic techniques for preventing chronic post surgery pain under different surgical categories: A meta-analysis. *Scientific Reports*, *7*(1), 678-9. http://doi.org/10.1038/s41598-017-00813-5

Zhou, Y., & Danbolt, N. C. (2014). Glutamate as a neurotransmitter in the healthy brain. *Journal of neural transmission, 121*(8), 799–817. https://doi.org/10.1007/s00702-014-1180-8

Appendix A
PRISMA Diagram: Phase 1



Appendix B
PRISMA Diagram: Phase 2



Appendix C
Evidence Table: Phase 1

1st Author Name (Publication Yr)	Study Purpose/ Aims	Research Questions /Hypotheses (IF different from/specifically described separately from study purpose & aims)	Study Design	Total Sample Size (How many initially, how many at final analysis?)	Sampling Plan	Independent Variables AND LEVEL OF MEASUREMENT	Dependent Variables AND LEVEL OF MEASUREMENT	Statistical Analyses - what tests were used for which research questions?	Results	Strengths (how promoted internal/external validity)	Weaknesses (biases; poorly controlled threats to internal/external validity)	LEVEL OF EVIDENCE - using JHNEBP tool (Strength and Quality)
Bruce et al., 2004	Estimate the prevalence of chronic postoperative chronic pain. Compare characteristics of CPSP after different surgeries using McGill Pain Questionnaire	Same as study purpose	Observational Cohort Study	511 pts (1990-1995) 1348 pts (1995-2000) Total pts 2210 Finished 666	Three separate questionnaires at different times on separate surgical groups.	Literature review, no independent variables	1.Pain rating intensity using scale weight values 2.Pain rating intensity using scale weighted rank 3.Number of works chosen	Package for the Social Sciences (SPSS)	Questionnaire may be a useful instrument to include in such studies	3-large scale independent surgical populations	Surveys at different time periods during a 10-yr period	IIIB
Cook et al., 2017	Evaluation of the validity and response burden of patient self-reported pain. Screening tool and outcome registry. PASTOR	Same as study purpose	Questionnaire study Non-experimental cohort	681 comparing baseline and follow-up care	Data collected during routine clinic practice at two military health clinics. Patients >18 with complaint of pain completed study	Defense and Veterans Pain Rating Scale	Emotional well-being, anxiety, depression, anger	Paired t-tests	Supports the use of DVPRS and PROMIS. Distinguish levels of pain and pain related outcomes	First to evaluate the psychometric properties of PRO measures. First to evaluate validity of PROMIS	Time frame of the study did not allow collection of a substantial number of follow up assessments.	IIIB
Fish et al., 2013	Further investigate reliability and validity of the CPAQ8	Same as study purpose	Questionnaire study Non-experimental cohort	Initial 716 Excluded 238 End 478	478 online articles reviewed.	Anxiety Acceptance Fear of movement Pain catastrophizing Psychological Inflexibility	CPAQ8 scores	SPSS Expectation maximization (EM) algorithm	Pain acceptance, measure with CPAQ8, was associated with less depression anxiety, pain, interference, fear of anxiety, pain catastrophizing, psychological inflexibility in pain and higher levels of satisfaction, pain self-efficacy and general acceptance	CPAQ is a reliable and valid measure of pain acceptance	Test-retest sample had a high incidence of participants reporting fibromyalgia. Missing data ranged from 0-4.7% and Little's missing completely at random (MCAR) test was statistically significant , indicating data was not missing	IIIB

Kopf et al., 2005	Define and clarify chronic pain, current treatment regimen to include opioid and non-opioid	Same as study purpose	Literature review	N/A - literature review	Articles discussing pain and pain pathways Articles discussing pain treatments	Literature review No independent variables	Pain pathways Pain treatment modalities	N/A	Definition and scope of the problem Chronic pain is unique to each patients Opioid medications Non-opioid medications Pre Intra and Post management	Multitude of articles, all encompassing	Not a research study No mention of sample size No clearly stated objectives No discussion or recommendations included	IIIA

Appendix D
Evidence Table: Phase 2

1st Author Name (Publication Yr)	Study Purpose/Aims	Research Questions/ Hypotheses (IF different from/specifically described separately from study purpose & aims)	Study Design	Total Sample Size (How many initially, how many at final analysis?)	Sampling Plan	Independent Variables AND LEVEL OF MEASUREMENT	Dependent Variables AND LEVEL OF MEASUREMENT	Statistical Analyses - what tests were used for which research questions?	Results	Strengths (how promoted internal/external validity)	Weaknesses (biases; poorly controlled threats to internal/external validity)	LEVEL OF EVIDENCE - using JHNEBP tool (Strength and Quality)
Candiotti et al., 2010	Evaluation of safety and efficacy of two doses of DEX for sedation for pts undergoing a broad range of surgical procedures	Same as study purpose	Randomized, multicenter, double blinded, Phase III Food and Drug Administration study	390 screened 326 selected 309 finished	A sample size of 250 patients was required to provide >99% power	Patients DEX 0.5 g/kg, DEX 1 g/kg, or saline placebo initial loading dose. Followed by a maintenance infusion of 0.2–1.0 g kg 1 h 1 of DEX (or equivalent volume of saline) titrated to a targeted level of sedation	Drug Patients assessed for level of sedation using the Observer's Assessment of Alertness/Sedation Scale (OAA/S)	Two-sample t-test for each dexmedetomidine arm versus placebo	Significantly fewer patients in the 0.5- and 1-g/kg DEX groups required supplemental midazolam compared with placebo and at lower doses to achieve an OAA/S 4 before and during surgery compared with the saline group Both DEX groups required significantly less fentanyl for all surgical subtypes	Randomized double blind, Adequate sample size, t-test	Infusions for patients were continued to the end of surgery following study design which may have prolonged discharge	IB

Chan et al., 2016	Determine whether the administration of intravenous dexmedetomidine for sedation would decrease postoperative morphine consumption in the first 24 hr following surgery.	Hypothesized that the administration of intravenous dexmedetomidine would decrease postoperative morphine consumption in the first 24 hours following surgery.	Prospective double-blinded randomized-controlled parallel group trial	40 patients undergoing total knee arthroplasty with a standardized spinal anesthetic	Patients were randomized to receive either a dexmedetomidine loading dose of 0.5 μg·kg−1 over ten minutes, followed by an infusion of 0.5 μg·kg·hr−1 for the duration of the surgery, or a normal saline loading dose and an infusion of an equivalent volume	Received dexmedetomidine Received normal saline	Consumption of morphine Patient satisfaction	Statistical analysis was performed using SigmaPlot® version 13.0 Using a two-sided test with an alpha of 0.05 and a power of 0.9, the required sample size for a two-sample comparison of means was estimated at 19 patients per group. Data were tested for normality using the Shapiro-Wilk test with a cut-off of 0.05 Student's t-tests were used to analyze the outcomes in data with normal distribution. Mann-Whitney U test was used for data that were not normally distributed The Wilcoxon rank-sum test was used to analyze patient satisfaction.	Patients receiving IV dexmedetomidine for procedural sedation showed a significant reduction in postoperative opioid use 53% less morphine than the control group VAS scores were not significantly different between both groups Patient satisfaction was higher in the dexmedetomidine group	Good sample size Equal distribution of demographics	Delayed discharge leading to inefficiencies in postoperative patient disposition and operating flow Patients' level of sedation was not measured on ward Lack of local anesthetics and other non-opioid pharmacological interventions administered in the postoperative period	IA

Coluzzi et al., 2017	Practical suggestions for perioperative management of surgical opioid tolerant patients, together with schemes of opioid conversions for chronic pain patients	Same as study purpose	Literature review	64 articles analyzed	Surgical opioid-tolerant patients Opioid conversion for chronic pain patients	Guarantee baseline requirements for opioids, regardless of anesthetic technique	Opioid requirements in postoperative period Duration of postoperative pain treatment Pain control	Narrative review for clinical perspective for opioid tolerant patients	No data suggesting the preference for a specific intraoperative opioid over another in patients chronically treated with opioids or addiction There may be a 4-fold increase in opioid requirements postoperative. Duration of postoperative treatment is about 3 times longer Adequate pain control should not be withheld from patients Continue baseline requirements	Discussed preoperative and intraoperative management. Provided conversion of PO opioids to IV	Literature review, not a study	IIIB

Devine & McGirt, 2015	Comprehensive literature review to determine grades of recommendation for commonly used agents in multimodal pain management and provide a best practice guideline.	Same as study purpose	Literature review	13 Articles	English language publications in Medline, PubMed; National Library of Medicine, Bethesda, Md.	Level of evidence I - V based on North American Spine Society's (NASS) standardized levels of evidence tables.	Reduction in postoperative pain and narcotic requirements.	Independently assigned levels of evidence for each study. Grading based on NASS guidelines	Multimodal approach is preferred for perioperative pain management in spine surgery. Evidence suggests that chronic opioid use in the perioperative period may have a negative impact on outcomes following spinal procedures.	Independent evidence assignment. Large review sample Covered multiple publications. Compared multiple phases of anesthesia.	Review of literature Not a study	IIIB
Dunn et al., 2018	Investigate the incidence and perioperative risk factors associated with chronic opioid	Same as study purpose	Retrospective review	1477 patient records reviewed 412 opioid naive pts prior to surgery 1065 patients use opioids prior to surgery	Patients >18 who underwent elective major spine surgery of 2 or more levels	Opioid use prior to surgery Opioid naive prior to surgery	VRS pain scores Total daily postoperative opioid use Nonopioid analgesic use Opioid use 1, 6, 12 months post-surgery	Descriptive statistics were presented as number and proportion for dichotomous variables Mean and standard deviation for continuous variables Logistic regression models were used to examine whether chronic opioid use through 12 months Odds ratios presented for ease of interpretation Statistical significance was adjusted with Bonferroni correction All analyses were performed in R version 3.3.2	Decreased VRS Decreased intraoperative opioid use 12 months after surgery, those using opioids prior continued to be prescribed opioids postoperatively	Standardized anesthesia induction and maintenance	Individualized anesthesiologist assessment for IV hydromorphone at end of procedure Retrospective study and the results suggest associations rather than causality Opioid use was determined based on medication reconciliation, and present a limitation as there is not sufficient data to determine actual opioid use	IIIB

Gandhi 2017	Investigated the role of dexmedetomidine as an anesthetic sparing agent and as a sole postoperative analgesic	Same as study purpose	Prospective, randomized, observer blinded, placebo-controlled trial	60 total patients	ASA 2 patients 18-60 years old undergoing 1-2 vertebrae cervical spine surgery, randomized into 2 groups	IV dexmedetomidine infusion 0.5 mcg/kg/hr throughout surgery with a loading dose 1 mcg/kg over 10 minutes plus postoperative infusion continued at 0.2 mcg/kg/hr Volume matched bolus and infusion of 0.9% saline	Rescue analgesic requirements Hemodynamic stability Sedation scores Pain scores	The statistical analysis was performed using SPSS version 18.0. Normal distributed data were compared with independent 2-sample t test, Skewed data were compared by Mann-Whitney U test Measures over time were compared with repeated-measures analysis of variance followed by post hoc analysis with Bonferroni correction Qualitative or categorical variables were compared using the X2 or Fisher test Groups were compared for pain-free duration using the log-rank test to obtain Kaplan-Meier survival plots All statistical tests were 2-sided and were performed at significance level of P <0.05	Dexmedetomidine offered longer pain-free period and reduced the requirements of a rescue analgesic in the postoperative period without any significant side effects Did not result in increased sedation scores	Baseline demographics were comparable between the groups Good sample size according to power analysis	Included patients who underwent surgery in both supine and prone positions Additional limitation is that even though anesthesiologists who were not involved in the study prepared the test drug infusion, administration can cause significant hemodynamic changes during surgery and could have created some bias to anesthesia care providers	1B

Hamp et al., 2018	To estimate the population prevalence of nonminor chronic localized and widespread pain in the United States, and to examine whether the pattern of chronic pain differs by age, sex, or race/ethnicity.	Same as study purpose	Random subsample of NHANES survey and additional pain questionnaire. Experimental Pilot study	10,291 respondents 10,271 included	A random subsample of responders from the NHANES survey completes an additional pain questionnaire through personal interviews. 20 yrs old and above	1 back pain 2 pain in the legs/feet 3 pain in the arms/hands 4 headache 5 abdominal pain 6 pain in the face/teeth 7 chest 8 sex 9 race/ethnicity	Completed data of the NHANES survey	Regression models to test association of sex and race/ethnicity	1) Highest prevalence estimates back (10%), legs/feet (7%), arms/hands and headache (4%) each. Abdominal, face/teeth, and chest pain (1%) each. 2) Population prevalence stratified by race/ethnicity within sex. Mexican-American's men and women were lower than non-Hispanic white and non-Hispanic black for back pain, pain in legs/feet, and pain in the arms/hands. 3) results of logistic regression models for the pain outcomes, simultaneously adjusting for sex, race/ethnicity, and age. Women had higher odds than men for all pain sites, but these were statistically significant only for headache, abdominal pain, and chronic widespread pain. Mexican Americans had lower odds for all pain outcomes compared with the other races. The differences were statistically significant compared with non-Hispanic white and black people for chronic back pain, pain in the legs/feet, and pain in the arms/hands, as well as for chronic	Experimental pilot study, Large national epidemiological survey that encompasses diverse chronic localized and widespread pain conditions and includes adequate numbers of minority respondents.	NHANES is a household survey, and institutionalized subjects are excluded, homeless people and households without telephones were not included.	IIB

									localized and widespread pain.			
Hudson & Hemming, 2011	Determine the effects of anesthetics on the extremes of age	Same as study purpose	Literature Review	Referenced 69 articles	English language publications in Medline, PubMed; National Library of Medicine, Bethesda, MD, British Journals	Inhaled anesthetics can have profound and long-lasting effects during key neurodevelopmental periods by increasing apoptosis and reducing neurogenesis	Clinical data for the pediatric population is conflicting. Elderly patients are recognized to be at increased risk of postoperative cognitive dysfunction.	Prospective randomized clinical trials are underway to address the clinical significance of these findings, but there are major challenges in designing, executing, and interpreting such trials.	Definitive clinical studies involving general anesthetics of neurotoxicity are unlikely to become available in the near future, requiring clinicians to use careful judgment when using these profound neuro depressants in vulnerable patients.	Independent evidence assignment. Discussed young brain vs. old brain. Discussed volatile agents and neurotoxicity Covered multiple publications.	Review of literature. Not a study.	IIIB

Kim et al., 2016	Assess the efficacy of a novel preemptive multimodal analgesic regimen for reducing postoperative pain and complications	Same as study purpose	Prospective, randomized clinical trial	Started - 113 Excluded - 33 Finished - 80	80 patients randomly assigned to receive either only intravenous morphine or a preemptive multimodal (celecoxib, pregabalin, extended-release oxycodone, and acetaminophen) analgesic regimen	Intravenous morphine or a preemptive multimodal (celecoxib, pregabalin, extended-release oxycodone, and acetaminophen analgesic regimen)	Postoperative pain and functional levels were measured by the visual analog scale (VAS) and Oswestry Disability Index (ODI) Intraoperative blood loss, postoperative Hemovac drain output Nonunion rates were evaluated for complications	Results were expressed as mean ± SD All statistical analyses were conducted using SPSS ver. 18.0 software (SPSS Inc., Chicago, IL, USA) Two-sample Student's t-test was performed to compare mean differences in patient demographics, VAS and ODI scores, and intra- and postoperative drain output measurements Chi-square test performed to evaluate difference in nonunion rates P values \0.05 were considered significantly different	No differences were observed between the two groups in age, bone mineral density, or intraoperative and postoperative blood loss No other postoperative complications such as wound hematoma or dehiscence, gastroduodenal perforations, ulcers, or bleeding episodes were observed Group1 had significantly lower VAS and ODI scores at all time points than those of group 2, except the ODI on postoperative day 1 Three patients in group 1 and four patients in group 2 developed nonunion	Large review sample	Other agents or local anesthetic injections were not used Analgesics, such as a-2 agonists, N-methyl-D-aspartate receptor antagonists, or glucocorticoids could be candidates for an ideal regimen A local anesthetic injection at the surgical site is not preemptive but can be beneficial as one part of multimodal analgesia Probability is that a placebo effect had some influences on the result Same dose of each agent was administered to all patients within the study group, without considering patient weight, which is a potential limitation Time between analgesia and the surgery was insufficient for the drugs to be absorbed to the peak concentrations	IB

Loftus et al., 2010	Investigate the efficacy of preventive ketamine infusions in patients with chronic pain	Hypothesized that ketamine would reduce postoperative opiate consumption	Randomized, prospective, double-blind and placebo-controlled trial	Started - 301 Excluded - 136 Final - 165	Patients with chronic pain scheduled for elective lumbar surgery requiring hospital admission	A computer-generated block randomization scheme to randomize patients into racemic ketamine or placebo (saline) group	Total morphine consumption during the first 48 hrs Visual analog score during the first 48 h and at 6 weeks, 6-week morphine equivalents	Primary comparison was an unadjusted analysis using an unpaired Student t-test Categorical binary outcomes were compared using Fisher exact test Multivariate regression approach was then undertaken to assess the impact of potentially confounding covariates	Intraoperative ketamine reduces opiate consumption in the 48 h-postoperative period in opiate-dependent patients with chronic pain Ketamine may also reduce opioid consumption and pain intensity throughout the postoperative period	Principal investigators, patients, nursing staff, anesthesia providers were blinded to treatment assignments during the entire hospital stay All patients used VAS Standardized anesthesia induction and maintenance protocol followed for all patients All patients received 0.5mg/kg of the study solution	Unclear to what extent preoperative morphine use increases postoperative opiate consumption	IA

Pendi et al., 2018	Evaluate the effectiveness of perioperative supplemental ketamine to reduce postoperative opioid analgesic consumption	Same as study purpose	Literature review Meta-analysis of randomized controlled trials	Starte - 1846 Duplicates removed - 696 Excluded based on title review and abstract - 1135 Final - 14	14 randomized controlled trials 649 patients	Patients who received supplemental ketamine were compared with control group	Postoperative morphine equivalent consumption Pain scores Adverse events	Comprehensive search of PubMed, the Cochrane Central Register of Controlled Trials for prospective RCTs, Web of Science, and Scopus Supplemental ketamine compared with the control group in terms of postoperative morphine equivalent consumption, pain scores and adverse events Mean differences and 95% confidence intervals were used to describe continuous outcomes Odds ratios and 95% CIs were applied to dichotomous outcomes	Supplemental perioperative ketamine reduces postoperative opioid consumption up to 24 hours	Large sample size Systematic screening method	Many trials excluded patients with preoperative narcotic use Some trials did not acknowledge preoperative opiate consumption, leaving it unclear as to whether opiate tolerant patients were included. As a result, if chronic opiate use mitigated ketamine analgesia, the magnitude of this effect is indeterminate with the available data Study indicates low-dose supplemental ketamine may be useful for short-term analgesia, this metaanalysis was not designed to evaluate dose, timing, or mode of ketamine administration	IB

Rajpal et al., 2010	Compare perioperative oral multimodal analgesia vs IV analgesic	Same as study purpose	Retrospective Cohort Study	Started - 200 Finished - 200	Historical control group of 100 spine surgery patients who received conventional IV PCA with a prospective group of 100 spinal surgery patients who received a form of perioperative oral multi modal analgesia	IV PCA Oral pain control	Pain level Opioid usage Patient satisfaction 24 hours postoperative	Independent T-test Power analysis 2-sided analysis	Patients who received the new perioperative multimodal oral regimen had significantly less opioid consumption, lower ratings of Least Pain, less nausea, drowsiness, interference with walking/coughing/ deep breathings compared with the IV PCA group	X2 analysis Generalizable to clinical setting Offered relevant information on the efficacy and safety of multi modal agents Good variation between different surgical approaches	Small sample size Practice-change QI study- results of this study cannot be generalized Modifications in the regimen were made to meet individual patient	IIIA
Rivikin & Ravkin, 2014	Commonly used non-opioid analgesic agents that are incorporated into multimodal perioperative pain management protocols in spinal surgeries	Same as study purpose	Literature review	55 randomized controlled trials	107 articles reviewed	Patients received IV or IM ketamine before surgery Bolus dose of ketamine intraoperatively Ketamine infusion Sodium chloride injection	Pain reduction postoperatively	Guideline study No statistical tool used	Results were mixed, with much variability in the ketamine dose, administration, route of administration and dosing frequency Ketamine in addition to opioid PCA failed to decrease postoperative pain Continuous infusion as well as single dose regimen attenuated narcotic consumption	Decent sample size Randomized controlled trials Investigated multiple methods of ketamine administration	Inconsistent method of administration of drugs for comparisons	IIIB

Sun et al., 2018	Evaluate the efficacy between IV and oral acetaminophen as adjunct to multimodal analgesia regimens for pain management	Same as study purpose	Literature review Only included randomized controlled trials, fixed/random effect model, chi square test	207 RCT's	Sample size ranges from 116 - 120 Experimental groups received IV acetaminophen and the control groups received PO	Patients who received IV Acetaminophen VS PO Acetaminophen	Pain scores at 12,24,48 hrs postoperative Opioid consumption at 12,24,48hrs Length of hospital stay Postoperative complications	Statistical heterogeneity using the standard chi square test When there is no statistical evidence of heterogeneity, a fixed effects model is adopted Otherwise, a random-effect model is used	IV acetaminophen to multimodal analgesia does not demonstrate a significant benefit in reducing pain and opioid consumption compared to PO formulation Higher-quality RCTs are required for further research	Quality of evidence for main outcomes in our study was assessed using the GRADE system Evidence quality for each outcome was moderate	Only 2 RCTs are included and the sample size in each trial is small Functional recovery is an important outcome, which is not included Different dose of acetaminophen in both groups is not discussed; therefore, more RCTs are needed for subgroups analysis The follow-up period is short which leads to the underestimation of complications Publication bias that existed in the meta-analysis also influences the results	IB

Tsaousi et al., 2018	Systematic review and meta-analysis appraise the clinical evidence on efficacy and safety of dexmedetomidine (DEX), as a sedative and analgesic	Same as study purpose	Heterogeneity tested by 12 statistics Meta-analysis performed	Started - 15 studies Total patients - 913	182 records incorporating a placebo comparison group were included in the meta-analysis	RCT groups treated with Dexmedetomidine both as a sedative and analgesic	Consumption of morphine equivalents and propofol both intraoperatively and postoperatively after being treated with Dexmedetomidine	Results of RCTs being suitable for quantitative analysis were pooled and weighed separately and then together, using Review Manager (version 5.2.5; The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark) Risk ratios calculated the mean differences with 95% confidence interval (CI) for continuous data Values presented as median and 25%–75% interquartile range (IQR) were transformed to mean and standard deviation Opioid consumption was expressed as morphine equivalents (mg)	DEX attaining a notable reduction of intraoperative consumption of both anesthetics and opioids DEX offers satisfactory control of pain and reduce rescue analgesic requirements	Two RCTs using opioids as controls suggested a clear benefit of DEX use compared to remifentanil and fentanyl for PONV prevention DEX reduces intraoperative propofol and opioids consumption Available data are insufficient for conclusions to be drawn for inhalational and other sedative agents	Findings not easily generalizable, as only adult populations were included Available data are in minor spine procedures while those supporting the use of DEX in major spine surgery are limited	IIIB

Weingarten et al., 2015	Test the hypothesis that sedating analgesics used in multimodal protocol are associated with an increased rate of phase 1 post-anesthesia respiratory depression.	Same as study purpose. Retrospective design.	Internal anesthesia department review of total joint arthroplasty patients from 2008-2012.	11,970 patient charts reviewed. 2836 with episodes of respiratory depression.	Patient records were reviewed for episodes of post anesthesia respiratory depression, and potential causative factors were abstracted and analyzed for potential associations.	Neuraxial anesthesia General anesthesia Gabapentin administration Higher dose sustained release oxycodone Administration of NSAIDS	Respiratory depression	Student t-test or rank sum test for continuous variables X2 test for categorical variables. Multivariable logistic regression analysis to assess potential associations between respiratory-specific events and abstracted variables.	Long-acting sedative potential was associated with increased risk of respiratory depression during phase 1 anesthesia recovery. The effects were more pronounced when used in conjunction with general anesthesia than with neuraxial anesthesia.	Large sample size. No large change of surgical techniques. Anesthesia provided by only 15 providers. Well established and consistent ERAS protocols.	Internal anesthesia review. Adherence to multimodal analgesic protocol was not mandatory. Dosing regimens of sedation analgesics were adjusted for age.	IIIB
Westrich et al., 2019	Evaluate if IV Acetaminophen would reduce pain with activity, opioid usage, or opioid-related side effects, compared to PO acetaminophen	IV acetaminophen would reduce pain with activity, opioid usage, or opioid-related side effects, compared to oral acetaminophen	Randomized Double-blind trial	Start - 558 Excluded - 404 Finished 154	154 pt's	Acetaminophen/placebo and PO Acetaminophen/placebo	Pain with activity on POD 1 Cumulative opioid use POD 0 - POD 3 Opioid-related side effects POD 1	Between groups using c2 or Fisher exact tests Secondary outcomes measured at multiple timepoints analyzed using the GEE method with an unstructured correlation structure Identity link for continuous outcomes Logit link for binary outcomes	No differences between groups were detected in any of the 3 primary outcomes of pain	Comprehensive multimodal analgesia, consisting of neuraxial anesthesia; postoperative, opioid-free, patient-controlled analgesia; and nonsteroidal anti-inflammatory drug administration	Single-center trial High-volume orthopedic hospital with specialized surgeons and anesthesiologists and an experienced acute pain service	IB
Zhou et al., 2017	Compare efficacy and safety of regional anesthesia to manage chronic post-surgical pain	Same as study purpose	Meta-analysis Randomized controlled trials that focused on chronic pain frequency, analgesic consumption and adverse effects	Articles reviewed - 1803 Excluded - 1015 Final - 21	1980 patients	Regional anesthesia provided vs no regional anesthesia provided	Patient satisfaction Post-surgical pain	Random-effects model, presented as standardized mean difference and 95% confidence interval using inverse variance method	Regional anesthesia significantly reduced the incidence in patients with chronic pain at different surgery sites compared with traditional analgesia	Subgroups were analyzed based on year, country, sample size, surgical sites, follow up duration Sensitivity analysis performed on each trial All tests were 2 tailed and $p<0.05$	Relatively high heterogeneity, data on most outcomes were too small to reach robust conclusions Quality and reliability may be limited by the quality of the underlying data	IIIB

Appendix E
CPAQ-8

Chronic Pain Acceptance Questionnaire 8 (CPAQ-8)

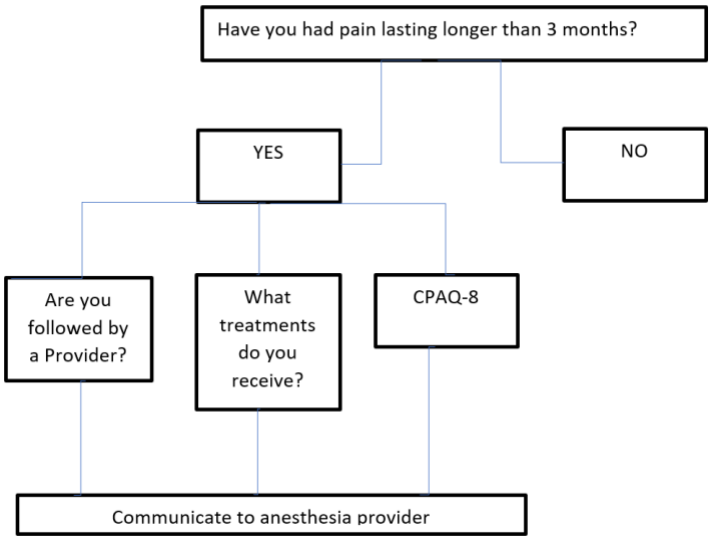
Directions: Below you will find a list of statements. Please rate the truth of each statement as it applies to you by circling a number. Use the following rating scale to make your choices. For instance, if you believe a statement is "Always True", you would circle the 6 next to that statement.

Never true	Very rarely true	Seldom true	Sometimes true	Often true	Almost always true	Always true
0	1	2	3	4	5	6

1.	I am getting on with the business of living no matter what my level of pain is	0	1	2	3	4	5	6
2.	Keeping my pain level under control takes first priority whenever I am doing something	0	1	2	3	4	5	6
3.	Although things have changed, I am living a normal life despite my chronic pain	0	1	2	3	4	5	6
4.	Before I can make any serious plans, I have to get some control over my pain	0	1	2	3	4	5	6
5.	I lead a full life even though I have chronic pain	0	1	2	3	4	5	6
6.	When my pain increases, I can still take care of my responsibilities	0	1	2	3	4	5	6
7.	I avoid putting myself in situations where my pain might increase	0	1	2	3	4	5	6
8.	My worries and fears about what pain will do to me are true	0	1	2	3	4	5	6

Reference: Fish, R., McGuire, B.E., Hogan, M., Stewart, I. & Morrison, T. (2010). Validation of the Chronic Pain Acceptance Questionnaire (CPAQ) in an Internet sample and development and preliminary validation of the CPAQ-8. Pain, 149, 435-443.

Appendix F
Pain Pre-Admissions Screening Tool



Demographics

Demographics:

Age:_____ Sex: M / F Duty Status: Active / Retired / Veteran / Dependent

Surgical Service:_____.

1. Do you have pain lasting longer than three months? Yes / No
2. Are you followed by a provider for this pain? Yes / No
    a. If so, who? _____
3. Are you receiving treatment for this pain? Yes / No
    a. If so, which treatment? _____
4. Complete CPAQ-8 (*see reverse*)

Appendix G

Badge Reference Card

Preoperative Period	**Intervention Medication**	**Recommended Dosage**
Preoperative	Opioids	Maintain current opioid regime
	Acetaminophen	15 mg/kg for patients under 50 kg (otherwise 1gm)
Intraoperative	Ketamine	Initial bolus: 0.15 - 0.5 mg/kg IV Infusion: 1 - 10 mcg/kg/min
	Dexmedetomidine	Initial bolus: 0.2 - 1 mcg/kg IV Infusion: 0.2 - 1.0 mcg/kg/hr IV

Badge Reference Card

Chronic Pain Screening Tool
Chronic pain diagnosis **Yes No**
Followed by a provider for pain management **Yes No**
Pain > 3 months **Yes No**
If **Yes** refer to back for recommendations

Appendix H

Business Case Analysis

BUSINESS CASE with VALUE BASED CARE ASSESSMENT

Proposed Title for Project/Initiative/Opportunity to Improve

Multimodal Pain Recommendations for Patients Identified with Chronic Pain Undergoing Major Joint or Neuro-spine Surgery

Opportunity Statement *(Description of proposed project/initiative/opportunity to improve)*

Identification of patients with pain greater than three months and evidenced-based recommendations for major joint and neuro-spine surgeries will increase time to first opioid, decrease total opioid consumption and decrease hospital stays for the MTF.

Business Opportunity/Objectives *(Prioritize listing – macro and micro-objectives)*

The goal is to optimize patient outcomes following major joint or neuro-spine procedures.

- Macro objectives:
  - Identify patients that have pain greater than three months.
  - Implement cost effective multimodal anesthetic recommendations for identified patients with pain greater than three months.

- Micro objectives:
  - Increase time to first opioid, decrease total opioid consumption and decrease hospital length of stay.

Potential Impact of the Initiative/Project *(Identify outcome metrics & benchmarks/and how objectives align with Quadruple Aim, Value Based Care, and HRO goals)*

- Better care: Identification and implementation of evidence-based screening and multimodal recommendations will enhance chronic pain management, resulting in better care. Additionally, better care will increase patient satisfaction, decrease readmission rates and improve overall experience within the MTF. This will directly reflect in a patient's increased time to first opioid, decreased opioid consumption, and shorter inpatient stays. Additionally, increasing pt's satisfaction, decreasing readmission rates and improved overall experience within the MTF. Improved experiences will result in increased beneficiaries seeking our MTF's services.

- Better Health: Understanding the root cause of chronic pain in major joint or neuro-spine surgery patients will reduce long term health complications, encourage healthy behaviors, focus on prevention and increase resilience. Helping patients achieve better health through management of chronic pain will have benefits including increased work productivity, decreased disability and job loss days.

- Enhanced Readiness: Any measures that contribute to deployability is the highest priority. All activities that ensure medical competence, maintain medical readiness and medical skills, while providing highest-quality care to achieve best health outcomes is our ultimate goal.

Reference: Defense Health Agency. (2019, February). *Quadruple Aim Performance Process: Transforming Performance Improvement.* file:///Users/ariaklein/Downloads/Quadruple%20Aim%20Performance%20Process%20Transforming%20Performance%20Improvement%20(3).pdf

Alternatives (courses of action) chosen for Analysis

- Focus on preemptive/preoperative medications (acetaminophen, continuation of prescribed opioids per provider's instructions) to decrease total opioids requirements, improve postoperative pain and patient satisfaction, while allowing for provider preference for intraoperative pain management.

- Focus on intraoperative pain management with ketamine, dexmedetomidine and opioids, while allowing for provider preference for opioid management.

- Focus on recommendations for perioperative multimodal pain control, through incorporation of acetaminophen, ketamine, dexmedetomidine and opioids, helping to decrease postoperative pain scores, while still allowing for provider preference for pain management.

- *"Status Quo"*: Continue with provider preference of pain management in chronic pain patients at our MTF (non-individualized patient management, poor satisfaction and pain control).

Analysis of Alternatives

<table>
<tr><td>Alternative 1:</td><td colspan="2">Identify patients that have pain greater than three months. Focus on multimodal anesthetic recommendations for perioperative multimodal pain control, through incorporation of continuation of home opioids, acetaminophen, ketamine, dexmedetomidine. These interventions will help to decrease postoperative pain scores, increase time to first opioid, decrease opioid consumption, and hospital length of stay, while still allowing for provider preference for pain management.</td></tr>
<tr><td colspan="2">Pros</td><td>Cons</td></tr>
<tr><td colspan="2">

Benefits:

“Surgical patients with preexisting chronic pain and long-term opioid use are likely more at risk for poorly managed postoperative pain, longer length of hospitalization, and need for specialized pain management services. Evidence supports that multimodal analgesia, or use of analgesics with various mechanisms of action, provides not only better pain control but also improved recovery, reduction in morbidity, and lower costs” (Jackman, 2019).
“A multimodal analgesic protocol should be surgery-specific, functioning more like a checklist than a recipe, with options to tailor to the individual patient” (Schwenk & Mariano, 2018).

Cost Savings/Avoidance

Expected savings of “$3,444 per patient, which equated to a greater than 15% cost savings per patient” (Patil et al., 2019).

Expectations

Communication with patients regarding pain management and realistic expectations (Patil et al., 2019) and synergistic effect of pre and intraop pain management.

Impact

“A central impact of a successful program is cooperation of an interdisciplinary team approach including patient education and perioperative care” which will increase pain control, decrease pain scores and increase patient satisfaction (Patil et al., 2019).
“Creating protocols that have some flexibility, using alternative NSAIDs if one is not available, will prevent entire classes of drugs from being omitted in the perioperative period, while providing clinicians some options” (Schwenk & Mariano, 2018).

Business Impact

Reduce 30-day patient readmission rates and cost. “Total costs were reduced by 11.77% and hospital length of stay was 29% shorter than those patients on high dose opioid regimens (McLaughlin et al, 2018).
“The reduction in mean costs is primarily associated with lower hospital-based costs, with the greatest overall cost difference appearing in ASA III-IV patients, significant reductions in hospital room and board and medical and surgical supply costs” (Duncan et al., 2010).

</td><td>

The concept of “multimodal anesthesia” is a well-recognized method in decreasing the use of powerful opioids which can have many negative side effects. However, there is little research investigating the harmful effects of combining analgesics. There is limited data detailing if simpler methods of “pain control vs bombarding” with a plethora of analgesics is superior (Rawal, 2016).
“An additional challenge in managing perioperative pain today is that of ongoing drug shortages. Because three pharmaceutical companies manufacture 70% of the injectable medications used in the US and some perioperative medications are almost exclusively made by one company, shortages can have major, far-reaching effects” (Schwenk & Mariano, 2018).

</td></tr>
<tr><td>Alternative 2:</td><td colspan="2">Focus on intraoperative pain management with ketamine, dexmedetomidine and opioid strategies only, while allowing for provider preference for pain management.</td></tr>
<tr><td colspan="2">Pros</td><td>Cons</td></tr>
<tr><td colspan="2">

Benefits:

“Interruption of the pain pathways & receptors, improve postoperative surgical pain, improve gastrointestinal motility, early ambulation, decrease complications, decrease hospital length of stay, decrease costs, flexible to meet patient needs, enhance patient experience, decrease emergency room visits and readmission rates, help alleviate opioid crisis (Patil et al., 2019; Kahokehr et al., 2008).

Cost Savings/Avoidance:

Decreased length of hospital stay = $3814/night (Patil et al., 2019).

Expectations:

Communication with patients regarding pain management and realistic expectations (Patil et al., 2019).

Impact:

</td><td>

Focus on only intraoperative pain management may not allow for clinical synergism and maximal benefits while minimizing individual side effects (Kaye et al., 2019).
Challenge postoperative pain management. “Undertreated pain remains a serious problem and is virtually the biggest constraint for meeting patient discharge criteria and is a commonly cited reason for postoperative readmission rates” (Kaye et al, 2019).
Increased rate of complications. “Chronic postsurgical pain represents a persistent pain that lasts over 3-6 months after a procedure and occurs roughly after 10-50% of all surgical procedures” (Kaye et al., 2019).

</td></tr>
</table>

○ "A central impact of a successful program is cooperation of an interdisciplinary team approach including patient education and perioperative care" which will increase pain control, decrease pain scores and increase patient satisfaction (Patil et al., 2019). ● Business Impact: ○ Reduce 30-day patient readmission rates and cost. "Total costs were reduced by 11.77% and hospital length of stay was 29% shorter than those patients on high dose opioid regimens (McLaughlin et al, 2018).	
Alternative 3:	Focus on preemptive/preoperative medications (i.e. acetaminophen, continuation of pt's prescribed opioids as recommended) to decrease total opioid requirements and improve postoperative pain, while allowing for provider preference for pain management intraoperative.
Pros	**Cons**
● Benefits: ○ Evidence shows many benefits of preoperative pain management strategies to include "improved postoperative surgical pain, improved gastrointestinal motility, early ambulation, decrease complications, decrease hospital length of stay, decrease costs, flexible to meet patient needs, enhance patient experience, decrease emergency room visits and readmission rates, and help alleviate opioid crisis (Patil et al., 2019; Kahokehr et al., 2008). ● Cost Saving/Avoidance: ○ Compared to the cost of conventional perioperative care vs that of the standardized guideline, patients found an average cost savings of $3,444 per patient, which equated to a greater than 15% cost savings per patient" (Patil et al., 2019). ● Expectations: ○ Communication with patients regarding pain management and realistic expectations (Patil et al., 2019). ● Impact: ○ "A central impact of a successful program is cooperation of an interdisciplinary team approach including patient education and perioperative care" which will increase pain control, decrease pain scores and increase patient satisfaction (Patil et al., 2019). ● Business Impact: ○ Reduce 30-day patient readmission rates and cost. "Total costs were reduced by 11.77% and hospital length of stay was 29% shorter than those patients on high dose opioid regimens (McLaughlin et al, 2018).	● "Barriers include financial, treatment delays, cultural perception (increased provider workload, perception of insufficient training, resistance to change, confrontation avoidance, and insufficient leadership support" (Giannitrapani et al, 2018). ● "Process standardization has been slow to gain traction or to demonstrate a positive impact on safety of care" (Leotsako et al., 2014). ● "No statistical significant difference was noted in morphine equivalent usage and average pain scores" reflecting inadequate pain management (Ciummo et al., 2016). ● "The adjusted 90-day readmission rate was 1.8% among patients who did not receive a block compared to 1.7% among patients who received a block. Nerve blocks were not associated with improved measures of long-term postoperative resource use" (Chi et al., 2019).
Alternative 4:	*"Status Quo"*: Continue with provider preference of pain management in chronic pain patients at our MTF (non-individualized patient management, poor satisfaction and pain control).
Pros	**Cons**
● Provider experience with the specific surgery and effectiveness of previously used pain strategies for postoperative pain management. ● "Quality efforts are inherently flawed, hampered by lack of data concerning outcomes and alternatives, as well as lack of distinction between quality and efficacy, most quality improvement efforts do not seem well suited to correct potential benefits" (Dahmen & Albrecht, 2009).	● No change to standard of practice. ● No individualized patient pain management. ● No improved efficiency or strong quality patient centered improvements.
Assumptions	
● The average hospital length of stay for neuro-spine and major joint surgeries at WPAFB MC is less than 2 post op days. ● Inadequate pain relief has been shown to increase hospital length of stay, time to discharge, and readmission rates (Gan, 2017). "38% of patients with uncontrolled surgical pain experienced unexpected hospital readmission" or returned for pain management problems (Gan, 21017).	

- The mean cost for follow-up management of chronic pain after surgery is roughly $1800 - $4500 per patient (Gan, 2017). Overall cost of treating chronic pain has "been estimated at $1million per patient in a lifetime" (Gan, 2017).
- Patients with uncontrolled pain have an increased recovery time. (Gan, 2017).
- The benefits of implementing an evidence-based standardized protocol in hospitals may also help alleviate the opioid crisis by decreasing the risk of patients using chronic opioids. Evidence of opioid "use during and after surgery to treat pain could increase the risk of long-term opioid use up to 44% (Echeverria-Villalobos et al, 2020).

Recommendation and Rationale

Recommendation: Alternative #1

Proposal: Identify patients that state they have pain greater than three months. Recommend standardized guideline for perioperative multimodal pain control, through incorporation of continuation of home opioids, acetaminophen, ketamine and dexmedetomidine, leading to increased time to first opioid, decreased opioid consumption, decreased hospital length of stay, while still allowing for provider preference for pain management.

Rationale

Evidence has shown the use of a multimodal evidenced based platform interrupts pain transduction, transmission perception and modulation to have the best results in enhanced pain control and patient satisfaction with reduced length of hospital stays.

Value Based Care - Investment Required by the Organization and the Associated "VALUE" or $ GAINED. *Below represents two ways to present this information. Depending on the initiative, you may need to alter this outline. Please adjust as appropriate and if need be ... do not hesitate to create this portion on a separate document and then attach to this assignment.*

	Number of neuro-spine cases per year	114
	Number of major joint surgeries per year	480
	Total	**594**

I. *Reimbursement calculated for: Avg cost of*

	Costs	
	Cost per night of inpatient medical surgical unit at WPAFB MC: $3,814/night 2 nights X 594 patients	$ 4,531,032.00
	Acetaminophen IV cost $40/vial x 594 patients	$ 23,760
	Ketamine cost (200mg/vial): $168 x 594 patients	$ 99,792
	Dexmedetomidine cost (4mg/vial): $228 x 594 patients	$ 135,432
	Total	**$ 4,790,016**

reference: www.drugs.com

II. *Costs:*

Variable Costs:

Supplies (Paper, poster, misc.)	$ 1000 (est)
Training/hour for x4 MD's ($200/hr) and x14 CRNA's ($86)	$ 2000
Total	**$ 3000**

Fixed Costs:

Labor SRNA investigators one hour/day for approximately six months	$ 6000 ($50/hr x 20 hrs/mth x 6 mths)
Overhead (use of facility, lights, HVAC, computers, monitors, projectors, etc)	$ 2000 (est)
Total	**$ 8000**

III. *Savings to WPAFBMC*

Decrease hospital length of stay 1 night in 20% of patient population (~119 patients) = $453,866
+
Acetaminophen PO savings 594 patients (per tab $0.07 x 3 tabs: $0.21 x 594 patients= $124.74) = $23,635.26

PROJECTED$ 477,501.26 SAVINGS

Risks and Mitigation Plan

Risks	**Plan**
1. Understated or overstated response from patient on CAPQ8	1. Educate pre-admission nurses on the importance of accurate feedback and how to assist the patient if they have questions.
2. Incomplete pain screening tool form.	2. Reinforce and retrain the pre-admission nurses when needed to ensure completion of the form.
3. Lack of buy-in, staff refusal, apprehension and non-compliance	3. Provide education to staff members on the benefits of chronic pain screening, CPAQ8 and multimodal anesthetic recommendations i.e., decreased work postoperatively.
4. Patient refusal, apprehension	4. Educate patients on benefits to multimodal pain management
5. Lack of meaningful feedback from patient	5. Emphasize value of feedback
6. Ineffective treatment plan resulting in increased pain and decreased satisfaction	6. Collect data, determine failure, then return to status quo

Implementation Plan

Step 1:	• Gather evidence on pain screening tools, pain recommendations and identify metrics to be used for measuring time to first opioid, total opioid consumption and total hospital length of stays.

Milestone Description:	• Conduct/analyze evidence-based literature reviews regarding chronic pain screening tools and recommendations for pain management in chronic pain patients.	
Deliverables	Due Date	Accountable Person
• Organize relevant articles and categorize medications for the perioperative period based on evidence-based recommendations.	November 2020	Investigators
• Find appropriate chronic pain rating scales.	November 2020	Investigators
• Create multimodal evidence-based recommendations.	November 2020	Investigators
Resources Needed		
• Access to research databases through the USUHS school library. • Collaborate with the MTF regarding the number of neuro-spine and major joint surgeries performed annually.		
Expected Level of Benefit		
• Evidence is needed to support and deliver recommendations. Surveys are the foundation of our evidence-based project helping to determine the best methods to assess chronic pain patients.		
Step 2:	• Submit IRB/Leadership approval for project	
Milestone Description:	• Submit IRB for approval • Obtain leadership approval	
Deliverables	Due Dates	Accountable Person
• Completed IRB • Obtain approval from leadership	December 2020	Investigators
Resources Needed		
• IRB form.		
Expected Level of Benefit		
• Obtain IRB approval to proceed with our evidence-based project.		
Step 3:	• Leadership/pre-admissions staff meeting	
Milestone Description:	• Meet with leadership to obtain buy-in. Presentation to pre-admissions staff via PowerPoint.	
Deliverables	Due Dates	Accountable Person
• Complete knowledge check back quiz pre-admission staff	Jan 2021	Investigators
• PowerPoint presentation to pre-admission staff.	Jan 2021	Investigators

Resources Needed		
• Time with staff to present education and reference. Utilization of the learning resource center and anesthesia classroom. Mitigate risks by setting a specific time and date for training.		
Expected Level of Benefit		
• Educate staff on how to complete the CPAQ8 questionnaire and chronic pain screening tool to obtain buy-in for a change in practice. • Having written recommendations allows the staff initial education on the project but also allows for future reference when needed.		
Step 4:	• USUHS VPR submission and approval/Phase 1 implementation	
Milestone Description:	• Preoperative nurses ensure 100% completion of the pain screening tool on patients being interviewed for neuro-spine and major joint surgeries. • Pre-admissions nurses ensure completion of CPAQ8 for patients with pain greater than three months.	
Deliverables	Due Dates	Accountable Person
• Obtain approval from USUHS VPR • Retrospective chart review • 100% completion of the pain screening tool • 100% completion of demographics • 100% of pain providers and current treatment • 100% completion of the CPAQ8 for patients with pain greater than three months.	January 2021 - March 2021	Investigators
Resources Needed		
• Copies of the Chronic Pain Assessment Questionnaire for every patient.		
Expected Level of Benefit		
• Providing necessary resources and ensuring every patient completed a pain screening tool and questionnaire if applicable		
Step 5:	• Data collection Phase 1 and dissemination	
Milestone Description:	• Collection of Phase 1 findings, synthesis of information and PowerPoint presentation to anesthesia staff.	
Deliverables	Due Dates	Accountable Person
• Data collection phase 1 • Professional PowerPoint presentation with 100% staff exposure	Mar 2021 April 2021	Investigators Investigators
Resources Needed		

- Completed pain screening tool and CPAQ8 questionnaires
- Time to develop a PowerPoint presentation
- Scheduling availability of leadership and anesthesia staff in the common area
- Discuss presentation with colleagues and experts to ensure accuracy of information

Expected Level of Benefit

- Provide the evidence to support multimodal anesthesia recommendations..

Step 6:	• Provide recommendations to leadership for feedback and acceptance
Milestone Description:	• Conduct meetings with medical center leadership. • Measurable Goal: approval of executive leadership to proceed with the project proposal.

Deliverables	Due Date	Accountable Person
• Summarized raw data with need for standardized chronic pain guideline	May 2021	Investigators and department heads of the anesthesia department.

Resources Needed

- Scheduled meetings with department leadership.
- Hospital costs associated with inpatient stays by insurance.
- Reimbursed costs of medications covered by insurance.

Expected Level of Benefit

- Positive leadership feedback will facilitate staff compliance.

Step 7:	• Implementation of evidence-based recommendations throughout the anesthesia unit.
Milestone Description:	• Standardized evidence base guideline willingly implemented into daily activity by staff providers

Deliverables	Due Dates	Accountable Person
• Staff education phase 2 • Phase 2 Data collection	April 2021 July 2021	Investigators Investigators

Resources Needed

- Time for staff to implement evidence based standardized recommendations
- Continued education regarding recommendations.

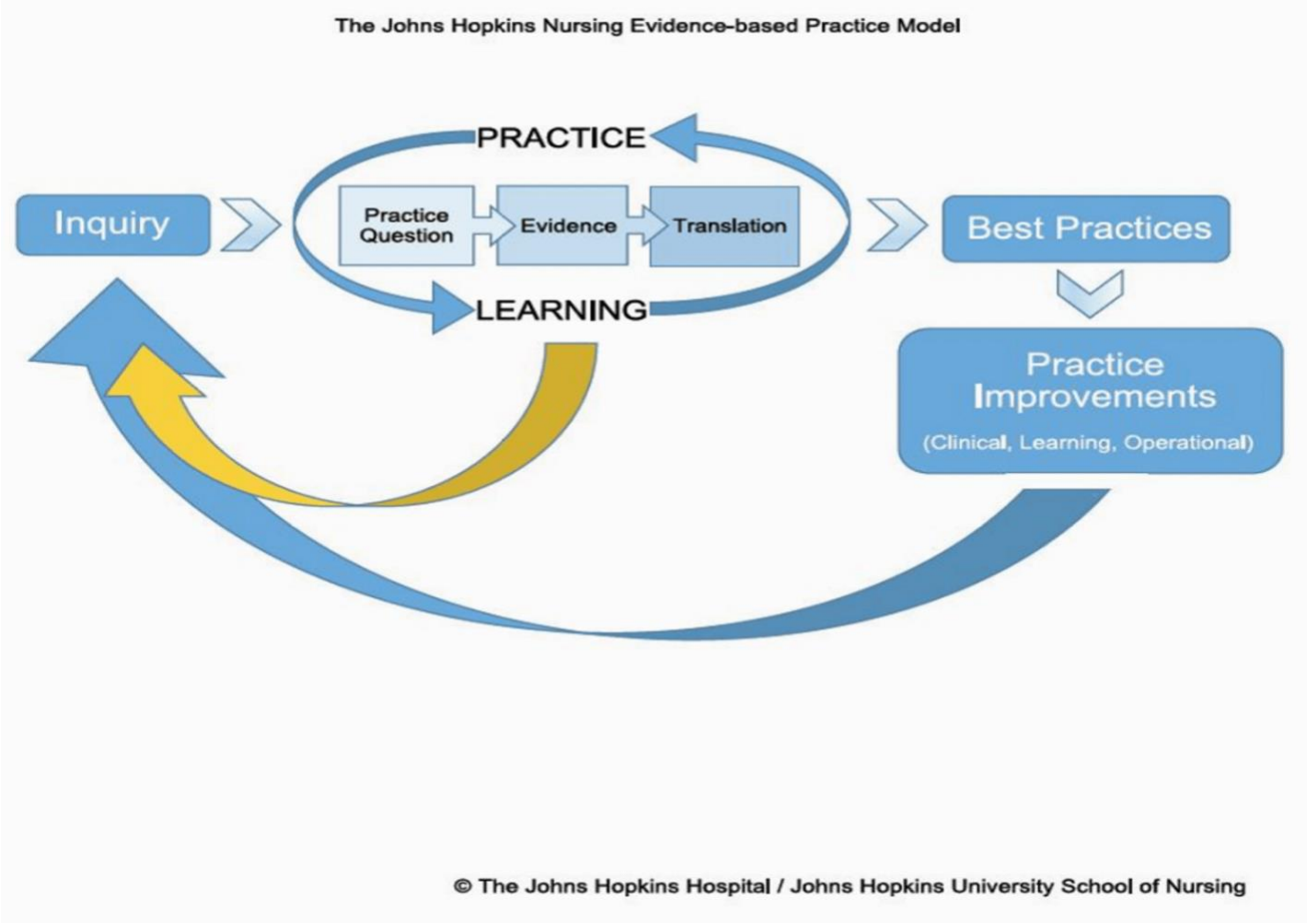
Expected Level of Benefit

- Department adoption and compliance with recommendations.

Step 8:	• Re-evaluate the recommendations effect on the patient population and validate purpose.

Milestone Description:	• Assessment of recommendations affects the patient population .	
Deliverables	Due Dates	Accountable Person
• Compare data from phase 1 to phase 2 • Determine if recommendations had an effect on patient population • Prepare poster for USUHS research week	August 2021 August 2021 August 2021	Investigators Investigators Investigators
Resources Needed		
Expected Level of Benefit		
• Ensure that proposed recommendations are suitable, tailored and effective for the patient population and staff.		
Step 9	• Provide data results to anesthesia leadership/USUHS faculty	
Milestone Description:	• Conduct meetings with medical center leadership. • Measurable Goal: approval of executive leadership to proceed with the project proposal.	
Deliverables	Due Dates	Accountable Person
• Data to leadership/USUHS faculty • USUHS research week	September 2021 May 2022	Investigators
Resources Needed		
• Microsoft PowerPoint Presentation		
Expected Level of Benefit		
• Presentation of a problem with solution to a Mass audience of health care workers		
Step 10:	• Revision and sustainment of the project.	
Milestone Description:	• Revision of the project and education of champions to maintain the project.	
Deliverables	Due Dates	Accountable Person
• Develop Formalized ERAS Protocol. • Revise projects to improve possible shortfalls and sustainment. • Educate the champion on the importance of this project and the tools needed to sustain it.	October 2021 December 2021 December 2021	Investigators
Resources Needed		
• Time to evaluate projects and recommendations from experienced staff on how to improve and help sustain the project. • Time to educate superusers to ensure competence and ability to sustain the project.		
Expected Level of Benefit – A formalized ERAS protocol will be implemented for sustainment of the project		

Appendix I
Organizing framework



https://www.hopkinsmedicine.org/sebin/v/d/2017%20EBP%20Model.png

Appendix J
Procedural Steps

Project Year 1 (2020)												
Activity/Month	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
PICOT question				X								
Literature Review				X	X	X	X	X	X	X	X	
Data Analysis Plan							X	X	X	X	X	
Protocol Creation and Approval: • Create multimodal anesthetic recommendations									X	X	X	
Site IRB Submission and Approval												X
Protocol Creation and Approval: • Leadership Meetings • Approval for project												X
Project Year 2 (2021)												
Activity/Month	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Pre-admissions Education Phase 1: • Presented at staff meeting via PowerPoint • Knowledge checkback quiz	X											
USUHS VPR Submission and Approval	X											
Implement Phase 1: • Screening tool/Retrospective Chart Review	X	X	X									
Data Collection Phase 1	X	X	X									

Staff Education Phase 2: • Multimodal recommendations presented at staff meeting via PowerPoint				X								
Implement Phase 2 multimodal anesthetic recommendations					X	X	X					
Data Collection: • Staff compliance • Increased time to first opioid • Decreased total opioid consumption • Decreased hospital length of stay					X	X	X					
Data synthesis and comparison of Phase 1 to Phase 2 data ● Prepare poster for USUHS research week								X	X	X	X	X
Dissemination of Data: • Leadership • USUHS faculty									X			
Formalized multimodal recommendations to anesthesia department										X		
Revision and Sustainment								X	X	X	X	X

Project Year 3 (2022)												
Activity/Month	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
Dissemination of Data: • USUHS Research Week					X							

Appendix K

Pre-Admissions Nurse Knowledge Check Back Quiz

1. Which patients will you ask about pain greater than 3 months?	Ortho Patients	Neuro-spine Patients	OB GYN Patients	All patients
2. Which patient will you administer the CPAQ8 to?	Ortho Patients	Neuro-spine patients	OB GYN patients	Patients identified having pain greater than 3 months
3. Where will the pain greater than 3 months be recorded?	On the physical record	In the systemic review comments section	With their allergies	In the pain comments section

Appendix L
Data Analysis Table: Phase 1

Population		Variable Name	Variable Description and type of measure	Data Source	Possible Range of Values	Level of Measurement	Time Frame for Collection	Statistical Test	Decision Rule
Event	**IV**	1. Age 2. ASA class 3. Type Procedure 4. Sex 5. Duty status 6. Followed by provider 7. Pain >3mo	Variable description: Demographics Measure Type: Process	EHR	Multiple	1. Ratio/Interval 2. Ordinal 3. Nominal 4. Nominal 5. Nominal 6. Nominal 7. Nominal	60 days	N/A	N/A
	DV	CPAQ-8 Score	Variable description: Quantitative measurement of pain acceptance. Measure Type: Outcome	CPAQ 8 Form	0-48	Ordinal	60 days	N/A	N/A

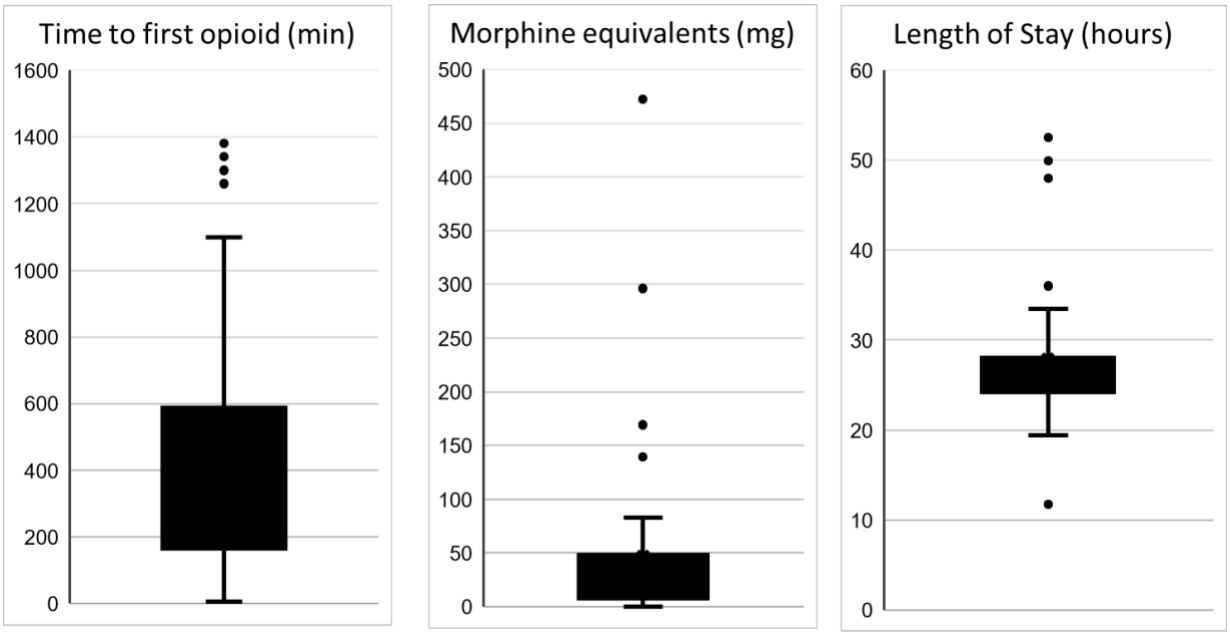
Appendix M

Data Analysis Table: Phase 2

Population		Variable Name	Variable Description and type of measure	Data Source	Possible Range of Values	Level of Measurement	Time Frame for Collection	Statistical Test	Decision Rule
Chronic pain patients undergoing major joint or neuro-spine	**IV**	Provider utilization of Anesthetic recommendations for the Management of chronic pain patients	Variable description: Department lacks anesthetic management protocol for chronic pain patients undergoing major joint or neuro-spine surgery. Measure Type Process	Evidence based literature	0. No interventions utilized. 1. one intervention utilized. 2. two interventions utilized 3. three interventions utilized 4. four interventions utilized	Nominal	April-May 2021	N/A	Patients presenting for surgery with pain lasting >3 months
	DV	1. Time to 1st opioid administration 2. Total opioid consumption 3. Total hospital length of stay 4. Provider survey	1. Time of 1st opioid request by patient 2. Total opioid consumption 3. Total hospital length of stay 4. Provider practice satisfaction (Likert Scale) Measure Type Outcome	1.EHR 2.EHR 3.EHR 4.Provider survey	1. 0-48hr 2. Total opioid consumption 3. Total hospital length of stay 4. 1 - 5 (where 1 = strongly disagree and 5 = strongly agree)	1. Interval/Ratio 2. Interval/Ratio 3. Interval/Ratio 4. Ordinal		1. T-test 2. T-test 3. T-test 4. N/A	1. Evaluation of electronic health records time to 1st opioid administration. 2. Evaluation of electronic health records to evaluate total opioid consumption. 3. Evaluation of electronic health records to evaluate total hospital length of stay. 4. Recommendations useful?

Appendix N
Whisker Plot

Major Joints



Neuro-spine