The Impact of a Standardized Pain Pathway for Enhanced Recovery After Surgery (ERAS) Patients

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Abstract

Introduction/Purpose

Healthcare professionals conventionally use opioids to treat pain, but the emergence of enhanced recovery after surgery (ERAS) shifts pain management from traditional practice to evidence-based practice. Implementing a standardized pain pathway would result in a coordinated effort to improve the current ERAS pain management tenet by decreasing variation in practice, minimizing opioid use with increased multimodal treatment, and upholding positive patient outcomes from the ERAS program. The purpose of this quality improvement (QI) project was to implement a standardized pain pathway for ERAS surgical patients based on evidence-based best practices to improve surgical pain management at a large urban medical center in Hawaii.

Methods

This QI project used a prospective pre-/post-implementation design to determine the effectiveness of a standardized pain pathway for ERAS patients by evaluating opioid use, pathway compliance, pain scores, time in the post-anesthesia care unit (PACU), and length of stay (LOS).

Results

After a three-month observation from June to August 2021, average pain scores, time in the PACU, and LOS were not statistically significant. However, opioid use decreased in the intraoperative and PACU stages, which was statistically significant for Fentanyl administration. Overall, a decrease in pain management variation and an increase in multimodal pain practice were appreciated.

Discussion

Pain after surgery is an evident problem with negative consequences that can be potentially lifelong for the patient. Although this QI project did not find the pain pathway statistically significant, the clinical value of standardized, evidence-based care integrated into a coordinated clinical practice to provide exceptional patient care transpired. Therefore, implementing a standardized pain pathway for ERAS patients can resolve the clinical practice variation, mitigate opioid use, and improve time in the PACU and LOS.

Keywords: enhanced recovery after surgery, pain management, standardized pain protocol, opioid-sparing, multimodal

The Impact of a Standardized Pain Pathway for Enhanced Recovery After Surgery (ERAS) Patients

The fear of pain is a leading patient apprehension after surgery. Opioids are often prescribed after surgery, exposing patients for the first time to the potential for prescription misuse, opioid use disorder, and overdose (Huynh et al., 2020; Offodile et al., 2019; Rawal, 2016). Despite the U.S. Department of Health and Human Services (HHS) (2021) declaring a public health emergency and changes in opioid prescribing practice, opioids were implicated in 67% of drug overdose deaths in 2018. There is a serious and fatal risk of addiction in taking prescription opioids that can provoke an economic strain of more than $1trillion, with escalating costs commensurate to the increasing prevalence of opioid use disorder (Florence et al., 2021). The arising opioid epidemic, financial impact, and possible mortality are factors that call for a change in surgical pain management.

Background

Healthy People 2030 continues the health improvement objective to reduce misuse of prescription drugs as nearly 6% of the surgical patient population have the potential to endure persistent opioid use after surgery (Dowdy, 2019; Office of Disease Prevention and Health Promotion [ODPHP], 2021). In 2019, 9.7 million people reported misusing prescription pain medications, with 36.8% obtained from health care providers (Substance Abuse and Mental Health Services Administration [SAMHSA], 2020). In Hawaii, healthcare providers wrote fewer opioid prescriptions than the national average (National Institute on Drug Abuse [NIH], 2020). Nevertheless, opioid misuse persists as a serious public health issue with urgency for Hawaii hospital communities to improve patient safety and promote strategies to mitigate risk, especially after surgery.

Healthcare professionals conventionally use opioids to treat pain, but the emergence of enhanced recovery after surgery (ERAS) shifts pain management from traditional practice to evidence-based best practice. According to leading surgical scholars, "ERAS is a multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery" (ERAS Society, 2016, para. 3). Thus, multimodal pain control with an opioid-sparing method is one of the ERAS program's central tenets (Dowdy, 2019).

Problem Statement

Pain management for ERAS patients at a large urban medical center in Hawaii was not standardized. Variation in pain management existed with the continued and predominant use of opioids. The approach this quality improvement (QI) project used to improve pain management for ERAS surgical patients was to implement a standardized pain protocol or pathway based on evidence-based best clinical practice guidelines.

Organizational "Gap" Analysis of Project Site

The Hawaii medical center commenced the first ERAS program for colorectal surgeries in 2014. The gynecology (GYN) surgical patients entered the program five years later. The ERAS program, however, did not include a standardized pain pathway. Even with physician orders for ERAS and opioid-sparing patient education in place, the perioperative nurses experienced inconsistent orders resulting in first-line opioid treatment when necessary (R. Benjamin, personal communication, January 23, 2021; N. Kaneshiro, personal communication, January 26, 2021; M. Sosa, personal communication, January 25, 2021). Based on an anesthesia department survey that staff nurse anesthetists deployed in 2018, only 59% of the anesthesia providers were accustomed to using opioid-sparing techniques in their clinical practice, thus

indicating a culture void of multimodal pain management (L. Fong & K. Morrison, personal communication, January 19, 2021).

Outside of the urban medical center in Hawaii, significant improvement in surgical complication rate and mortality compared to national benchmarks, such as the *National Surgical Quality Improvement Program (NSQIP)* and length of stay (LOS), were realized after network related facilities in Northern California's extensive ERAS program implementation, which included a standard anesthetic pathway and multimodal analgesia (Liu et al., 2017). Despite the Hawaii urban medical center's ERAS program success, pain management variation among ERAS patients was still occurring, and multimodal pain practices were underutilized. Implementation of a standardized pain pathway would result in a coordinated effort to improve the ERAS pain management tenet by decreasing variation in practice, minimizing opioid use with increased multimodal treatment, and upholding positive patient outcomes from the ERAS program.

Review of the Literature

Search Strategy

Published articles of the preceding five years (2016-2021) were processed through a relevant database search, including PubMed, CINAHL, and Scout. The search strategy included key search terms using the MeSH terms with Boolean operators of "enhanced recovery after surgery," AND "pain management," AND "standardized pain protocol," NOT "preemptive pain management," NOT "acute pain service," NOT "chronic pain," resulting in an initial 123 articles. The extracted articles featured the pain management component to the ERAS pathway among various surgical settings and specialties. In addition, the search strategy intentionally excluded chronic pain due to the unique treatment required in caring for these patients. The

search was limited to full-text articles in peer-reviewed journals written in the English language. The review further excluded non-pain management articles, specific pain modalities studies, pediatric studies, non-ERAS, non-perioperative settings, evaluation tool interventions, post-discharge interventions, and preliminary trials. The final screening process resulted in 31 eligible available articles once duplicate removal and exclusion by screening titles and abstracts.

ERAS Pain Management

In response to the variation of current pain practices, endorsement for standardized anesthesia and analgesia are repeatedly echoed in recent literature (Ackerman et al., 2019; Bhatia & Buvanendran, 2019; Bollag et al., 2021; Collett et al., 2021; Hahl et al., 2016; Hutto et al., 2020; Huynh et al., 2020; Joshi & Kehlet, 2019; Kaye et al., 2019; Keller et al., 2017; Keller et al., 2016; Li et al., 2020; Mitra et al., 2018; Mujukian et al., 2020; Offodile et al., 2019; Rawal, 2016; Soffin et al., 2019; Temple-Oberle et al., 2017; Trowbridge et al., 2018). Among the recommended ERAS pain management pathways, themes of procedure-specific, opioid-sparing, and multimodal analgesia aim to optimize patient recovery (Ackerman et al., 2019; Bergstrom et al., 2018; Bhatia & Buvanendran, 2019; Bollag et al., 2021; Crosson, 2018; Curley et al., 2021; Hutto et al., 2020; Huynh et al., 2020; Joshi & Kehlet, 2019; Kaye et al., 2019; Keller et al., 2016; Kim & Aloia, 2018; Li et al., 2020; Mitra et al., 2018; Modesitt et al., 2016; Mujukian et al., 2020; Offodile et al., 2019; Olson et al., 2021; Rawal, 2016; Ruiz-Tovar et al., 2019; Soffin et al., 2019; Temple-Oberle et al., 2017; Trowbridge et al., 2018; Ueland et al., 2020). These themes take a synergistic pain management approach tailored to the surgery performed, using an array of medications and techniques to target pain receptors. This combined approach will help lessen opioid use, which in turn prevents known untoward effects. Improved patient outcomes appreciated from the effective ERAS pathway include a significant reduction in opioid

requirements, opioid use, pain scores, postoperative complications, hospital readmissions, and LOS (Ackerman et al., 2019; Bergstrom et al., 2018; Bhatia & Buvanendran, 2019; Brown et al., 2020; Collett et al., 2021; Curley et al., 2021; Hahl et al., 2016; Hutto et al., 2020; Huynh et al., 2020; Kaye et al., 2019; Keller et al., 2017; Keller et al., 2016; Li et al., 2020; MacGregor et al., 2021; Modesitt et al., 2016; Mujukian et al., 2020; Offodile et al., 2019; Trejo-Avila et al., 2019; Trowbridge et al., 2018; Ueland et al., 2020). Opioid stewardship and patient satisfaction are secondary outcomes from the ERAS standardized pathway, a well-known benchmark for recovery (Collett et al., 2021; MacGregor et al., 2021; Mitra et al., 2018; Modesitt et al., 2016; Offodile et al., 2019; Trowbridge et al., 2018).

Standardizing Best Practices

With emerging high-quality evidence and strongly recommended guidelines, health professionals urge a standardized pain management strategy limiting opioids (Kremer & Griffis, 2018). Standardized clinical practice guidelines have substantially benefitted patients and hospital systems, avoiding variation in care (Chou et al., 2016; Grant et al., 2019; Gustafsson et al., 2018; Nelson et al., 2016; Nelson et al., 2019). Early ERAS guidelines state that standardization is necessary to ensure the best quality care and provide a way to evaluate the program's effectiveness (Nelson et al., 2016). Unfortunately, traditional pain practices are generalized without compliance with a standardized ERAS pathway, and pain management variation develops (Joshi & Kehlet, 2019).

Evidence-based Practice: Verification of Chosen Option

The standardized pain pathway indexed short-acting, multimodal pain management medications and techniques based on current best practice guidelines from the *ERAS Society* and the *American Pain Society* that can be reviewed in Appendix A. The proposed clinical question

was: In ERAS surgical patients (P), will implementation of an evidence-based standardized ERAS pain pathway (I) as compared to traditional pain management (C) decrease opioid use, pain scores, time in the post-anesthesia care unit (PACU), and LOS (O) after three-months (T)?

Theoretical Framework

A hybrid of Lewin's Change Management Model (Mind Tools, 2021) and Prochaska & DiClemente's Stages of Change (1983) model provided a framework for the organization's ERAS leaders and the perioperative stakeholders to apply the standardized pain pathway for ERAS patients. The advantage of this hybrid theoretical framework was overarching in the perioperative setting and for all surgical patients who are ERAS program candidates. Both theories describe the dynamic stages individuals and organizations move through to change and improve processes.

The Outer Ring: Lewin's Change Model

Appendix B contains a two-ring conceptual map to illustrate a hybrid theory application of a standardized ERAS pain pathway integration. Lewin's change model describes the organizational change process using the block of ice analogy on the outside ring. The "why" for a standardized pain pathway was emphasized, beginning with *unfreezing*, where change is needed. The second stage was the initiated *change* or "different way," such as a standardized ERAS pain pathway. Lastly, stability was established in the *refreezing* stage, where the "different way" was adopted. ERAS leaders and champions committed to the change and celebrated the success, communicating confidence to the perioperative stakeholders.

The Inner Ring: Stages of Change

The inner ring represents Prochaska and DiClemente's Stages of Change model to describe the change dynamic for the nurses or providers in patient care who exist at various

acceptance stages. In the *pre-contemplation* phase, this nurse had no intention to change or was unaware of the improvement initiative. In the *contemplation* phase, this nurse was fully aware of the opioid crisis and was receptive to learning opioid alternatives. Encouraging the spirit of inquiry was vital at this stage. The nurse in the *preparation* phase was ready to act, albeit with their reservations of success, actively attending education in-services and reading evidence-based practice updates. The first three stages of change coincide with the unfreezing stage in the outer ring, representing the shift from tradition.

In the *action* phase of the Stages of Change model, the nurse was ready to commit to using opioids sparingly or not at all. This phase aligns with the change stage in the outer ring, where a standardized pain pathway was shaped. The nurse continued what worked well in the action phase with consistent reevaluation for pathway improvement in the *maintenance* phase. Data learned will be disseminated in the rarely attainable *termination* phase to help implement the standardized pain pathway for future ERAS programs in other surgical services. The last phases sync with the refreezing stage in the outer ring to solidify the newly adopted standardized ERAS pain pathway.

Goals, Objectives, and Expected Outcomes

The goal was to evaluate the impact of an evidence-based standardized pain pathway for ERAS patients. The objectives the primary investigator (PI) achieved were:

1. Conducted a 30-minute perioperative staff training session on the evidence-based standardized pain pathway for ERAS patients. Refer to Appendix C.
2. Implemented the standardized pain pathway for ERAS patients. Refer to Appendix D.
3. Collected and logged data used to measure a change in outcomes (e.g., opioid

use, pain scores, time in the PACU, and LOS). Refer to Appendix E.

4. Evaluated the effectiveness of the standardized pain pathway three months after implementation.

Expected outcomes for ERAS surgical patients included decreased opioid use, pain scores, time in the PACU, and LOS.

Methods

Project Design

This QI project used a prospective pre-/post-implementation design. A retrospective chart review was performed to assist in determining project effectiveness. Two groups were reviewed among the colorectal and GYN ERAS cases, consisting of 61 retrospective and 68 prospective cases. The standardized pain pathway was incorporated into the existing ERAS surgical program currently in place. The pathway detailed short-acting, multimodal medications and techniques organized by each perioperative phase (e.g., preoperative, intraoperative, and postoperative) and surgical service (e.g., colorectal or GYN) (see Appendix D). The pathway was available to all perioperative staff in a laminated paper form, as featured in Appendix D, accessible in each department and operating room.

Project Site and Population

This project was conducted at a large urban medical center in Hawaii among the perioperative service departments (e.g., preoperative, anesthesia, and postoperative). The perioperative and anesthesia departments were equipped with the appropriate personnel, medications, and skilled providers to implement a standardized ERAS pain pathway. Also, an ERAS program committee was in place and included a comprehensive transdisciplinary team to help support standardized practice guidelines.

The sample population included elective colorectal and GYN surgeries scheduled in the ERAS program. The ERAS surgical patients were of a diverse adult age range (i.e., 19-90 years old) and underwent various colorectal or GYN surgeries with an inpatient or outpatient discharge plan. The sample excluded emergent surgeries, non-ERAS patients, pediatrics, and other non-colorectal or non-GYN surgical patients.

Setting Facilitators and Barriers

Having the ERAS program already in place was considered a setting facilitator. The surgeon designated the patient as an ERAS candidate. The surgeon activated the ERAS order set in the electronic medical record (EMR). Pain management order entries are limited to preoperative and postoperative for the surgeons. Intraoperative pain management by the anesthesia staff was provider-dependent. Appendix F displays the process flowchart of the ERAS workflow.

Setting barriers consisted of the variation in pain management beliefs and practice, the need for staff and patient education, and physician support. The PI collaborated with the key organizational stakeholders on planning and implementing the project to address these barriers. In addition, the PI conducted education sessions for staff during regularly scheduled meetings (held two Fridays a month) to introduce the new pathway and advocate for compliance.

Measurement Instruments

Data was collected from the EMR and managed by the PI. Descriptive data included the patient's age, gender, race/ethnicity, American Society of Anesthesiologists (ASA) physical status classification, type of procedure (e.g., colorectal or GYN), and whether the surgery was an inpatient or outpatient. Quantitative data included opioid use, pain scores, time in the PACU, and LOS. Time in the PACU and LOS was captured from the EMR. Data collection occurred at one-

month intervals for three months. The PI recorded and tracked the data on Excel spreadsheets. Appendix E displays the data collected in workbooks for colorectal and GYN ERAS patients, respectively. To determine compliance with the pathway, the PI conducted a retrospective review of ERAS patients' EMRs to track the types of multimodal or opioid alternative medications and techniques used during the preoperative, intraoperative, and postoperative phases. Compliance was determined based on meeting the multimodal pain management definition. Experts define the multimodal analgesia approach (MMA) as the effective pain control strategy delivering two or more different opioid alternative medications or techniques (American Association of Nurse Anesthetists [AANA], 2016; American Society of Anesthesiologists [ASA], 2018; Chou et al., 2016; Graff & Grosh, 2018; Interagency Pain Research Coordinating Committee [IPRCC], 2016).

Data Collection Procedure

SDSA Framework

Standardize. The PI created the standardized pain pathway based on evidence-based practice guidelines specific to colorectal and GYN ERAS surgeries. Prior to implementation, the PI conducted a 30-minute education session (see Appendix C) for the anesthesia and perioperative nursing staff via face-to-face and an asynchronous format (e.g., prerecorded PowerPoint presentation). These education sessions were organized for the anesthesia, preoperative, and postoperative nursing staff, during a regularly scheduled morning and afternoon meeting in May 2021.

Do. In June 2021, the PI implemented the standardized pain pathway and commenced the retrospective and prospective chart reviews to extract the data. Descriptive data included the patient's age, gender, race/ethnicity, ASA physical status classification, type of procedure (e.g.,

colorectal or GYN), and whether the surgery was inpatient or outpatient to help describe the population. Quantitative data included opioid use, pain scores, time in the PACU, and LOS. Data collection occurred at one-month intervals for three months from the patients' EMRs by the PI. The PI logged the data on an Excel spreadsheet (see Appendix E).

Data Analysis (Study). The PI analyzed the data using Excel (Microsoft). ERAS surgical patients' characteristics were analyzed as descriptive data and reported as means, frequencies, and percentages. A breakdown of ERAS patient opioid use, multimodal anesthesia, and analgesia techniques was examined preoperatively, intraoperatively, and postoperatively. Lastly, the analysis determined pain scores, length of time in the PACU, and LOS. Independent sample *t*-tests were used to compare pre-intervention and post-intervention mean data differences from continuous variables for colorectal and GYN ERAS patients. Chi-square tests analyzed non-parametric data. A p-value ≤ 0.05 determined statistical significance to explain the impact of a standardized pain pathway. Progress reports in a dashboard platform (see Appendix G) were provided monthly by the PI to ERAS team members and staff. Tables and charts, as appropriate, were used to organize and display cohort demographics and project outcomes interpreted later in the results.

Act. Areas for change reinforcement, sustainability, and potential modifications were identified and considered by the PI explained in the discussion section.

Cost-Benefit Analysis/Budget

ERAS program pathways have gained recognition as a value-based method to meet the demands of optimizing health system performance using robust evidence-based practice to improve outcomes and decrease cost. However, after successful ERAS implementation in colonic surgery patients and proven favorable outcomes, hospitals continue to abandon tradition

to adopt a standardized approach that improves cost variation and potential income (Ackerman et al., 2019). A shift toward standardization is vital considering the exceeded benefits of an improved continuum of care around the operating room, which is an area of high profitability potential.

The ERAS program at this large urban medical center in Hawaii appreciated a half-day in-hospital stay savings, which amounted to $900 per day or $1.3 million annual savings at a 70% confidence level (C. Fitzgerald, personal communication, September 14, 2020). Because ERAS is already an operational program at this large urban medical center, the expense impact of an ERAS coordinator and patient supplies were already considered yielding a positive revenue of reduced unit variable costs. It was reasonable to believe that the expected project outcomes would result in even further cost savings for this large urban Hawaii medical center. The expenses to be incurred by the PI included paper, printing, laminating, and time dedicated to planning, implementing, and evaluating the project.

Timeline

Total project time was anticipated at one year. While planning took four months, the implementation period was three months, and evaluation required one month. Accordingly, seven months will be needed for dissemination and publication. Appendix H presents the ERAS standardized pain pathway project schedule using a Gantt chart.

Ethical Considerations/Protection of Human Subjects

Before initiating this project, the University of Alabama (UA) IRB approval was obtained. All elective colorectal and GYN surgery patients scheduled in the ERAS program received evidence-based perioperative care in accordance with the standardized pain pathway. The risks to elective colorectal and GYN surgery patients included in the project were no greater

than the risks to elective colorectal and GYN surgery patients who did not receive care in accordance with the standardized pain pathway. All patients were protected by the Health Insurance Portability and Accountability Act of 1996 (HIPAA), including the protection and privacy of patient health information. Informed consent would not be required since this is a quality improvement project. No patient identifiers were included. All data collected were managed on a single spreadsheet using Excel with password protection known only by the PI. The password was not shared with anyone else. This electronic file will be stored on the HIPAA secure UA Box for a minimum of two years after completing the project.

Results

Descriptive Analysis

Launched in June 2021, the standardized pain pathway was implemented for ERAS patients. The total sample size (n) of the pre-ERAS pain pathway (pre-EPP) group was 61 patients, comprised of 19 colorectal patients and 42 GYN patients. The post-ERAS pain pathway implementation (post-EPP) group's total sample size (n) was 68 patients consisting of 16 colorectal patients and 52 GYN patients. A total of five patients were excluded from the project due to meeting the exclusion criteria of emergent surgery and chronic pain. There are no differences in the demographic makeup of age, gender, race/ethnicity, or ASA physical status classification reviewed in Appendix I. All colorectal ERAS patients were inpatients in both groups, with colon and robot-assisted laparoscopic surgeries mainly performed. Nearly two-thirds of ERAS GYN patients are outpatients who underwent a laparoscopic hysterectomy.

Opioid use

Perioperative use of opioids for pain management was observed from June to August of 2021 after the ERAS pain pathway was implemented and compared to the same timeframe one

year prior, which can be found in Appendix J. Preoperative opioid use was not analyzed as it was not common practice at the project site. Intravenous Fentanyl, Morphine, and Dilaudid were often used in the intraoperative and PACU period; however, Fentanyl was predominantly used Pre-EPP and Post-EPP due to the short-acting profile aligning with the ERAS practice guidelines. In the postoperative period, Oxycodone was commonly administered.

Both intraoperative and PACU's Fentanyl intravenous use decreased for Colorectal and GYN ERAS surgeries. The intraoperative Fentanyl use of Post-EPP (Colorectal M = 123mcg, SD = 78.25, n = 16; GYN M = 123mcg, SD = 64.79, n = 52) was less than of the Fentanyl use of Pre-EPP (Colorectal M = 213mcg, SD 84.73, n = 19; GYN M = 154mcg, SD = 64.78, n = 42). Fentanyl use in the PACU Post-EPP (Colorectal M = 22mcg, SD = 31.46, n = 16; GYN M = 33mcg, SD = 48.44, n = 52) was also less than the Fentanyl used Pre-EPP (Colorectal M = 26mcg, SD = 42.88, n = 19; GYN M = 42mcg, SD = 58.09, n = 42). A statistical significance was only found in the Fentanyl intraoperative use, Colorectal $t(33) = 3.25$, $p = 0.003$ (2 tailed); GYN $t(88) = 2.33$, $p = 0.022$ (2 tailed) as seen in Appendix J.

Comparatively, IV opioids were sparingly used or not used in the postoperative period. It is of note that oral Oxycodone increased during the postoperative surgical phase among Colorectal and GYN ERAS surgeries after EPP was implemented (Colorectal M = 23mg, SD = 44.98, n = 16; GYN M = 14mg, SD = 14.78, n = 15). While the postoperative Oxycodone increase was not statistically significant for the Colorectal cohort, statistical significance was found for the GYN sample, $t(19) = -2.56$, $p = 0.019$ (2 tailed).

ERAS Pain Pathway Compliance

The opioid alternative medications and techniques included PO or IV Acetaminophen, Celecoxib, Dexamethasone, Dexmedetomidine, Gabapentin, Ibuprofen, Ketorolac, Ketamine,

Lidocaine infusion, or a transversus abdominis plane (TAP) block. As a result, the post-EPP colorectal and GYN groups increased compliance to nearly 70%. This outcome equated to an overall 30% change for the colorectal group and an 11% change for the GYN group.

The following are the change breakdown of compliance for each perioperative period that can be reviewed in Appendix K. Preoperative EPP compliance did not change for the colorectal cohort as it was not common for surgeons to order preoperative or preemptive pain medication at the project site. The GYN cohort increased compliance to 63% (15% change). Intraoperative EPP compliance markedly improved to almost 100% compliance in both colorectal (19% change) and GYN (18% change) groups. Finally, the postoperative EPP compliance in the colorectal group increased to almost 70% (10% change). Further, it is important to note the 100% compliance of the MMA administration for the GYN groups (i.e., pre-EPP and post-EPP), despite no change. Subsequently, compliance was not significant based on Chi-square tests (see Appendix K). Additionally, the ERAS pain pathway was not found to be significant on compliance for the colorectal group, $t(33) = -1.37$, $p = 0.179$ (two-tailed) or the GYN group, $t(92) = -1.78$, $p = 0.078$ (two-tailed), as seen in Appendix L.

Pain Scores

Average pain scores were examined pre-EPP and post-EPP among the colorectal groups and GYN groups in the PACU and postoperative period using the documented Numerical Pain Rating Scale (NPRS), which is a scale comprised of 0 (no pain) to 10 (severe pain). Average pain scores among the pre-EPP/post-EPP groups are displayed in Appendix M.

In the Pre-EPP colorectal group (M = 2, SD = 2.24, n = 19), average pain scores were mildly minimized after EPP implementation (M = 1, SD = 1.09, n = 16). There was no change in the postoperative period. The GYN group also did not undergo change in average pain scores in

the PACU, yet experienced a mild pain increase for those admitted to the hospital (M = 4, SD = 1.51, n = 15) compared to the average pain scores pre-EPP (M = 3, SD = 1.75, n =12). Overall, average pain scores were not statistically significant in the PACU, (Colorectal $t(27) = 1.30$, $p = 0.204$ (two-tailed); GYN $t(90) = -0.53$, $p = 0.600$ (two-tailed)) or the postoperative period (Colorectal t(33) = 0.195, p = 0.847; GYN t(22) = -0.575, p = 0.571) referred to in Appendix L.

PACU Time and Length of Stay

Lastly, length of time in the PACU (hours, minutes) and average LOS (days) were evaluated pre-EPP (June to August 2020) and post-EPP (June to August 2021) for the colorectal and GYN groups. Based on Appendix N, the pre-EPP and post-EPP PACU time and LOS did not distinctly change for the colorectal group and further displayed an increase in average LOS over the observed post-EPP timeframe. The GYN group was unique due to the inpatient and outpatient status (i.e., pre-EPP and post-EPP). PACU time for outpatients decreased by 42 minutes from pre-EPP (M = 4 hours 42 minutes, SD = 1.9, n = 30) to post-EPP (M = 4 hours, SD = 1.5, n = 37). The inpatients also slightly decreased by staying 18 minutes less in the PACU from pre-EPP (M = 2 hours 36 minutes, SD = 4.8, n = 12) to post-EPP (M = 2 hours 18 minutes, SD = 1.2, n = 15). Additionally, the GYN inpatients' post-EPP average LOS (M = 1.7, SD = 1.2, n = 15) decreased by 1.2 days from the pre-EPP LOS (M = 2.9, SD = 4.8, n = 12). Overall, the PACU and LOS time was not statistically significant for the colorectal and GYN groups, as illustrated in Appendix L.

Discussion

Interpretation

The results of this QI project support the clinical effectiveness of a standardized pain pathway for ERAS patients. Intraoperative opioid use declined and was statistically significant

for Fentanyl administration in the colorectal and GYN groups. Despite an increase in postoperative Oxycodone in both groups, this finding was only statistically significant for the GYN group. The impact of the pain pathway for this group may be multi-factorial. In an effort to minimize overall opioid use and increase MMA pain management, intraoperative opioids decreased while postoperative opioids increased. Another factor unaccounted for was the timing limitations of subsequent opioid alternative administration, like Acetaminophen or Non-Steroidal Anti-inflammatory Drugs (NSAIDs). Many GYN patients received preoperative MMA, which restricted a successive opioid alternative dose and resulted in postoperative Oxycodone administration.

The overall compliance of the ERAS pain pathway expanded after the EPP implementation. Preoperative compliance did not change for the colorectal group yet increased for the GYN group. Intraoperative compliance improved for both groups. Lastly, the postoperative compliance improved for the colorectal group and remained constant at 100% compliance for the GYN group. Although there was not a statistical significance found, the result was clinically significant. Many ERAS patients post-EPP received only one opioid alternative where they may not have been provided pre-EPP, challenging to meet the MMA definition of delivering two or more opioid alternatives throughout the perioperative periods (e.g., preoperative, intraoperative, and postoperative) (American Association of Nurse Anesthetists [AANA], 2016; American Society of Anesthesiologists [ASA], 2018; Chou et al., 2016; Graff & Grosh, 2018; Interagency Pain Research Coordinating Committee [IPRCC], 2016). The clinical value of this project was the shift in practice towards MMA through a standardized method for pain management.

Average documented pain scores remained minimal for all ERAS cases from pre-EPP compared to post-EPP. No statistical significance was found. Therefore, the effectiveness of an ERAS pain pathway on pain scores cannot be assumed. However, it is important to acknowledge that pain assessment practices at this project site were not standardized, suggesting a future QI project.

Finally, time was a valuable measurement in this project and commonly measured in ERAS research (Ackerman et al., 2019; Collett et al., 2021; Curley et al., 2021; Keller et al., 2017; Keller et al., 2016; Li et al., 2020; MacGregor et al., 2021; Modesitt et al., 2016; Offodile et al., 2019; Olson et al., 2021; Trejo-Avila et al., 2019; Trowbridge et al., 2018; Ueland et al., 2020). Although time in the PACU did not change for the colorectal group, time was decreased for the GYN group, which leads to a clinical significance for GYN inpatients and outpatients. Moreover, the decreased average LOS for the GYN group was also clinically significant after standardizing the pain management for ERAS patients.

Cost-effectiveness

Standardized best-practice approaches, such as ERAS, are an all-encompassing effort to improve the quality of patient care and mitigate emerging healthcare expenditures (Ackerman et al., 2019; Collett et al., 2021; Modesitt et al., 2016; Trowbridge et al., 2018). The ERAS initiative comes at a perfect time as healthcare transitions from a fee-for-service method to value-based care, especially with today's rising healthcare costs (Porter-O'Grady & Malloch, 2018, Chapter 2). The CDC (2021) reports that as of 2018, 17.7% of the gross domestic product in the U.S. is spent on healthcare. As healthcare costs rise, accountability for outcomes with a solid approach of team-based, coordinated care, and patient-focused will facilitate towards achieving

the Institute for Healthcare Improvement's (IHI) (2021) "Triple Aim" to elevate the patient care experience for all patient populations at an affordable cost.

Since June of 2021, a decrease in pain management variation and an increase in multimodal pain practice were appreciated, with an overall compliance of nearly 70% in the colorectal and GYN groups. As a result, the ERAS pain pathway will be an ever-evolving protocol that will continuously be updated to the emerging evidence to support and provide optimal patient care. Therefore, evaluating ERAS outcomes is essential and strongly recommended for practice change and quality improvement (Gustafsson et al., 2018; Nelson et al., 2019).

While this project's implementation expenses were low, the actualized cost-benefit is challenging to pinpoint where variables of time, nursing staff, staff training, medications, multi-disciplinary coordination, and patient education, to name a few, are not realized. However, projected potential savings of approximately four days for colorectal and half-day for GYN patients at $900 per adult medical/surgical hospital stay motivated the ERAS pain pathway initiative (C. Fitzgerald, personal communication, September 14, 2020; C. Uyeno, personal communication, September 8, 2021). Therefore, the layered benefits of ERAS must continuously be promoted, updated, and evaluated to maintain clinical improvement and cultivate change.

Change Sustainment

Organizational and stakeholder buy-in facilitated the movement for change in implementing the ERAS pain pathway. An elevated spirit of inquiry and collaboration among engaged staff was a tremendous strength in this project. Staff members actively participated and adopted multimodal pain management into their daily practice. This clinical practice engagement is substantiated in the increased pain pathway compliance over the surgical period. A

coordinated IRB-approved plan with clear, simple goals, continuous and frequent communication, and monthly evaluation through in-person department meetings, bulletin boards, and emailed newsletters was key to sustaining staff engagement through the implementation period.

One unique challenge included the lack of an ERAS hospital order set. Without a standardized order set, anesthesia providers must manually tailor postoperative orders to the ERAS pain pathway, particularly short-acting analgesics for each patient. This disadvantage uncovered technology resistance and the lack of informatics and informational technology (IT) support. However, with coordinated multi-disciplinary effort, an ERAS PACU order set for anesthesia is well under development with the future application by the end of this year. Another disadvantage was the limited education training period before implementation. This identified barrier includes the lack of time due to the constraints of an ongoing patient-facing setting and limited personnel to deliver education sessions.

Recommendations for the Future

This QI project was not without limitations that should be acknowledged. The design was a pre-/post-implementation retrospective review which is complex to arrive at correlational findings. In addition, there were noted outliers in the collected data, such as chronic pain, frailty, blood transfusion requirements, postoperative nausea and vomiting (PONV), and the inability to void, which hindered the rapid recovery goal. Also, neighbor island patients who request an overnight stay are unique to this project site. More limitations include the sole facility and small, non-randomized sample observed, which inhibits generalizability. Regardless of these recognized limitations, improvement opportunities surfaced.

Standardizing evidence-based care calls for a comprehensive effort that is intentional, meaningful, and collaborative. Further improvement of the measured outcomes and adoption of the ERAS pain pathway will evolve from continued auditing. Thus, an ERAS pain pathway or even an all-inclusive ERAS program checklist will be advantageous and innovative as an auditing tool in the future.

The patient perspective was another area of opportunity identified. Achieving the ERAS program requires team effort, starting with the patient and the surgeon who designates the patient as an ERAS candidate. Patient education before surgery is crucial as this sets their expectations for the recovery period when handling pain. Because pain is the "fifth vital sign," postoperative practices, especially the pain continuum, are the most influential and pivotal to patient recovery and health (Bhandoria et al., 2021). So, a postoperative patient evaluation beyond their hospital stay can potentially augment the patient's journey through the surgical process.

Lastly, chronic pain patients were highlighted as a limitation in this hospital setting. As surgeons selected patients for the ERAS program, their chronic pain history was not addressed accordingly, which led to inefficient pain management for this persistent condition and further pointed out the lack of anesthesia pain service and a disconnect with the current pain management department. Future research and a QI project to develop a patient-specific pain pathway are necessary to provide definitive care for chronic pain patients.

Dissemination of this ERAS pain pathway implementation will perhaps pave the way for upcoming surgical specialties and perioperative teams planning to implement the ERAS program. Prospective journals to be considered for publication include the Association of periOperative Registered Nurses (AORN), the Journal of Perioperative Practice, and the American Association of Nurse Anesthesiology (AANA). In addition, a poster presentation at the

facility will help maintain communication, inter-professional connection, and engagement to sustain pain pathway compliance. Sharing this quality improvement experience of evidence-based practice will help contribute to quality patient care and outcomes while strengthening the practice-based evidence.

Conclusion

Pain after surgery is an evident problem with negative consequences that can be potentially lifelong for the patient. Pain management is only one tenet of the many ERAS program guidelines, but it is substantial (Bhatia & Buvanendran, 2019; Dowdy, 2019; Joshi & Kehlet, 2019; Kaye et al., 2019; Mitra et al., 2018). The robust evidence-based practice was extracted from clinical practice guidelines and integrated into the current ERAS program at a large urban medical center in Hawaii by implementing a standardized pain pathway.

Standardized practice guidelines benefit the surgical patient, healthcare providers, and hospital system, aligning with the IHI's "Triple Aim" goals to provide the best cost-effective care for all patients (IHI, 2021). The process will be continuous as information is dynamic with the ever-changing evidence advancing in health care and effort to alleviate the opioid epidemic. This QI project to implement a pain pathway for ERAS patients has shown that integrating clinical-based practice guidelines through each perioperative period establishes a coordinated standard of care, resolving clinical practice variation while mitigating opioid use and improving time in the PACU and LOS overall. Future research on the long-term effects of ERAS for other surgical procedures is recommended. Such studies may help identify successes and lead to the adaptability of ERAS pain pathways in other surgical specialties.

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Appendix A

Table A1

ERAS Society Colorectal Evidence-based Guidelines

ERAS Item	ERAS Colorectal 2018 Recommendations	Level of Evidence	GRADE of Recommendation
Pre-Anesthetic Medication	Avoid or minimize sedation medication; Consider Acetaminophen, NSAID, and Gabapentin to achieve Multimodal, Opioid-sparing analgesia (adjusted for age & dose). Gabapentin CAUTION: elderly and renal dysfunction.	Moderate	Strong
Standard Anesthetic Protocol	Use Short-acting General Anesthetics in Opioid-sparing ERAS pathway, Propofol for induction, short-acting opioids (Fentanyl or Sufentanil) if required, consider TIVA, SEVO or DES, consider avoiding N2O.	Low	Strong
Postoperative Analgesia	Minimize Opioids. Apply Multimodal analgesia with regional methods when appropriate	Moderate	Strong
Epidural Block	Thoracic Epidural Analgesia (TEA) with low-dose Local Anesthetic and Opioids recommended for Open Colorectal surgery	High/Moderate	Strong
Lidocaine Infusions	Reduces opioid consumption postoperatively for open and laparoscopic colorectal surgery; 1.5-3mg/kg/h	High	Strong
TAP Block	TAP blocks reduce opioid consumption and improve recovery providing analgesic coverage from T10 to L1. Consider subcostal and rectus adjunct blocks for the upper abdomen.	Moderate	Strong

(Gustafsson et al., 2019)

Table A2

ERAS Society Gynecology/Oncology Evidence-based Guidelines

ERAS Item	ERAS GYN/ONC 2019 Recommendations	Level of Evidence	Grade of Recommendation
Pre-anesthetic Medication	Avoid routine sedative administration	Low	Strong
Standard Anesthetic Protocol	Use Short-acting anesthetics to minimize residual anesthetic effects for rapid recovery. Propofol, Sevoflurane, Desflurane. Consider TIVA (with Propofol), Dexmedetomidine, Ketamine, and Lidocaine infusion. Avoid high dose or long-acting opioids. Consider avoiding N2O.	Low	Strong
Opioid-sparing Postoperative Analgesia	Multimodal post-operative analgesic pathway successfully minimizes opioid use. 1st line treatment with non-opioid alternatives including NSAIDs, Acetaminophen, Gabapentin, Dexamethasone, and regional blocks (TAP or TEA).	High	Strong

(Nelson et al., 2019)

Table A3

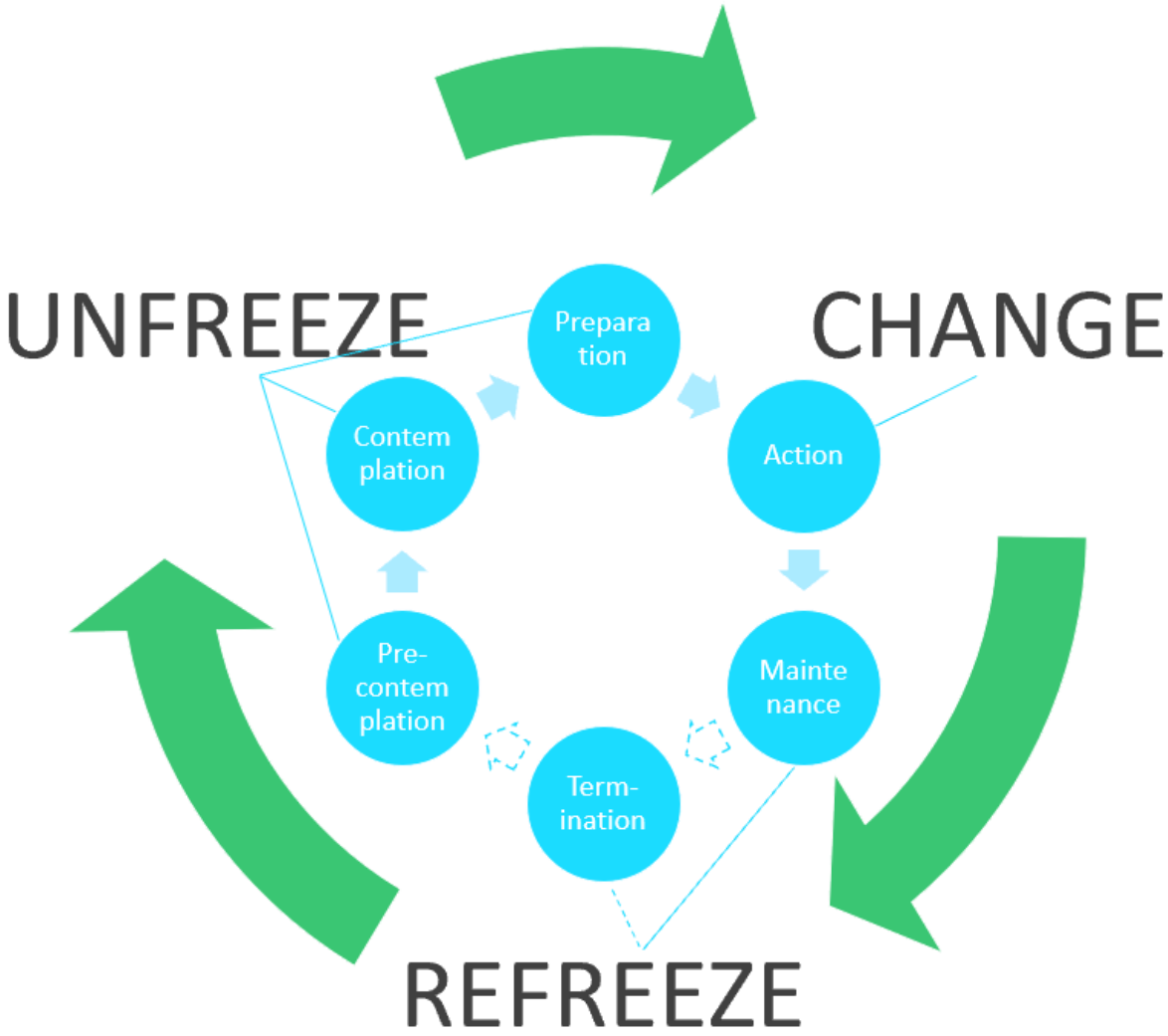
American Pain Society Postoperative Pain Clinical Practice Guidelines

Recommendations	Summary	Level of Evidence	Grade of Recommendation
Recommendation #6: Offer multi-modal analgesia, or the use of a variety of analgesic medications and techniques combined with non-pharmacological interventions, for treatment of postoperative pain.	Administer around the clock non-opioid analgesics and non-pharmacologic therapies in Multi-modal pain management. Multi-modal pain management = deliver more than one Opioid Alternative	High	Strong
Recommendation #10: Administer oral over IV opioid administration to able patients.	Long-acting oral opioids and preoperative opioids are NOT recommended, unless opioid tolerant.	Moderate	Strong
Recommendation #15: Provide Acetaminophen and/or NSAIDs combination for multi-modal postoperative analgesia.	The combination is highly effective in minimizing postoperative pain and opioid use than either medication taken individually. NSAIDs CAUTION: bleeding risk, renal or CAD patients.	High	Strong
Recommendation #16: Consider preoperative dose of Celecoxib PO	Common dose 200-400mg up to 1H preoperatively. Contraindicated in CABG Hx patients.	Moderate	Strong
Recommendation #17: Consider preoperative dose of Gabapentin PO	Consider for major surgeries. CAUTION: potential dizziness and sedation. Adjust for dose and age.	Moderate	Strong
Recommendation #18: Consider Ketamine IV	Decreases postoperative pain medication requirements and pain scores. Preoperative bolus of 0.5 mg/kg. Consider infusion at 10mcg/kg/min intraoperatively.	Moderate	Weak
Recommendation #19: Consider Lidocaine infusion for open and laparoscopic abdominal surgery.	Minimizes ileus. Consider infusion of 2mg/kg/h intraoperatively.	Moderate	Weak
Recommendation #26: Offer neuraxial analgesia for major thoracic and abdominal procedures, especially cardiac, respiratory, or prolonged ileus risk patients.	Lowers postoperative pain scores or postoperative breakthrough pain medication and opioid requirements.	High	Strong

(Chou et al., 2016)

Appendix B

Conceptual Map of a Standardized ERAS Pain Pathway



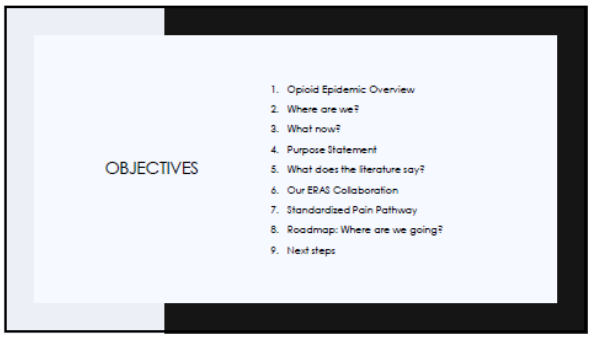
(Mind Tools, 2021; Prochaska & DiClemente, 1983)

Appendix C

Presentation: Evidence-based Standardized Pain Pathway for ERAS Patients

1

2



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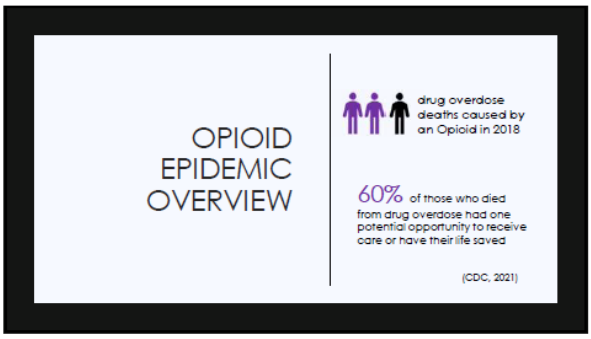

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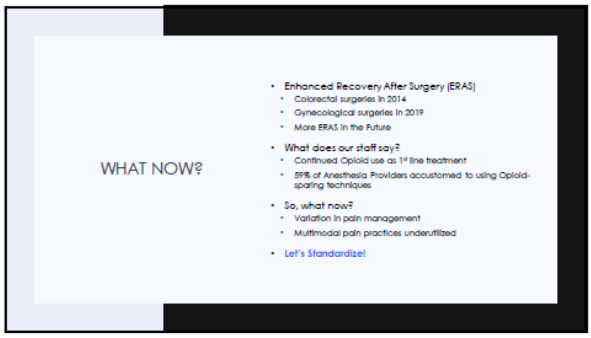

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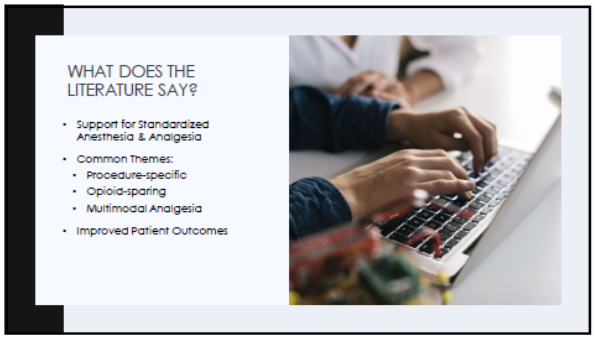

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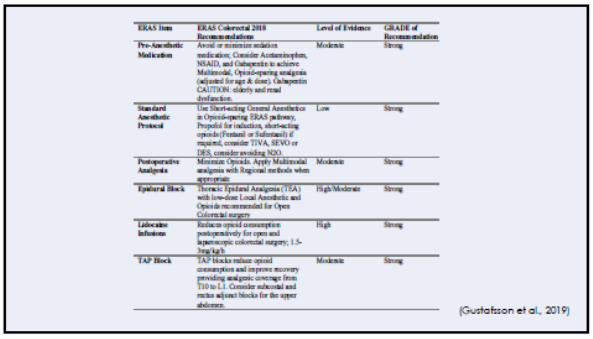

ERAS Item	ERAS Colorectal 2018 Recommendations	Level of Evidence	GRADE of Recommendation
Pre-Anesthetic Medication	Avoid or minimize sedation medication; Consider Acetaminophen, NSAID, and Gabapentin to achieve Multimodal, Opioid-sparing analgesia (adjusted for age & dose). Gabapentin CAUTION: elderly and renal dysfunction.	Moderate	Strong
Standard Anesthetic Protocol	Use Short-acting General Anesthetics in Opioid-sparing ERAS pathway, Propofol for induction, short-acting opioids (Fentanyl or Sufentanil) if required, consider TIVA, SEVO or DES, consider avoiding N2O.	Low	Strong
Postoperative Analgesia	Minimize Opioids. Apply Multimodal analgesia with Regional methods when appropriate	Moderate	Strong
Epidural Block	Thoracic Epidural Analgesia (TEA) with low-dose Local Anesthetic and Opioid is recommended for Open Colorectal surgery	High/Moderate	Strong
Lidocaine Infusions	Reduce opioid consumption postoperatively for open and laparoscopic colorectal surgery; 1.5-3mg/kg/h	High	Strong
TAP Block	TAP blocks reduce opioid consumption and improve recovery providing analgesic coverage from T10 to L1. Consider subcostal and rectus adjunct blocks for the upper abdomen.	Moderate	Strong

(Gustafsson et al., 2019)

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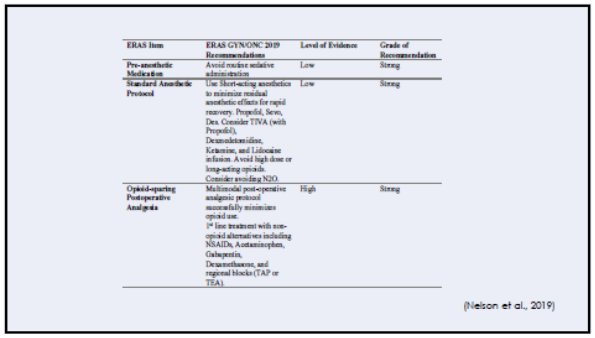

ERAS Item	ERAS GYN/ONC 2019 Recommendations	Level of Evidence	Grade of Recommendation
Pre-anesthetic Medication	Avoid routine sedative administration	Low	Strong
Standard Anesthetic Protocol	Use Short-acting anesthetics to minimize residual anesthetic effects for rapid recovery. Propofol, Sevo, Dex. Consider TIVA (with Propofol), Dexmedetomidine, Ketamine, and Lidocaine infusion. Avoid high dose or long-acting opioids. Consider avoiding N2O.	Low	Strong
Opioid-sparing Postoperative Analgesia	Multimodal post-operative analgesic protocol successfully minimizes opioid use. 1st line treatment with non-opioid alternatives including NSAIDs, Acetaminophen, Gabapentin, Dexamethasone, and regional blocks (TAP or TEA).	High	Strong

(Nelson et al., 2019)

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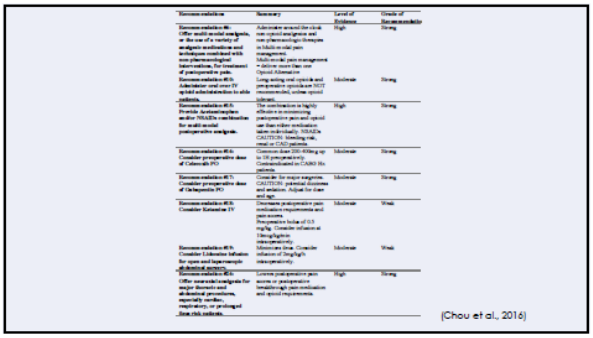

Recommendation	Summary	Level of Evidence	Grade of Recommendation
Recommendation #6: Offer multimodal analgesia, or the use of a variety of analgesic medications and techniques combined with non-pharmacological interventions, for treatment of postoperative pain.	Administer around the clock non-opioid analgesia and non-pharmacologic therapies in block or trial pain management. Multimodal pain management = deliver more than one Opioid Alternative	High	Strong
Recommendation #6.b: Administer oral over IV opioid administration to wide patient	Long-acting oral opioids and perioperative opioids are NOT recommended, unless opioid	Moderate	Strong
Recommendation #6.b: Provide Acetaminophen and/or NSAIDs combination for multimodal postoperative analgesia.	The administration is highly effective in minimizing postoperative pain and opioid use than either medication taken individually. NSAIDs CAUTION: bleeding risk, renal or CAD patients	High	Strong
Recommendation #6.b: Consider preoperative dose of Celecoxib PO	Common dose 200-400mg up to 1H preoperatively. Contraindicated in CABG Hx patients	Moderate	Strong
Recommendation #6.b: Consider preoperative dose of Gabapentin PO	Consider for major surgeries. CAUTION: potential dizziness and sedation. Adjust for dose and age.	Moderate	Strong
Recommendation #6.b: Consider Ketamine IV	Decreases postoperative pain medication requirements and pain scores. Preoperative bolus of 0.5 mg/kg. Consider infusion at 1mcg/kg/min intraoperatively	Moderate	Weak
Recommendation #6.b: Consider Lidocaine Infusion for open and laparoscopic abdominal surgery	Moderate dose. Consider infusion of 2mg/kg/h intraoperatively	Moderate	Weak
Recommendation #6.b: Offer non-opioid analgesia for major surgical, non-abdominal procedures, especially cardiac, respiratory, or prolonged ileus risk patients.	Lowers postoperative pain scores or postoperative opioid-related pain medication and opioid requirements.	High	Strong

(Chou et al., 2016)

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ANESTHESIA FOR ERAS IN A NUTSHELL

STANDARD ANESTHETIC PROTOCOL

GOAL: PROVIDE OPTIMAL ANESTHESIA WITH MINIMAL RESIDUAL EFFECTS AND RAPID RECOVERY

- AVOID ROUTINE SEDATION
- USE SHORT-ACTING ANESTHETICS
- MONITOR NMB + COMPLETE REVERSAL
- USE LUNG PROTECTIVE STRATEGY

(Gustafsson et al., 2019; Nelson et al., 2019)

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ERAS POSTOPERATIVE PAIN MANAGEMENT IN A NUTSHELL

OPIOID SPARING MULTIMODAL POSTOP ANALGESIA

- REDUCE OPIOID ADMINISTRATION
- Start PREOP Education early!
- Minimize Opioid use with Multimodal postoperative analgesia pathway
  - Non-opioid alternatives 1st
  - Opioids recommended as "rescue" medications
- OPIOID STEWARDSHIP

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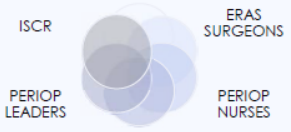
ERAS PAIN PATHWAY COLLABORATION



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STANDARDIZED PAIN PATHWAY

1. PREOP Minimize routine sedative meds
2. INTRAOP
3. POSTOP
   - Deliver 2 or more Opioid Alternatives
4. [illegible]

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WHAT'S THE PLAN?

THE NEED: decrease variation, increase use of multimodal pain management

TARGET: ERAS patients

OUTCOMES:
Opioid use
Protocol compliance
Pain scores
Length of stay

Activity: Standardized ERAS Pain Pathway

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ROADMAP: WHERE ARE WE GOING?

18

Next steps

First

Implement ERAS PAIN PATHWAY

for Colorectal and GYN patients

Second

Evaluate effectiveness after 3 months

Future offerings:

Multimodal Pain Management updates series

Third

LET'S DO THIS!!!

GO LIVE: JUNE 1ST, TUESDAY!!!

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Questions?

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MAHALO FOR YOUR TIME!

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Appendix D

Figure D1

ERAS Colorectal Standardized Pain Pathway

ERAS

COLORECTAL

KAISER MOA Enhanced Recovery After Surgery PAIN PATHWAY

PREOP

GABAPENTIN[1,2]	300mg PO	x1
(Consider for chronic pain or continue if already on Gabapentin) CAUTION: renal pts; may cause dizziness, drowsiness		
Minimize routine sedative medication[1]		

INTRAOP

Multimodal Pain Management = deliver 2 or more Opioid Alternatives[1,2]

ALL COLORECTAL	***Minimize Opioids**		
	If already on Opioids, continue opioid regimen		
	***Short-acting GA[1]**	FENTANYL or SUFENTANIL[1]	
	Consider TIVA[1]	PROPOFOL[1]	
	Consider avoiding N2O[1]	SEVO or DES[1]	
	ACETAMINOPHEN IV[1,2]	1000mg IV	x1 (if not given in PREOP) CAUTION: hepatic insufficiency/disease
	KETOROLAC[1,2]	15-30mg IV	confirm with surgeon; administer at the end CAUTION: renal pts, >65yo, bleeding risk
	KETAMINE[2]	0.5mg/kg IV	CAUTION: may cause dysphoria, excessive salivation
	KETAMINE gtt[2]	0.1-0.5mg/kg/H IV	
	MAGNESIUM[3]	30-50mg/kg IV	over 30min
	DEXMEDETOMIDINE[1]	0.5-1mcg/kg IV (over 10min)	CAUTION: may cause severe bradycardia and hypotension; severe hypertension during loading dose, reduce dose in >65yo
	DEXMEDETOMIDINE gtt[1]	0.2-0.5mcg/kg/H IV	
LAPAROSCOPIC	TAP block[1,2]		
	LIDOCAINE gtt[1,2]	1.5mg/kg/H IV	Consider if NO regional; CAUTION: may cause conduction block, dizziness, seizures, bradycardia
OPEN	THORACIC EPIDURAL[1,2]	confirm with surgeon and notify PACU *low-dose LA + Opioid Epidural infusion[1]	
	TAP block[1,2]	Consider if NO epidural	
	LIDO gtt[1,2]	Consider if NO regional	

POSTOP

***Minimize Opioids**

TAP BLOCK[1]	Consider if not administered INTRAOP	
ACETAMINOPHEN IV[1,2]	1000mg IV	Q6H (and if not given in PREOP/INTRAOP) CAUTION: hepatic insufficiency/disease
KETOROLAC[1,2]	15-30mg IV	confirm with surgeon; CAUTION: renal pts, >65yo, bleeding risk

SDS POST/FLOOR POD 1+

***Minimize Opioids**

ACETAMINOPHEN[1,2]	1000mg IV or PO	Q6H CAUTION: hepatic insufficiency/disease
KETOROLAC[1,2]	15-30mg IV	Q6H CAUTION: renal pts, >65yo, bleeding risk
GABAPENTIN[2]	300mg PO PRN	CAUTION: renal pts; may cause dizzness, drowsiness
If already on Opioids, continue daily opioid regimen		
OXYCODONE PRN		
FENTANYL IV PRN		
THORACIC EPIDURAL[1,2]	Continue up to POD 2 or surgeon request	

Multimodal Mechanism of Action Legend[3]

- Prostaglandin synthesis inhibitor (CB1)
- COX-1,2 inhibitor
- Sodium Channel blockade
- Alpha 2-delta subunit of voltage-gated CA channel inhibitor
- NMDA blockade
- Alpha-2 adrenergic agonist
- Opioid (Mu, Delta, Kappa)

Note . CA = Calcium; CB1 = cannabinoid receptor; COX = Cyclooxygenase; DES = desflurane; GA = general anesthesia; gtt = continuous medication drip; H = hour; INTRAOP = intraoperative; IV = intravenous; kg = kilogram; LA = local anesthetic; LIDO = lidocaine; mcg = microgram; mg = milligram; min = minute; N2O = nitrous oxide; NMDA = N-Methyl-D-aspartic acid; PO = by mouth; POD = postoperative day; POSTOP = postoperative; PREOP = preoperative; PRN = as needed; pts = patients; Q = every; SDS POST = Same Day Surgery Postoperative; SEVO = sevoflurane; TAP = transversus abdominis plane; TIVA = total intravenous anesthesia; yo = year old.

References

1. Gustafsson et al., 2018 [ERAS Society]
2. Chou et al., 2016 [American Pain Society]
3. Marano et al., 2021 [UpToDate]

Figure D2

ERAS GYN Standardized Pain Pathway

ERAS

GYN

KAISER MOA Enhanced Recovery After Surgery PAIN PATHWAY

PREOP		
ACETAMINOPHEN[1,2]	1000mg PO or IV	x1
CELECOXIB[2]	200mg PO	x1 CAUTION: renal or CAD pts
GABAPENTIN[2]	300mg PO	x1 (Consider for chronic pain or continue if already on Gabapentin) CAUTION: renal pts; may cause dizziness, drowsiness
Minimize routine sedative medication[1]		

INTRAOP			
Multimodal Pain Management = deliver 2 or more Opioid Alternatives[1,2]			
ALL GYN/ONC	***Minimize Opioids**	High dose or long-acting opioids avoided[1]	
	If already on Opioids, continue opioid regimen		
	***Short-acting GA**[1]	Short-acting Opioids[1]	
	Consider TIVA[1]	PROPOFOL[1]	
	Consider avoiding N2O[1]	SEVO or DES[1]	
	ACETAMINOPHEN IV[1,2]	1000mg IV	x1 (if not given in PREOP) CAUTION: hepatic insufficiency/disease
	DEXAMETHASONE[1]	0.05-0.2mg/kg IV	
	KETOROLAC[1,2]	15-30mg IV	confirm with surgeon; administer at the end CAUTION: renal pts, >65yo, bleeding risk
	KETAMINE[1,2]	0.5mg/kg IV	CAUTION: may cause dysphoria, excessive salivation
	KETAMINE[1,2]	0.1-0.5 mg/kg/H IV	
	MAGNESIUM[3]	30-50mg/kg IV	over 30min
	DEXMEDETOMIDINE[1]	0.5-1mcg/kg IV (over 10min)	CAUTION: may cause severe bradycardia and hypotension; severe hypertension during loading dose, reduce dose in >65yo
	DEXMEDETOMIDINE gtt[1]	0.2-0.5mcg/kg/H IV	
LAPAROSCOPIC	TAP block[1,2]		
	LIDOCAINE gtt[1,2]	1.5mg/kg/H IV	Consider if NO regional; CAUTION: may cause conduction block, dizziness, seizures, bradycardia
OPEN	TAP block[1,2]		
	THORACIC EPIDURAL[1,2]	confirm with surgeon and notify PACU *low-dose LA + Opioid Epidural infusion[1]	
	LIDO gtt[1,2]	Consider if NO regional	

POSTOP		
***Minimize Opioids**		
ACETAMINOPHEN IV[1,2]	1000mg IV	Q8H (and if not given in PREOP/INTRAOP) CAUTION: hepatic insufficiency/disease
IBUPROFEN[1,2]	600mg PO	2x/day CAUTION: renal or CAD pts
KETOROLAC[1,2]	15-30mg IV	Q8H CAUTION: renal pts, >65yo, bleeding risk
DEXAMETHASONE[1]	0.05-0.2mg/kg IV	
GABAPENTIN[1,2]	300mg PO	2x/day CAUTION: renal pts; may cause dizziness, drowsiness
If already on Opioids, continue daily opioid regimen.		
FENTANYL IV PRN	for breakthrough pain	

SDS POST/FLOOR POD 1+		
***Minimize Opioids**		
ACETAMINOPHEN[1,2]	1000mg IV or PO	Q6H CAUTION: hepatic insufficiency/disease
IBUPROFEN[1,2]	600mg PO	2x/day CAUTION: renal or CAD pts
or KETOROLAC[1,2]	15-30mg IV	Q8H CAUTION: hepatic insufficiency/disease
GABAPENTIN[1,2]	100mg PO	3x/day CAUTION: renal pts; may cause dizziness, drowsiness
If already on Opioids, continue daily opioid regimen		
OXYCODONE PRN	for breakthrough pain	
FENTANYL IV PRN	for breakthrough pain	
THORACIC EPIDURAL[1,2]	Continue up to POD 2 or surgeon request	

Multimodal Mechanism of Action Legend[3]

Prostaglandin synthesis inhibitor (CB1)
Corticosteriod
COX-1,2 inhibitor
Sodium Channel blockade
Alpha 2-delta subunit of voltage-gated CA channel inhibitor
NMDA blockade
Alpha-2 adrenergic agonist
Opioid (Mu, Delta, Kappa)

Note. 2x/day = two times daily; 3x/day = three times daily; CA = Calcium; CB1 = cannabinoid receptor; COX = Cyclooxygenase; DES = desflurane; GA = general anesthesia; gtt = continuous medication drip; GYN = gynecology; H = hour; INTRAOP = intraoperative; IV = intravenous; kg = kilogram; LA = local anesthetic; LIDO = lidocaine; mcg = microgram; mg = milligram; min = minute; N2O = nitrous oxide; NMDA = N-Methyl-D-aspartic acid; ONC = oncology; PACU = post anesthesia care unit; PO = by mouth; POD = postoperative day; POSTOP = postoperative; PREOP = preoperative; PRN = as needed; pts = patients; Q = every; SDS POST = Same Day Surgery Postoperative; SEVO = sevoflurane; TAP = transversus abdominis plane; TIVA = total intravenous anesthesia; yo = year old.

References
1. Nelson et al., 2019 [ERAS Society]
2. Chou et al., 2016 [American Pain Society]
3. Mariano et al., 2021 [UpToDate]

Appendix E

Figure E1

Excel Data Tracker for Colorectal ERAS Patients

CASE#	Admission Date	Age	Gender	Race/ Ethnicity	ASA	INPT/ OUTPT	Procedure	Length of Stay (LOS)		
								Planned D/C	D/C date	LOS

PREOP pain meds	INTRAOP												INTRAOP Opioids				
Gabapentin	*TIVA*	*IA + Propofol gtt*	*IA*	*Acetaminophen*	*Dexamethasone*	*Ketorolac*	*Ketamine*	*Dexmedetomidine*	*Lido gtt*	*MG gtt*	*Propofol gtt*	*Regional*	*Fentanyl*	*Sufentanil*	*Morphine*	*Dilaudid*	*Intraop Opioids used*

PACU				PACU Opioids							PACU pain score	PACU LOS		
TAP BLOCK	*Acetaminophen*	*Ketorolac*	*Opioid Alternative*	*Fentanyl*		*Morphine*		*Dilaudid*		*PACU Opioids used*		Time IN PACU	Time D/C	LOS in PACU

POSTOP				POSTOP Opioids			Postop pain score	Multimodal: 2 or more Opioid Alternatives			NO OPIOIDS POSTOP	OPIOID FREE	COMMENTS
Acetaminophen	Ketorolac	Gabapentin	Opioid Alternative	Oxycodone	Fentanyl	*Floor Opioids used*		*PREOP*	*INTRAOP*	*POSTOP*			

Note. ASA = American Society of Anesthesiologists physical status classification; D/C = discharge; gtt = continuous medication drip; IA = inhalational agent; INPT/OUTPT = Inpatient/Outpatient; INTRAOP = intraoperative; Lido = Lidocaine; LOS = length of stay; MG = Magnesium; PACU = Post-Anesthesia Care Unit; POSTOP = postoperative; PREOP = preoperative; TIVA = Total Intravenous Anesthesia.

Figure E2

Excel Data Tracker for GYN ERAS Patients

CASE#	Admission Date	Age	Gender	Race/ Ethnicity	ASA	INPT/OUTPT	Procedure	Length of Stay (LOS)		
								Planned D/C	D/C date	LOS

PREOP pain meds			INTRAOP												INTRAOP Opioids				
Acetaminophen	*Celecoxib*	*Gabapentin*	*TIVA*	*IA + Propofol gtt*	*IA*	*Acetaminophen*	*Dexamethasone*	*Ketorolac*	*Ketamine*	*Dexmedetomidine*	*Lido gtt*	*MG gtt*	*Propofol gtt*	*Regional*	*Fentanyl*	*Sufentanil*	*Morphine*	*Dilaudid*	*Intraop Opioids used*

PACU						PACU Opioids										PACU LOS		
Acetaminophen	*Dexamethasone*	*Ibuprofen*	*Ketorolac*	*Gabapentin*	*Opioid Alternative*	*Oxycodone*		*Fentanyl*		*Morphine*		*Dilaudid*		*PACU Opioids used*	PACU pain score	Time IN PACU	Time D/C	LOS in PACU

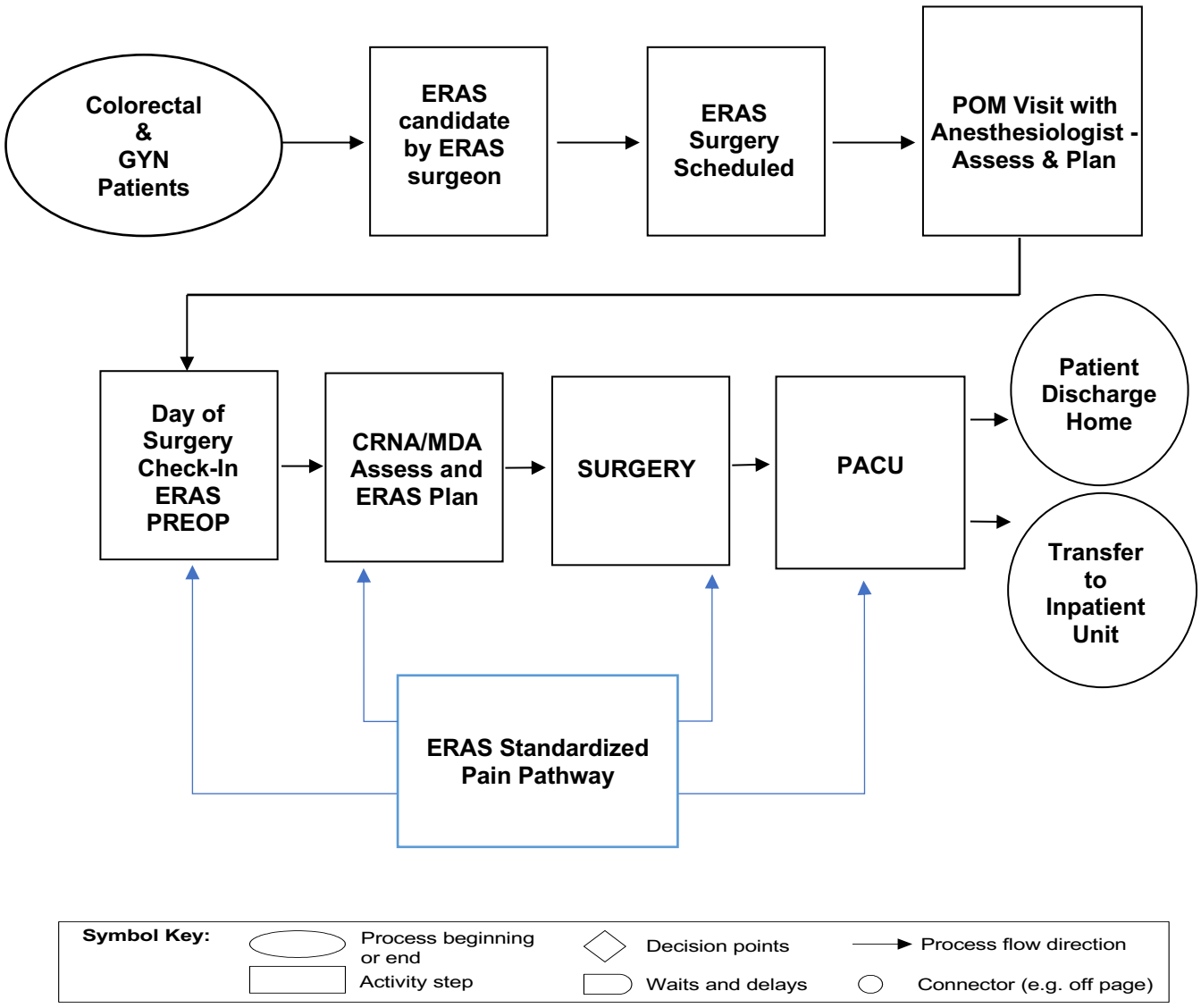
POSTOP				POSTOP Opioids			Postop pain score	Multimodal: 2 or more Opioid Alternatives			NO OPIOIDS POSTOP	OPIOID FREE	COMMENTS
Acetaminophen	*Ketorolac*	*Gabapentin*	*Opioid Alternative*	*Oxycodone*	*Fentanyl*	*Floor Opioids used*		*PREOP*	*INTRAOP*	*POSTOP*			

Note . ASA = American Society of Anesthesiologists physical status classification; D/C = discharge; gtt = continuous medication drip; IA = inhalational agent; INPT/OUTPT = Inpatient/Outpatient; INTRAOP = intraoperative; Lido = Lidocaine; LOS = length of stay; MG = Magnesium; PACU = Post-Anesthesia Care Unit; POSTOP = postoperative; PREOP = preoperative; TIVA = Total Intravenous Anesthesia.

Appendix F

Specialty Care Practice High Level Flowchart

Perioperative Department



Note. CRNA = Certified Registered Nurse Anesthetist; ERAS = Enhanced Recovery After Surgery; GYN = gynecology; MDA = Anesthesiologist; PACU = postoperative anesthesia care unit; POM = perioperative medicine; PREOP = preoperative.

(Institute for Excellence in Health and Social Systems, 2001)

Appendix G

Figure G1

Colorectal ERAS Dashboard: June 2021

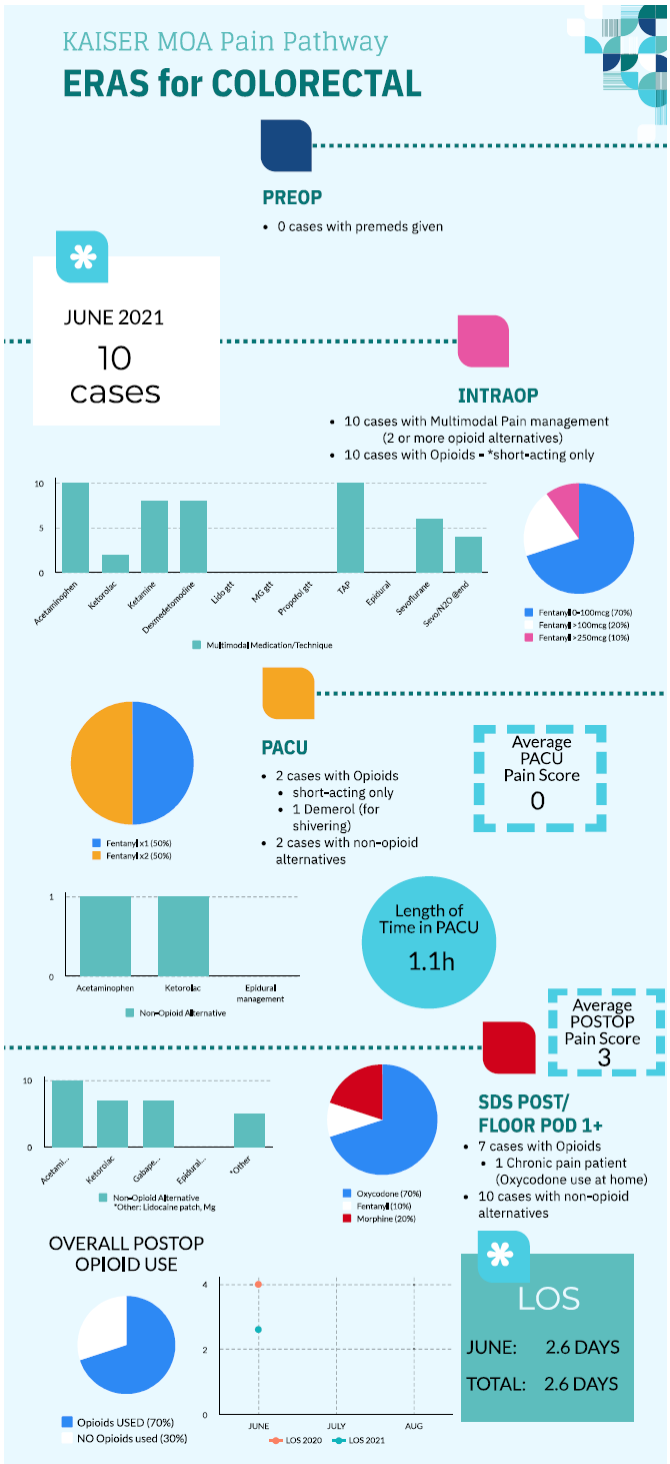


Figure G2

Colorectal ERAS Dashboard: July 2021

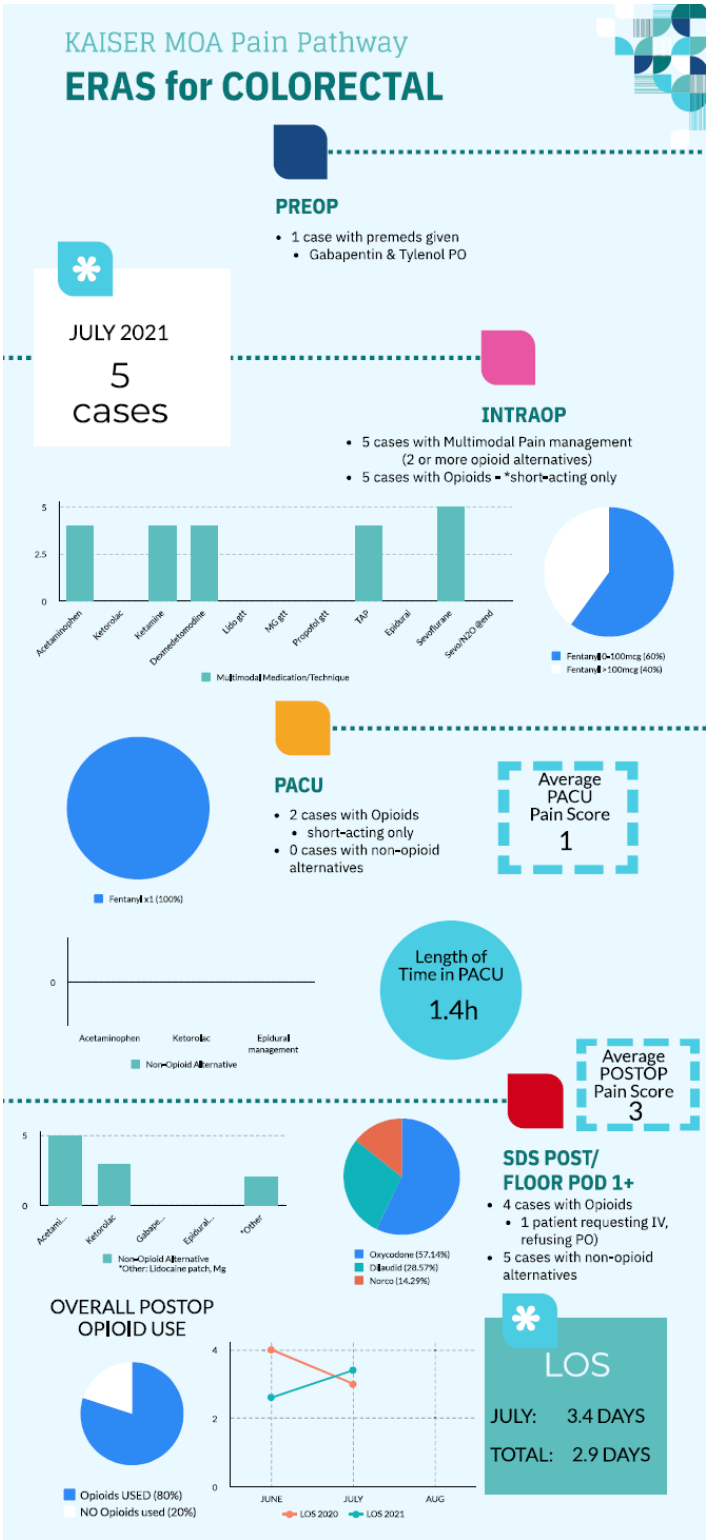


Figure G3

Colorectal ERAS Dashboard: August 2021

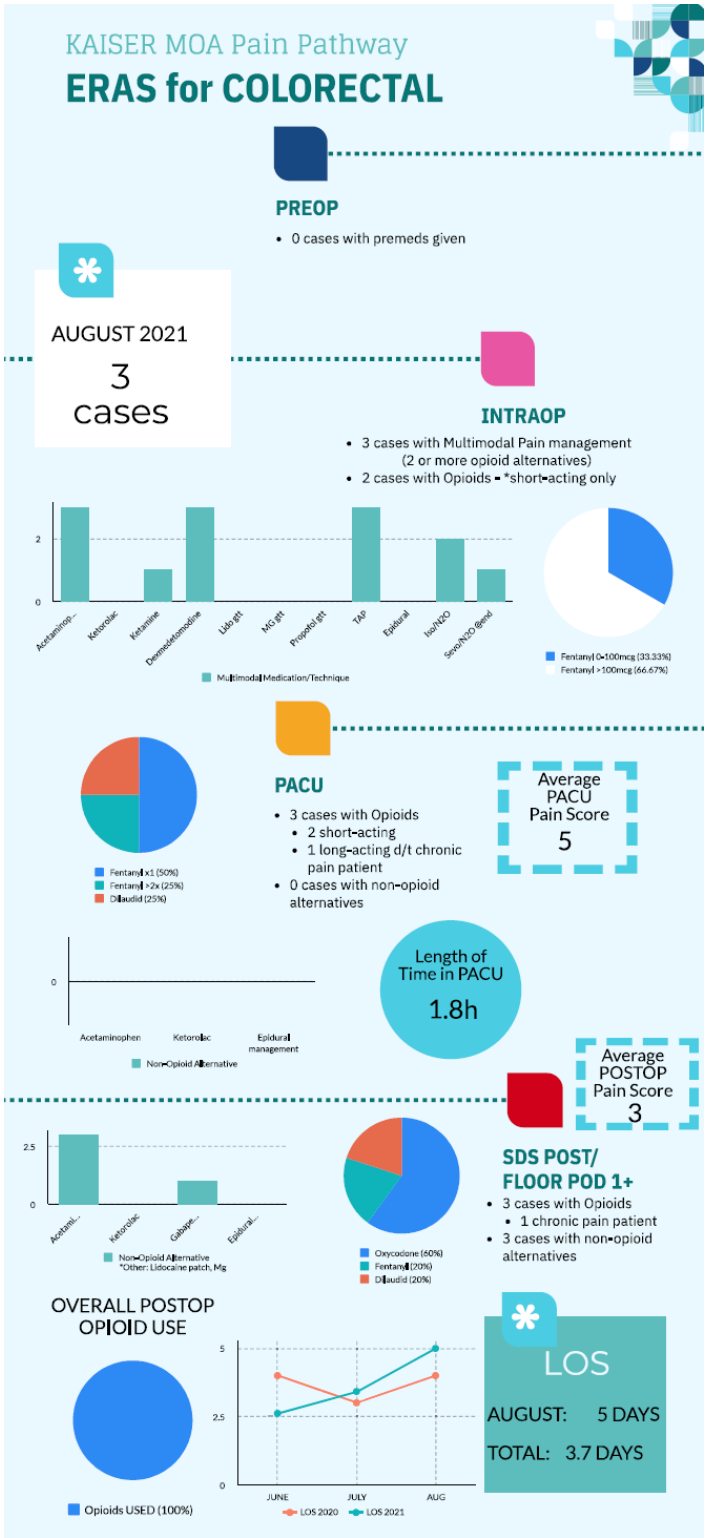


Figure G4

GYN ERAS Dashboard: June 2021

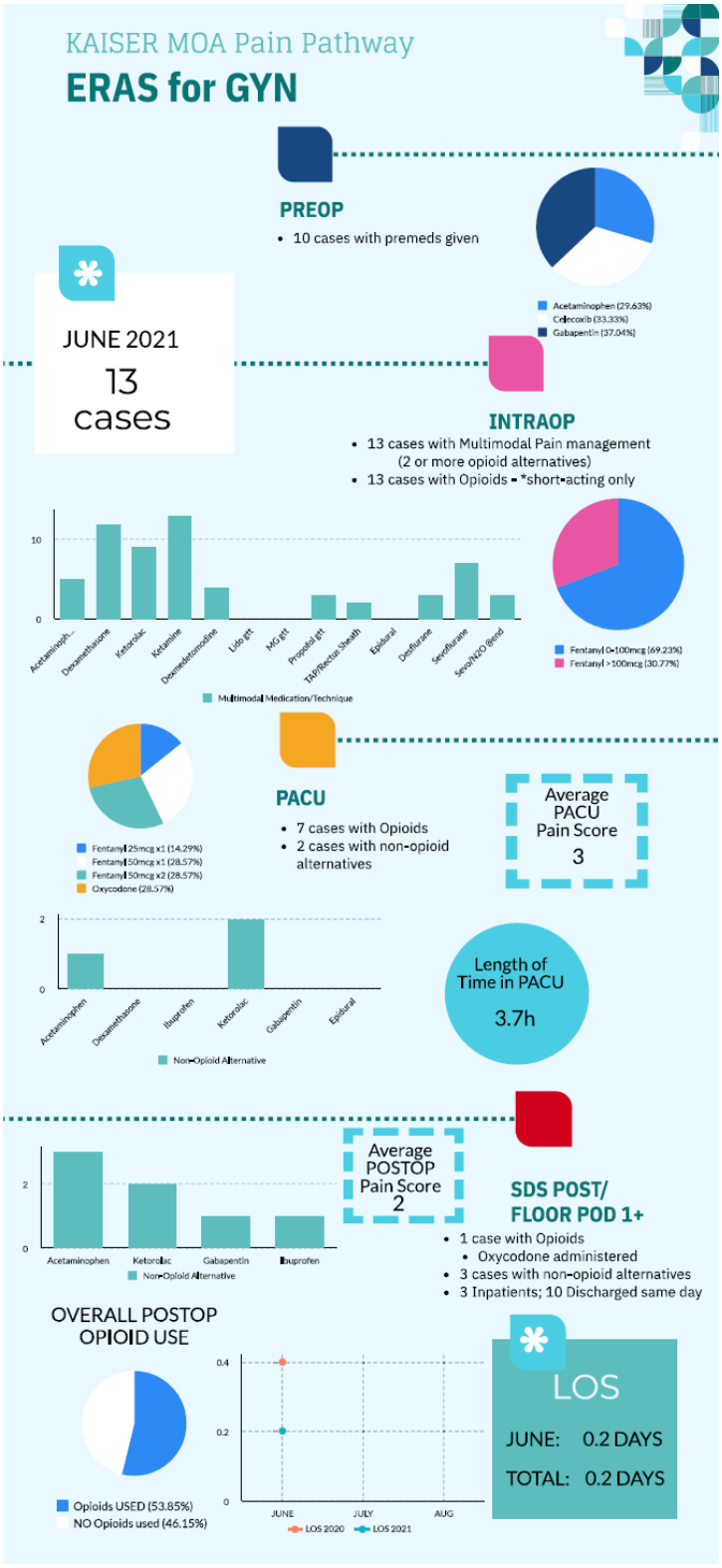


Figure G5

GYN ERAS Dashboard: July 2021

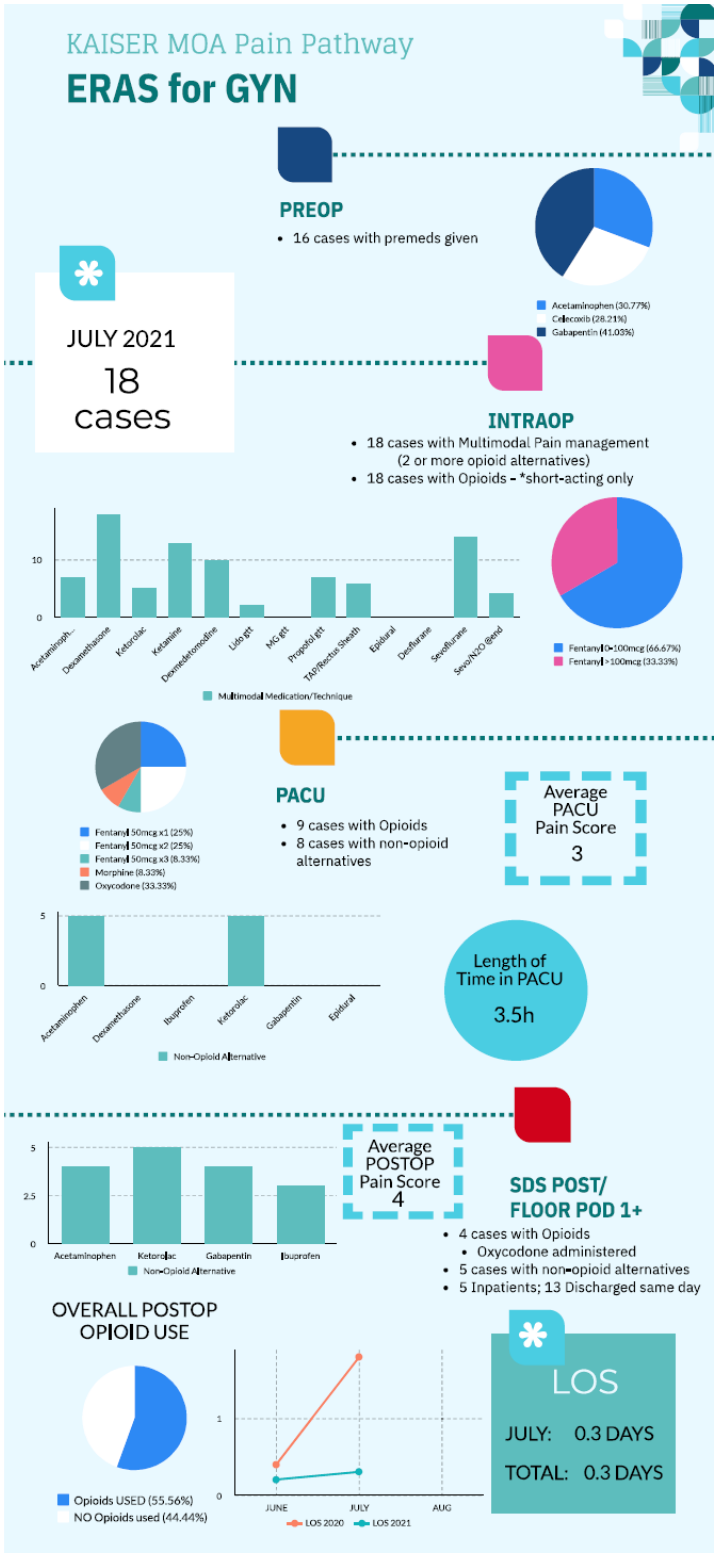
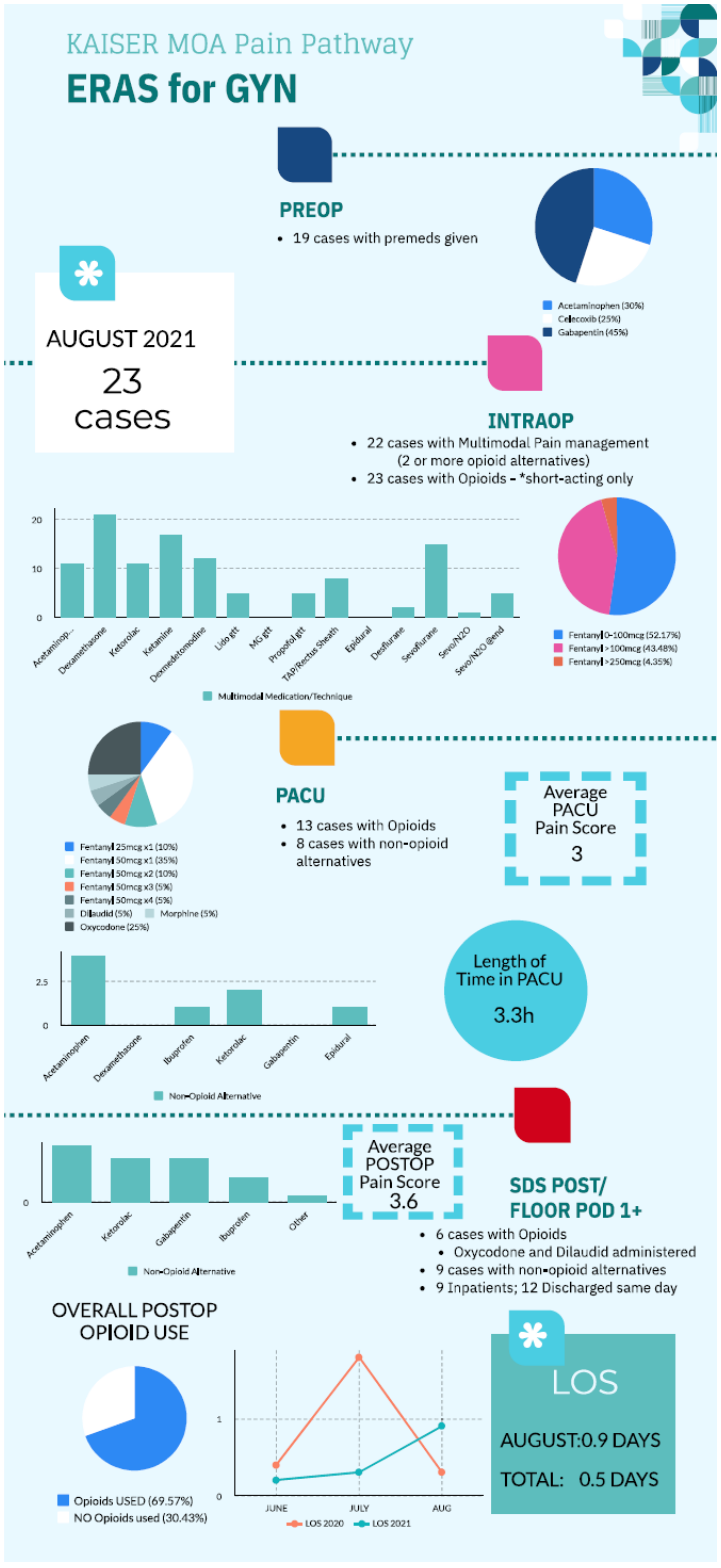


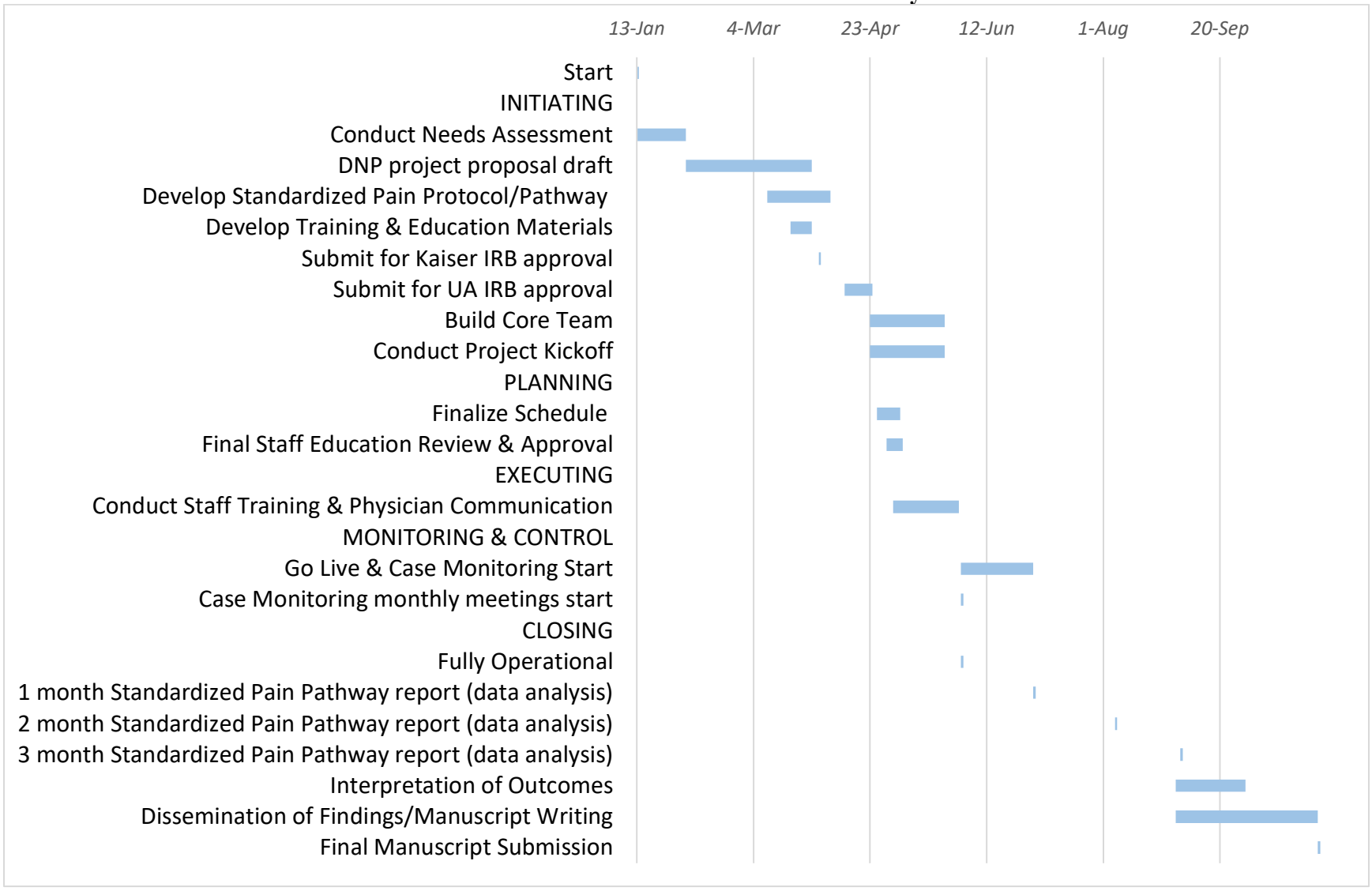
Figure G6

GYN ERAS Dashboard: August 2021



Appendix H

Gantt Chart for the ERAS Standardized Pain Pathway Milestones



Appendix I

Demographic and Clinical Characteristics Table Between Pre-EPP and Post-EPP Groups

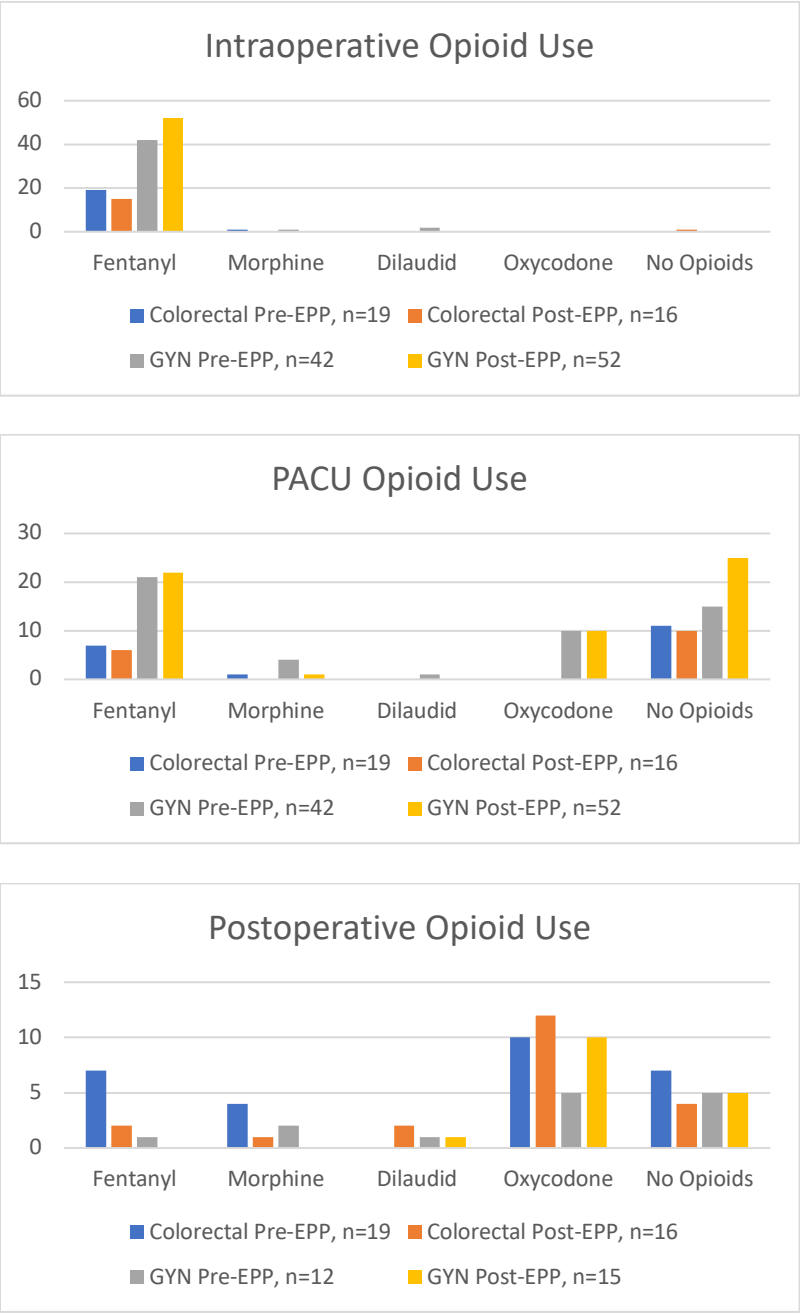
			Pre-EPP n=61			*Post-EPP n=68*		
			Colorectal n=19	GYN n=42	**TOTAL**	Colorectal n=16	GYN n=52	**TOTAL**
Age, years, mean ±SD			61 ±11	46 ±8	51 ±12	64 ±15	46 ±11	50 ±15
Min, Max			40, 86	26, 67	26, 89	26, 89	22, 83	22, 89
Gender	Female		32%	98%		38%	100%	
	Male		68%	2%		63%	0%	
Race/Ethnicity	Asian				34%			46%
	Black				3%			1%
	Hawaiian/Pacific Islander				10%			10%
	Hispanic				0%			0%
	White				20%			15%
	Other				33%			28%
ASA	I				20%			13%
	II				57%			59%
	III				23%			28%
	IV				0%			0%
Admission Status	Inpatient		100%	29%		100%	29%	
	Outpatient		0%	71%		0%	71%	
Type of Surgery	Colorectal	Colon	79%			56%		
		Rectal	21%			44%		
		Laparoscopic	32%			25%		
		Robot-Assisted Laparoscopic	53%			63%		
		Open	16%			12%		
	GYN	Hysterectomy		74%			67%	
		• Laparoscopic			77%			74%
		• Robot-assisted Laparoscopic			6%			11%
		• Open			3%			3%
		• Vaginal			14%			11%
		Cystectomy		7%			10%	
		Other		19%			23%	

Note. ASA = American Society of Anesthesiologists physical status classification; EPP = enhanced recovery after surgery pain pathway; GYN = gynecology; Min = minimum; Max = maximum; SD = standard deviation.

Appendix J

Figure J

Perioperative Opioid Use



Note. GYN = gynecology; n = total number of individuals in the sample; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation.

Table J1

Group Statistics for Opioid Use

		n	M	SD	SE
Intraoperative Fentanyl		***Colorectal***			
	Pre-EPP	19	213 mcg	84.73	19.44
	Post-EPP	16	123 mcg	78.25	19.56
		GYN			
	Pre-EPP	42	154 mcg	64.78	10.00
	Post-EPP	52	123 mcg	64.79	8.98
PACU Fentanyl		***Colorectal***			
	Pre-EPP	19	26 mcg	42.88	9.84
	Post-EPP	16	22 mcg	31.46	7.86
		GYN			
	Pre-EPP	42	42 mcg	58.09	8.96
	Post-EPP	52	33 mcg	48.44	6.72
Postoperative Oxycodone		***Colorectal***			
	Pre-EPP	19	10 mg	13.99	3.21
	Post-EPP	16	23 mg	44.98	11.24
		GYN			
	Pre-EPP	12	3 mg	5.77	1.67
	Post-EPP	15	14 mg	14.78	3.82

Note. GYN = gynecology; M = mean; mcg = microgram; mg = milligram; n = total number of individuals in the sample; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation; SD = standard deviation; SE = standard error.

Table J2

Independent Two-sample t-Tests for Opioid Use, Equal Variances Not Assumed

	t	df	*t Critical*	**p* (2-tailed)
Intraoperative Fentanyl				
Colorectal				
Pre-EPP, n = 19	3.25	33	2.03	0.003
Post-EPP, n = 16				
GYN				
Pre-EPP, n = 42				
Post-EPP, n = 52	2.33	88	1.98	0.022
PACU Fentanyl				
Colorectal				
Pre-EPP, n = 19				
Post-EPP, n = 16	0.35	32	2.04	0.727
GYN				
Pre-EPP, n = 42				
Post-EPP, n = 52	0.76	80	1.99	0.450
Postoperative Oxycodone				
Colorectal				
Pre-EPP, n = 19	-1.14	17	2.11	0.268
Post-EPP, n = 16				
GYN				
Pre-EPP, n = 12				
Post-EPP, n = 15	-2.56	19	2.09	0.019

Note. GYN = gynecology; df = degrees of freedom; n = total number of individuals in the sample; *p* = *p*-value; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation; *t* = *t*-statistic; *t* Critical = *t*-critical value.
*p ≤ 0.05

Appendix K

Table K1

ERAS Pain Pathway Compliance (use of 2 or more opioid alternatives)

	Pre-EPP	Post-EPP	% Change
Colorectal	*n = 19*	*n = 16*	
Preoperative	0%	6%	-
Intraoperative	84%	100%	+19%
PACU	0%	0%	-
Postoperative	63%	69%	+10%
≥ 2 perioperative periods	53%	69%	+30%
GYN	*n = 42*	*n = 52*	
Preoperative	55%	63%	+15%
Intraoperative	83%	98%	+18%
PACU	5%	6%	+20%
	n = 12	*n = 15*	
Postoperative	100%	100%	-
≥ 2 perioperative periods	62%	69%	+11%

Note. ERAS = enhanced recovery after surgery; GYN = gynecology; n = total number of individuals in the sample; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation.

Table K2

Chi-Square Tests for ERAS Pain Pathway Compliance

	0-33% 1 of 3 Periop periods	34-67% 2 of 3 Periop periods	68-100% 3 of 3 Periop periods	n	Chi-Square	df	*p
	Colorectal						
Pre-EPP	9	10	0	19			
Post-EPP	5	10	1	16	1.900	2	0.387
	GYN						
Pre-EPP	16	24	2	42			
Post-EPP	16	25	11	52	5.247	2	0.073

Note. GYN = gynecology; df = degrees of freedom; n = total number of individuals in the sample; *p* = *p*-value; Periop = perioperative; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation.
*$p \leq 0.05$

Appendix L

Independent Two-sample t-Test for Compliance, Pain, and LOS

	t	df	*t* Critical	**p* (2-tailed)
	EPP Compliance			
Colorectal Pre-EPP, n = 19 Post-EPP, n = 16	-1.37	33	2.03	0.179
GYN Pre-EPP, n = 42 Post-EPP, n = 52	-1.78	92	1.99	0.078
	Pain Scores			
Colorectal Pre-EPP, n = 19 Post-EPP, n = 16	-PACU 1.30	27	2.05	0.204
	-Postoperative 0.19	33	2.03	0.847
GYN Pre-EPP, n = 42 Post-EPP, n = 52	-PACU -0.53	90	1.99	0.600
Pre-EPP, n = 12 Post-EPP, n = 15	-Postoperative -0.56	22	2.07	0.571
	Time in PACU			
Colorectal Pre-EPP, n = 19 Post-EPP, n = 16	0.70	33	2.03	0.489
GYN Outpatients Pre-EPP, n = 30 Post-EPP, n = 37	1.69	54	2.00	0.097
GYN Inpatients Pre-EPP, n = 12 Post-EPP, n = 15	0.35	16	2.12	0.728
	LOS			
Colorectal Pre-EPP, n = 19 Post-EPP, n = 16	0.53	33	2.03	0.600
GYN Pre-EPP, n = 12 Post-EPP, n = 15	0.83	12	2.18	0.423

Note. EPP = enhanced recovery after surgery pain pathway; GYN = gynecology; df = degrees of freedom; LOS = length of stay; n = total number of individuals in the sample; *p* = *p*-value; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation; *t* = *t*-statistic; *t* Critical = *t*-critical value.
*p ≤ 0.05

Appendix M

Average Pain Scores

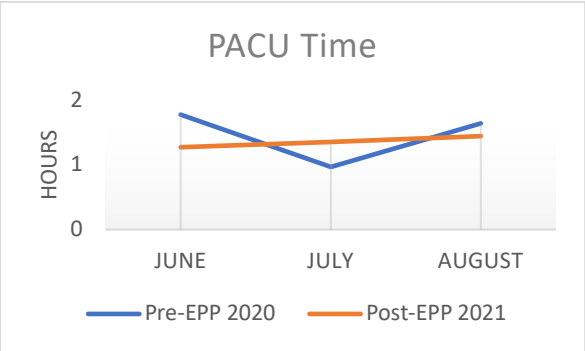
	n	M	SD	SE	95% CL Lower	95% CL Upper
Colorectal						
	PACU					
Pre-EPP	19	2	2.24	0.51	0.6	2.7
Post-EPP	16	1	1.09	0.27	0.3	1.5
	Postoperative					
Pre-EPP	19	3	1.98	0.46	1.9	3.8
Post-EPP	16	3	1.61	0.40	1.9	3.6
GYN						
	PACU					
Pre-EPP	42	3	2.01	0.31	2.0	3.2
Post-EPP	52	3	2.16	0.30	2.2	3.4
	Postoperative					
Pre-EPP	12	3	1.75	0.51	2.1	4.3
Post-EPP	15	4	1.51	0.39	2.7	4.4

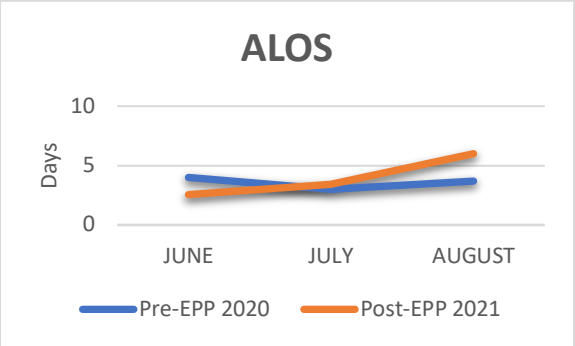
Note. CL = confidence level; GYN = gynecology; M = mean; n = total number of individuals in the sample; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation; SD = standard deviation; SE = standard error.

Appendix N

PACU Time and Length of Stay (LOS)

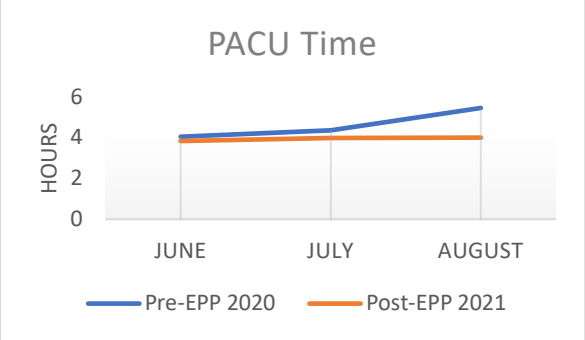
Colorectal



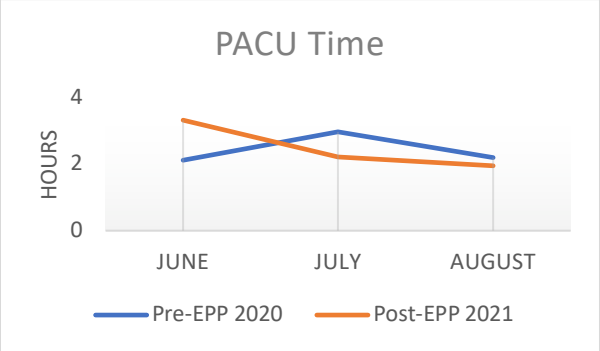


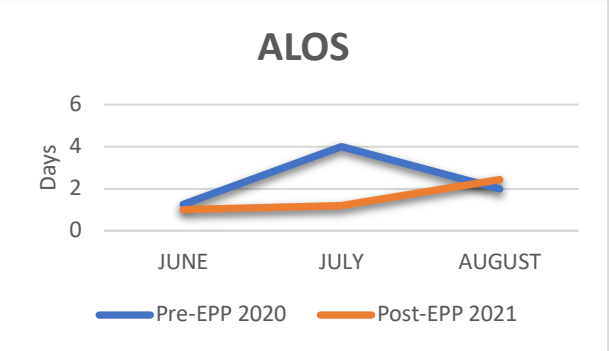
GYN

Outpatients



Inpatients





Note. ALOS = average length of stay; GYN = gynecology; PACU = post-anesthesia care unit; Pre-EPP = before enhanced recovery after surgery pain pathway implementation; Post-EPP = after enhanced recovery after surgery pain pathway implementation.