

A case for team-based behavior change and a practical toolkit for opioid use elimination via postoperative, compounded, multidrug nerve blocks in a community hospital setting

A. INTRODUCTION

Unmet Need

One in 5 patients undergoing thoracotomy, cardiac surgery, limb amputation, or surgery experiences chronic pain post-surgery.¹⁻⁴ Poorly controlled postoperative pain is associated with short- and long-term morbidity, limits recovery, and may lead to prolonged opioid use.⁵ Chronic postoperative pain is typically defined as pain that lasts more than 3 months' post procedure or past the time of normal tissue healing.⁶ Mild, persistent postoperative pain affects quality of life, has a significant individual and societal burden, and may contribute to the opioid epidemic, which has cost the United States economy an estimated \$1 trillion since 2001.^{7,8}

Opioid Use and Anesthesia Culture

Opioid use in the United States has become a major public health crisis, with opioid overdose being a leading cause of accidental death. Deaths associated with drug overdose involving prescription opioids increased from 3442 in 1999 to 16,416 in 2020.⁹ The risks of opioid use, including the potential for overdose and addiction, have led to numerous efforts to reduce the prescription and use of these medications, and to increase access to treatment for addiction.

Opioid use in pre-, intra-, and postoperative pain care is ubiquitous. Management of postoperative pain with opioids is often unsatisfactory in clinical practice due to opioid-related adverse events (ORAEs), including respiratory, gastrointestinal, and central nervous system complications—all while contributing to the opioid epidemic.¹⁰ A 1-day course of opioid therapy may pose a 6% risk of long-term opioid use, and dependency can start within 3 days of initial opioid use.¹¹

The incidence of ORAEs among surgical patients has ranged from 1.8% to 13.6%, and patients with ORAEs experience higher rates of inpatient mortality and 30-day readmission, as well as prolonged length of stay (LOS) and high cost of hospitalization.¹² Results of a study of postsurgical ORAEs within a large health system revealed that 99.8% of surgical patients received postsurgical opioids; 11.5% of those patients experienced an ORAE.¹³

The average cost of an ORAE is reported to be up to \$8000 USD per episode in 2020. In the hospital setting, ORAEs are associated with an increase in LOS, cost of hospitalization, and inpatient mortality.¹² Inadequate pain control and patient satisfaction are major concerns for surgeons. Based on a retrospective analysis conducted on clinician satisfaction scores at an outpatient surgical center, decreased opioid prescribing in the postsurgical setting was not associated with decreased clinician satisfaction ratings.¹⁴ Another retrospective, single-institution study analyzing implementations of postoperative opioid-free protocols reported lower overall average pain scores in surgical patients who received no oral or analgesia pump opioids at all compared to those who received opioids.¹⁵ These challenges necessitate a shift toward alternative pain management strategies.

Opioid Reduction

Prolonged opioid use is a significant concern in the postsurgical setting due to increased incidence of misuse and opioid-related safety issues.¹ As a result, various multimodal, opioid-sparing therapies have been studied, including the use of a combination of analgesics such as nonsteroidal anti-inflammatory drugs, acetaminophen, dexamethasone, neuraxial analgesia, ketamine, and peripheral nerve blocks (PNBs).¹⁶ One of the main advantages of PNBs is that they can provide long-lasting pain relief with fewer side effects compared to other pain management techniques. They can also be used in

conjunction with other pain management strategies, such as physical therapy and nonopioid medications, to provide a more comprehensive pain management approach. Studies have shown superior pain control, reduction in opioid use, and earlier physical therapy participation in patients receiving PNB compared to those receiving opioids for various surgical procedures.¹⁷

Multimodal Pain Management as Part of Enhanced Recovery After Surgery (ERAS)

ERAS programs are a set of protocols that aim to shorten LOS, minimize complications, and facilitate early mobility and recovery by streamlining patient processes before, during, and after surgery.¹⁸ The goal of ERAS is to minimize the physiological stress of surgery and accelerate the recovery process. ERAS protocols are commonly used in colorectal, gynecologic, and bariatric surgery, but they have also been implemented in other surgical specialties. ERAS protocols typically involve a combination of preoperative, intraoperative, and postoperative interventions, including preoperative patient education, intraoperative use of minimally invasive techniques, avoidance of opioids for pain management, early mobilization, and early discharge from the hospital. As part of an ERAS program, methods such as multimodal analgesia (MMA) may be utilized. MMA uses a combination of analgesic drugs from different classes along with analgesic techniques targeting different pain mechanisms. An example of such is utilizing nerve block analgesia, a key element of MMA. The goal of MMA management is to provide each patient with optimized analgesia while minimizing side effects of the drugs or procedures.¹⁹

Summa Health is a nonprofit, integrated health care delivery system in Northeast Ohio.²⁰ The Department of Anesthesia at Summa Health recognizes that the operating room (OR) can be an entry point to opioid addiction. Recent studies observing opioid-naïve patients found various surgical procedures associated with an increased risk of chronic opioid use in the postoperative period, with certain subpopulations such as elderly patients being particularly vulnerable.^{21,22} Summa Health has consequently committed to combat opioid overuse, improve patient outcomes, and shorten hospital stays through a hospital-wide improvement process utilizing postoperative opioid-free pain management protocols and specifically focused on the surgical patient throughout their surgical episode of care. As part of an ERAS program, these protocols included using a compounded combination drug product consisting of bupivacaine HCl, dexamethasone sodium phosphate, and epinephrine.²⁰

B. METHODS

Implementing Multimodal Pain Management in the Community Hospital Setting

Implementing multimodal pain management as part of a robust ERAS program requires a change in culture to allow for more team-based behaviors to enable optimal patient care, including process improvement, time management, and surgeon buy-in.¹⁹ The ERAS program involved all surgical patients and was implemented in stages over a span of 2 years, from 2020 to 2022. Audits were conducted by the same-day team, with involvement from in-room certified registered nurse anesthetists (CRNAs), who collected and analyzed data. The ERAS program was modified gradually based on the outcomes of these audits. The program was initially launched on March 1, 2016, marking the beginning of its 2-year launch period (2016 to 2018).²⁰

Perioperative Description of ERAS program

In the preoperative phase of the ERAS program at Summa Health, patients received education and counseling on the program's goals and expectations for recovery. Additionally, preoperative physical therapy is often utilized to improve range of motion and functional strength, depending on the type of surgery. The optimization of comorbidities, such as diabetes and hypertension, prior to surgery is also a crucial aspect in the preoperative phase. By addressing these factors prior to the procedure, patients have the best chance at experiencing better outcomes and a smoother recovery. MMA begins

preoperatively. Agents such as celecoxib, acetaminophen, gabapentin, methocarbamol, and PNBs are utilized. A customized ERAS plan with select agents is designed for each patient.

During the intraoperative phase, strategies are employed to minimize tissue trauma and reduce postoperative pain. These include the use of minimally invasive surgical techniques and MMA, which is administered to minimize opioid use and its side effects. At Summa Health, one of the most crucial aspects of the intraoperative phase of the ERAS program is an aggressive approach to provide PNBs to all eligible patients, virtually eliminating opioid when used in certain procedures. A goal of more than 3 multimodal agents is emphasized to ensure optimal patient outcomes. The use of tranexamic acid is also considered to reduce blood loss and the need for blood transfusion. Other agents used intraoperatively include midazolam, ketamine, dexmedetomidine, propofol, lidocaine, esmolol, magnesium, intravenous acetaminophen, dexamethasone, and ondansetron. Near the end of the procedure, a nitrous bridge may be utilized to enhance the effects of drug on *N*-methyl-D-aspartate receptors during the anesthesia emergence process. All blocks outside of the OR were coordinated in-house by the acute pain team. They assessed the patient and arranged for the block to be performed in conjunction with the relevant team. Through the implementation of a comprehensive nausea protocol and the omission of opioids, a significant reduction in the incidence of nausea in surgical patients was observed, decreasing from 6% to 2%.²³ This positive outcome can be attributed to a synergistic effect of these 2 factors, because patients' surgery-related nausea was better controlled, along with no longer experiencing nausea as a result of opioid administration.

In the postoperative phase, early mobilization is initiated to prevent complications. Complications are monitored and managed using a standardized protocol at Summa Health. MMA and cryotherapy are used in collaboration with an integrated acute pain team for effective postoperative pain management. Lorazepam may also be utilized in specific cases upon arrival of the patient to the postanesthesia care unit (PACU). The final components of the ERAS program include discharge planning and follow-up care, which include home physical therapy and pain management. By utilizing these strategies, patients may experience shorter hospital stays, reduced pain, and improved recovery outcomes.

ERAS Program Personnel and Training

The ERAS program at Summa Health has grown and developed over recent years. ERAS study and audit sheets are utilized by the Same-Day Anesthesia Team at Summa Health to train, organize, and document the program. ERAS study sheets allow the Same-Day Anesthesia Team liaison, with team members of different surgical specialties, to create a more customized ERAS plan optimized to specific procedures. After reviewing results of an ERAS program implementation, team members share feedback to allow altering and improvement of a set optimized plan or protocol.

The regional team component of the ERAS program at Summa Health included a team of 20 CRNAs rotating on a daily 3-person team dedicated to regional blocks and procedures. Lean Six Sigma training was implemented in training CRNAs. After achieving appropriate training levels, CRNAs were able to perform nerve blocks without proctorship. All CRNAs part of the official regional team were capable of performing all nerve blocks included in the ERAS program. However, those who have not yet achieved a qualifying number of blocks are paired with a team member who has achieved this level on the day that particular block is being performed. This pairing ensures that the CRNA performing the block receives adequate support and guidance for successful execution. All blocks are reviewed every 6 months, and education modes such as cadaver labs and didactics are employed to bolster training. Nerve block technique, block components, and complication education are extensively reviewed in these training sessions.

Standardization of Product

Patients continue to suffer unnecessary injuries as a result of preventable medication errors. For this reason, the importance of managing medication-related risks and reducing preventable harm through pharmacy standardization is at the forefront of patient care at Summa Health. Prior to this initiative, standardizing concentrations of this particular compounded sterile preparation (CSP) were not available, leading to variable concentrations and potentially serious medication errors. Advantages of this particular CSP ready-to-administer syringe include decreased compounding burden on providers, consistent and reliable concentrations of product, the availability of prepackaged and labeled product, and an extended beyond-use date compared to in-hospital compounds. Each of these factors contributes to efficiency in providing care to the patient and cost.

The use of these nerve block agents allowed an aggressive rehabilitation setting. By streamlining production of the CSP product, Summa Health providers optimized workflow by reducing dispensing times, pharmacy utilization, and waste. A standardized CSP encouraged a higher volume of nerve blocks performed, ensured product consistency, and improved patient outcomes and safety. Currently, all patients who are eligible for a nerve block at Summa Health receive a standardized CSP product. For both the above-stated efficiency and safety, other multimodal medications have been prepackaged in unit doses in Summa's ERAS protocols for plug-and-play ease of use.

C. RESULTS

Results of Implementing Multimodal Pain Management as Part of ERAS

To enhance the effectiveness of nerve blocks, the use of teams and a patient-centered approach was utilized to bring about cultural change. To ensure the highest level of care, the model advocates the use of checklists to ensure best practices are followed, as well as customized tools for efficient and standardized care. By leveraging the diverse skill sets of team members, every aspect of care can be delivered with expertise to each patient. This approach encourages all team members to practice at the highest level of their skill set, resulting in comprehensive and effective patient care.

Culture change in the OR has been significantly important in the transition to using combination nerve blocks as standard therapy. Early on, physician buy-in was challenging due to misconceived information on the additional time and training required to administer blocks and the financial burden associated with therapy. However, as culture has shifted to more specialized treatment, quicker recovery time, and optimizing rehabilitation, most surgeons at Summa Health now view ERAS medications and blocks as standard of care. Patient-centricity has been another shift in culture, with patients now actively self-advocating and being involved in their own care, as well as understanding the consequences of opioid use. Other factors such as standardization of the CSP product used in the Summa Health ERAS program, improved patient rehabilitation outcomes, and an addition of anesthesia personnel to block teams served as a catalyst for physician buy-in. Prior to increased implementation of ERAS protocols in eligible surgical patients, multimodal analgesic nerve blocks were used only in select patients (eg, those with existing opioid addictions). The nerve block would also take an average time of around 30 minutes to ensure that the personnel performing the block were appropriately trained and that appropriate equipment was available (unlike with the newer ERAS program, there was no appointed nerve block team in the past). This meant that only 10% of patients received ERAS management and around 600 blocks per year were performed, whereas 98% of eligible surgical patients

received opioids. After implementing ERAS protocols and utilizing the CSP nerve block in eligible surgical patients, ERAS was used in 100% of patients, accounting for more than 13,000 blocks per annum, reducing opioid use to only 10% of eligible patients. The significance of both the compounded combination drug product and the premade, pre-labeled, unit-dose form of other ERAS medications lay in the standardization and efficiency they provide for the CRNAs.²³

Improved patient outcomes were seen across all surgical areas in which the ERAS program was implemented, particularly in the total-knee program, in which the care team was now able to conduct aggressive rehabilitation as early as 5 days' post operation. This resulted in an increased range of motion in patients within the first few months of rehabilitation.²⁰

Figure 1. Opioid Utilization and Patient Satisfaction With the ERAS Program: A 3-Year Analysis

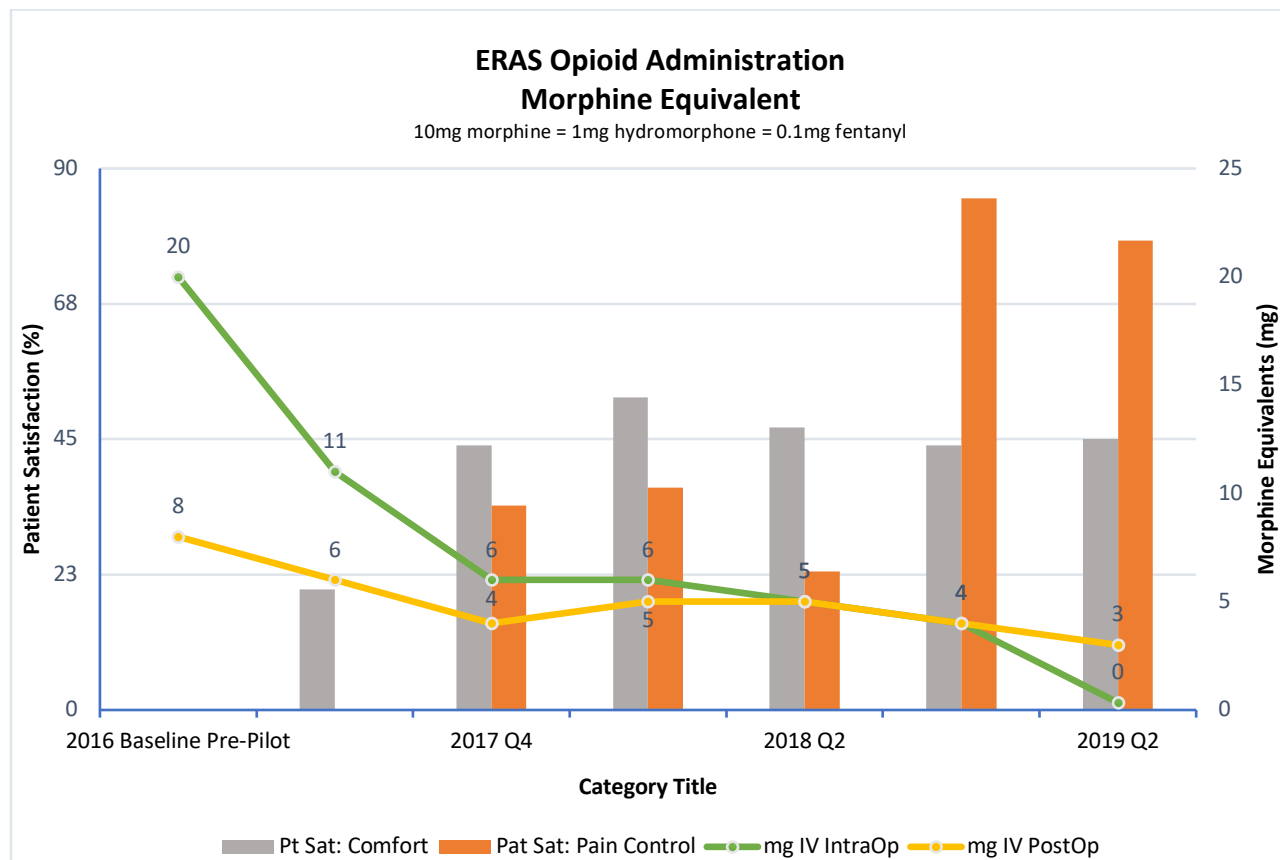


Figure 1. Over a 3-year span from when the ERAS program was initiated, there was an observed decrease of nearly 99% in overall intraoperative opioid consumption.²³

Fifteen different types of combination nerve blocks have been utilized at Summa Health, all of which have had meaningful impact on the reduction of opioid use. These nerve blocks include pericapsular nerve group (PENG), fascia iliaca (FI), popliteal, pectoralis (PECS), serratus anterior plane (SAP), and erector spinae plane (ESP). The time to perform nerve blocks for PECS, SAP, and ESP took an average of 205 seconds, 105 seconds, and 135 seconds, respectively. Field blocks have been observed to have the greatest success at this institution.²³

Nerve Block Duration

Given the importance of block duration in achieving optimal pain management outcomes, it is essential to standardize the administration of regional blocks. Standardization can help ensure that all patients achieve the maximum length of action for the regional block, thereby reducing postoperative pain issues. A regional block has been administered in more than 60% of surgical cases at Summa Health, with an average administration time of 178 seconds. Of these, 250 blocks were performed during anesthesia induction.²⁰ Transversus abdominis plane (TAP) blocks were administered in 76 gynecological or laparoscopic abdomen cases. On average, analgesia from TAP blocks lasted for a duration of 67.8 hours compared to the national time of 24 to 48 hours.²⁴ Of 54 cases treated with a supraclavicular block for various hand and lower arm surgeries, pain block was observed for an average of 28.6 hours compared to the national time of 12 hours.²⁵ Of 62 FI/PENG blocks administered to patients undergoing hip surgeries, block duration was observed for an average of 46.7 hours compared to the national time of 7 to 14 hours with PENG administration.²⁶

Table 1. Average Time of Analgesia

Average Time of Pain Block		
Nerve Block Type	Summa Health	National
TAP block (n = 76)	67.8 h ²⁰	24-48 h ²⁴
Supraclavicular block (n = 54)	28.6 h ²⁰	12 h ²⁵
FI/PENG (n = 62)	46.7 h ²⁰	7-14 h ²⁶

Time collection of peripheral nerve blocks included a sensory/motor function assessment of the patient to ensure the nerve block's efficacy, a verbal check-in with the patient, and patient education on lasting PNB effects and when they are considered "worn off." Education included patient instruction on any notice of incision pain or numbness of surgical site.

TAP blocks are often overlooked because they do not provide initial anesthesia past the incision plane as compared to other field blocks. However, in most surgical cases, experts estimate that incisional pain may amount to ~65% of total intraoperative pain. Utilizing TAP blocks effectively is therefore critical in surgical anesthesia. The TAP block is posited by experts to operate in a dualistic mechanism. Primarily, it induces anesthetic effects on the anatomical plane when injected with precise localization. Subsequently, as the lidocaine is absorbed into the systemic circulation and undergoes reabsorption, it effectively parallels the action of a continuous intravenous drip. Additionally, there is a synergistic effect when a TAP block is combined with epinephrine. As the medication mobilizes over the next 2 days' post injection, it provides further pain control with its local anesthetic properties.

At Summa health, the use of a nerve block and any ERAS medication (regional block plus CSP) resulted in a 98.7% elimination of opioid use in the operating room, with 77% reduction in recovery.²⁰ Implementation of the ERAS program with team-based care also resulted in a reduction in total surgical operating room time (Table 2).^{20,27-29}

The duration of in-room to release from anesthesia can vary depending on the type of surgery, the patient’s medical history, and the hospital’s protocols. However, the average duration of in-room to release from anesthesia in US ORs is typically between 15 and 36 minutes.^{27,28} This time period includes the initial postoperative monitoring period in the OR, during which the patient’s vital signs and level of consciousness are closely monitored to ensure a smooth transition to the recovery area. Once the patient is stable, they are typically transferred to the PACU for further monitoring and pain management.

The duration of in-room to incision in US ORs also varies widely depending on the type of surgery, complexity of the case, and hospital protocols. Some operations may require extensive preparation time, which will increase this variable. Reducing the duration of in-room to incision can have a significant impact on surgical outcomes, because it can reduce the time the patient spends under anesthesia and minimize the risk of complications.

When compared to national times, implementation of the ERAS program and team-based care at Summa Health saved around 13 to 15 minutes per surgical case.^{20,27-29}

Table 2. Surgical Times With ERAS Program Implementation

Throughput Times		
	Summa Health	National
In-room to release from anesthesia	10 min ²⁰	15-36 min ^{27,28}
In-room to incision	21 min ²⁰	50 min ²⁹

D. CONCLUSION AND DISCUSSION

When comparing duration of analgesia to other literature, it is important to note that the duration of PNBs can vary depending on the specific medications used, the dosage, and the individual patient's physiology, as well as the specifics of their procedure. It is also important to note that PNBs are just one part of a comprehensive pain management plan and that other techniques, such as oral medications and physical therapy, may also be used to manage pain post-surgery.

The use of multimodal pain management techniques, such as nerve blocks, has been shown to be an effective strategy to decrease opioid use and improve pain control for surgical patients. At Summa Health, the implementation of the ERAS program and the utilization of various nerve blocks have resulted in a significant decrease in intraoperative opioid consumption. Over a 3-year span, there was an observed decrease of nearly 99% in overall intraoperative opioid consumption, which is a remarkable accomplishment. Fifteen different types of combination nerve blocks have been utilized at Summa Health, with field blocks having the greatest success. Additionally, the time to perform nerve blocks for PECS, SAP, and ESP took an average of 205 seconds, 105 seconds, and 135 seconds, respectively, which is a relatively short duration. The duration of the nerve blocks at Summa Health was also found to be longer than the national time, with an average block duration of 46.7 hours for FI/PENG blocks administered to patients undergoing hip surgeries, compared to the national time of 7 to 14 hours with PENG administration.^{20,26} These results highlight the importance of multimodal pain management

techniques and suggest that implementing these strategies can significantly reduce opioid consumption while improving patient outcomes.

The prevalence of chronic postoperative pain, along with the associated morbidity and economic burden, has prompted efforts to reduce opioid use in pain management. ORAEs are common and increase LOS, cost, and inpatient mortality. Perioperative ERAS protocols have been effective in reducing opioid use while improving patient outcomes. An ERAS program is a comprehensive, evidence-based protocol that aims to improve patient outcomes and reduce complications following surgery. ERAS programs enable faster recovery and reducing LOS, pain, discomfort, reliance on opioids, and their associated side effects, such as nausea, vomiting, and constipation. Other advantages of ERAS programs include improved surgical outcomes, reduced health care costs, and improved patient satisfaction.³⁰ An integral piece of ERAS protocols is MMA, including peripheral nerve blocks, which have shown promise in providing effective pain management with fewer side effects.³¹ Overall, ERAS programs represent a patient-centered approach to surgical care that focuses on optimizing the patient's health and well-being before, during, and after surgery. The Department of Anesthesia at Summa Health has implemented an ERAS program with opioid-free pain management protocols, including the use of a compounded combination drug product, to combat opioid overuse and improve patient outcomes, and can serve as an example for other health care organizations looking to implement similar programs.

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