The Use of an Enhanced Recovery Bundle in Surgical Spine Patients to Reduce Opioid Requirements, Improve Patient Comfort, and Shorten the Length of Stay

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PART I: DNP PROJECT PROPOSAL

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Abstract

Purpose: The number and cost of spine surgeries have increased over the past decade. Various perioperative interventions continue to provide care for spine surgical patients despite evidence indicating that Enhanced Recovery After Surgery (ERAS) consistently decreases the stress response to surgery and improves patient outcomes.

Methods: A multidisciplinary evidence-based quality improvement (QI) project was implemented in a community-based acute care facility to address an identified gap in best practice. As the gold standard in perioperative care, the ERAS protocol provided a preoperative oral carbohydrate drink (CHO), acetaminophen, and gabapentin to existing interventions for a more complete ERAS spine bundle.

Results: This scholarly quality improvement (QI) project found a statistically significant reduction in total morphine milligram equivalents (TMME) required in the post-anesthesia recovery unit (PACU). Patients had improved comfort that was not statistically significant, in the PACU with a reduction in the need for postoperative nausea and vomiting (PONV) medications, and the length of stay (LOS) in the PACU increased slightly but was not statistically significant.

Discussion: Enhanced Recovery After Surgery (ERAS) guidelines are reproducible evidenced-based practice models with a known impact on patient outcomes and satisfaction without an increase in readmission or complications. The use of a QI ERAS spine bundle found that patients not only required less narcotics in the PACU but also needed less PONV medication for comfort. This QI ERAS bundle is evidence that the use of multimodal analgesia and CHO combined with existing ERAS spine interventions is vital not only to reduce patient exposure to unnecessary narcotics but improve comfort. Individually, these interventions do not appear impactful, but patient outcomes are positively impacted when bundled together in a care bundle or model. LOS

can be a challenge to quantify and evaluate for accuracy when bed and staffing shortages are a constant problem to patient recovery and workflow in a facility post-pandemic. For the future, a better LOS measurement could have been the arrival time in PACU to discharge home. Additional QI ERAS projects evaluating patients' TMME post-surgery to discharge home, and patients' satisfaction surveys would be a valid next step in improving an ERAS spine bundle. These findings also show the impact of inexpensive and simple interventions for other surgical specialties in reducing TMME and improving patient comfort.

Keywords: Enhanced Recovery after Surgery, ERAS, spine surgery, acetaminophen, Tylenol, gabapentin, oral carbohydrate

The Use of an Enhanced Recovery Bundle in Surgical Spine Patients to Reduce Opioid Requirements, Improve Patient Comfort, and Shorten the Length of Stay

Spinal disorders and back pain (LBP) are among the most common health problems found in the U.S. healthcare system affecting people of all ages and socioeconomic levels (Fatoye et al., 2023). The incidence of spine surgery has increased by 220% over the last two decades, and in 2015 close to 80 lumbar fusions were performed per 100,000 United States (U.S.) adults (Gerlach et al., 2022). Spinal fusion procedures average $27,600 per patient per hospital stay in the U.S. (Gerlach et al., 2022). Hospitals across the country are experiencing the ever-increasing costs associated with providing safe patient care. To curtail healthcare costs, and improve patient outcomes, the Centers for Medicare and Medicaid Services (CMS) have implemented a pay-for-performance model of reimbursement to reimburse healthcare systems for care provided based on patient outcomes. With the increased frequency with which spine surgeries are being performed and the high costs and reimbursement stipulations associated with these procedures, healthcare organizations have been motivated to rethink procedural processes for spine surgeries, moving from an in-patient model to an outpatient mode to improve efficiency and quality of services while maximizing reimbursement potential.

The U.S. on average spends 100 billion dollars annually both directly and indirectly on LBP (Smith et al., 2019). Large amounts of money are spent annually on numerous interventions for LBP that assist in improving people's quality of life. Patients with LBP can seek treatment with pain specialists and receive injections to alleviate pain and/or undergo spine surgery to address LBP. Depending on the underlying pathology, various surgical procedures can be performed such as spinal fusions, laminectomies, and minimally invasive microdiscectomies. Spine surgery often ameliorates LBP and improves the quality of life for patients, but a patient's

recovery depends on the invasiveness of the spinal surgery, comorbidities, and possible complications that can arise after surgery. Surgeons, anesthetists, and nurses can alter the course of recovery, decreasing complications and the requirement for pain medications intraoperatively and postoperatively by implementing evidence-based protocols.

Enhanced recovery after surgery (ERAS) pathways are multidisciplinary guidelines aimed at decreasing surgical stress response, optimizing the physiological function of patients, and facilitating a quicker recovery from surgery (AANA, 2023b). Furthermore, with an evidence-based protocol patient outcomes are improved, hospital expenditures are decreased, and lower narcotic use is required for surgical patients (AANA, 2023b).

Background

The cause of LBP is often unknown and affects an estimated 250 million people (Suman et al., 2019). LBP is the most commonly occurring musculoskeletal disorder in the world and costs the U.S. about 91 billion dollars (Suman et al., 2019). The pain can be debilitating and is associated with high direct and indirect costs due to missed days at work and disability. LBP and various spine diseases can often be managed conservatively without surgery, but many times patients do require surgical interventions. The average cost associated with surgical spine fusions is suggested to be 7% of the total healthcare costs annually (Gerlach et al., 2022). Despite this cost, there is no unified consensus on how to measure the quality of surgical spine services or the value determined by the ratio of quality to cost. Medical decisions will be made based on cost if fee-for-service models continue, not only in LBP and spine surgery but also in other areas of medicine. Pay-for-performance quantifies the quality of care a surgical spine patient receives, allowing impartiality among patients and the recreation of the same patient outcomes in other facilities worldwide (Gerlach et al., 2022). Spine surgery should have

universal metrics to evaluate the efficacy and impact on patient outcomes, and ERAS for spinal procedures provides an evidence-based approach to consistently meet that expectation.

Over fifty years ago, Dr. Henrik Kehlet studied the surgical stress response in people who had received steroid treatment (Rigshospitalet, 2023). Since this early study, Kehlet devoted his life's work to ERAS to improve patient outcomes after surgery across the world and transform all surgical specialties. Kehlet chose to study why patients were hospitalized and retrospectively determine how and why patients had the specific outcomes they did. He then worked to reduce these causes for future patients (Rigshospitalet, 2023). His work has evolved over the decades into the ERAS protocols and has been adopted in hospitals across the world as best practice standards of care. The ERAs protocol utilizes evidence-based protocols to guide standardized preoperative, inter-operative, and postoperative interventions to decrease patients' stress response to the surgical process (BJS Academy, 2023; Rigshospitalet, 2023). There are an estimated 300 million surgeries performed in the world annually and due to the implementation of ERAS protocols patient outcomes have substantially improved since the inception of these specific protocols and the ERAS Society in 2001 (Rigshospitalet, 2023).

Bardram et al. (1995) introduced the concept of reducing the length of stay (LOS) to 2-3 days in patients 70 years or older diagnosed with colon cancer who underwent laparoscopic colon surgery. The combination of laparoscopic surgery, epidural analgesia, and the return of oral nutrition decreased nausea and vomiting, and postoperative ileus (Bardram et al., 1995). The findings showed promise for the future of reducing the surgical stress response and the acceleration of surgical recovery with a multimodal approach.

Kehlet (1997) introduced a multimodal approach to postoperative recovery in the late 1990s known as the "fast track" era that addressed the surgical stress response and the demands

placed on organs. Over the years, Kehlet's work evolved into the present-day enhanced recovery after surgery protocol that incorporates a multidisciplinary, multimodal approach to pre-operative, intra-operative, and post-operative care to improve patient outcomes (Kehlet, 1997). Initially, ERAS was utilized to improve patient outcomes for colorectal surgery. Due to the success of the protocols in improving patient outcomes, ERAS has now been applied to other surgical specialties with similar findings and positive patient outcomes. There are slight variations or adjustments needed in the ERAS protocols depending on the surgery, but the key elements of the enhanced recovery pathways are still the same. The focus of the protocol is patient and family education, patient optimization by primary care and specialists before surgery, decreased fasting times by allowing clear liquids and carbohydrate drinks up to four hours before surgery, and the use of multimodal analgesics with selective opioid administration. The ERAS pathway promotes a high carbohydrate drink preoperatively, non-narcotic medications throughout the perioperative period, regional blocks, goal-directed intravenous (IV) fluid management, and preemptive nausea and vomiting medications based on the patient's preoperative nausea and vomiting (PONV) risk score. (AANA, 2023b; Debono, Wainwright, et al., 2021).

Hospitals with established ERAS programs have shown a reduction in patient complications, LOS, and hospital costs. Patients and families feel more empowered and satisfied with their healthcare. Therefore, the Agency for Healthcare Research and Quality (AHRQ) Safety Program has recommended the adoption of ERAS by all US hospitals (Agency for Healthcare Research and Quality, 2017).

Current surgical protocols compound the opioid crisis in our country. Opioid misuse remains a leading cause of accidental death, and often the first episode of opioid consumption

can be traced to the perioperative period (AANA, 2023b). ERAS also creates a strong partnership between the patient, anesthetist, and surgical team to support a safer plan of care for pain management. Patients are active participants in their care with realistic pain expectations following surgery and reliance on opioids is decreased, lowering the future risk for addiction and abuse (Brummett et al., 2017).

The current practice setting is a 210-bed level two trauma center in a suburb outside of Chicago, Illinois. There is inconsistent utilization of ERAS protocols based on anesthesia practitioners and the preferences of surgeons. Total joints, hysterectomies, and colorectal service lines have implemented ERAS protocols with little success. An evidence-based approach to pre-operative, intra-operative, and post-operative care has not been fully translated into the remaining surgical service lines in the hospital. The pathway is loosely followed by surgeons and anesthetists as there are no strict guidelines for integration into practice. A unified multidisciplinary consensus for pre-operative, intra-operative, and post-operative care is lacking.

The implementation of ERAS has shown an average savings of $639.06 to $5,560 per patient (Chipollini et al., 2017; Golder & Papalois, 2021; Schmidt et al., 2016). In addition, an improvement in patient comfort and outcomes can be seen through decreased LOS by three to four days on average, and decreased use of opioids intra-operatively and post-operatively, with a reduction in 30-day readmission rates and costs (Chipollini et al., 2017; Thiele et al., 2015; Wick et al., 2015). The ERAS Society continues to publish new research and add to the expanding surgical service protocols for different types of surgical specialties. To assist in worldwide adherence, the ERAS Society has an audit system to help hospitals start new ERAS protocols or improve conformity of ERAS from facility to facility (Golder & Papalois, 2021).

Problem Statement

The focus of ERAS protocols is to utilize known evidence-based practices to unify a multidisciplinary team to not only improve the quality of the entire surgical experience but to also decrease the recovery time after surgery so patients can reach their full potential in life. With the ever-increasing number of surgeries across the world each year and the aging population with multiple comorbidities, ERAS has had the greatest impact on patient outcomes when compared to other interventions (Kehlet, 2020). The purpose of this DNP quality improvement project was to implement an evidence-based multidisciplinary multimodal protocol to promote recovery after surgery for patients undergoing spine surgery to decrease opioid use and improve patient comfort preoperatively, intraoperatively, and postoperatively.

Organizational Needs Assessment of Project Site

Inconsistent use of ERAS evidence-based protocols at this practice location varies depending on anesthesia practitioner and surgeon preferences and has only been implemented for three specific procedures: laparotomies, total joints, and hysterectomies. The implementation of the ERAS pathway has been loosely followed by the multidisciplinary providers, and inconsistently applied which has resulted in a lack of consistent, structured preoperative, intraoperative, or postoperative guidelines for the various surgical service lines offered at this organization. The Agency for Healthcare Research and Quality (AHRQ) Safety Program for ERAS 2017 recommended the implementation of ERAS pathways in U.S. hospitals due to the positive impact on patient benefits, reduced complications, and LOS (Agency for Healthcare Research and Quality, 2017).

In addition to the AHRQ recommendations, the anesthesia department had an external audit in the past two years to assess the efficiency of preoperative, intraoperative, and postoperative care protocols and patient outcomes. The audit identified gaps in clinical practice

and highlighted the need for a process improvement plan to implement the consistent use of ERAS protocols within the hospital for all surgical patients. Findings from the gap analysis specifically found that uniform preoperative orders are lacking as well as adequate preoperative anesthesia testing (PAT). Best practice guidelines endorsed and published by the American Association of Nurse Anesthesiology (AANA) recommend ERAS for a more uniform perioperative, intraoperative, and postoperative clinical pathway (AANA, 2023b; Debono, Wainwright, et al., 2021).

Furthermore, in the past year, there has been a push from the other two affiliated hospitals within the facility network to have unified ERAS guidelines with standard protocols for specific service lines across organizations. The community hospital has partnered with the MD Anderson Cancer Center (MDACC) to provide systematic treatment and care for patients diagnosed with cancer. In recent meetings, MDACC has requested that all three affiliated hospitals in the area provide uniform PAT and surgery-specific ERAS protocols.

Findings from the gap analysis have and will continue to inform the development and implementation of an integrated, interdisciplinary, multimodal approach to systematically address identified opportunities for improvement in surgical services. This DNP quality improvement project aimed to address the identified gap in clinical practice through the implementation of an evidence-based enhanced recovery after surgery care transition program based on current best practice standards.

Review of the Literature

The review of the literature was conducted using CINAHL and PubMed databases. The search terms included Enhanced Recovery after Surgery or ERAS and spine surgery. Search parameters included literature from 2018 to 2023. Initially, the CINAHL database returned 78

articles which was reduced to 71 after being filtered for full-text and academic journals. These articles were then reviewed and excluded if not pertinent to the existing topic and 16 articles were identified and 11 finally included. The PubMed database returned 123 articles which were reduced to 11 after being filtered for full-text and academic journals. These articles were then reviewed and excluded based on the same criteria used in CINAHL and yielded 11 articles. Once these articles were reviewed, only two were found to be pertinent to the existing topic, and one had already been retrieved from the CINAHL database. Articles from both databases were limited to clinical trials, meta-analyses, randomized control trials (RCT), consensus papers (CP), and systematic reviews (SR). Database articles were excluded for topics about tumors or lesions, oncology or cancer, craniotomies, neuromuscular scoliosis, peripheral nerve surgery, adolescents less than 18 years of age, technical comparisons for spine surgery techniques, non-English, orthopedic surgery, and chronic pain syndrome (CPS).

Two of the 11 articles were reviews that included many of the articles included in this literature review. One was a CP published in 2021 and the second was a SR that contained many articles within the 2021 CP in addition to articles published after 2023. These two articles were evaluated using the Johns Hopkins Research Evidence Appraisal Tool. Debono, Wainwright, et al. (2021) was a CP that reviewed 256 articles that included SR, RCT, and observational cohort studies on adults greater than 18 years of age who received lumbar spinal fusion surgery and ERAS protocols. The authors stated the purpose of the CP was to identify the most pertinent information for inclusion in the ERAS guidelines and not necessarily to provide a full summary of the literature. Debono, Wainwright, et al. (2021) used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system to rate the quality of evidence from the articles reviewed making recommendations for the use of the given ERAS topic. Contartese

et al. (2023) conducted an SR of extant literature to examine evidence-based interventions, measurements, and outcomes associated with ERAS-based "fast-track" spine surgeries. The stated eligibility criteria for inclusion in the SR were broader, inclusive of a variety of spine surgery techniques, ERAS, or fast-track protocols, but often lacked comparison groups. Specifically, the authors evaluated articles for inclusion that contained preoperative, intraoperative, and post-operative aspects and only included randomized or prospective studies. The included articles were evaluated by two reviewers who used the Quality Assessment Tools of the National Heart, Lung, and Blood Institute (NHLBI). A total of 57 articles were reviewed according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). Of the total, 46 were retrospective cohort studies, 10 were prospective cohort studies, and one was an RCT (Contartese et al. 2023).

Findings from the CP by Debono, Wainwright, et al. (2021) and the SR by Contartese et al. (2023) provided a comprehensive review of existing literature, reinforcing the efficacy of standardized evidence-based enhanced recovery protocols pre-, intra-, and postoperative in reducing surgical complications. The purpose of the CP was to provide the most updated evidence-based information for ERAS in lumbar spine fusion so current standards can be established in multidisciplinary practice settings where patient outcomes can be optimized (Debono, Wainwright, et al, 2021).

The SR concluded that ERAS interventions in other surgical service lines reduced LOS, increased patients' return to presurgical functional levels, decreased postoperative pain, and decreased spine surgery costs without increasing complications from ERAS and spine surgery (Contartese et al., 2023). Many studies included in the SR used a variety of pain medications, but the benefits appear not from the specific medications themselves, but from the multimodal pain

medication approach. In addition, early oral intake and early ambulation improved patient recovery, LOS, and return to a baseline functional capacity. With these positive findings, the authors emphasized the importance of each patient's role in the surgical preparation from the preoperative education to the surgical recovery process (Contartese et al., 2023). The results from the SR are auspicious, but the challenge still exists in determining to what extent each aspect of the ERAS protocols affects the decrease in surgical stress response; therefore, hastening improved patient outcomes and decreased LOS.

The findings from the literature review were very similar when compared to the conclusions made both by SR and the CP (Contartese et al.,2023; Debono, Wainwright, et al, 2021). Most articles were retrospective cohort studies, historical cohort, quality improvement studies, or quasi-experimental with small sample sizes of less than 100 (Doujun et al., 2021; Leng et al., 2022; Lu et al., 2023; Porche, et al., 2022; Smith et al., 2019; Soffin et al., 2020; Wang et al., 2020; Young et al. 2021). Garge et al. (2021) and Fiasconaro et al. (2020) had the largest ERAS patient cohort with 316 people and 265,576 respectively. The one RCT evaluated the quality of patient recovery with a secondary aim that assessed the LOS, opioid use, and time for patients to meet discharge requirements (Soffin et al., 2020). The study was small with no power analysis performed and only 25 patients received the ERAS interventions. Soffin et al. (2020) had mixed conclusions. Patients in the ERAS group did have higher scores on comfort postoperatively ($p=0.008$), but this waned after postoperative day 3. Furthermore, the median time to oral intake was shorter ($p=0.010$), the LOS of less ($p=0.112$), and less opioid consumption ($p=0.030$) was noted in the ERAS intervention group (Soffin et al., 2020). The Porche et al. (2022) study was a retrospective patient cohort receiving transforaminal lumbar interbody fusions (TLIF) of one to two levels. The specific ERAS interventions were categorized

based on pre-, intra, and postoperative areas. Of the 57 patients who received ERAS, LOS decreased from 4.6 to 3.6 days ($p<0.0001$) and intravenous daily total morphine milliequivalents (TMME) decreased from 36 to 8 ($p<0.0001$) without an increase in complications (Porche et al., 2022). Similarly, the Leng et al. (2022) historical cohort study evaluated patients who had an anterior cervical discectomy and fusions (ACDF) with or without ERAS. This study was very specific in defining the ERAS interventions that included non-pharmacology and pharmacology changes in patient treatments. These authors also found a reduced LOS and lower costs with the ERAS ACDF group, with higher patient satisfaction from the ERAS ACDF group and significantly fewer complications than the non-ERAS ACDF group (Leng et al., 2022). Furthermore, this study most closely aligns with the interventions already currently in use and the ones proposed for this scholarly project.

A few retrieved articles did not specifically mention the ERAS interventions utilized but did a retrospective generalized comparison from pre-ERAS to post-ERAS implementation (Debono, Sabatier, et al., 2021; Lampilas et al., 2021). Others like Feng et al. (2019) reviewed the percentage of ERAS interventions utilized on a given patient population. Lampilas et al. (2021) had a LOS that decreased from 6 to 3.33 days ($p<0.001$) and had a mean admission cost ($p=0.038$) that was lower with ERAS implementation. These articles typically reviewed LOS, morbidity, complications, and 30-day readmission rates and were less helpful in determining the most beneficial ERAS interventions to improve patient outcomes. Despite this, many articles highlight the importance of patients being stakeholders and being proactive in their care; therefore, these articles are still reviewed and summarized in this literature review (Debono, Sabatier, et al., 2021).

Duojun et al. (2021) was the one quasi-experimental study that evaluated LOS, but only

mentioned non-pharmacy ERAS interventions and focused on the surgical technique more than the utilized ERAS interventions. Furthermore, it was unclear in this article if patients received general anesthesia or local subcutaneous anesthesia and IV sedation intraoperatively (Duojun et al., 2021). Despite the lack of clarity, the article was still reviewed as the ERAS intervention group in the study had significantly lower Visual Analog Scale (VAS) scores for three days following surgery when compared to the non-ERAS group intraoperatively (Duojun et al., 2021). The study had a reduced LOS without complications for patients receiving ERAS and percutaneous endoscopic transforaminal discectomy (Duojun et al., 2021). Another article by Wang et al. (2020) did a retrospective cohort study and evaluated staff compliance with an implemented ERAS program. This was less helpful for the proposed project.

To date, the primary sources of literature about spine studies and ERAS are retrospective, non-randomized, or cohort studies. As many articles concluded, there is a need for more RCTs focused on ERAS and specific spine surgery techniques to explore the effect on patient outcomes (Contartese et al., 2023; Debono, Wainwright, et al., 2021; Leng et al., 2022; Soffin, et al., 2020). Soffin et al. (2020) theorized that LOS might be more of how discharge criteria are defined instead of a reflection of patients' true recovery from surgery. Even more specific research is needed to study specific interventions from ERAS protocols to learn what individual techniques have the most benefit to stress reduction, patient preparation, and outcome optimization. However, despite the lack of RCT with ERAS and spine surgeries, there is a plethora of evidence to support the efficacy of ERAS protocols in improving patient overall outcomes from other RCTs from other surgical specialties. Similarly, ERAS protocols make hospital organizations adhere to better care delivery through order sets that promote the achievement of ERAS goals and in turn lead to better patient outcomes (Soffin et al., 2020).

An additional secondary literature review was also conducted using these same two databases and combining three separate search terms: gabapentin and spine surgery; acetaminophen, Tylenol, and spine surgery; and oral carbohydrate (CHO) and spine surgery. Search parameters included literature from 2018 to 2023 and limited articles to clinical trials, meta-analysis, RCT, and SR. The CINAHL database returned 12 articles for gabapentin and spine surgery, and once articles were reviewed by the same criteria used in the initial literature review, three articles remained. In the same database, a search of acetaminophen, Tylenol, and spine surgery returned 14 articles and after review, two articles remained. The third search in CINHAL for CHO and spine surgery returned no results. The same three literature reviews were also conducted in the PubMed databases with the same search terms. Gabapentin and spine surgery initially returned 26 articles and after review, two remained. To note, these two articles were the same two articles found in the CINAHL search. The acetaminophen, Tylenol, and spine surgery search in the PubMed database found 45 articles that were then decreased to one. The third set of search terms, CHO and Spine surgery also returned no articles in PubMed. Ultimately, after the final review, only the RCT and meta-analysis were included (Peng et al., 2017; Raja et al., 2019)

Preoperative Recommendations

Patient Education

According to the literature, patient education and counseling in the preoperative period resulted in higher patient satisfaction, but there was less evidence supporting a reduction in postoperative pain or LOS. Spine surgery can result in unwanted negative side effects and with sufficient patient education before surgery, anxiety and concerns can be alleviated so recovery is not impacted (Lu et al., 2023). Furthermore, providing education in different mediums like oral

and written forms is better for reducing patient fears and anxiety (Contartese et al, 2023; Duojun et al., 2021; Garg et al, 2021; Leng et al., 2022; Debono, Sabatier, et al., 2021). When preoperative education provides detailed information on what to expect, not only has it been shown to improve patient satisfaction, but improves pain control after surgery (Golder, 2019; Smith et al., 2019). Proper patient education and planning can reduce canceled cases and delays and save healthcare dollars (Smith et al., 2019). Leng et al. (2022) provided their patients with a detailed handout that included the goals of ERAS, the analgesia component, the preoperative CHO, information on the type of procedure, expectations for rehabilitation after surgery, and postoperative follow-up visits. This level of detailed education improved patient satisfaction with the ERAS group ($p<0.05$) (Leng et al., 2022). Debono, Wainwright, et al. (2021) recommended the use of preoperative patient education despite the low quality of the evidence. Contartese et al. (2023) found that 86% of articles provided patient and family education that discussed the surgical procedure, potential complications, rehabilitation, and hospital discharge. Preoperative pain medication discussion only occurred in 33% of the articles. Patients are unable to reduce fear regarding pain when it is not discussed adequately before surgery. Furthermore, having actively engaged patients is a highly critical piece to a successful ERAS protocol implementation (Feng et al., 2019)

Prehabilitation

Prehabilitation is defined as the optimization of the functional capacity of patients before a surgical procedure and can determine how quickly patients can return to their normal physiological function (Debono, Wainwright, et al., 2021). Interventions often encompass exercise, nutrition counseling, and psychological assistance. The literature regarding prehabilitation is currently mixed as prehabilitation has been shown to improve recovery for

general surgery, but not necessarily LOS days for other surgeries like spine surgery (Leng et al., 2022; Debono, Wainwright, et al., 2021; Golder, 2019). Despite this fact, Leng et al. (2022) required presurgical patient assessments by both surgeons and anesthesia on every patient undergoing an ACDF with ERAS and did have significantly shorter LOS with improved patient satisfaction and decreased complications. However, the authors were not specific regarding the exact preoperative optimization entailed and what, if any, specific rehabilitation interventions were done (Leng et al., 2022). Porche et al. (2022) specified in their study that patients received a preoperative evaluation that not only included anesthesia, but also a multisystem evaluation that included cognitive, physical, and nutritional evaluations. The authors believed this contributed to a reduction in LOS from 4.6 to 3.6 days ($p<0.0001$), less administration of IV opioid use, and earlier ambulation ($p<0.0001$) (Porche et al., 2022).

At present, prehabilitation should be recommended for the frailer, more elderly patients with psychiatric illness or multiple comorbidities. Debono, Wainwright, et al. (2021) evaluated preoperative nutritional supplementation and found that LOS was decreased when preoperative oral nutritional supplements were given. The grade of the current evidence was still considered low regarding preoperative nutritional assessment and nutritional interventions, but the recommendation was still strong as other studies outside spine fusions have proven the benefits of optimized nutrition before surgery (Debono, Wainwright, et al., 2021). Contartese et al. (2023) found multidisciplinary consults, like dieticians or psychiatrists, occurred in 61% of the articles, and physical therapy was only included in 21% of the included articles (Contartese et al. 2023). Garg et al. (2021) referred patients preoperatively to nutrition if their body mass index (BMI) was less than 18.5 or greater than 30 and set a hemoglobin A1 goal of less than seven in diabetic patients. Furthermore, patients with advanced age were scheduled as the first cases of

the day, and severe osteoporosis was evaluated and optimized before surgery (Garg et al., 2021).

Doujun et al. (2021) mentioned that patients were evaluated by a psychologist for anxiety and depression before surgery to improve the mental state of ERAS patients and potentially improve recovery. These authors specifically state that prior research has shown that anxiety and depression are correlated negatively with postoperative recovery and return to quality-of-life baseline (Duojun et al., 2021).

Smoking Cessation

Smoking cessation before surgery for more than four weeks reduces respiratory complications and wound healing postoperatively, decreasing overall complications, but is not always made a requirement by researchers (Doujun et al., 2021; Garg et al., 2021; Leng et al., 2022; Porche et al., 2022; Staartjes et al., 2019). Garg et al. (2021) required 12 weeks of smoking cessation since a moderate quality of evidence exists with a strong recommendation for patient postoperative success. In addition, preoperative alcohol cessation for four to eight weeks before surgery also decreased postoperative cardiopulmonary complications, infection, ileus, delirium, bleeding, and deep vein thrombosis (Debono, Wainwright, et al., 2021; Garg et al., 2021).

Oral Carbohydrates (CHO)

Preoperative oral carbohydrate (CHO) intake lessens insulin resistance and the catabolic state of the body in patients undergoing surgery (Debono, Wainwright, et al., 2021). The AANA and the American Society of Anesthesiologists (ASA) nothing by mouth (NPO) guidelines allow clear liquids up to two hours before surgery. The quality of evidence is high, and the recommendation is strong for the use of CHO in surgery; however, limited spine fusion studies have been performed regarding routine CHO use (Debono, Wainwright, et al., 2021).

Leng et al. (2022) encouraged the ACDF ERAS patients to drink CHO up to two hours before surgery and found that patient satisfaction improved to a significant level ($p<0.05$) and PONV decreased but was not significant ($p>0.05$). Soffin et al. (2020) utilized a CHO drink four hours before surgery and found that patients were more comfortable compared to the non-intervention group up to postoperative day 3. Furthermore, patients returned quicker to eating and drinking compared to the non-ERAS group (Soffin et al., 2020). Lu et al. (2023) allowed CHO up to two hours before surgery and reported a reduction in LOS and lower hospital costs without an increase in complication rate or 30-day readmission rates.

Some articles did not include CHO preoperatively but allowed clear liquids up to two hours before surgery (Fiasconaro et al., 2020; Porche et, al., 2022). One article by Garg et al. (2021) administered an IV 5% dextrose solution overnight before surgery and a second by Staartjes et al. (2019) mentioned nothing regarding the NPO status for their study. The fasting period was included in 61% of articles from the systematic review of Contartese et al. (2023), and CHO loading four hours before surgery with clear and solid fasting was included in 42% of the studies.

Spine surgery from fusions to minimally invasive techniques lacks strong studies with evidence for CHO preoperatively. This is interesting given the plethora of studies in other surgical fields supporting the safety and efficacy of CHO use (Golder & Papalois, 2021). With the use of CHO comes the benefit of increased insulin sensitivity and a decrease in nausea, vomiting, thirst, anxiety, and catabolism (Golder & Papalois, 2021). By decreasing the catabolic state of the body, less glucagon and cortisol are released, which is part of the stress reduction response promoted by the ERAS Society research (Ljungqvist et al., 2020). The use of preoperative CHO decreases patient NPO discomfort, improves patient satisfaction, and

eliminates wide variability in blood sugar (Golder & Papalois, 2021; Leng et al., 2022).

Intraoperative Recommendations

Prophylactic Antibiotics and CHG

ERAS has several interoperative interventions. One is the use of prophylactic antibiotics for spine surgery. The evidence is lacking regarding the type of antibiotic agent and the dosing, but the administration of a broad-spectrum antibiotic like cefazolin 30 to 60 minutes before skin incision with redosing at four-hour intervals, is well-accepted evidence (Debono, Wainwright, et al., 2021; Garg et al., 2021; Leng et al, 2022; Porche et al., 2022; Smith et al., 2019; Staartjes et al., 2019). This intervention has a high quality of evidence and is strongly recommended. Furthermore, surgical skin preparation before the day of surgery with a chlorohexidine gluconate-type (CHG) or alcohol-based iodine solution has a high quality of evidence and a strong recommendation for the prevention of surgical site infection (SSI) (Franker et al., 2021; Garg et al., 2021).

Multimodal Medication

Multimodal medication can be taken preemptively in the preoperative setting as well as be utilized during surgery. Leng et al. (2022) used preoperative celecoxib, pregabalin, and acetaminophen and had a decrease in LOS, overall hospital cost, and nausea and vomiting with improved patient satisfaction. The RCT by Soffin et al. (2020) utilized preoperative oral acetaminophen 1,000mg and gabapentin 300mg and found both a reduction in IV patient-controlled analgesia (PCA) medication ($p<0.001$) and less opioid consumption in the first 24 hours postoperatively ($p=0.030$). The authors also found that pain scores were lower on postoperative day one ($p=0.005$) during the physical therapy session (Soffin et al., 2020).

The standardization of anesthetics intraoperatively is often determined by the policy and drug availability within a facility (Debono, Wainwright, et al., 2021). An example of this was found in Porche et al. (2022) where preoperative oral acetaminophen, duloxetine, gabapentin, and methadone were administered followed using IV dexmedetomidine, ketamine, lidocaine, and methadone intraoperatively. Furthermore, these same authors did mention the benefits of multimodal anesthetic strategies like the use of dexmedetomidine and ketamine in reducing pain with a lower occurrence of PONV (Debono, Wainwright, et al., 2021). Administering gabapentin preoperatively has been shown to decrease visual analog scale (VAS) scores at 12 and 24 hours and decrease TMME (Peng et al., 2017). Additionally, Contartese et al. (2023) found that 82% of the reviewed articles mentioned multimodal analgesia and pain medication. There is moderate to high-quality evidence recommending the use of medications other than opioids for other surgical procedures. A multimodal approach to pain medication in the operative setting has been shown to improve patient outcomes by lessening narcotics during and after surgery, lessening the possibility of patients requiring narcotics upon discharge, and reducing narcotic exposure (AANA, 2023b).

Normothermia and Normovolemia

Hypothermia has extensive supporting evidence that it increases blood loss, shivering, cardiac complications, SSIs, and LOS. Furthermore, based on unreputable evidence the AANA, ASA, Association of Perioperative Registered Nurses (AORN), and Anesthesia Safety Foundation (APSF) have advocated for almost twenty years for preemptive warming preoperatively and active warming throughout the surgical period (AANA, 2023; Sessler, 2021; Stanton, 2022). Therefore, the evidence is strong, and the recommendation is strong for prewarming and active warming through forced warming devices and intravenous (IV) fluid

warmers even before this literature review. Porche et al. (2022) controlled the temperature of the operating room to 25 degrees Celsius and actively warmed IV fluids and forced air-warming devices to non-operated areas but did not state the minimum that patient temperatures were allowed to fall. In contrast, Duojun et al. (2021) stated that the warming of IV fluids and the use of forced air warming devices were utilized to keep the temperature of patients no lower than 36 degrees Celsius. Soffin et al. (2020) achieved normothermia by using forced air warming devices and warmed IV fluids and raising the OR room temperature if both these interventions did not maintain normothermia between 36 to 38 degrees Celsius.

Goal-directed fluid administration is encouraged by the ERAS Society, but the evidence at this point is lacking in spine surgeries. IV fluid should be administered to keep patients as close to euvolemia as possible. (Debono, Wainwright, et al. 2021; Staartjes et al., 2019). The RCT targeted IV fluid administration and tailored it to hemodynamics and urine output, if a urinary catheter was used, but had no specific IV fluid technique or formula (Soffin et al., 2020). Along with the preoperative consumption of CHO and euvolemia, there is also a push for patients to return to normal diets as soon as they are able.

Postoperative Recommendations

Pain Control

Postoperative pain from spine surgery can vary greatly and can often depend on the surgical technique, surgeon, and multimodal pain modalities used (Lu et al., 2023). Pain after spine surgery can be multifactorial from nociceptive, inflammatory, or neuronal pain and solely using opioids does not always manage all these types of pain (Raja et al., 2019). By utilizing a multifactorial approach to postoperative surgical spine pain with opioids, NSAIDs, and other adjuncts, patients have better pain control and relief with less risk of chronic postsurgical pain

(Raja et al., 2019). Patients who are noted to be on opioids before surgery should receive a pain consult to assist with pain management after surgery (Smith et al., 2019). Lu et al. (2023) opted for a multimodal technique with an opioid-sparing technique with their ERAS protocol and found a reduction in opioid use without a significant increase in pain scores in the ERAS intervention group. Pain control postoperatively is poor in more than 50% of patients after spine surgery (Debono, Wainwright, et al. 2021). According to Contartese et al (2023), multimodal pain management was included 89% of the time in the articles reviewed. (Contartese et al., 2023). According to the literature, the opioid-sparing drugs of choice were acetaminophen, gabapentin, pregabalin, celecoxib, and non-steroidal anti-inflammatory drugs (NSAIDs). When postoperative pain is not adequately controlled, patients can develop CPS. Standardizing the multimodal pain medication of ERAS can reduce the use of opioids in recovery, reduce the possible misuse of narcotics, and reduce the risk for CPS (Debono, Wainwright, et al. 2021). Acetaminophen is the safest and least expensive nonopioid medication available to patients. The use of acetaminophen, either orally or IV, should be a standard of ERAS practice. Furthermore, RCT included in the CP utilized not only acetaminophen but also NSAIDs, gabapentin, magnesium sulfate, local anesthetic infusions, ketamine, and dexmedetomidine. Porche et al. (2022) utilized acetaminophen, duloxetine, gabapentin, and methadone and had a reduction in IV opioid use from 35.7 TMME to 8.2 TMME ($p<0.0001$). Interestingly, there were no noticeable differences in pain scores from the ERAS and non-ERAS groups except for scores noted on day zero following surgery ($p= 0.01$) (Porche et al., 2022). The quality of evidence for the use of multimodal analgesia protocol is moderate, but strongly recommended (Debono, Wainwright, et al. 2021; Duojun et al., 2021; Garge et al., 2021; Lu et al., 2023; Porche et al., 2022; Young et al., 2021). Smith et al. (2019) noted the inclusion of additional ketamine administration with the

induction of anesthesia for patients with chronic pain to assist with better pain control postoperatively.

Post Operative Nausea and Vomiting (PONV)

PONV is a high-risk factor for 80% of all surgical patients and utilizing a PONV risk assessment is important in ERAS and spine surgeries. Patients who are female, nonsmokers, and have a history of PONV or motion sickness have a higher risk of developing PONV (Apfel et al., 1999). Soffin et al. (2020) assessed for PONV risk and applied scopolamine patches preoperatively for patients at high risk with a score of three or four for PONV. Smith et al. (2019) administered dexamethasone and ondansetron to all patients; however, if a patient had an Apfel PONV score of more than two, aprepitant 40mg was given additional preoperatively. These interventions by Smith et al. (2019) assisted in the decreased (24% compared to 40% or p=0.0125) need for rescue antiemetics in the ERAS group in the PACU. The use of multimodal medications for PONV prophylaxis, routine use of a risk assessment scale for PONV, and PONV rescue from a different class of anti-emetic has a strong quality of evidence and is highly recommended (Debono, Wainwright, et al., 2021; Leng et al, 2022). The use of PONV prophylaxis or rescue medications was limited in the Contartese et al. (2023) article. Fiasconaro et al. (2020) found a reduction in LOS when antiemetics and steroids were administered together for PONV.

Early Mobilization

No level-one articles evaluated early mobilization after spine surgery, but in cohort studies, early mobilization after spine surgery did reduce LOS and morbidity. The use of early physical therapy (PT) after surgery in high-risk patients can potentially decrease the side effects of bed rest postoperatively. In addition, early PT returns patients to their functional activity level

faster reducing pulmonary complications and thromboembolisms, muscle wasting, insulin resistance, and impaired oxygenation of end organs (Debono, Wainwright, et al., 2021). Fiasconaro et al. (2020) in their retrospective cohort study found that the early use of PT had the greatest patient outcomes. Contartese et al. (2023) supported early mobilization within 24 hours after surgery, noting that 72% of studies referenced early mobilization to improve patient recovery outcomes. Soffin et al. (2020) promoted early ambulation by requiring patients to be out of bed or working with physical therapy within two hours of being admitted to the PACU.

The primary outcome for ERAS protocols when used in spine surgeries has demonstrated a decrease in LOS for post-surgical patients. Leng et al. (2022) stated that having clear discharge criteria for ERAS ACDF patients contributed to reduced LOS in their study. To note, this study did occur in China where there are societal rules regarding when hospitals can discharge patients given members of society do not have easy or quick access to medical services if an emergency arises (Leng et al., 2022). There was no change or a reduction in adverse outcomes and readmission when ERAS was compared to non-ERAS interventions (Debono, Sabatier, et al., 2021; Leng et al, 2022). Furthermore, patients had increased satisfaction from the use of ERAS and a faster return to function.

Guidelines, Standards, and Evidence-based Best Practices

Enhanced Recovery after Surgery Society

Guidelines, standards, and evidence-based best practices for enhanced recovery after surgery are currently researched and published by the Enhanced Recovery after Surgery Society. An international group of healthcare providers founded in 2010, the Society is a strong governing association for ERAS (Golder & Papalois, 2021). The purpose of this group of provider researchers is to ensure that current healthcare providers have the most efficacious best

practice standards and practice guidelines for patient care available. They continuously research and publish articles about ERAS protocols and have expanded the protocols for all surgical service lines. Without consistent evidence-based guidelines healthcare providers can become inundated with complex interventions that require a multidisciplinary team and patient outcomes can suffer (Golder & Papalois, 2021). All ERAS guidelines are maintained and available on the society's website and contain 34 surgery-specific ERAS guidelines or links to consensus papers that are continually being updated to reflect the most recent evidence (ERAS© Society, 2023).

American Association of Nurse Anesthesiology (AANA)

The American Association of Nurse Anesthesiology (AANA) is a national professional association for certified registered nurse anesthetists (CRNAs) that assists with the advancement of nurse anesthesiology with evidence-based practice standards and research (AANA, 2023a). Furthermore, the AANA supports providers holistically to balance clinical practice and life, so they are better equipped to provide high-level anesthesia care to their patients. The AANA advocates for CRNA scope of practice and policy change at the national level, as well as assists in connecting CRNAs to their local state associations (AANA, 2023 a).

The AANA promotes the utilization of valid and evidence-based guidelines for ERAS (AANA, 2023b). The AANA has recognized the significance of evidence-based standardized protocols in the surgical care of patients and has a dedicated website to ERAS. In addition, the AANA states ERAS pathways are an orchestrated coordination of care and services that begins with patients at home before surgery and then transcends the preadmission, preoperative, intraoperative, and postoperative phases of surgery until patients are discharged home safely (AANA, 2023b). The AANA provides evidence-based guidance on ERAS prehospital, preoperatively, intraoperatively, postoperatively, post-discharge, audit compliance, and after-

surgery information. (See Appendix A for the ERAS Program Phase Chart). They also discuss the advantages of implementation, how to implement the protocols, the role of an ERAS coordinator, and how certified registered nurse anesthetists (CRNAs) contribute to successful patient outcomes. The AANA maintains a repository of ground-breaking articles and white papers as a resource for healthcare providers (AANA, 2023b).

Evidence-based Practice: Verification of Chosen Option

A multidisciplinary quality improvement (QI) project was implemented based on the evidence-based best practices of the ERAS protocols. Extant literature and findings from the organizational gap analysis served to guide and inform the development and implementation of this project. Patient education for the enhanced recovery bundle for spine surgery was added to an already implemented preoperative patient education video. An oral carbohydrate drink, acetaminophen, and gabapentin were added to the current preoperative use of CHG wipes, prophylactic antibiotic use, and balanced intraoperative anesthetic technique to further improve patient outcomes. The goal of the project was to answer the PICOT questions: In a community-based medical center (D), how does the implementation of an evidenced-based ERAS bundle for spine surgical patients (I) compare to the current practice (C) by altering patient opioid requirements, comfort, and LOS (O) over two months (T)?

Theoretical Framework or Evidence-based Practice Model

From the available evidence, ERAS protocols have a larger influence on patient outcomes than any other intervention in the last twenty years (Kehlet, 2020). The evidence-based theoretical framework that guided this QI project was the ERAS guidelines established by the ERAS Society (2023). Since the establishment of the ERAS Society in 2010, the chasm between evidence and implementation has decreased, resulting in better overall patient outcomes after

surgical procedures. Furthermore, the Agency for Healthcare Research and Quality (AHRQ) Safety Program has endorsed the use of ERAS due to the available evidence supporting quality patient outcomes from measurable outcomes (Agency for Healthcare Research and Quality, 2017). Patients should be viewed as unique individuals with specific goals and needs, but this can be overshadowed by complex healthcare systems, patient comorbidities, and a large multidisciplinary team. Without clear evidence-based objectives for patients and providers, best intentions can fall short. ERAS protocols form a specific guide that can be tailored to each patient while holding patients and providers to specific standards of care.

The ERAS protocols from the ERAS Society and promoted by AANA have six overarching umbrellas for care, with specific interventions within these overarching care areas, which are noted in Appendix A and B. All interventions require a multidisciplinary approach and communication to ensure optimized outcomes are achieved. The prehospital phase entails the patient and family education that includes the expectation of pain after surgery and realistic pain management with appropriate medication. This phase also requires the optimization of patient comorbidities and rehabilitation of patients who meet preselected criteria. The second phase is the preoperative phase which also contains the QI project interventions. The consumption of 12 ounces of CHO two hours before surgery occurred in the prehospital setting before the patient arrived at the facility. In the preoperative phase, a nurse administered the multimodal medications that included oral acetaminophen 975 mg and gabapentin 300mg. If a patient had a score of 3 to 4 on the PONV risk assessment, either a scopolamine patch was applied behind an ear for 24 hours and/or oral aprepitant 40mg was given before surgery in the preoperative area. The third phase, the intraoperative phase promotes the use of multimodal analgesia with opioid-sparing medications, normovolemia, PONV prophylaxis, normothermia, normoglycemia, and the

limited use of drains and tubes. The fourth postoperative phase includes early nutrition, early ambulation, multimodal analgesia, PONV medication, limited IV fluid use, and ongoing patient and family education. The fifth phase or post-discharge phase promotes monitoring for changes in health or worsening of symptoms such as infection, respiratory difficulties, bleeding, or blood clots. This phase also contains follow-up with the surgeon or other medical providers as needed, physical therapy, and rehabilitation. The final phase is the review and analysis of outcome measures and evaluation for improvement of the delivery of care to patients (AANA, 2023b; ERAS, 2023; Sahajananda, 2022).

Goals, Objectives, and Expected Outcomes

The primary objective of this DNP project was to implement an evidence-based ERAS bundle for elective spine surgery patients over two months. The primary goal of the project was to decrease LOS in the post-anesthesia care unit by 10% from similar cases in the previous year. Secondary goals were to decrease the total opioid use postoperatively and decrease the occurrence of PONV by 15% from similar cases in the previous year. This DNP project used a multidisciplinary team approach to meet stated objectives and achieve the above goals. Objectives to meet project goals were:

- Revise preoperative patient education material regarding oral CHO consumption before surgery and preop multimodal analgesic medications. Preoperative patient and family education is required for 100% of patients before surgery. Educational material was provided in video and written format for improved comprehension.
- Revised pre-operative and post-operative order sets to incorporate ERAS guidelines.
- 100% of the patients receiving elective spine surgery received preoperative CHO, acetaminophen, and gabapentin.

- Patients already taking the pregabalin medication, were encouraged to take the scheduled morning dose of pregabalin and then not receive gabapentin preoperatively. Both pregabalin and gabapentin are antiepileptic medications that work by mimicking the effects of gamma-aminobutyric acid (GABA). Pregabalin is more potent than gabapentin.
- Before implementation, multi-disciplinary education was provided to 100% of the staff regarding ERAS guidelines. Education included staff from all multidisciplinary teams; the spine surgical office, preoperative, operating room (OR), anesthesia, post-operative recovery unit (PACU), and postoperative patient unit.
- Before implementation remediation and re-education were provided for 100% of the nursing staff regarding the importance of normothermia, normovolemia, PONV prophylaxis, multimodal opioid-sparing techniques, and drain use reduction.
- Before implementation remediation and re-education were provided for 100% of the anesthesia staff regarding completion of the patient risk assessment in electronic medical records (EMRs) for PONV.
- 100% compliance with documentation of completed patient risk assessments in the electronic medical records (EMRs) for PONV upon arrival to PACU, phase II, and the ICU on the day of surgery. If a patient was admitted, the nurse documented PONV at 8-hour intervals until the patient was discharged home.
- Weekly updates were provided during implementation to the participating neurosurgeon and the nurse practitioner involved in this project.
- Weekly reviews were done for surgical spine patients for complications including surgical site infections and 30-day readmissions.
- Daily documentation was reviewed for completeness of anesthesia PONV assessments

and concurrent remediation was provided as needed.

- Daily documentation was reviewed on surgical spine patients for compliance with ERAS guidelines with concurrent remediation if needed.

Methods

A gap analysis and SWOT assessment were completed to identify gaps in current practice as well as organizational readiness for change. An extensive review of literature was conducted that was relevant to the topic of interest. The extant literature served to guide the development of the PICOT question and evidence-based interventions identified to be implemented in this project.

This DNP QI project implemented a standardized evidence-based pre-and post-surgical care protocol for all elective spine surgeries based on the recommendations of the Agency for Healthcare Research and Quality (AHRQ), an external peri-operative external audit, the American Association of Nurse Anesthesiology (AANA) and affiliated hospitals within the network as well as MD Anderson Cancer Center (MDACC), a partnering organization within the community. The ERAS Society framework and implementation guide distributed by the AANA were used to guide the implementation of the ERAS protocol throughout the project.

Project Design

A quality improvement (QI) design was utilized for the proposed project using evidence-based interventions with a multidisciplinary team. Quantitative methods were utilized to measure LOS, TMME, and patient comfort measured by the incidence of PONV. The project included patients who were 18 years or older and underwent elective spine surgery with plans for direct admission or discharge as same-day surgical patients. The project was led by a nursing leader from the surgical spine department along with an ERAS coordinator from the anesthesia

department. The ERAS coordinator was also the DNP student and principal investigator (PI) for the QI project. Both were stakeholders within the organization, well-vested in the success of the project, and well-versed in barriers within the hospital. Following IRB approval, the ERAS coordinator and the nursing leader worked with the spine steering committee to implement the ERAS bundle for spine surgery. The ERAS coordinator, as PI, was the bridge between nursing department units, spine surgery, and anesthesia. The spine steering committee met quarterly and was comprised of the spine nursing educator, intensive care unit (ICU) manager, spine surgery nurse practitioner, spine surgeon, anesthesia, and staff nurses.

The ERAS bundle was brought to the Spine Steering Committee by the ERAS coordinator, as PI for review and approval. This Steering Committee provided oversight of the QI project. Permission was granted by key stakeholders and one participating neurosurgeon and orthopedic spine surgeon to proceed with implementation from this spine steering committee. A smaller subcommittee met weekly during the implementation of the project to help oversee the project, answer questions, address any concerns that arose, and monitor the data collection process.

The spine steering committee assisted the nurse leader and the ERAS coordinator in policy changes regarding nursing education before implementation, the development of staff education for the project, and updates needed on the patient education video and written preoperative material. Education was performed for nurses in the surgical office, PAT phone clinic, preoperative admission area, PACU, OR, anesthesia, neuro ICU, and neuro floor.

Preoperative order sets were adjusted to include the addition of oral CHO drink and oral acetaminophen and gabapentin administration in the preoperative phase. Patients consumed oral CHO before coming to the hospital, and nurses documented this time in the intake and output

nursing flowsheet upon admission to the hospital in the preoperative holding area. Furthermore, these medication changes received approval from the neurosurgeon, orthopedic surgeon, and the spinal steering committee before implementation. The measurement of compliance with the preoperative consumption of oral CHO and preoperative medications was documented in the intake and output nursing flowsheet and by the patient bringing in the initialed CHO instruction sheet. Consultation with information technology (IT) was performed to ensure adequate changes were made to the preoperative order set of EMR. Consultation with IT was also done to ensure that the incidence of PONV was accurately measured in recovery and on the floor. The medication administration record (MAR) quantified the use and occurrence of medications for PONV in the PACU, the neuro ICU, and the neuro step-down unit. The Spine Steering Committee, including participating surgeons, guided and approved all revisions to order sets and organizational and operational process changes.

Project Site and Population

The project site is a 210-bed not-for-profit Magnet © hospital with a level II trauma center. The hospital is one of three hospitals in the region that make up a larger umbrella care network. Approximately 50% of the insurance payer mix is comprised of Medicare and Medicaid (Illinois Hospital Report Card, 2020). The hospital is affiliated with multispecialty medical groups and neurosurgery and neurology ranked 14th in the nation in recent years (Rush, 2023). In addition, the hospital received the Beacon Award for Excellence for evidence-based practice implementation to improve patient outcomes, and patient and staff satisfaction (Rush, 2023). The project site is equivocally positioned within a one-mile radius where the counties of Kane, DuPage, Kendall, and Will meet (Geology.com, 2023). These four counties are some of the largest counties in the state with a total combined population of 2.2 million residents (United

States Census Bureau, 2020).

In the post-pandemic era, staffing has been a constant struggle for the project location. Maintaining adequate nursing staff as well as specialized providers in surgery and anesthesia has been an ongoing issue with months of adequate staffing followed by poor staffing rates. Despite these challenges, the hospital received a 73% recommendation from patients that they would recommend the hospital to others seeking care which was 6% higher than the state average (Illinois Hospital Report Card, 2020). Furthermore, the Leapfrog Group gave the hospital a grade of "A" (The Leapfrog Group, 2023).

Within the project site, the DNP quality improvement project took place in the perioperative area which includes the preoperative admission area, ORs, and PACU. The project included patients who were 18 years or older undergoing elective spine surgery with plans for direct admission or discharge as same-day surgical patients. Following the scheduled surgical interventions, patients were either discharged from the PACU to the neuro ICU or back to the preoperative area for discharge home.

Measurement Instruments

Data for the analysis of project interventions was obtained from the EMR in aggregate format taking precautions to de-identify all records and remove all patient identifiers in accordance with Health Insurance Portability and Accountability Act of 1996 (HIPAA) regulations. Three outcomes were measured: LOS in minutes from arrival to PACU and discharge from PACU, opioid consumption measured in TMME from PACU arrival to discharge from PACU, and number of PONV medication doses administered in PACU. Retrospective baseline data for these same three measurable outcomes was collected by reviewing the EMR on patients receiving spine surgery by the same spine surgeons for the previous time the year prior.

All patient records were de-identified with no personally identifiable information collected or reported.

The Epic electronic documentation system was the primary instrument used to collect, measure, and store data. Epic is the largest EMR capable of safely maintaining and organizing patient data. It is an encrypted, dual-authenticated password-protected system meeting all HIPPA compliance and safety guidelines within the healthcare organization. The Epic EMR quantifies PACU admission to discharge in a range of minutes, the number of TMME administered to a patient in PACU in milligrams (mg), and the MAR for medication doses for PONV.

The numerical rating scale (NRS), a standardized measurement, is a second tool that was used in PACU to assess pain levels before the administration of pain medication. The NRS is currently an established tool and provides a quantitative way to measure patients' pain both before medication administration and after the reevaluation of pain. The NRS is an 11-point scale ranging from zero to ten. A score of zero represents the patient has no pain and a score of ten means the pain is the worst pain imaginable. The patient is then asked to choose one number that best indicates the level of pain they are experiencing. The NRS has been validated and proven to be reliable for pain intensity, specifically in the elderly and less educated patients (Alghadir et al., 2018). The validity and reliability of the NRS in assessing the degree of pain experienced by patients has been well documented in the literature (Ferreira-Valente et al., 2011). In addition, the NRS has the potential to be more sensitive as the tool has more response levels than the Visual Analogue Scale (VAS) or the Faces Pain Scale-Revised (FPS-R) (Ferreira-Valente et al., 2011).

On the day of surgery, the Apfel Score was used within a preexisting EMR algorithm within the intraoperative section of the anesthesia chart to determine a risk score for PONV and

prompt staff to administer appropriate PONV medications based on a determined score from zero to four (Apfel et al., 1999). This helped anesthesia providers modify medications and techniques to decrease a patient's risk of developing PONV preoperatively and intraoperatively. Apfel et al. (1999) showed reliability for the scoring of PONV by cross-validating risk factors between two separate facilities residing in different countries.

LOS and TMMEs are considered quantitative measurements. Nausea is a subjective measurement determined by what a patient feels, and vomiting is objective. By monitoring the EMR for PONV medication administration in PACU, patient comfort can be determined by a more objective and quantifiable metric. Making this outcome a "yes, the patient received PONV medication in PACU" or "no, this patient did not receive PONV medication in PACU", a numeric rating was utilized to describe the data. Retrospective data for these same three measurable outcomes was collected by reviewing the EMR on patients who underwent elective spine surgery before the QI project.

Data Collection Procedures

The QI project followed the ERAS Society phases of care as seen in Appendix A and B to provide pre-procedural and post-procedural evidenced-based interventions to improve the overall quality and care of this patient population. A plan-do-study-act cycle framed the implementation, interventions, and interpretation of the QI scholarly project. In full compliance with all HIPPA regulations, pre- and post-implementation data was securely obtained through the EMR. All information obtained was de-identified, and void of any patient identifiers to ensure patient privacy. Only the PI and spine nurse coordinator had access to the de-identified data and only accessed the data as required for this QI project. The data was stored in a password-protected EMR on a password-protected computer in a locked office with only the PI

having an access key. All hard copies of de-identified data were secured in a locked file cabinet, in a locked office, to which only the PI had the key to access. These de-identified hard copies will be destroyed after the QI scholarly project.

Data was obtained from the EMR in aggregate format to analyze the interventions. In accordance with HIPPA regulations, all patient records were de-identified with no personally identifiable information collected or reported. Three outcomes were measured: LOS in minutes from arrival to PACU to discharge from PACU, opioid consumption measured in TMME from PACU arrival to discharge from PACU, and PONV medication administration in PACU. Retrospective baseline data for these same three measurable outcomes was collected by reviewing the EMR on patients receiving spine surgery by the same spine surgeons a year before implementation.

Pre-Procedural Phase

Before project implementation, key stakeholders at the facility met to discuss buy-in at the quarterly Spine Steering Committee. These stakeholders included three spine surgeons, two advanced practice nurses (APRNs), a quality improvement representative, the Spine Program Coordinator, the ICU manager and director, the neuroscience director, and anesthesia. The specific interventions added to the spine bundle included patients drinking a 12-ounce oral CHO two hours before surgery, and the administration of oral acetaminophen 975mg and gabapentin 300mg in day surgery before surgery. These three interventions and rationale were added to the patient education video and a handout, see Appendix C. The handout was given to each patient in the surgical office at the time the surgery was scheduled. These three points were reiterated by the PAT clinic when preoperative phone calls are made before surgery.

In addition, staff education occurred before the interventions. Staff included in the

intervention education included nurses from the surgical offices, PAT clinic, day surgery admission unit, PACU, OR, anesthesia, and Neuro ICU/stepdown. The education included the rationale for additional interventions to the ERAS spine bundle due to existing research and a review of documentation of specific interventions in EMR. The project was approved by the hospital as an evidence-based best practice QI initiative within the facility, see Appendix D, before implementation. The project focused on the two spine surgical offices, the preoperative, interoperative, and postoperative areas of the facility. Informed consent was not required as this is an organizational QI project.

Procedural Phase

Patients received the preoperative education video, CHG wipes, and printed surgical education material when elective surgery was scheduled in the spine surgery office. On the day of surgery, the patient was instructed to drink 12 ounces of a CHO within two hours of the scheduled surgical time. Upon arrival at the facility on the day of surgery, the preoperative nurse documented the time of CHO consumption in the intake and output nursing flowsheet. No change in the preparation of the patient before surgery occurred except for the added preoperative oral medications of acetaminophen 975 mg and gabapentin 300 mg. No patients were allergic to either medication, but two patients were already on schedule Lyrica and therefore did not receive gabapentin. An Apfel PONV risk assessment was prepopulated with recommendations by the EPIC software, and easily visualized by anesthesia in the intraoperative portion of the EMR. If patients scored a three or four on this four-point scale, additional preoperative and intraoperative medications were administered. These medications typically included the administration of oral aprepitant 40 mg and scopolamine transdermal patch preoperatively, and intravenous dexamethasone and ondansetron intraoperatively. There was no

change to the intraoperative administration of prophylactic antibiotics, PONV prophylaxis based on risk assessment, normovolemia, normothermia, multimodal anesthesia with opioid-sparing interventions, and the minimalistic approach to drains and tubes as the facility already adheres to these interventions. Despite this fact, the importance of timely antibiotic administration, active warming with forced air warming devices, conservative fluids for all spine surgeries regardless of surgery length, multimodal analgesia, and preemptive PONV medication. In addition, there was reinforcement but not change regarding the early mobilization and oral intake, multimodal analgesia, early removal of drains and tubes if used, and continued patient and family support and education in the post-operative phase. The project site already requires any admitted spine surgery patients to remain in the neuro ICU and step-down unit before discharge home. Patients being discharged the same day as surgery went from the PACU back to the day surgery area to be discharged home. The ERAS coordinator and spine nurse leader were available daily either in person or by phone for questions or concerns that arose during the implementation phase.

Post-Procedural Phase

With the preoperative additions to create an all-encompassing ERAS spine bundle, aggregate data collection was required to determine if the bundle would decrease LOS and opioid use and improve patient comfort. De-identified data specific to the ERAS metrics were monitored weekly during the ten weeks of implementation for completeness. The EMR was used to assess compliance with CHO intake and acetaminophen and gabapentin administration preoperatively. De-identified patient PONV risk scores were obtained in aggregate form from the EMR along with the TMME and PONV medications that were administered and the frequency postoperatively. The EMR record assisted with the conversion of all opioids to TMME.

Furthermore, the EMR was utilized to track the time from arrival into the PACU until

discharge home. In the post-intervention phase, benchmark data for elective spinal surgeries from the same time frame in the previous year was reviewed for data comparison with post-intervention data. The EMR was used to determine the non-ERAS comparable spine patients by the same two surgeons participating in the QI project. Participants were protected by HIPAA to ensure their privacy and associated health information was safeguarded. All obtained data was deidentified of patient identifiers before use.

Data Analysis

For the three measurable outcomes, pre- and post-intervention aggregate data was collected from the EMR by the principal investigator and compared to baseline line data from the prior year to determine the efficacy of the ERAS interventions. Statistical analysis was performed with the support of a statistician from The University of Alabama (UA). LOS and TMME are ratio variables, as such, a t-test was best for statistical analysis. Administration of PONV medication in PACU is considered a nominal variable and best statistically analyzed using the Chi-square test (Sylvia & Terhaar, 2018). Descriptive statistics for demographic data were collected. Weekly checks of the QI data collection and completeness of the EMR occurred by the ERAS coordinator. The nurse leader was available and worked closely with staff when questions or concerns arose during implementation. The results of the data analysis will be disseminated to stakeholders, administration, and facility staff within a three-month timeframe.

Results

Upon IRB approval, pre-intervention baseline data was retrospectively collected on patients who had spine surgery during a similar 10-week period in 2023. The baseline cohort consisted of 27 EMR reviews for patients 18 years and older who had elective spine surgery from March 6 to May 12, 2023. The pre-intervention baseline cohort was compared and analyzed

to the ERAS bundle post-intervention cohort. Descriptive statistics were collected along with LOS in the PACU, TMME, and PONV medication administration during the PACU portion of the hospital stay. One surgeon performed 55.6% or 15 of the cases and the second surgeon performed 44.9% or 12 of the surgical volume reviewed. Thirteen of the 27 cases were lumbar microdiscectomies, 10 were anterior cervical discectomies and fusions, three were lumbar fusions, and there was one posterior cervical fusion. Of the total cases, women consisted of 59.3% or 16 of the individuals and males were 40.7% or 11 individuals. The average age was 52.4 years and ages ranged from 33 to 79 years. One individual had an ASA score of 1, 13 had an ASA score of 2, and 13 had an ASA score of 3. Eighteen of the individuals were listed as obese in the preoperative anesthetic assessment, 12 patients had a history of diabetes (DM), three were diagnosed with obstructive sleep apnea (OSA), and three were active smokers. Only three of the 27 participants had a history of PONV. The MAR of all 27 participants was reviewed for the intravenous administration of acetaminophen either in the interoperative or PACU portion of the surgical procedure and recovery as this might impact findings when compared to the 2024 QI data. Twelve participants or 44.4% received IV acetaminophen during their perioperative period. Unfortunately, Apfel scores could not be obtained for this 2023 cohort as they were not computed nor saved in the EMR.

The mean length of time in the PACU before discharge to the floor or phase two during the 2023 period was 84 minutes with a minimum range of 23 to 46 minutes and a maximum range of 155 to 190 minutes. The largest number of participants had a LOS range of 47-70 minutes, and the least was the range of 119 to 142 minutes or 167 to 190 minutes. TMME had a mean of 50.74 mg with most individuals requiring 19 to 38 TMME. Two individuals required 159 to 178 TMME in the PACU. There was a mean of 0.15 for PONV medication administration

or 4 out of 27 individuals. Data analysis and findings from the 2023 retrospective baseline data were then compared to post-intervention data collected during 10 weeks in 2024.

Implementation of the QI project began on March 4, 2024, with concurrent data collection maintained throughout implementation. Post-intervention data collection began immediately following the completion of the QI project in late May 2024. The QI ERAS intervention cohort consisted of 23 patients who underwent elective spine surgery during the 10 weeks from March 4 to May 10, 2024. Patients who did not receive the entire bundle of CHO, acetaminophen, or gabapentin were excluded. Patients who were scheduled for surgery during these ten weeks before QI implementation were also excluded. Two patients were already being prescribed pregabalin before surgery, so additional gabapentin was not administered preoperatively. Due to the similar mechanism of action of gabapentin and pregabalin and the medication being taken by the two participants on the day of surgery, these two patients were still included in the QI 2024 cohort.

Descriptive statistics were collected along with LOS in PACU, TMME, and PONV medication administration during the PACU portion of the hospital stay. One surgeon performed 56.5% or 13 of the cases and the second surgeon performed 43.5% or 10 of the surgical cases. Eleven of the 23 cases were lumbar microdiscectomies, three were anterior cervical discectomies and fusions, six were lumbar fusions, two were posterior cervical fusions, and there was one minimally invasive lumbar and thoracic fusion. Of the total cases, women consisted of 43.5% or 10 of the individuals and males were 56.5% or 13 of the individuals. The average age was 58 years and ages ranged from 31 to 79 years. Two individuals had an ASA score of 1, 11 had an ASA score of 2, and 10 had an ASA score of 3. Seventeen of the individuals were listed as obese in the preoperative anesthetic assessment, six patients had a history of diabetes (DM), nine were

diagnosed with obstructive sleep apnea (OSA), and one was an active smoker. Only one of the 23 participants had a history of PONV.

The mean length of time in the PACU before discharge to the floor or phase two for the intervention group was 87 minutes with a minimum range of 23 to 46 minutes and a maximum range of 215 minutes or greater. The largest number of participants had an LOS range of 71 to 94 minutes, and the least was one individual with a range of 191 to 214 minutes and another with a LOS greater than 215 minutes. TMME had a mean of 17.5 mg with most individuals requiring less than 19 TMME. Six individuals required 19 to 38 TMME and only one required 59 to 78 TMME. The mean for PONV medication administration was 0.04 or 1 out of 23 individuals.

A paired sample t-test was used to analyze and compare pre- and post-intervention data. There was an increase in LOS by three minutes from the retrospective preintervention data compared to the postintervention data, but this increase was not statistically significant ($p=.036$). The need for PONV medication in PACU decreased from the preintervention to postintervention groups but was not statistically significant ($P=.083$). There was a reduction in TMME from the pre to postintervention group that was statistically significant with $p<.001$. TMME decreased from 50.7 mg to 17.5mg or a decrease of 33.2mg. There was not a large variability found between the pre-and post-intervention groups for gender, age, ASA classification, obesity, HTN, OSA, DM, smoking, or history of PONV in the past. There was a general mix of different types of spine cases from the retrospective group to the intervention group with about half of the cases also involving a fusion at one or more levels. In the 2023 data,14 of the 27 (51%) cases involved a fusion. In the 2024 data, 12 of the 23 (52%) cases involved a fusion.

Interpretation/Discussion

Enhanced Recovery After Surgery (ERAS) guidelines are reproducible evidenced-based

practice models with a known impact on patient outcomes and satisfaction without an increase in readmission or complications. The use of this QI ERAS spine bundle found that patients not only required less narcotics but also needed less PONV medication to improve comfort in the PACU. This QI ERAS bundle provides evidence to support the use of multimodal analgesia and CHO combined with existing ERAS spine interventions is vital not only to reduce patient exposure to unnecessary narcotics but also to improve postoperative patient comfort. Individually, these interventions do not appear impactful, but when bundled together in a care bundle or model, patient outcomes are positively impacted with improved outcomes and hospital expenditures remain lower.

LOS can be challenging to quantify, and the evaluation for accuracy can be difficult when bed and staffing shortages influence workflow can alter LOS, and hinder timely patient discharge. LOS did not improve from the preintervention to the postintervention group, but this was most likely a reflection of available hospital beds, nursing staff, or available rooms in the phase two discharge area. There was also a great deal of staff turnover from 2023 to 2024 that could also have impacted how agency and permanent staff interpreted discharge criteria. A future QI project could increase the measurement for LOS to encompass the entire hospital stay. Previous authors measured LOS in days due to the nature of performing surgical cases with multiple spine-level involvement. This QI project measured LOS in minutes as more patients were scheduled for outpatient procedures at this facility. Unfortunately, LOS will be impacted by available beds and adequate nursing staff to some extent, and other authors noted the challenge of measuring LOS due to the quantification of discharge criteria many times instead of actual recovery time (Soffin et al., 2020).

The use of oral acetaminophen and gabapentin greatly reduced patient morphine

requirements in PACU. This finding correlates with findings from the extant literature (Leng et al., 2021; Peng et al., 2017; Soffin et al., 2020). The addition of CHO preoperatively did decrease the incidence of patients requiring PONV medication in the PACU, but it was not statistically significant. This was similar to the findings found by Lang et al. (2022). With a decrease in opioid requirements also comes the possibility for a reduction in PONV postoperatively. Opioids are well described in the literature as causing nausea and vomiting. By administering an ERAS bundle to patients, acetaminophen and gabapentin also reduced the incidence of PONV in PACU.

The reduction in TMME and PONV is further evidence that the theoretical framework by the ERAS Society and AANA should be implemented to encompass all outpatient surgical patients, to reduce opioid usage and exposure, and assist with reducing patient opioid requirements once discharged to home. The impact of reducing opioids by combining multimodal oral medications given before a stressful insult like surgery cannot be ignored. These findings also show the impact of inexpensive and simple interventions for other surgical specialties in reducing TMME, improving patient comfort, and decreasing patient exposure to higher doses of opioids.

Additional QI ERAS projects evaluating patients' TMME post-surgery to discharge home, and patients' satisfaction surveys would be a valid next step in improving an ERAS spine bundle. Furthermore, EMRs were reviewed for 30-day readmissions for patients in the 2024 intervention cohort, but no data was specifically collected or analyzed. Future studies could possibly incorporate a larger number of patients at a tertiary facility to see if these same interventions increased 30-day readmission rates on a larger scale.

There has also been an ongoing discussion regarding the rate of blood sugar control in

DM patients who consume CHO on the day of surgery. Despite there currently being no contraindication to DM consuming CHO, practitioners continue to be concerned that there could be an increase in blood sugar levels in this subset of patients. Conducting future studies on CHO consumption as it specifically relates to blood sugar levels and SSIs in DM throughout the perioperative timeline, could prove helpful to reduce these concerns.

Cost-Benefit Analysis/Budget

The number of spine surgeries is projected to increase and due to the aging population and increased comorbidities, using ERAS implementation is ideal for cost reduction (Garg et al., 2021). Implementation of the ERAS spine bundle had no additional costs to the hospital. Other bundle ERAS interventions already taking place at the facility were previously accounted for and did not increase the expenditures for this QI project. No external funds were sought for this QI project.

Preoperative CHO was purchased by the PI and distributed to patients when surgery was scheduled. Preoperative administration of acetaminophen and gabapentin are both generic and currently cost $0.03 and $0.10 respectively. As expected, these three interventions increased patient comfort, and the initial cost was neutralized. Despite there being no change in LOS in PACU, the facility and patients benefited from a decrease in costs related to narcotic administration in recovery. Furthermore, patients were exposed to less narcotics and with a reduction in opioid exposure have a decreased risk for addiction to narcotics post-surgery. There were no reports of any patients in the postintervention cohort being readmitted in 30 days due to complications related to the surgical procedure.

Despite 44.4% of preintervention patients receiving IV acetaminophen during the perioperative period, TMME did not appear to be impacted enough to alter the statistical

significance when compared to the postintervention cohort. IV acetaminophen costs $3.89 for a 1,000mg/100-milliliter bag. Twelve pre-intervention cohort patients received IV acetaminophen for a total cohort cost of $46.68 with no significant change in TMME in PACU. All 23 patients in the postintervention cohort received oral Tylenol with a total cohort cost of $0.69. This corroborates the current research by Pelzer et al. (2021) that found no difference in patients who took IV over oral acetaminophen in the perioperative period. If patients can take oral acetaminophen, they should, as both appear equally efficacious, and the oral route is less expensive.

Timeline

Upon Institutional Review Board (IRB) approval, see Appendix E, the quality improvement interventions were implemented on March 4, 2024. Order set updates occurred in late January and early February 2024. Staff education in the PAT clinic, preoperative day surgery, PACU, Neuro ICU/step-down, OR, and anesthesia took place in the third and fourth week of February 2024. Education occurred on the education Fridays in January and February for OR, PACU, preop day surgery, and anesthesia staff. An email with specific details was also sent after these sessions. PAT clinic and the neuro ICU/stepdown occurred in person the week before implementation. On March 4 implementation began, ran for 10 weeks, and ended on May 10. Concurrent Data collection occurred during these same weeks. Data analysis occurred in late May and early June 2024 with data dissemination occurring over the following two months in June and July 2024. Full public dissemination could take up to 12 months.

Ethical Considerations/Protection of Human Subjects

UA and organizational IRB approval was obtained before initiating this QI project. The implementation and data collection of the QI project were HIPPA compliant and maintained the

privacy of patients and their associated health information. Furthermore, the Standards of Care for advanced practice nurses were followed carefully. Information was collected as aggregate data without containing patient identifiers or personal health information. Included patients were insured confidentiality with the use of a unique identification number. Deidentified data was stored in an electronic data UA Box that was password protected. Any hard copy data or identification numbers were stored in a securely locked file cabinet within a locked office and only accessible by the PI. The hard copies and identification numbers will be destroyed after the completion of the QI project and publication. The risk to the patients included in this QI ERAS spine project did not differ from patients receiving standard care for spine surgery. Current research has shown no increase in adverse events or outcomes exists when ERAS guidelines are implemented.

Conclusion

Spine surgery is a painful surgical procedure often requiring the use of large amounts of opioids. With the expected increase in surgical spine surgeries, the use of multimodal pain medication and a multidisciplinary team with clearly unified goals are required for patient success. The use of ERAS guidelines has shown improvements in patient outcomes and opioid requirements, reductions in LOS, and improved patient satisfaction and engagement in multiple surgical specialties across the world. The object of this QI ERAS bundle for spine surgery was not to increase the body of knowledge but to bridge the gap between ERAS research and the ERAS application as evidence-based best practice in a surgical spine practice. By improving upon already existing interventions in the intraoperative setting and bundling them with the three additional interventions, the goal was to reduce LOS, TMME, and patient comfort. Despite there not being a reduction in LOS, there was a profound decrease in TMME required in PACU and

patients had less incidence of PONV. This QI project is a validation of the other evidence by previous authors that combining more than one intervention has a synergistic or additive effect on positive patient outcomes.

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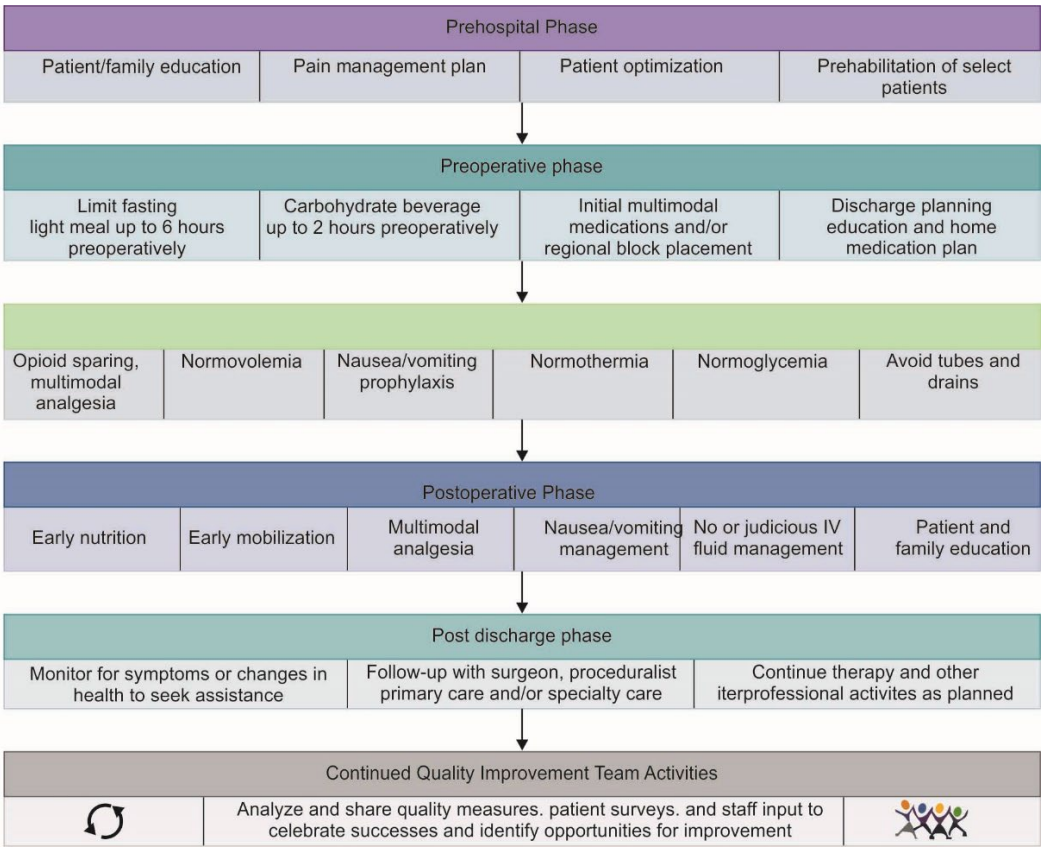
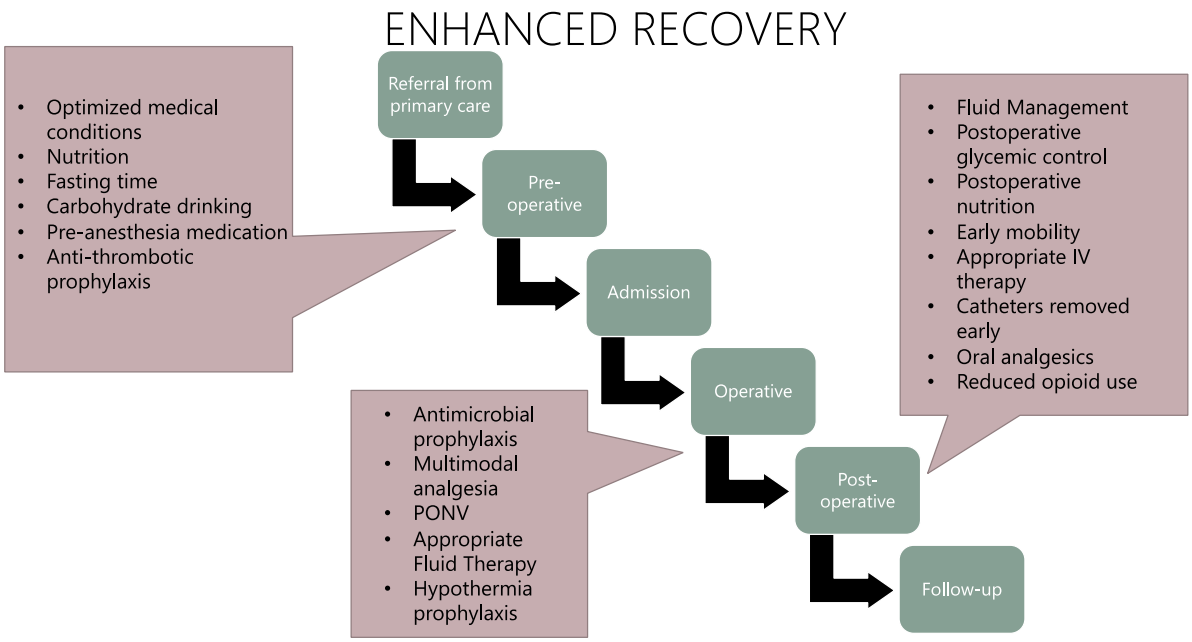
Appendix A

ERAS Program Phase Chart



(AANA, 2023; Sahajananda, 2022)

Appendix B



(ResearchGate, 2022)

Appendix C

Enhanced Recovery after Surgery (ERAS) Protocol with Gatorade

On the day of surgery:

- 2 to 4 hours before your scheduled surgery time, drink 12 ounces of Gatorade (NOT "low calorie")
- Drink **MUST** be completed **2 hours before** your scheduled surgery time.
- Follow your pre-admission medication instructions.

Why do you need to drink Gatorade before surgery?

- To make you comfortable before surgery
- To help reduce your body's stress response to surgery.
- To lessen your nausea after surgery

DO NOT:

- DO NOT eat any solid food after midnight.
- DO NOT drink anything after midnight (including water)- except the 12 ounces of Gatorade.
- DO NOT chew gum before your surgery.
- DO NOT eat any candy before your surgery.

Enhanced Recovery after Surgery (ERAS) Protocol Preoperative Medications Given at the Hospital Before Surgery

Once you arrive at the hospital, a nurse will give you oral acetaminophen and gabapentin.

Why Do you receive these medications before surgery?

- The medications help decrease pain after surgery.
- The medications reduce the amount of other medications, such as narcotics or opioids, you need to help manage your pain.

Appendix D

Rush-Copley Medical Center
2000 Ogden Avenue, Aurora, IL 60504

DATE:	January 9, 2024
TO:	Kierste Schafer, CRNA
FROM:	Copley Memorial Hospital IRB
STUDY TITLE:	[2130040-1] The Use of an Enhanced Recovery Bundle in Surgical Spine Patients to Reduce Opioid Requirements, Improve Patient Comfort, and Shorten the Length of Stay
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	January 9, 2024
EXPIRATION DATE:	
REVIEW TYPE:	Full Committee Review

Thank you for your submission of New Project materials for this research study. The Copley Memorial Hospital IRB has APPROVED your submission *[to use at (NAME OF CENTRAL IRB)]*. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Full Committee Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

This is to certify that the information contained herein is true and correct as reflected in the records of the Copley Institutional Review board. We certify that Copley IRB is in full compliance with good clinical practices as defined under the Federal Regulations pertaining to research.

If you have any questions, please contact Lynn Rico at (630) 978-4977 or lynn.rico@rushcopley.com. Please include your study title and reference number in all correspondence with this office.

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Appendix E

THE UNIVERSITY OF ALABAMA | Research & Economic Development
Office for Research Ethics & Compliance

February 19, 2024

To: Kierste Schafer, CRNA
DNP Student
Capstone College of Nursing
Box 870358

From: Edward M. Shirley, MA, CIP
Interim IRB Team Lead

Re: **Notice of Approval**

IRB Application #:	e-Protocol 23-11-7126
Project Title:	"The Use of an Enhanced Recovery Bundle in Surgical Spine Patients to Reduce Opioid Requirements, Improve Patient Comfort, and Shorten the Length of Stay"
Submission Type:	New
Approval Date:	February 19, 2024
Expiration Date:	February 18, 2025
Funding Source:	None
Review Category:	EXEMPT
Approved Documents:	Study Protocol

Dear Kierste Schafer:

The University of Alabama Institutional Review Board has approved your proposed research. Therefore, your application has been approved according to 45 CFR part 46 as outlined below:

(4) Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met: (ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;

The approval for your application will lapse, as noted above. If your research will continue beyond this date, please submit the Continuing Review to the IRB as University policy requires before the lapse. Please note any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

All the best with your research.