

Enhanced Recovery After Surgery for Colorectal Surgery

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Abstract

The objective for this project was to inform, educate, and assess the knowledge base of student registered nurse anesthetists (SRNAs) on the importance of using an Enhanced Recovery After Surgery (ERAS) protocol during colorectal surgery. Historically, recovery from colorectal surgery has been problematic, leading to an increase in complications and prolonged hospital stays. However, the advent of ERAS has resulted in improved outcomes for patients, decreased lengths of stay (LOS), and reduced costs. A literature review concerning ERAS protocol and its advantages with colorectal surgery was conducted and an educational PowerPoint presentation was developed and presented to the 2018 & 2019 Adventist University of Health Sciences (ADU) SRNA cohort. A pre-test was given to assess baseline knowledge of the topic before the presentation. Following the presentation, a post-test was administered to assess the increase in knowledge base of the SRNAs. Once all the post-tests were collected, the researchers graded each test and the data were then sent to Dr. Roy Lukman for analysis. A paired sample t-test in SPSS was conducted. The results indicated that the mean post-test scores ($M=83.06$, $SD=14.34$) were significantly greater than the mean pretest scores ($M=52.47$, $SD=19.58$), $t(48) = -10.473$, $p < .001$. Based on these findings, it was determined that the educative material presented to the SRNAs improved their knowledge of ERAS.

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Introduction

Colorectal surgery is considered a routine procedure, but it is often associated with a variety of complications, including nausea and vomiting, bleeding, venous thromboembolism, uncontrolled pain, postoperative ileus, anastomotic leaking, and infection (Gustaffson et al., 2012). As a result, significant morbidity and prolonged hospitalization are not uncommon in this population (Gustaffson et al., 2012). For this reason, an Enhanced Recovery After Surgery (ERAS) protocol was created for patients undergoing colorectal surgery.

ERAS is a comprehensive and multifaceted approach which incorporates multiple evidence-based practices to improve upon the traditional management of colorectal surgery. Traditional practices utilized prolonged fasting periods, liberal fluid administration, postoperative nasogastric tubes, and opioid-based postoperative analgesia (Gustaffson et al., 2012). Implementation of ERAS protocols have standardized care leading to reduced surgical complications, decrease length of stay (LOS) and medical costs, and improve patient outcomes and satisfaction (Gustaffson et al., 2012).

ERAS is initiated preoperatively and continues throughout the perioperative period. It requires the collaboration of several perioperative disciplines, including nursing, anesthesia, and surgeons. As a part of the perioperative team, it is important for the nurse anesthetist to understand the rationale for using ERAS practices as well as how to manage a colorectal case using ERAS interventions. With such collaboration vital to the success of ERAS, education on these practices is important as they improve patient care and decrease medical expenditures; both of which will be discussed in the literature review. For this scholarly project, an extensive literature review was conducted and literature on ERAS was found to be abundant, ranging from 10 years to as recent as last year.

The purpose of this scholarly project was to create an educational presentation for the 2018 and 2019 ADU SRNA cohort on ERAS for colorectal surgery. While there are many features to an ERAS protocol, this project focused on those that were most pertinent to anesthesia providers. Two questions posed in PICOT format assisted in a systematic review of the literature. The first addressed the clinical problem, the second addressed the educational innovation. PICOT: In patients undergoing elective colorectal surgery (P), how do ERAS protocols (I) compared to traditional management (C) improve patient outcomes (O) throughout the perioperative period (T)? PICO: In Adventist University student registered nurse anesthetists (P), does a 30 minute (T) PowerPoint presentation regarding ERAS protocols (I) result in an increase in knowledge base (O).

Literature Review

Perioperative Care and Multimodal Therapies

ERAS is a comprehensive protocol which has improved upon the traditional management of colorectal surgery. The goals of ERAS include adequate analgesia, early mobility, early return of gastrointestinal (GI) motility, and reduction in complications (Gustaffson et al., 2012). These aims are achieved by integrating several strategies during the perioperative period.

Preoperative optimization. Firstly, in the preoperative period, patient education and health counseling, including smoking and alcohol cessation, are performed to optimize a patient for elective surgery. A meta-analysis by Gustaffson et al. (2012) concluded that alcohol abusers were at two to three times greater risk for surgical complications, including bleeding, wound healing, and cardiopulmonary problems. Smokers were found to be at increased risk for pulmonary and wound issues. Four weeks of smoking and alcohol cessation was found to reduce the occurrence of postoperative morbidity (Gustaffson et al., 2012).

Preoperative liquids. Fasting guidelines for elective surgery have conventionally called for a minimum of eight hours without intake of solids before procedures (American Society of Anesthesiologists, 2017). However, the consumption of clear liquids with carbohydrates up to two hours preoperatively has become the standard for colorectal surgery and has shown no difference in gastric content or pH when compared to fasting beyond midnight. The addition of carbohydrates to clear liquids has proven to keep patients more metabolically stable, reducing insulin resistance and helping to mitigate the surgical stress response (Gustaffson et al., 2012). The allowance of clear liquids with carbohydrates alone has resulted in a mean reduction in LOS by one day (Awad et al., 2012).

Venous thromboembolism. Another concern for patients undergoing colorectal surgery has been the prevention of venous thromboembolism (VTE). According to Gustaffson et al. (2012), deep vein thrombosis (DVT) occurred in 30 percent of colorectal surgical patients who did not receive prophylactic treatment. As a result, recommendations for thromboprophylaxis include compression stockings, intermittent mechanical compression, and low molecular weight heparin (Gustaffson et al., 2012).

Nausea and vomiting. Postoperative nausea and vomiting (PONV) has been a major concern for colorectal surgery patients, with as much as a 70 percent occurrence of PONV after major colorectal surgery (Gustaffson et al., 2012). Females, nonsmokers, and patients with a history of motion sickness are at increased risk. Additionally, the use of inhalational anesthetics and opioids increases the risk. Multimodal treatment has been successful in reducing the occurrence of PONV. Pharmacological prophylaxis includes serotonin (5-HT₃) antagonists, dopamine (D₂) antagonists, anticholinergics (M₁), antihistamines (H₁), and dexamethasone. In addition to medication, minimal fasting and adequate hydration have also proved to be helpful

(Gustaffson et al., 2012). Furthermore, reduction of postoperative opioid use by utilizing transversus abdominal plane (TAP) blocks, epidurals, and non-steroidal anti-inflammatory drugs (NSAIDs) has helped reduce the incidence of PONV (Gustaffson et al., 2012).

Nasogastric tubes. Nasogastric tubes (NGT) have commonly been inserted during colorectal surgery to decompress the stomach and reduce any possible gastric contents. Traditionally, NGTs have been left in postoperatively to allow continued emptying of gastric fluid if necessary. However, prolonged nasogastric decompression has been associated with occurrence of fever, atelectasis, pneumonia, and ileus (Gustaffson et al., 2012). Furthermore, patients who underwent colorectal surgery showed an improvement in the time to passage of the first flatus by one half day when postoperative NGT was avoided (Gustaffson et al., 2012). Thus, ERAS has recommended the removal of NGTs before cessation of anesthesia.

Fluid management. Another important initiative incorporated into the ERAS guidelines was fluid management. Historically, perioperative fluid management has varied from patient to patient and from case to case. Variables have included NPO time, fluid deficits, patient hemodynamics, and type of procedure. Compared to laparoscopy, laparotomy has been associated with greater evaporative loss and fluid shifts due to bowel manipulation and greater activation of the systemic inflammatory response system (SIRS) (Gustaffson et al., 2012). However, Trendelenburg positioning and pneumoperitoneum during laparoscopic surgery can reduce cardiac output. Regardless of technique, these factors must be considered by the anesthesia provider.

One causative factor of hypotension is hypovolemia. If left uncorrected, a subsequent reduction in the delivery of oxygen to organs and tissues can occur. Conversely, excessive fluid administration has resulted in tissue edema and lung atelectasis. This has been of particular

concern in colorectal surgery where bowel edema has led to anastomotic leaking (Levy et al., 2012). Gustaffson et al. (2012) found that the single greatest risk factor for postoperative ileus was excessive fluid administration. ERAS guidelines have aimed to minimize variables in fluid management and reduce complications related to fluid administration.

According to ERAS guidelines, in the setting of hypotension, the anesthetist can look at a patient's cardiac output and stroke volume variation (SVV) to determine if fluid or vasopressor administration is warranted. An SVV < 13 has been shown to correlate with normovolemia, indicating that hypotension should be corrected using a vasopressor (Gustaffson et al., 2012). ERAS recommendations to minimize fluid shifts during colorectal surgery include avoidance of bowel preparation, allowing clear liquids up to two hours preoperatively, and minimization of bowel manipulation. Additionally, intravenous fluid should only be given when the clinical picture necessitates, with balanced crystalloids being favored over 0.9% saline. Finally, enteral fluids should be resumed as soon as possible (Gustaffson et al., 2012).

Opioid Sparing Methodologies. A major initiative of ERAS has been the reduction of opioid usage. The unfavorable effects of opioids have been well-documented and include sedation, respiratory depression, nausea, and decreased gastrointestinal motility (Dorn, Lembo, & Cremonini, 2014, Gustaffson et al., 2012). These side effects have proven to be especially detrimental in the patient undergoing colorectal surgery. As a result, ERAS protocol has incorporated a multimodal approach to analgesia.

Beginning in the preoperative area, patients are given a combination of opioid-sparing medications. The preoperative administration of analgesics has shown efficacy in controlling postoperative pain and the multimodal medications utilized have included acetaminophen, gabapentin, and celecoxib (Gustaffson et al., 2012). Gabapentin is an anticonvulsant that also has

application in neuropathic pain through its action on the alpha-2-delta-1 subunit of voltage-gated calcium channels. It has also shown effects on NMDA receptors and reduction in protein kinase C and inflammatory cytokines (Kukkar et al., 2013). Celecoxib is a selective cyclooxygenase-2 (COX-2) inhibitor which does not inhibit platelet aggregation or cause GI irritation. When celecoxib was given as part of an enhanced recovery (ER) protocol it was found that patients used less opiates, had decreased times to resumption of solid diet, decreased time to first bowel movement, and shorter LOS (Lohsiriwat, 2016). Additionally, almivopan, a peripheral mu-opioid receptor antagonist, may be administered. Almivopan antagonizes the effect of opioids in the bowel. When given as part of ERAS protocol, it enhanced GI recovery and reduced LOS in patients who received postoperative opioids (Gustaffson et al., 2012).

Upon induction, patients are given ketamine, an NMDA receptor antagonist with analgesic properties. Maintenance of anesthesia is achieved with inhalational agents and the addition of a ketamine and lidocaine infusion. The benefit of ketamine and lidocaine are their opioid-sparing effects through ketamine's antagonism of glutamate and opioid receptors and lidocaine's peripheral and central inhibition of pain conduction.

An additional opioid-sparing intervention is a transversus abdominal plane (TAP) block. TAP blocks have been shown to provide a greater duration of analgesia than local surgical site infiltration and have demonstrated equal efficacy as epidurals in laparoscopic surgery (Park et al., 2015). Utilization of bilateral TAP block in ERAS has correlated with decreased postoperative opioid needs and decreased LOS after laparoscopic colorectal surgery (Favuzza & Delaney, 2013).

Thoracic epidurals have also proven to be effective at reducing postoperative opioid use and incidence of ileus, especially with laparotomies (Gustaffson et al., 2012). However, they are

not without adverse effects, including block failures, inadvertent motor blockade, postdural puncture headache, and infection (Gustaffson et al., 2012). Furthermore, epidurals cause hypotension, pruritus, and urinary retention. Lastly, they are very resource-intensive, requiring constant monitoring and maintenance (Gustaffson et al., 2012). For this reason, thoracic epidurals are not a part of every ERAS protocol and the risk-benefit of such a technique must be weighed before utilizing.

Length of Stay & Cost

Patients undergoing traditional colorectal surgery tend to have a prolonged hospital stay due to the complexity of the surgical procedure and potential complications. According to Thiele et al. (2015), the average hospital stay after open colorectal surgery was five to seven days and three to five days for laparoscopy. According to another study by Miller et al. (2014), the median LOS after open approach was seven days and six days following the laparoscopic approach. These prolonged hospital stays not only negatively affected the hospital's productivity but also the patient's recovery process (Thiele et al., 2015).

According to Thiele et al. (2015), patient LOS was decreased by two days with an Enhanced Recovery (ER) protocol. Miller et al. (2014) corroborated these findings, showing a decrease in LOS by two days for laparotomy and one day for laparoscopic approach. Fewer patient bed days allowed hospitals in the studies to admit more patients which led to additional revenue (Miller et al, 2014). More importantly, ER participants showed fewer complications, shorter durations of ileus, and fewer readmissions (Miller et al., 2014).

ERAS has helped hospitals achieve a reduction in total medical costs, therein saving institutions money (Miller et al., 2014). The reduction in LOS and complications has made the implementation of ERAS the new standard of care for patients undergoing colorectal surgery

(Thiele et al, 2015). The implementation of this protocol has not only benefited hospital expenditures and productivity, but more importantly patient well-being.

Patient Satisfaction

The Institute of Medicine (IOM) identified patient-centeredness as one of the six domains that comprise quality care and defined it as “providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions.” (Committee on Quality Health Care in America, Institute of Medicine, 2001). With the recent changes in healthcare, patient satisfaction became a fundamental indicator of an institution’s quality. This important measure has had an impact on hospital ratings as well as reimbursement. Additionally, future revenue from return business is not likely if a patient is not satisfied with the care received. Satisfaction scores also drive an institution to improve standards of care (Thiele et al., 2015). Without these statistics, institutions would be neglecting an integral part of healthcare, the patient.

One of the key determinants of patient satisfaction is pain (Thiele et al., 2015). Pain is an inevitable consequence of surgery, but uncontrolled pain can have a negative effect on a patient’s outcome. Thiele et al. (2015), showed that an ER protocol for colorectal surgery, when implemented in the laparoscopic approach, reduced pain on postoperative day (POD) one, two, and three. However, the use of the ER protocol during laparotomy, resulted in increased pain scores in patients on all three PODs when compared to opioid analgesia (Thiele et al., 2015). The increase in postoperative pain with laparotomy may be linked with the avoidance of opioid usage. However, opioids come with side effects that may increase the risk of postoperative complications and the possibility of a prolonged LOS. According to Miller et al. (2014), the alternative use of opioid-sparing methodologies, such as thoracic epidurals, dramatically

decreased pain in the post-operative period when compared to narcotics alone. This decrease in pain was not only in the early post-operative period but extended up to five to seven days post-operatively.

Although pain is a vital part of patient satisfaction, several other factors contribute to this statistic. Thiele et al. (2015), showed that the benefits of ERAS extended to categories of the patient satisfaction survey including readiness for discharge and chance of recommending the facility. These improvements in survey scores showed that patients not only felt better, but were more prepared for discharge (Thiele et al., 2015).

Contribution and Dissemination/Justification

The purpose of the project was to increase the knowledge base of ADU SRNAs regarding the ERAS protocol during colorectal surgery through use of an educative PowerPoint presentation. The PowerPoint presentation was designed to increase the knowledge base of the participants by offering information regarding the objectives for ERAS protocol, its supporting evidence, how to implement the protocol, and the expected outcomes. The educational presentation was implemented in the Fall of 2017 and was presented in the combined MSNA 501 & 504 Clinical Conference Course to the 2018 and 2019 ADU SRNA cohort. Dissemination of the results will occur in the Spring of 2018 with the poster presentation.

Project Aims

The primary aim of this educational project was to increase the knowledge base of the 2018 & 2019 ADU SRNA cohort regarding colorectal ERAS protocols as demonstrated by a statistically significant improvement of post-test scores compared to baseline pre-test scores. The aim of the educative material was to help increase the knowledge base of these SRNAs so that in the clinical setting, they are adequately prepared to help implement and take part in the ERAS

protocol. Following conclusion of the presentation, the SRNAs knowledge base should include the objectives for ERAS protocol, its supporting evidence, how to implement the protocol, and the expected outcomes.

Project Methods

This project had a quantitative pre-post test design. A convenience sample of 50 SRNAs at Adventist University of Health Sciences (ADU) was planned. The inclusion criteria encompassed currently enrolled SRNAs in the nurse anesthesia program at ADU. Exclusion criteria was absence from the presentation and declination to participate in pre- and post-implementation data collection.

The ethical committee and institutional review board (IRB) approval was obtained. The presentation utilized a PowerPoint format and included information on ERAS practices. The PowerPoint was presented in the combined MSNA 501 & 504 Clinical Conference Course to the 2018 and 2019 ADU SRNA cohort. It contained the objectives for ERAS protocol, its supporting evidence, how to implement the protocol, and the expected outcomes.

The privacy of the participants was maintained by numerically assigning each pre- and post-test. This also ensured that data analysis was accurate. Electronic data was stored on the scholarly project team member's, Adam Lowe and Sebastian Mayer, personal computer and backed up on a Google Drive account for which password authentication was required. Following completion of the project, all physical data was shredded and all electronic data was deleted. Throughout the entire project implementation phase, only the project authors had access to the data.

Project Timeline

The timeline for this project was uniformly distributed over three academic semesters. During the summer semester, between the months of May & August 2017, the researchers' prepared and constructed the project topic and associated literature review findings. The topic then was approved by the faculty and committee chair. The project mentor was acquired and IRB approval was obtained. The PowerPoint presentation was constructed as well as a pre-test and a post-test. During the fall semester, between the months of August & December 2017, the project was implemented and data was collected and analyzed. During the spring semester of 2018, between the months of January and April, post-implementation data was compiled. Results will be disseminated during the spring MSNA 690 scholarly poster presentation on 4/9/2018 from 1-3pm.

Data Collection Plan

Data was collected utilizing a pre-test and a post-test with 12 multiple choice and true/false questions. Each SRNA received one pre-test that was completed before the presentation of the educational PowerPoint on ERAS for colorectal surgery. The pre-tests were collected by the researchers and counted to verify that one pre-test was completed per participant. Following the presentation, a post-test with the same questions, question order, and format was handed out to the SRNAs. The post-tests were counted to verify that each participant completed one. There was only one exchange for the pre-test and one exchange for the post-test. Neither the pre- or post-test contained any identifying data of the participants. Instead, numbers were used to ensure accurate comparison of pre- and post-test scores.

Evaluation Plan

This scholarly project was evaluated by the implementation of a pre-test prior to the PowerPoint presentation and a post-test afterward. The pre-test and post-test were identical and consisted of 12 questions in the form of true/false and multiple choice. Those questions included specific ERAS preoperative guidelines, intraoperative medication regimens, and postoperative strategies. The statistical data was collected and analyzed using a paired t-test. The significance threshold for the paired sample t-test was set using the traditional $p < .05$.

Limitations

As with all scholarly projects, limitations existed and impacted the outcome. The first limitation that was encountered was a small sample size of 49, which impacted the generalization of the researchers' results. Secondly, the PowerPoint presentation was presented after a full clinical day for most of the SRNAs and the anticipated sample size was 50. However, one SRNA was late due to their clinical assignment and/or traffic. This prevented them from participating in the pre-test and therefore excluded them from the post-test, which in turn decreased the sample size even further. Finally, the educative material was presented over a short, 45-minute period of time, which made it difficult for the participants to score adequately on the immediate post-test as well as retain the knowledge of the subject long-term. This also may have hindered their ability to apply this material in their clinical practice. This is in contrast to educative material that is given over a period of weeks to months with countless reviews and reinforced by clinical practice. Another limitation that was faced, was that the pre/post test wasn't tested for reliability or validity.

Results

Before the researchers began the educational PowerPoint presentation regarding ERAS for Colorectal Surgery, a pre-test consisting of twelve questions was administered to 49 participants from the 2018 & 2019 SRNA cohort. After the presentation was implemented, the 49 participants were given a post-test consisting of the same twelve questions from the pre-test. Once all the post-tests were collected, the researchers graded each test comparing each participants' pre-test scores to their post-test scores. The data were then sent to Dr. Roy Lukman to further analysis. A paired sample t-test in SPSS was conducted. The results indicated that the mean post-test scores ($M=83.06$, $SD=14.34$) were significantly greater than the mean pretest scores ($M=52.47$, $SD=19.58$), $t(48) = -10.473$, $p < .001$. Therefore, it was concluded that the educational PowerPoint presentation was successful in improving the participants' knowledge regarding ERAS for Colorectal Surgery. The statistical analysis in its entirety can be viewed in Appendix D.

Conclusions

A thorough literature review revealed the many benefits of implementing an ERAS protocol for colorectal surgery. It also provided information regarding the objectives of ERAS protocol, implementation strategies, expected outcomes, and supporting evidence. These findings were presented to the 2018 and 2019 ADU SRNA cohort through an educational presentation. In turn, this improved the knowledge base of the participants regarding ERAS for colorectal surgery. The presented information will help better prepare them in their clinical practice when exposed to these types of cases.

Appendix A: Informed Consent

ADU NAP CAPSTONE PROJECT – INFORMED CONSENT

Our names are Adam Lowe and Sebastian Mayer, and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called Enhanced Recovery After Surgery for Colorectal Surgery. This project is being supervised by Sarah L. Snell. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project, so you can make a decision about whether you want to participate.

WHAT IS THE PROJECT ABOUT?

The purpose of this project is to inform, educate, and assess the knowledge base of student registered nurse anesthetists (SRNAs) on the importance of using an Enhanced Recovery After Surgery (ERAS) protocol during colorectal surgery.

WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will address your knowledge base on ERAS for Colorectal Surgery. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately one hour.

WHY ARE YOU BEING ASKED TO PARTICIPATE?

You have been invited to participate as part of a convenience sample of students currently enrolled in the ADU NAP. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?

Although no project is completely risk-free, we don't anticipate that you will be harmed or distressed by participating in this project.

ARE THERE ANY BENEFITS TO PARTICIPATION?

We don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about Enhanced Recovery After Surgery for Colorectal Surgery.

HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS CONFIDENTIALITY

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, the investigators will numerically assign each pre-test and post-test. Electronic data will be stored on the scholarly project team member's, Adam Lowe and Sebastian Mayer, personal computer and backed up on a Google Drive account for which password authentication is required. When the project is completed, all physical data will be

shredded and all electronic data will be deleted. Thus, the investigators will not have access to any participants' identities.

WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?

Your participation will cost approximately one hour of your time, but will require no monetary cost on your part. You will not be paid to participate.

VOLUNTARY CONSENT

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. The investigators will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Adam Lowe (adam.lowe@my.adu.edu) or Sebastian Mayer (Sebastian.mayer@my.adu.edu). If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Program at (407) 303-9331.

_____ **Date** _____
Participant Signature

Participant Name (PRINTED LEGIBLY)

Appendix B: Pre-Test & Post-Test

Pre/Post Test Answer Key

1. Which medications would be given in the preoperative period for a patient participating in the ERAS protocol? (*Select three*)
 - a. Gabapentin (Neurontin)**
 - b. Rocuronium
 - c. Celecoxib (Celebrex)**
 - d. Oxycodone
 - e. Acetaminophen (Tylenol)**

2. What percentage of patients develop postoperative nausea and vomiting after major colorectal surgery?
 - a. 10%
 - b. 30%
 - c. 50%
 - d. 70%**

3. ERAS protocol decreases length of stay but at the expense of increased hospital costs.
 - a. False**
 - b. True

4. Within the ERAS protocol, which interventions are utilized to prevent/control postoperative pain while avoiding opioid use? (*Select three*)
 - a. Thoracic Epidurals**
 - b. Labetolol
 - c. Transversus Abdominis Plane (TAP) Block**
 - d. Ketamine/Lidocaine Infusions**

5. ERAS protocol decreases the length of stay for patients undergoing laparoscopic colorectal surgery, but the length of stay for the open approaches remained the same.
 - a. True
 - b. False**

6. Within the ERAS protocol, it is recommended to leave the nasogastric tube (NGT) in postoperatively to facilitate emptying of any gastric contents.
 - a. False**
 - b. True

7. At the beginning of the case, a patient undergoing colorectal surgery has an SVV of 10, a blood pressure of 100/74, and a heart rate of 78. One hour into the case, the patient's SVV is now 8, blood pressure is 82/50, and heart rate is 85. According to ERAS guidelines, what should the anesthesia provider do to support the patient's blood pressure.

- a. Give a 1 L bolus of IV crystalloid
- b. Administer Neosynephrine 100 mcg IV**
- c. Give 250 mL of Albumin 0.5%
- d. Administer Glycopyrrolate 0.2 mg IV

8. Preoperative fasting guidelines included in ERAS protocol includes which of the following?

- a. Coffee with creamer three hours preoperatively
- b. Turkey egg white flatbread six hours preoperatively
- c. Clear liquids with carbohydrates up to two hours preoperatively**
- d. Toast with jelly six hours preoperatively

9. Interventions that reduce the incidence of postoperative ileus after major colorectal surgery include? (*Select two*)

- a. Prolonged preoperative fasting
- b. Resumption of PO diet ASAP**
- c. Early mobilization**
- d. Maintaining gastric decompression with nasogastric tube
- e. Controlling postoperative pain with opioid analgesics

10. The opioid-sparing effect of Ketamine is achieved through its action at which receptors? (*Select two*)

- a. NMDA**
- b. GABA
- c. Opioid**
- d. K^+ channel

11. The mechanism of action of Lidocaine and the reason for its opioid-sparing effect is?

- a. Binds to internal H gate of Na^+ channel and increases Na^+ channel permeability resulting in inability to reach *threshold potential*
- b. Binds to internal H gate of Na^+ channel and decreases Na^+ channel permeability resulting in reduction of *resting membrane potential*
- c. Binds to internal H gate of Ca^{2+} channel and decreases Ca^{2+} channel permeability resulting in inability of *membrane repolarization*
- d. Binds to internal H gate of Na^+ channel and decreases Na^+ channel permeability resulting in inability to reach *threshold potential***

12. Which is not a risk factor for the occurrence of postoperative nausea and vomiting?

- a. Female
- b. History of motion sickness
- c. Smoking**
- d. Use of inhalational anesthetics
- e. Use of opioid analgesics

Appendix C: PowerPoint Presentation

2/23/18

**Enhanced Recovery After
Surgery (ERAS):
For Colorectal Surgery**

Presenters: Adam Lowe, BSN, RN & Sebastian Mayer, BSN, RN
Project Chair: Sarah Snell, DNP, CRNA
Project Mentor: Chad Pritts, MD

Objectives

- The objective for this project is to inform, educate, and assess the increase in knowledge base of student registered nurse anesthetists (SRNAs) on the importance of using an Enhanced Recovery After Surgery (ERAS) protocol during colorectal surgery.
- The primary aim of this educational project will be to increase the knowledge base of the 2018 & 2019 Adventist University of Health Sciences SRNA cohorts regarding colorectal ERAS protocols

Problem

- Historically, recovery from colorectal surgery has been problematic, leading to an increase in complications and prolonged hospital stays.
 - Nausea & vomiting (N/V)
 - Uncontrolled pain
 - Postoperative ileus
 - Anastomotic leaking
 - Bleeding
 - Venous Thromboembolism (VTE)
 - Infection

Problem

- Traditional practices:
 - Prolonged fasting periods
 - Liberal fluid administration
 - Postoperative nasogastric tubes
 - Opioid-based postoperative analgesia

What is ERAS?

- Comprehensive
- Multifaceted
- Evidence-based
- Improves upon the traditional management of colorectal surgery
- Standardization of care leading to:
 - Reduced surgical complications
 - Decreased length of stay (LOS)
 - Decreased medical costs
 - Improved patient outcomes and satisfaction

Collaboration

- Preoperative nurses
- Post Anesthesia Care Unit (PACU) nurses
- Inpatient nurses
- Anesthesia providers
- Surgeons

2/23/18

ERAS Case Study

- 56 year old male
- Chief complaint: Abdominal pain
- History of present illness: Abdominal bloating and cramps, fevers, diarrhea
- Past Medical History: Crohn's disease
- Past Surgical History: Small bowel resection x 3
- Procedure: Hand-assisted laparoscopic ileocecal resection
- Clear liquids 2 hours prior to procedure
- Preoperative medications:
 - Gabapentin 600 mg
 - Celebrex 200 mg

ERAS Case Study

- Intraoperative medications:
 - Standard induction with propofol, neuromuscular blocker, fentanyl, lidocaine
 - Ketamine infusion
 - Lidocaine infusion
 - Ofrimov 1 g
 - Robaxin 1 g
- Postoperative analgesics:
 - Gabapentin
 - Celebrex
 - Tramadol
 - Ofrimov
- Post-op day (POD) 1 highest pain score: 8/10
- POD 2 highest pain score: 6/10
- Ice chips after surgery, gas passed on POD 1, clear liquids resumed POD 1, and diet advanced to full liquid POD 2, discharged POD 6

ERAS Recommendations for Perioperative Care and Multimodal Therapies

Perioperative Care and Multimodal Therapies

- Goals of ERAS include:
 - Adequate analgesia
 - Early mobility
 - Earlier return of gastrointestinal (GI) motility
 - Reduction in complications

Preoperative Optimization

- Patient education and health counseling
- Smoking and alcohol cessation
- Maximize functional capacity [Metabolic Equivalents (METs) and exercise tolerance]
- Alcohol abusers:
 - 2-3x greater risk for surgical complications including:
 - Bleeding
 - Wound healing
 - Cardiopulmonary problems

• (Gustafsson et al., 2012)

Preoperative Optimization

- Smokers:
 - Increased pulmonary complications and decreased wound healing
- Smoking cessation
 - Short-term effects:
 - Carbon monoxide half-life = 4-6 hours
 - P50 returns to normal in 12 hours
 - Return of pulmonary function takes 6 weeks
 - Decreased airway reactivity
 - Increased mucociliary clearance
 - Increased pulmonary immune function

2/23/18

Preoperative Fasting

- ERAS recommendation
 - **Clear liquids with carbohydrates up to two hours preoperatively**
- Benefits:
 - Metabolic stability
 - Reduced postoperative insulin resistance
 - Mitigation of surgical stress response
- The allowance of clear liquids with carbohydrates alone has resulted in a **mean reduction in LOS by one day** (Awad et al., 2012).

Venous Thromboembolism

- Deep vein thrombosis (DVT) occurred in 30 percent of colorectal surgical patients that did not receive prophylactic treatment (Gustafsson et al., 2012)
- Recommendations:
 - Compression stockings
 - Intermittent mechanical compression
 - Low molecular weight heparin (LMWH)

Nausea and Vomiting

- **As much as a 70% occurrence of PONV after major colorectal surgery** (Gustafsson et al., 2012)
- Increased risk:
 - Female
 - Nonsmoker
 - History of motion sickness
 - Inhalational agents
 - Opioids

Nausea and Vomiting

- Pharmacological prophylaxis:
 - Serotonin (5-HT₃) antagonists
 - Ondansetron
 - Dopamine (D₂) antagonists
 - Droperidol
 - Anticholinergics (M₁)
 - Scopolamine
 - Antihistamines (H₁)
 - Diphenhydramine
 - D₂, H₁, & M₁
 - Promethazine
 - Prochlorperazine
 - Dexamethasone

Nausea and Vomiting

- ERAS recommendations
 - Minimization of fasting
 - **Clear liquids two hours preoperatively**
 - Adequate hydration
 - Goal-directed fluid therapy
 - Reduction of opioid use through:
 - Transversus abdominis plane (TAP) blocks
 - Thoracic epidurals
 - NSAIDS
 - Acetaminophen
 - Gabapentin

Nasogastric Tubes

- Prolonged nasogastric decompression associated with:
 - Fever
 - Atelectasis
 - Pneumonia
 - Ileus
- Patients who underwent colorectal surgery showed an improvement in the time to passage of the first flatus by one half day when postoperative nasogastric tube (NGT) was avoided (Gustafsson et al., 2012).
- ERAS recommendation
 - **Removal of NGT before cessation of anesthesia**

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Fluid Management

- Hypovolemia:
 - Hypotension
 - Reduced oxygen delivery to organs and tissues
- Excess fluid administration:
 - Tissue edema
 - Bowel edema → Anastomotic leaking
 - Atelectasis
- Gustafsson et al. (2012) found that the single greatest risk factor for postoperative ileus was excessive fluid administration.

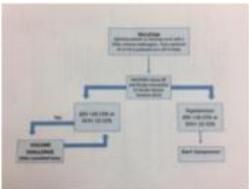
Fluid Management

- Goal-directed fluid therapy
 - ClearSight/Flotrac
 - Cardiac Output (CO)
 - Cardiac Index (CI)
 - Stroke Volume (SV)
 - Stroke Volume Variation (SVV)



Fluid Management

- U.S. Anesthesia Partners (USAP) ERAS fluid management algorithm



Fluid Management

- Start of case:
 - Optimize patient on Starling curve with 250 mL crystalloid volume challenge
 - Once optimum SV or CO is achieved, turn off intravenous (IV) fluids
- Intraoperative assessment of blood pressure (BP), SV, and SVV
- Correction of hypotension:
 - SVV > 13 = 250 mL crystalloid volume challenge
 - SVV < 13 = Vasopressor

Fluid Management

- ERAS recommendations
 - Avoidance of bowel prep
 - Clear liquids up to two hours preoperatively
 - Minimization of bowel manipulation
 - IV fluid only given when clinical picture necessitates
 - Balanced crystalloids favored over 0.9% saline
 - Resumption of fluids by mouth (PO) as soon as possible

• (Gustafsson et al., 2012)

Opioid Sparing Methodologies

- Unfavorable effects of opioids:
 - Respiratory depression
 - Nausea
 - Decreased GI motility
 - Oversedation
 - Pruritus

• (Dorn, Lembo, & Cremonini, 2014)

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Opioid Sparing Methodologies

- Preoperative medications ordered by surgeon:
 - **Acetaminophen (Tylenol)**
 - **Celecoxib (Celebrex)**
 - Cyclooxygenase-2 (COX-2) inhibitor which does not inhibit platelet aggregation or cause GI irritation
 - **Gabapentin (Neurontin)**
 - Anticonvulsant that also has application in neuropathic pain through its action on the alpha-2-delta-1 subunit of voltage-gated calcium channels (VGCCs)
 - It has also shown effects on N-Methyl-D-Aspartate (NMDA) receptors and reduction in protein kinase C and inflammatory cytokines
- Some surgeons will also order Alvimopan (Entereg)
 - Peripheral mu-opioid receptor antagonist
 - Antagonizes the effect of opioids in the bowel

• (Kukkar, Bali, Singh, & Jaggi, 2013)

Opioid Sparing Methodologies

- Intraoperative adjuncts:
 - **Ketamine**
 - NMDA receptor antagonist
 - Dissociative anesthesia
 - Analgesia via thalamocortical system and opioid receptors
 - **Ketamine bolus:**
 - 30 mg [or 0.5 mg/kg Ideal Body Weight (IBW)] at induction or prior to incision
 - **Ketamine infusion:**
 - 30 mg/h [or 0.25 – 0.5 mg/kg/h]
 - Medfusion pump: 5 mcg/kg/min – 10 mcg/kg/min
 - No additional dose 45 minutes before end of surgery

Opioid Sparing Methodologies

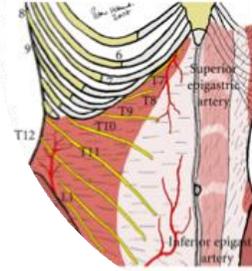
- **Lidocaine**
 - Conjugate acid binds to alpha subunit of internal H gate of sodium (Na⁺) channels and decreases Na⁺ channel permeability resulting in the inability to reach threshold potential
 - Peripheral and central inhibition of pain conduction
- **Lidocaine bolus:**
 - 1.5 mg/kg
- **Lidocaine infusion:**
 - 2 mg/kg/h

Opioid Sparing Methodologies

- Intraoperative adjuncts continued:
 - **Thoracic epidurals**
 - Effective at reducing postoperative opioid use and incidence of ileus, especially with laparotomy
 - Adverse effects include:
 - Block failure or incomplete block
 - Inadvertent motor blockade
 - Post-dural puncture headache (PDPH)
 - Infection
 - Hypotension
 - Pruritus
 - Urinary retention
 - Resource-intensive
 - Requires constant monitoring and maintenance
 - Not a part of every ERAS protocol
 - Risk/benefit ratio must be weighed

Transabdominal Plane (TAP) Block

- Innervation of the anterolateral abdominal wall arises from the anterior rami of spinal nerves T7-L1
 - Intercostal nerves (T7-T11)
 - Subcostal nerve (T12)
 - Iliohypogastric & Ilioinguinal nerves (L1)



TAP Block

- Three muscular layers:
 - External oblique
 - Internal oblique
 - Transversus abdominus



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TAP Block

Supplies:	Technique:
<ul style="list-style-type: none"> • Ultrasound with a high frequency probe (5-10 MHz) • Needle (5-10 cm) (22 gauge blunt for single-shot) (18 gauge Tuohy for continuous infusion) • Injection tubing and syringe (20 mL) • 20 to 30 mL of local anesthetic (Bupivacaine 0.25% or Ropivacaine 0.2%) • TAP block relies on local anesthetic spread rather than concentration (volume dependent) 	<ul style="list-style-type: none"> • Single-shot or continuous • 2 mL normal saline (NS) injected to open up plane • Catheter advanced to approximately 3 cm beyond needle tip • Position verified by injecting local anesthetic bolus (20 mL) • Infusion of local anesthetic started (7-10 mL/hr)

TAP Block



- TAP blocks have shown greater duration of analgesia than local surgical site infiltration and have demonstrated equivalent efficacy as thoracic epidurals in laparoscopic surgery (Park et al., 2015)

Postoperative Management

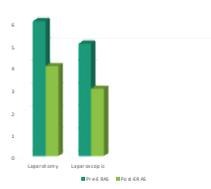
- Clear liquids allowed in PACU
- Out of bed (OOB) day of surgery (DOS)
- Multimodal analgesia continued postoperatively:
 - Acetaminophen (Tylenol)
 - Celecoxib (Celebrex)
 - Gabapentin (Neurontin)

Decreased Length of Stay

Length of Stay

- Patients undergoing traditional colorectal surgery tend to have a prolonged hospital stay due to the complexity of the surgical procedure (Thiele et al., 2015).
- Traditionally:
 - Laparotomy (open approach)
 - 5-7 days
 - Laparoscopic approach
 - 3-5 days
- Can negatively affect:
 - Hospitals productivity (nosocomial infections, readmissions, etc.)
 - The patient's recovery process (ileus, infection, DVT, etc.)

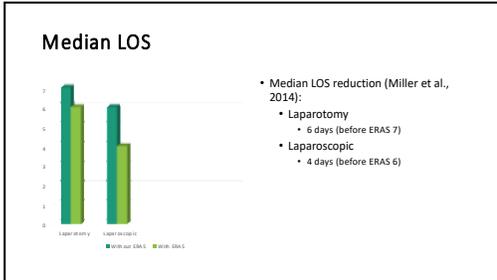
Median LOS



Approach	Median LOS (before ERAS)
Laparotomy	4 days
Laparoscopic	3 days

- Median LOS reduction (Thiele et al., 2015):
 - Laparotomy
 - 4 days (before ERAS 6)
 - Laparoscopic
 - 3 days (before ERAS 5)

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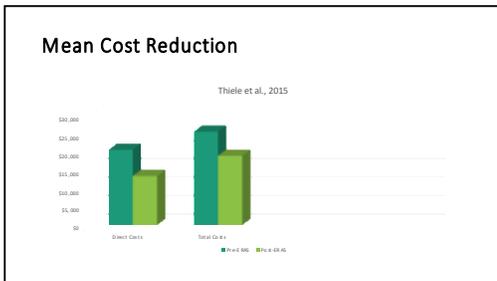
Length of Stay: Main Points

- After the implementation of ERAS, LOS decreased with both the laparotomy and laparoscopic approaches.
- ERAS resulted in shorter duration of ileus and fewer overall complications. This resulted in shorter LOS and fewer readmissions.
- Helped hospitals productivity, but more importantly the patient's recovery.

Decreased Cost

Cost

- Problems with colorectal surgery:
 - Prolonged LOS
 - Associated with an abundance of postoperative complications:
 - N/V, Ileus, Infection, & VTE
- This increases costs for the hospital and the patient.
- After ERAS:
 - Decreases in cost were directly related to:
 - Shorter LOS & less postoperative complications
- According to Thiele et al., 2015, direct cost reduction:
 - \$7,129/patient (total cost savings of \$777,061)
 - Allowed facilities to admit more patients. (saved 261 patient-bed days)



Patient Satisfaction

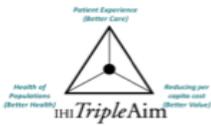
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Patient Satisfaction

- Why is this important?
- The Institute of Medicine (IOM) has identified patient-centeredness as one of the six domains that define quality care (Committee on Quality Health Care in America, Institute of Medicine, 2001).
 - Patient-centeredness
 - Care that is respectful & responsive to:
 - Patient's preferences, needs, and values.
 - All clinical decisions should be based on the individual values of each patient.

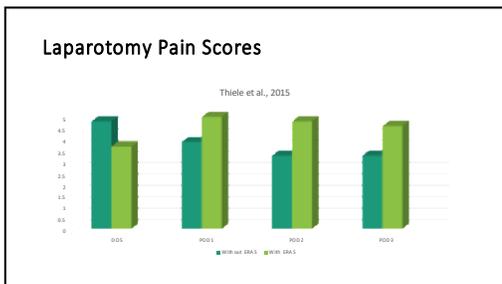
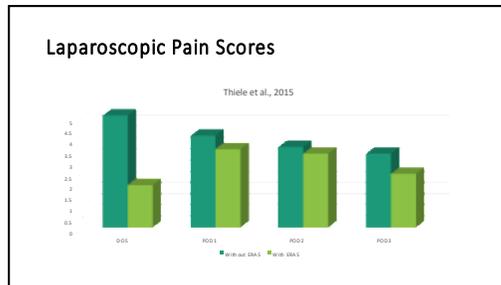
Patient Satisfaction

- Model developed by the Institute for Healthcare Improvement (IHI) to optimize health system performance (The IHI Triple Aim. (n.d.). Retrieved October 09, 2017).
- Reimbursement based on outcomes versus services rendered



Patient Satisfaction

- One of the biggest measurements of patient satisfaction is pain.
- According to Thiele et al., 2015, after ERAS:
 - Laparoscopic approach
 - Decreased pain scores on all three days postop.
 - Laparotomy
 - Increased pain scores on all three days postop.
 - Avoidance of opioids?
 - Pros & cons



More Than Just Pain

- Along with pain, there are many other areas that correlate with patient satisfaction.
- According to Thiele et al., 2015, satisfaction survey scores improved.
 - Improvement in categories such as:
 - Pain control
 - Chance of recommending the facility
 - Readiness for discharge
- These improvements in survey scores showed that patients not only felt better, but were more prepared for discharge.

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Considerations

- Hydromorphone and Morphine shortage
- Lidocaine shortage
- Additional adjuncts:
 - Dexmedetomidine (Precedex)
 - Centrally acting pre-synaptic alpha-2 agonist:
 - Sedation via inhibition of pontine locus coeruleus
 - Analgesia via dorsal horn of spinal cord
 - Decreased sympathetic nervous system (SNS) tone via medulla
 - Inhibition of norepinephrine (NE) release and vasodilation via central alpha-2 agonism
 - Loading: 1 mcg/kg over 10 mins
 - Maintenance: 0.2-0.7 mcg/kg/hr
 - Benefits: Sedation, analgesia, anxiolysis, prevention of shivering
 - Adverse effects: Hypotension, bradycardia, over-sedation
 - Can cause transient vasoconstriction and hypertension if administered too rapidly
 - Via stimulation of peripheral post-synaptic alpha-2 receptors in arterial and venous circulations

Questions?

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Appendix D: Results Analysis

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	52.4694	49	19.58007	2.79715
	Post-Test	83.0612	49	14.34022	2.04860

Paired Samples Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Pre-Test - Post-Test	-30.59184	20.44802	2.92115	-36.46519	-24.71848	-10.473	48	.000

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