

Fall 2019

Perioperative Fluid Management for Elective Colorectal Surgery Patients Utilizing an ERAS Protocol: A Best Practice Recommendation

Callie Bridges

Nicole Mason Walters

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PERIOPERATIVE FLUID MANAGEMENT FOR ELECTIVE COLORECTAL
SURGERY PATIENTS UTILIZING AN ERAS PROTOCOL:
A BEST PRACTICE RECOMMENDATION

by

Callie Bridges and Nicole Mason Walters

A Doctoral Project
Submitted to the Graduate School,
the College of Nursing and Health Professions
and the School of Leadership and Advanced Nursing Practice
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Nursing Practice

Approved by:

Dr. Mary Jane Collins, Committee Chair
Dr. Nina McLain

Dr. Mary Jane Collins
Committee Chair

Dr. Lachel Story
Director of School

Dr. Karen S. Coats
Dean of the Graduate School

December 2019

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2019

Published by the Graduate School



ABSTRACT

CRNAs manage intraoperative fluid therapy as a vital part of anesthesia practice to optimize patient conditions. To maintain homeostasis, fluid therapy must incorporate the many fluid shifts that occur during the perioperative period, in particular, those patients undergoing elective colorectal surgery. Patients are at risk for under- and overhydration, both of which have detrimental effects (e.g. hypotension, pulmonary edema). Informal interviews with clinical affiliate CRNAs and lack of literature concerning CRNAs' education of an Enhanced Recovery After Surgery fluid management protocol suggests a knowledge deficit among these anesthesia providers. Adoption of an ERAS protocol for colorectal surgery entails implementing a goal-directed program that aims at decreasing perioperative stress, improving gut function and decreasing postoperative complications. The fluid management aspect of this multimodal program is where anesthesia providers can control how much fluid a patient receives based on a goal-directed regimen.

An educational module with a proposed policy was prepared and presented to an expert panel, which consisted of 10 CRNAs at affiliated facilities. They were all considered relevant stakeholders due to their advanced knowledge and daily involvement with the current topic. An evaluation tool was used to gather data, which gave the panel the ability to provide feedback on the education module and proposed policy on whether the information was useful and if they would consider implementing the policy. The panel agreed that this educational module with the proposed policy was appropriate for implementation and considered it DNP quality. Majority of the panel would consider the implementation of said policy.

ACKNOWLEDGMENTS

We would like to thank our committee chair, Dr. Mary Jane Collins, for your constant guidance, in-depth knowledge base, and encouragement throughout the completion of our project.

DEDICATION

We would like to dedicate this paper to each other. Through supporting one another and laughing along the way, we have finally made it! To our husbands, thank you for your encouragement over the last 3 years. To Mason and Maya, thank you for learning to cook for yourselves. To our favorite classmates, you know who you are, thank you for making this ride just a little more enjoyable.

TABLE OF CONTENTS

ABSTRACT ii

ACKNOWLEDGMENTS iii

DEDICATION iv

LIST OF TABLES viii

LIST OF ABBREVIATIONS ix

CHAPTER I - INTRODUCTION 1

 Problem Description 1

 Available Knowledge..... 3

 Knowledge Deficit 3

 ERAS Defined 4

 Traditional Fluid Management Versus ERAS 8

 Current Best Practice of Intraoperative Fluid Management 9

 Perioperative Patient Complications..... 10

 Economic Impact 11

 Patient Satisfaction..... 11

 Adult Education Methods 12

 Parts of a Best Practice 13

 Rationale 13

 Specific Aims..... 14

DNP Project	14
Summary	15
CHAPTER II – METHODS	17
Context.....	17
Steps.....	17
Intervention.....	18
Study of the Intervention	18
Measures	19
Analysis.....	20
Ethical Considerations	20
Summary	21
CHAPTER III - RESULTS.....	22
Summary.....	24
CHAPTER IV – DISCUSSION.....	25
Summary.....	25
Interpretation.....	25
Limitations	26
Consideration for Future Research	26
Conclusion	27
APPENDIX A – DNP Essentials	28

APPENDIX B – Report of Findings	29
Background	29
Available Knowledge.....	29
Suggestions for Best Practice.....	30
References.....	32
APPENDIX C – Proposed Policy	34
APPENDIX D – Post-Educational Module Questions and Answers.....	36
APPENDIX E – Evaluation Tools	38
APPENDIX F –IRB Approval Letter	39
APPENDIX G – Literature Matrix	40
APPENDIX H - Executive Summary	42
Available Knowledge.....	42
Process	43
Policy Recommendation	44
Proposed Policy	45
Post-Educational Module Questions.....	47
Post-Educational Module Answers.....	48
References.....	49
REFERENCES	55

LIST OF TABLES

Table 1 Panel of Experts' Beliefs on Proposed Best Policy 23

LIST OF ABBREVIATIONS

AACN	American Association of Colleges of Nursing
ASA	American Society of Anesthesiologists
CRNA	Certified Registered Nurse Anesthetist
DNP	Doctor of Nursing Practice
EBP	Evidence-Based Practice
ERAS	Enhanced Recovery After Surgery
GDFT	Goal-directed Fluid Therapy
IBW	Ideal Body Weight
IV	Intravenous
Kg	Kilogram
MAP	Mean Arterial Pressure
ml/kg/hr	Milliliter per kilogram per hour
NICOM	Noninvasive Cardiac Output Monitor
NPO	Nil Per Os
PONV	Postoperative Nausea and Vomiting
UAB	University of Alabama at Birmingham
USM	The University of Southern Mississippi
UVA	University of Virginia

CHAPTER I - INTRODUCTION

Problem Description

Fluid therapy is a major component of perioperative anesthetic management. Maintaining homeostasis of bodily fluids through volume and the composition of intravenous (IV) fluids is crucial during this period because of the many fluid shifts that occur due to surgical losses, third spacing, and preoperative fasting deficits (Feldheiser et al., 2015). Anesthesia alone can cause fluid imbalances in surgical patients due to its vasodilatory effects leading to hypovolemia, which causes hypotension (Lynn & Winner, 2014). “IV fluids are the primary means to address a patient’s need for fluid and electrolytes” (Lynn & Winner, 2014, p. 389). Certified Registered Nurse Anesthetists (CRNAs) manage intraoperative fluid therapy as a vital part of anesthesia practice to optimize patient conditions (Trinooson & Gold, 2013). Informal interviews with clinical affiliate CRNAs and lack of literature concerning CRNAs’ education of an Enhanced Recovery After Surgery fluid management protocol suggests a knowledge deficit among these anesthesia providers.

The current practice of intraoperative fluid management is based on a traditional method of estimating fluid replacement requirements. This method of fluid replacement is in question because it tends to increase pulmonary complications, cause prolonged ileus, and delay recovery (Feldheiser et al., 2015). Traditional perioperative IV fluid administration in abdominal surgery can cause patients to receive 3.5-7 liters of fluid, leading to a 3-6 kilogram (kg) weight gain. This excessive fluid administration delays the return of gastrointestinal function, impairs wound healing or anastomotic healing, and affects tissue oxygenation (Lassen et al., 2009). Negative impacts from the traditional

method also include fluid overload resulting in third spacing, edema of the intestinal wall, and disruption of anastomosis sites. Too much fluid disrupts that endothelial glycocalyx from an increased intravascular hydrostatic pressure. The glycocalyx plays an important role as being a barrier to extravasation (Miller, Roche, & Mythen, 2014). The goal of intraoperative fluid management should aim to maintain a net-zero fluid balance, or euvolemia, and maintain homeostasis (Feldheiser et al., 2015).

Adoption of an ERAS protocol for colorectal surgery entails implementing a goal-directed program that aims at decreasing perioperative stress, improving intestinal function and decreasing postoperative complications. The fluid management aspect of this multimodal program is where anesthesia providers can control how much fluid a patient receives based on a goal-directed regimen (Conn, McKenzie, Pearsall, & McLeod, 2015). Implementation of an ERAS protocol improves patient outcomes, and it is cost saving. For example, a hospital in Arkansas performed a retrospective review during the implementation of an ERAS protocol over a two years, which demonstrated a savings of \$2.3 million due to a decrease in length of hospital stay (Bradney et al., 2018). Patient satisfaction scores are proven to increase under the influence of an ERAS protocol. Horrattas et al. (2017) exhibited improvements to postoperative pain scores with a significant decline in narcotic use.

Informal interviews with clinical affiliate CRNAs and lack of literature concerning CRNAs' education of an Enhanced Recovery After Surgery fluid management protocol suggests a knowledge deficit among these anesthesia providers. CRNAs manage intraoperative fluid therapy as a vital part of anesthesia practice to optimize patient conditions (Trinooson & Gold, 2013). Knowledge concerning fluid

management, including under- and overhydration, and developing evidence-based practice (EBP) is essential for safe patient care (Camach-Navarro et al., 2015). Potential negative impacts of improper fluid management are perioperative patient complications, decreased patient satisfaction, and economic impacts (e.g., increased hospital and patient expenditures). Current peer-reviewed literature was utilized to compile a best practice guideline for fluid administration as a part of an ERAS protocol. This guideline was further used to prepare and propose an educational guideline for CRNAs at the clinical affiliate facility. The best practice guideline and the educational module was presented to anesthesia administration at the clinical affiliate facilities.

Available Knowledge

Knowledge Deficit

Informal interviews with CRNAs at clinical affiliate hospitals suggested a lack of education regarding the use of an ERAS protocol for perioperative fluid management during elective colorectal surgery. For instance, T.M. Martin (personal communication, September 26, 2018) claimed she was unaware of what an ERAS protocol consists of, and W.D. Sorrell (personal communication, September 26, 2018) stated that he would be hesitant to partake in the protocol because he has been practicing anesthesia for over 30 years and did not see a reason to try something new. When attempting to implement an ERAS protocol, education is critical because it could potentially be a barrier to enactment. Current literature refers to a knowledge deficit of anesthesia providers that can result in poor buy-in from key stakeholders. A proposed solution to this barrier is the continuing education of this group of professionals (Conn et al., 2015). “Staff education prior to the implementation of ERAS programs should be initiated. Education of staff

facilitates the change and should aid in the practice transition. Education programs should be an ongoing feature for the functioning of ERAS programs. Education programs could ensure that compliance with elements remains high” (Lyons, Solomon, & Harrison, 2014, p. 1379).

ERAS Defined

ERAS protocols are currently considered best practice. Understanding what the protocols entail is important for the implementation of this best practice. ERAS refers to multimodal and multidisciplinary programs, which have been developed to decrease postoperative complications, accelerate recovery, and promote early discharge. Interventions included in ERAS programs include best practices aimed at decreasing perioperative stress, postoperative pain, intestinal dysfunction, and infection as well as promoting early mobilization. The programs are implemented and carried out by a team of specialists, including surgeons, anesthesiologists, floor nurses, an ERAS coordinator, and preoperative care nurses. Interventions include, but are not limited to, individualized fluid therapy to reduce fluid overload, opioid-sparing pain control techniques, reduced preoperative fasting timelines, early physical mobility, and carbohydrate loading before surgery. These programs can be modified and tailored to fit the needs and setting in which they are used (Ljungqvist, Scott, & Fearon, 2017).

Several groups are dedicated to the development and implementation of ERAS protocols. While some differences between the group protocols exist, the framework remains the same amongst the groups. The ERAS Society is considered to be the leader in ERAS research and published their updated ERAS protocol for the perioperative care

of elective colorectal surgical patients. ERAS protocols are divided into three parts—preoperative, perioperative, and postoperative treatment (Gustaffson et al., 2018).

Preoperative guidelines are focused on optimizing the patient before surgery and include the following mentioned interventions. First, preadmission counseling and education prepare the patient for what to expect both during and after surgery.

Preoperative guidelines include information on smoking and alcohol cessation, pain control, and surgical recovery. Preoperative conditioning with an exercise plan is advised, especially in less fit patients, to increase physiological reserve. Nutritional care for malnourished patients is recommended seven to ten days before surgery to reduce surgical complications. Next, ERAS protocols advise the provider to optimize the patient's hemoglobin concentration preoperatively through iron or blood transfusions since anemia is a risk factor for surgical complications and mortality. Multimodal medications to avoid postoperative nausea and vomiting (PONV) and preoperative anxiety are also recommended by the ERAS Society. Further, antimicrobial prophylaxis given within 60 minutes before surgical incision and skin disinfection with a chlorhexidine-alcohol-based preparation should be utilized to prevent surgical site infection. Finally, the anesthesia provider should allow the patient to avoid prolonged fasting, consume carbohydrate-rich clear liquids up to two hours before surgery, and avoid mechanical bowel preparation if possible for the patient to maintain a euvolemic state in the face of fasting for surgical safety (Gustafsson et al., 2018).

Intraoperatively, the ERAS Society has five major recommendations for quality patient care (Gustafsson et al., 2018). The first recommendation is using short-acting anesthetics (e.g. propofol), sparingly giving opioids, and avoiding benzodiazepines.

Cerebral monitoring is recommended to reduce postoperative delirium along with monitoring the level of neuromuscular blockade and its reversal with drugs such as Sugammadex. Second, intraoperative fluid and electrolyte therapy is administered to maintain cardiac output and fluid homeostasis while avoiding fluid overload and organ hypoperfusion. This topic will be more thoroughly addressed later in this paper. Preventing intraoperative hypothermia through the usage of warming devices is recommended to avoid problems with bleeding, vasoconstriction, and cardiac arrhythmias. Next, minimally invasive surgical techniques (e.g., robotic, laparoscopic, and trans-anal approaches) are recommended as opposed to open abdominal procedures. Finally, Gustafsson et al. (2018) conveyed that the routine usage of pelvic and peritoneal drains should be avoided as it shows no benefit to the patient.

The ERAS Society has several postoperative recommendations for the elective colorectal surgical patient (Gustafsson et al., 2018). To begin, Gustafsson et al. (2018) recommend avoidance of routine nasogastric tube insertion for gastric discomfort and intraoperative removal if the placement is necessary. Multimodal pain control is recommended and includes epidural and spinal blockade, lidocaine infusions, and abdominal wall nerve blockade. Mechanical and pharmacological thromboprophylaxis should be instituted immediately after surgery. Further, postoperative fluid management should have a “near-zero” goal with balanced fluid solutions, similar to intraoperative protocol. Next, routine transurethral catheterization is recommended for 1-3 days postoperatively based on the patient’s risk for urinary retention. Finally, strict glycemic control, prevention of postoperative ileus through early mobilization and gum chewing, and early resumption of nutritional intake round out the ERAS postoperative protocol.

More specific to this project are the ERAS indications for perioperative fluid management. While most ERAS frameworks regarding fluid balance agree on key points, some differences can be grouped into three domains. This project's authors reviewed six different ERAS protocols to identify these trends in ERAS usage. The ERAS protocols reviewed include the ERAS Society (Gustafsson et al., 2018), the University of Alabama at Birmingham Hospital (UAB) (Morris & Chu, 2017), Duke University Hospital (Miller et al., 2014), Dartmouth University Hospital (Rawlinson, Kang, Evans, & Khanna, 2011), Banner Health System (Rawlinson et al., 2011), and the University of Virginia Hospital (UVA) (Thiele et al., 2015).

The variations reviewed are a “near-zero” fluid restriction approach, a goal-directed fluid therapy (GDFT) approach, invasive hemodynamic monitoring, noninvasive hemodynamic monitoring, and the fluids used for resuscitation (Gustafsson et al., 2018). UAB, Dartmouth, and the ERAS Society specifically recommend a “near-zero” approach to fluid resuscitation, with the ERAS Society recommending avoid more than a 2.5 kg weight gain (Gustafsson et al., 2018; Morris & Chu, 2017; Rawlinson et al., 2011). The ERAS Society, Banner Health System, UAB, and Dartmouth all agree that a GDFT should be employed only in patients with a high risk for fluid and protein shifts and large fluid losses or in open abdominal surgeries (Gustafsson et al., 2018; Morris & Chu, 2017; Rawlinson et al., 2011). No consensus on the usage of invasive hemodynamic monitoring (e.g. cardiac output monitor) versus the usage of noninvasive hemodynamic monitoring (e.g. NICOM) is available within this group. The ERAS Society and Duke University call for invasive monitoring and limiting the decrease in stroke volume to ten percent (Gustafsson et al., 2018; Miller et al., 2014). Both Dartmouth and UVA call for

noninvasive monitoring (Rawlinson et al., 2011; Thiele et al., 2015). The specific fluids used for resuscitation were the most consistently alike in all protocols, except for UVA, who had no set fluid regiment (Thiele et al., 2015). The other five groups called for crystalloid infusions between 1-4 milliliter per kilogram per hour (mL/kg/hr) based on the patient's ideal body weight (IBW) with 250 mL colloid boluses if mean arterial pressure (MAP) dropped below 60 mm Hg. UAB specified a bolus of 100 mL of 25% albumin (Morris & Chu, 2017).

While differences in how these groups adopted the original ERAS protocol developed by the ERAS Society exists, some obvious trends in pieces were kept. A restricted or "near-zero" approach is utilized unless the patient is high risk, at which time a GDFT is used. The usage of crystalloids at a low rate based on IBW with colloid boluses to maintain organ perfusion is also employed. Finally, the usage of invasive versus noninvasive monitoring is more institution-specific (Trinooson & Gold, 2013).

Traditional Fluid Management Versus ERAS

Traditionally, fluid management perioperatively utilizes formulas to judge how much fluid should be administered to the patient. These concepts are often directed at keeping the patient volume loaded. Patients who are having major surgery are usually given large volumes of fluid to compensate for extensive fasting periods and third space losses. Advantages of using the traditional method of fluid management include maintaining fluid volume in surgical patients and employing a predetermined calculation of fluids. Disadvantages of traditional fluid management are the use of tedious formulas, increased incidence of postoperative complications (e.g., pulmonary edema, ileus, pneumonia), volume overloading, and, ultimately, no final endpoints for organ perfusion.

When the ERAS pathway for fluid management is employed, fluid management is individualized for a euvolemic or near-zero perioperative amount and is goal-directed. The advantages of applying the ERAS pathway consist of the use of current evidence-based research, early discharge times, cost-savings due to decreased length of stay, higher reimbursement rates, and increased patient satisfaction scores (Miller et al., 2014; Paton et al., 2014). The goals of ERAS protocols are to reduce postoperative complications and facilitate early recovery after major surgery (Miller et al., 2014). Disadvantages of using the ERAS pathway include use of invasive monitors, which may increase the risk of complications, and risk for aspiration is increased due to changes in the NPO guidelines (Gustafsson et al., 2018). Presentation of advantages and disadvantages provides a comparison between the current fluid management practice of CRNAs and the ERAS pathway of fluid management. The comparison is important to our project because it details the vast contrast between the two practices.

Current Best Practice of Intraoperative Fluid Management

Perioperative fluid management is generally divided into two different schools of thought. The classical, or static, plan for intraoperative fluid replacement involves set parameters for replacement based on the patient's weight, hours in surgery, and insensible losses. The classical plan relies on traditional methods of evaluating patient fluid volume statuses such as heart rate, blood pressure, central venous pressure, and urine output. While this method has been proven to lead to both hypervolemia and hypovolemia due to these unreliable markers of fluid volume status, the classical method remains in current practice. Goal-directed fluid therapy (GDFT) is the more modern approach to fluid replacement in the operating room (Cesur, Cardakozu, Kus,

Turkyilmaz, & Yavuz, 2018). GDFT is highly individualized to each patient and relies on stronger indicators of fluid volume status such as variations in pulse pressure on arterial pressure waveforms, stroke volume estimates, left ventricular size estimates, and laboratory values such as serum lactate levels. If there are variations in these indicator baseline measurements of more than 15%, the patient is considered fluid-responsive and fluid boluses are administered until the variations are less than 10% to avoid hypervolemia. A balanced crystalloid is chosen for GDFT. This method has been shown to have decreased mortality and lower risks of pneumonia, acute kidney injury, wound infection, and shorter hospital stays when compared with classical or provider-driven fluid replacement strategies (Joshi, 2018). Analyzing these current practices is needed for a practice change.

Perioperative Patient Complications

Administration of excessive perioperative IV fluids, as with the traditional fluid management regimen, results in hypervolemia. Subsequently, an increased intravascular hydrostatic pressure, causes the release of atrial natriuretic peptides that damage the glycocalyx of endothelial cells. The release of atrial natriuretic peptides cause cellular leakage, resulting in interstitial edema (Miller et al., 2014). In the gastrointestinal system, edema of the intestinal wall is the most common sign of excessive fluid administration. Intestinal wall edema could lead to an increased likelihood of anastomosis rupture and postoperative ileus. Excess fluid in the lungs can potentially lead to pulmonary edema, pneumonia, and postoperative respiratory failure that causes prolonged mechanical ventilation (Cesur et al., 2018; Holte, Sharrock, & Kehlet, 2002).

Fluid overloading increases postoperative complications by 32% for each additional liter of fluid given (Gustafsson et al., 2018).

In addition to hypervolemia potentially causing patient complications, hypovolemia has its consequences as well. Intraoperative hypovolemia is the loss of 10-15% of blood volume that can result in splanchnic hypoperfusion leading to intestinal acidosis. Intestinal acidosis impairs intestinal function and furthers complications postoperatively (Rollins & Lobo, 2016).

Economic Impact

Implementation of an ERAS protocol has economic benefits that could potentially affect patients and hospitals. Patient outcomes have considerable effects on hospital performance and cost savings. According to Nelson et al. (2016), an economic analysis suggested that after accounting for intervention costs, the reductions in length of stay, complications, and readmissions produced cost savings. A net cost savings ranged between \$1.9 million to \$4.1 million or \$2,800 to \$5,800 per patient in an Alberta, Canada healthcare system utilizing an ERAS protocol. Paton et al. (2017) suggested that protocols that accomplish a decrease in length of stay are cost-saving. In a study performed by Thanh et al. (2016), adoption of ERAS led to every one dollar spent, \$3.80 came in return.

Patient Satisfaction

Determinants of patient satisfaction include the length of hospital stay, postoperative pain, and complications from surgery. Adoption of an ERAS protocol seeks to improve these determinants and increase patient satisfaction scores. Utilizing laparoscopic approaches to surgery, as in ERAS pathways, significantly decreases the

length of stay and complication rates (Lv, Shao, & Zhou, 2012). Substantial differences exist in the length of hospital stay across many studies performed regardless of surgery specialty by 0.5-3.5 days compared with conventional care (Paton et al., 2014). Since ERAS encompasses a multimodal analgesia approach to pain management, Stone et al. (2016) found that “most patients used fewer opioids while in the hospital and many did not need opioids after hospital discharge” (pp.219-224). Using GDFT has shown to decrease the length of hospital stay and complications following major surgery (Miller et al., 2014).

Adult Education Methods

Since CRNAs have obtained a master’s degree or higher, providing education in the most effective manner is important. Malcolm Knowles, an American educator known for his theories of education, popularized the usage of the term *andragogy* (Lambert, 2014). Andragogy refers to the education of adults, widely viewed as different than educating younger learners. Lambert (2014) stated that the teaching of adults requires a multi-faceted plan of attack. The three cornerstones of adult education are visual learning, auditory learning, and kinesthetic learning. Visual learners rely on notes, PowerPoint presentations, diagrams, and videos to digest the material they are learning. Auditory learners thrive on lectures while kinesthetic learners learn by doing. Kinesthetic learners often find the simulation and hands-on experience to be the best way to learn. A combination of these three styles of teaching is most effective in pedagogy (Lambert, 2014).

Parts of a Best Practice

To provide a best practice recommendation, the components of a best practice itself should be presented. Best practice recommendations and EBP are terms used interchangeably in the medical community. Best practice recommendations and EBP are approaches to health care; wherein, health professionals use the best evidence possible with the most appropriate information available to make clinical decisions for individual patients. EBP heightens and builds on clinical expertise, knowledge of disease processes, and pathophysiology. EBP involves complex and conscientious decision-making based not only on the available evidence but also on patient cultures, situations, and values. EBP is based on information gathered through rigorous testing and scientific and professional observation instead of rules, customs, and folklore (Sackett, Rosenberg, Grey, Haynes, & Richardson, 1996).

A best practice recommendation consists of three components. The first component is using the best available research to choose an action plan for patient care. The second component is the clinical expertise of the provider, which must be used to assess the patient's condition, needs, and care trajectory. Finally, the patient's preferences and values are an integral part of EBP. These three things must all work together to implement an EBP (Sackett et al., 1996).

Rationale

Informal interviews with CRNAs and the lack of literature concerning fluid management utilizing an ERAS protocol for elective colorectal surgery revealed a knowledge deficit of fluid management best practices among CRNAs. Based on available knowledge implementing an ERAS protocol for fluid management would

benefit patients and hospitals through improvement economic impacts, perioperative outcomes, and satisfaction scores (Gustafsson et al., 2018; Ly et al., 2012; Nelson et al., 2014). Presenting CRNAs with educational information regarding fluid management using an ERAS protocol will increase their knowledge of this practice recommendation. Therefore, CRNAs with an increased knowledge base will be more likely to adopt the practice change which has the potential to improve economic outcomes for the hospital and patients, reduce perioperative complications, and increase patient satisfaction scores (Conn et al., 2015; Lyon et al., 2014).

Specific Aims

The purpose of this project was to provide an EBP guideline for CRNAs on the use of an ERAS protocol for perioperative fluid management during elective colorectal surgery. The specific aim of preparing an educational module was to increase the knowledge base of these professionals of the benefits of such a protocol in hopes for implementation into clinical practice. Improvements in perioperative outcomes, economic impacts of patients and hospitals, and patient satisfaction scores were the ultimate goals of this project.

DNP Project

The requirements for a Doctor of Nursing Practice (DNP) project include meeting the American Association for Colleges of Nursing (AACN) DNP Essentials (AACN, 2006). This project primarily meets DNP Essentials I, II, III, and VI but can encompass all Essentials (Appendix A). First, Essential I: Scientific Underpinnings for Practice is focused on developing and evaluating new practices based on scientific research. This project met this Essential by using peer-reviewed scientific research to construct a best

practice guideline. Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking prepares the DNP graduate for making healthcare decisions that require organizational changes for improvement inpatient care. This project requires a practice change on both the practice level and the organizational level and, therefore, meets Essential II. Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice is met with this project by the usage of analytic methods to critically appraise existing literature and other evidence to determine and implement the best evidence for practice. Finally, this project meets DNP Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes. ERAS includes using a team of health professionals collaborating to communicate, define, and convey a best practice guideline for an organization.

Summary

Fluid therapy is an essential element of anesthesia in which CRNAs manage daily (Trinooson & Gold, 2013). Optimal fluid management is an important aspect of an ERAS protocol and is a part of each perioperative phase. In each perioperative phase, opportunities arise for improved patient outcomes, economic impacts for patients and hospitals, and patient satisfaction scores (Miller et al., 2014). Informal interviews with CRNAs at clinical affiliate facilities in Mississippi and a lack of literature regarding the education of CRNAs on ERAS fluid management assumes a knowledge deficit exists among CRNAs concerning an ERAS fluid management protocol for elective colorectal surgery. To effectively provide education to CRNAs, presentation of an educational tool that suits their educational learning styles is intuitive (Lambert, 2014).

Best practice guidelines assist medical professionals in providing EBP in the clinical setting. A best practice guideline can be formed through current literature, clinical expertise, and a patient's values (Sackett et al., 1996). Therefore, CRNAs can provide EBP to patients through a best practice guideline for fluid management utilizing an ERAS protocol that will ultimately improve perioperative outcomes, economic impacts, and patient satisfaction.

CHAPTER II – METHODS

Context

A synthesis of current EBP literature regarding fluid management for elective colorectal surgery using an ERAS protocol was conducted along with informal interviews with CRNAs from a clinical affiliate hospital. Based on the information synthesized, the conclusion was drawn that there was a knowledge deficit regarding fluid management for elective colorectal surgery for an ERAS protocol. These facilities in which the informal interviews were conducted perform elective colorectal surgeries utilizing ERAS protocols. The CRNAs at the facilities are aware of what an ERAS protocol entails, however, lacked the knowledge of the fluid management aspect.

Steps

Several steps were taken to complete this project. First, this project was proposed and approved by the DNP committee. Second, the International Review Board (IRB) approval was sought. After the project was approved by the USM IRB (Protocol # IRB-19-318, see Appendix F), an evidence-based best practice educational module was constructed. Next, an expert panel was assembled. This panel included 10 CRNAs from clinical affiliate hospitals. These stakeholders provided valuable guidance on the topic of fluid management for colorectal surgery and ERAS. Their experience working at these hospitals and their anesthesia expertise provided the authors with information for project implementation. After the expert panel was assembled, the proposed policy and educational module were provided by email. This email contained a link to USM Qualtrics, a survey platform used for creation of the administered survey (Appendix E). The expert panel anonymously provided feedback on the proposed policy and the

educational module on the survey. These data were compiled and placed in Table 1 Panel of Experts' Responses on the Proposed Best Practice Policy.

After being reviewed for comments and suggestions, no changes to the proposed policy and educational module were deemed necessary by the panel. The completed proposed policy and the educational module were presented as an executive summary (Appendix G) to the panel of experts at USM clinical affiliated hospitals. Finally, this information will be disseminated at Scholarship Day at USM.

Intervention

The intervention for this project was the development of a policy for perioperative fluid management following an ERAS protocol for colorectal surgical patients and the development of an educational module for CRNAs. The educational module consists of the Report of Findings (Appendix B), Proposed Policy (Appendix C), Post Educational Questions and Answers (Appendix D), and Evaluation Tool (Appendix E). The basis for the proposed policy and educational module was from recent evidence-based research on ERAS protocols, including information from The ERAS Society (Gustafsson et al., 2018). Further, other facilities have implemented their own ERAS protocols. Their colorectal surgery ERAS protocols were also studied with similarities and disparities noted.

Study of the Intervention

The approach chosen to assess the impact of the intervention was an evaluation tool (Appendix D) given to the expert panel using Qualtrics online survey platform. The panel was asked three questions including appropriateness of policy, consideration for implementation of policy, and suggestions for modifications of the policy (Appendix C).

Next, the feedback from the survey was reviewed for comments or suggestions for change. No changes were deemed necessary by the panel (see Table 1), and the final policy proposal and educational module (Appendix G) was presented to the expert panel for dissemination to their affiliate hospitals.

Measures

The expected impact of this education module and policy proposal is the adoption of the guideline into clinical practice at a USM clinical affiliate hospital. This impact has potential repercussions that are threefold. First, improved perioperative outcomes is expected. Research has shown ERAS protocols result in decreased mortality and lower risks of pneumonia, acute kidney injury, wound infection, and shorter hospital stays (Joshi, 2018). These improved patient outcomes potentially lead to the second expected impact, increased patient satisfaction. Patient satisfaction is increased with better perioperative outcomes, shorter hospital stays, decreased pain scores, and the ability to ambulate earlier (Horratas et al., 2017). Finally, an economic impact can be expected if the education is successful and the practice is adopted. Decreased length of stay and reimbursement from increased patient satisfaction are just two factors that would potentially be affected by this measure and make a financial impact. This financial impact would benefit both the patient and the hospital. The patient receiving ERAS protocol care potentially experiences a shorter length of stay, which yields fewer expenses for the patient. The hospital also potentially benefits financially from shorter lengths of stay, fewer readmissions, and complications (Nelson et al., 2016). Additionally, patients receiving ERAS protocol care report higher patient satisfaction

scores. These scores are tied to increased reimbursement for the hospital (Horratas et al., 2017).

Analysis

Qualitative data was collected through the evaluation tool (Appendix D). The responses from the expert panel were compiled into Table 1. Qualitative methods were used to draw inferences from the data. Their feedback was utilized to modify the proposed policy and educational module; however, no further recommendations from the panel of experts was given. Therefore, the policy proposed remained in its original composition.

Ethical Considerations

Ethical considerations play a role in all matters of healthcare (Stolt et. al., 2018). For this project, one of the ethical considerations was the provision of the highest and equal standard of care for every patient. A recommendation to change fluid management of surgical patients undergoing colon surgery has the potential to result in providing two levels of care, the ERAS method proposed in this project or traditional methods of fluid replacement. Evidence supports ERAS protocols as a more effective way of caring for patients undergoing elective colorectal surgery (Carmichael et al., 2017). Introducing the ERAS fluid management protocol has the potential for patients to receive two levels of care—the traditional fluid management pathway and the relatively new ERAS fluid management protocol. Confidentiality of the panelists maintained by reporting of data anonymously and password protected data. Electronic data was deleted following research dissemination.

Summary

Informal interviews with clinical affiliate CRNAs and lack of literature concerning CRNAs' education of an Enhanced Recovery After Surgery fluid management protocol suggests a knowledge deficit among these anesthesia providers. This project aimed to educate CRNAs on the best practice guidelines for ERAS and to propose these guidelines for adaptation at their clinical affiliate hospitals. The methods used to design and carry out this project meets the AACN DNP Essentials. The authors of this project compiled a body of evidence-based practice literature regarding ERAS protocols for fluid management. From that literature, the authors synthesized an educational module and policy proposal for CRNAs on an expert panel to review. After reviewing the module and proposed policy, the CRNAs were given the opportunity to provide feedback and suggestions for modifications using an anonymous online survey. This information was collected and reviewed by the authors. Because the expert panel members supported the module and policy as they were written, they were then forwarded to the USM affiliate hospitals' anesthesia administration for consideration of implementation.

CHAPTER III - RESULTS

An expert panel was given a Report of Findings (Appendix B) and a Proposed Policy (Appendix C) based on the available knowledge regarding perioperative fluid management of colorectal surgical patients with an ERAS protocol. Data was gathered using an anonymous evaluation tool (Appendix D), which assessed members of an expert panel's input on whether the proposed policy was appropriate, whether they would consider instituting the policy in their workplace, and whether they considered this project to be of DNP level quality. The members of the panel were also given the opportunity to provide anonymous feedback on the evaluation tool. The responses to the prompts and questions on the evaluation tool (Appendix E) are shown in Table 1.

The expert panel included 10 CRNAs from three hospitals that perform colorectal surgeries daily. Members of the expert panel were all considered relevant stakeholders due to their advanced knowledge and daily involvement with colorectal surgery patients and perioperative fluid management. Seven members of the panel of experts hold a master's degree and the remaining members hold a DNP. Their responses to the evaluation tool were gathered and analyzed. First, all 10 members of the panel completed the survey and deemed the policy appropriate for implementation. Second, nine panel members stated they would consider instituting the policy proposed in their facilities while one panel member stated they would not. Next, all 10 members again agreed that this project was of a quality suitable for a DNP program. Finally, the evaluation tool had a section for suggestions and comments. While no one replied with any suggestions for policy revision, several comments regarding ERAS protocols were given. For example,

one panel member stated, “I currently use ERAS for my colorectal surgery patients and the outcome using these practices has been very good.”

Table 1

Panel of Experts’ Beliefs on Proposed Best Policy

	Is this policy appropriate for implementation?	Would you consider implementing this policy at your facility?	Suggestions or recommendations for the policy?
Panelist 1	Yes	No	
Panelist 2	Yes	Yes	Great info. The ERAS cases that I have done have turned out really well. I agree with the fact that many of our patients are receiving too much fluids.
Panelist 3	Yes	Yes	
Panelist 4	Yes	Yes	
Panelist 5	Yes	Yes	Great job on the current knowledge to establish the guidelines for the policy.
Panelist 6	Yes	Yes	
Panelist 7	Yes	Yes	
Panelist 8	Yes	Yes	I currently use ERAS for my colorectal surgery patients and the outcome using these practices has been very good.
Panelist 9	Yes	Yes	
Panelist 10	Yes	Yes	

Summary

The data collected with the evaluation tool indicated that 100% of the expert panel reported the proposed policy was appropriate for implementation. Further, 90% of the expert panel would consider instituting the policy proposed into their facilities. Finally, no recommended policy changes were included in the panel's feedback, but an overall approval of ERAS protocols was indicated.

CHAPTER IV – DISCUSSION

Summary

Fluid therapy is a major component of anesthesia that CRNAs manage daily (Trinooson & Gold, 2013). Optimal fluid management is an important aspect of an ERAS protocol and is a part of each perioperative phase. In each perioperative phase, an opportunity for improved patient outcomes, economic impacts for patients and hospitals, and patient satisfaction scores exists (Miller et al., 2014).

CRNAs should be presented with current EBP guidelines regarding fluid management when an ERAS protocol is utilized for elective colorectal surgery. With preparation of this educational module, an increased knowledge base of CRNAs and 90% will be more likely to adopt the practice change which has the potential to improve economic outcomes for the hospital and patients, reduce perioperative complications, and increase patient satisfaction scores (Conn et al., 2015; Lyon et al., 2012). The proposed policy was reviewed by the expert panel and their recommendations were considered. The final draft of the proposed policy and education module was emailed to the expert panel for their use at their clinical affiliate hospitals in hope of implementation. After dissemination of the final draft to the panel of experts, a panelist expressed that their institution implemented the proposed policy.

Interpretation

A synthesis of current literature involving the fluid management aspect of ERAS protocols for elective colorectal surgery was compiled and an education module created to present to an expert panel of CRNAs in hopes that this panel will disseminate these findings to their clinical affiliate hospitals. This project followed all of the DNP

Essentials, shown in Appendix A, which outline the fundamentals necessary in obtaining a DNP degree (AACN, 2016). Following the administration of the education module and survey, the expert panel had the opportunity to provide feedback on the proposed policy in the form of suggestions and/or recommendations (Appendix D). Of the 10 panelists, three responded to the invitation for suggestions and/or recommendations. The suggestions and/or recommendations did not contain suggestions or recommendations. All of the respondents approved the policy proposed as appropriate for implementation. Ninety percent of respondents reported they would consider implementing the policy proposed at their affiliated hospital, and 10% stated they would not consider implementation. The executive summary of the policy proposed was disseminated electronically by email to the expert panel with the intent to implement at clinically affiliated hospitals (Appendix G).

Limitations

Limitations to this project include the relatively small panel of experts reviewing the education module. The results may not consolidate the views of all CRNAs in clinical affiliate hospitals; however, the CRNAs who made up the expert panel consisted of providers who have advanced knowledge and daily involvement of the current topic, colorectal surgery patients, and their perioperative fluid management.

Consideration for Future Research

Future research should be conducted on the outcomes of the implementation of the policy proposed such as improved postoperative complication rates and economic impacts. A cost-benefit analysis could be performed to assess the probable cost-savings

of the hospital. Lastly, expanding the policy to beyond colorectal surgical patients could be beneficial to facilities that participate in ERAS protocols.

Conclusion

The final evidence-based policy proposed has the potential to decrease perioperative stress, improve intestinal function, and decrease postoperative complications. In addition to these positive patient outcomes, the policy proposed also has the potential to decrease hospital spending, ultimately aiding the facility in saving millions of dollars (Nelson et al., 2016). Based on the feedback from the expert panel, the policy proposed is appropriate for implementation and the majority will consider it for implementation. Furthermore, the policy proposed was adopted at a USM clinical affiliate hospital of which a panelist is employed.

APPENDIX A – DNP Essentials

DNP Essentials	Clinical Implications
Essential one: Scientific Underpinnings for Practice	Evaluation of evidence relevant to the topic.
Essential two: Organizational and Systems Leadership for Quality Improvement and Systems Thinking	Communication with a panel of experts regarding proposed best practice guideline.
Essential three: Clinical Scholarship and Analytical Methods for Evidence-Based Practice	Evaluation of current evidence-based practice to recommend a best practice guideline and promote further research.
Essential four: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	Purpose of this project is to promote evidence-based practice that will lead to improved postoperative patient outcomes when an ERAS protocol is utilized in elective colorectal surgery.
Essential five: Health Care Policy for Advocacy in Health Care	Presentation of best practice recommendation regarding fluid management utilizing ERAS protocol.
Essential six: Interprofessional Collaboration for Improving Patient and Population Health Outcomes	Collaboration with an expert panel selected due to their advanced knowledge and experience.
Essential seven: Clinical Prevention and Population Health for Improving the Nation's Health	Education of expert panel of experts on available knowledge and recommendation of best practice to improve postoperative patient outcomes.
Essential eight: Advanced Nursing Practice	Evidence analysis, synthesis of data, education of panel of experts, and assessment of post-education of a panel of experts.

APPENDIX B – Report of Findings

Background

ERAS protocols in elective colorectal surgery has the potential to decrease perioperative stress, improve gut function, decrease postoperative complications, improve patient satisfaction, and provide cost savings (Bradney et al., 2018; Conn, McKenzie, Pearsall, & McLeod, 2015; Horrattas et al., 2017). Within the ERAS protocol, intraoperative fluid therapy is one modality certified registered nurse anesthetists (CRNAs) could use to implement evidence-based practice into their anesthetic plan. However, there is a lack of literature about the education of CRNAs regarding the fluid therapy component of an ERAS protocol for elective colorectal surgery. The purpose of this Doctor of Nursing Practice (DNP) project is to address the knowledge deficit among CRNAs by providing an educational module on perioperative fluid therapy utilizing an ERAS protocol.

Available Knowledge

Informal interviews with CRNAs at affiliated clinical sites together with the lack of current literature regarding the education of CRNAs utilizing ERAS fluid therapy protocols for elective colorectal surgery suggests a need for an educational module to optimize patient care (Trinooson & Gold, 2013). ERAS protocols are currently considered best practice and utilizing evidence-based practice to decrease perioperative stress, improve gut function, decrease postoperative complications, improve patient satisfaction, and provide cost savings (Bradney et al. 2018; Conn et al., 2015; Horrattas et al., 2017).

Traditionally, fluid therapy is administered by performing outdated calculations, possibly leading to fluid volume overload. This fluid volume overload could lead to further complications such as gut edema, postoperative ileus, or pulmonary edema. These complications may influence patient satisfaction and costs (Miller, Roche, & Mythen 2014; Paton et al., 2014).

Implementation of an ERAS protocol potentially could have economic impacts that affect patients and hospitals. The benefits an ERAS protocol provides, for instance, decreased the length of hospital stays and decreased postoperative complications rates, could lead to increased hospital reimbursement (Paton et al., 2017; Thanh et al., 2016). Furthermore, in today's healthcare, patient satisfaction is directly related to hospital reimbursement. Ly, Shao, and Zhou (2012) suggest that patient satisfaction encompasses the length of hospital stay, postoperative pain, and complications from surgery. Utilizing an ERAS fluid therapy protocol has shown to decrease the length of hospital stay and complications following major surgery (Miller et al., 2014).

Suggestions for Best Practice

Based on current evidence relevant to colorectal surgery, suggested ERAS guidelines for fluid therapy include a) use of goal-directed or "near-zero" fluid therapy to maintain normovolemia, not to exceed 2.5 kg weight gain; b) use of minimally invasive cardiac output monitors to target individualized fluid requirements; c) usage of balanced crystalloids are preferred over 0.9% normal saline; d) optimizing stroke volume with fluid challenges (i.e. 250 mL fluid bolus if MAP falls below 60 mm Hg) and repeating every 10 minutes until no further change is noted; e) usage of maintenance fluids of

balanced crystalloid delivered at 1-4 mL/kg/hr based on patient's IBW (Miller et al., 2014; Gustafsson et al., 2018).

References

- Bradney, L., Domeck, K., Mehaffey, G., Preston, M.A., Mizell, J.S. Mustain, W.C., & Laryea, J.A. (2018). The cost impact of implementing an Enhanced Recovery After Surgery Protocol: An institutional review. *Journal of the American College of Surgeons*, 227(4). doi: 10.1016/j.jamcollsurg.2018.08.280
- Conn, L.G., McKenzie, M., Pearsall, E.A., & McLeod, R.S. (2015). Successful implementation of an enhanced recovery after surgery program for elective colorectal surgery: A process evaluation of champions' experiences. *Implementation Science*, 10, 1-11. doi: 10.1186/s13012-015-0289-y
- Gustafsson, U. O., Scott, M. J., Hubner, M., Nygren, J., Demartines, N., Francis, N., & Ljungqvist, O. (2018). Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018. *World Journal of Surgery*, 43(3), 659-695. doi:10.1007/s00268-018-4844-y
- Horattas, M.C., Horattas, S.A., Heib, N., Brandstetter, S., Bahr, K., & Reissig, J. (2017). Enhanced recovery after surgery results in enhanced patient satisfaction. *Journal of the American College of Surgeons*, 225, 67-68. doi: 10.1016/j.jamcollsurg.2017.07.704
- Lv, L., Shao, Y., & Zhou, Y. (2012). The enhanced recovery after surgery (ERAS) pathway for patients undergoing colorectal surgery: an update of meta-analysis of randomized controlled trials. *International Journal of Colorectal Disease*, 27, 1549-1554. doi: 10.1007/s00384-012-1577

- Miller, T. E., Roche, A. M., & Mythen, M. (2014, October 28). Fluid management and goal-directed therapy as an adjunct to Enhanced Recovery After Surgery (ERAS). *Canadian Journal of Anesthesia*, *62*, 158-168. doi:10.1007/s12630-014-0266-y
- Paton, F., Chambers, D., Wilson, P., Eastwood, A., Craig, D., Fox, D., Jayne, D., & McGinnes, E. (2014). Effectiveness and implementation of enhanced recovery after surgery programs: a rapid evidence synthesis. *BMJ Open*, *4*, 1-10. doi:10.1136/bmjopen-2014-005015
- Thanh, N.X., Chuck A.W., Wasylak, T., Lawrence J., Faris, P., Ljungqvist, O., Nelson, G., & Gramlich L.M. (2016). An economic evaluation of enhanced recovery after surgery (ERAS) multisite implementation program for colorectal surgery in Alberta. *Canadian Journal of Surgery*, *59*, 415-421. doi: 10.1503/cjs.006716
- Trinooson, C.D., & Gold, M.E. (2013). Impact of goal-directed perioperative fluid management in high-risk surgical procedures: A literature review. *AANA Journal*, *81*, 357-368.

APPENDIX C – Proposed Policy

Policy Area: Anesthesia Department
Title of Policy: Perioperative Fluid Replacement utilizing an ERAS protocol for elective colorectal surgical patients
Effective Date:
Approved Date:
Supersedes:
Approved by:

1. Rationale or background to policy: Enhanced Recovery After Surgery (ERAS) protocols in elective colorectal surgery have the potential to decrease perioperative stress, improve gut function, decrease postoperative complication, improve patient satisfaction, and provide cost savings for both the hospital and the patient. ERAS protocols are currently considered best practice in the operative setting.
2. Policy: All anesthesia providers will follow ERAS guidelines for elective colorectal surgery patients. This is to include:
 - a. Goal-directed or “near-zero” fluid therapy to maintain normovolemia, not to exceed 2.5 kg weight gain.
 - b. Use of minimally invasive cardiac output monitors to target individualized fluid requirements, if available.
 - c. Use of balanced crystalloids instead of 0.9% normal saline.

- d. Optimize stroke volume with a fluid challenge (250 mL fluid bolus if MAP drops below 60 mmHg) and repeat every 10 minutes until no further change is noted.
- e. Infuse maintenance fluids at 1-4 mL/kg/hr based on patient's IBW with a balanced crystalloid solution.

APPENDIX D – Post-Educational Module Questions and Answers

- 1) What is the preferred type of fluid to be administered when utilizing an ERAS protocol for elective colorectal surgery?
 - a. D5W
 - b. 3% Normal Saline
 - c. Lactated Ringers
 - d. 0.9% Normal Saline

- 2) Weight gain of _____ kg should be avoided to maintain normovolemia.
 - a. 1.2 kg
 - b. 2.5 kg
 - c. 2 kg
 - d. 3.5 kg

- 3) How should stroke volume be optimized when administering fluid therapy when an ERAS protocol is applied to the anesthetic plan?
 - a. Administer fluids based on the 4-2-1 rule.
 - b. Give 2 liters of fluid within the first hour of surgery.
 - c. Provide a fluid challenge by administering 250 ml of fluid and assess changes in stroke volume.
 - d. Stroke volume is not important when administering fluids for an ERAS protocol.

Post-Educational Module Answers

- 1) C
- 2) B
- 3) C

APPENDIX E – Evaluation Tools

1. Does this policy appear appropriate for implementation?

Yes

No

2. Would you consider instituting this policy at your facility?

Yes

No

3. Please provide any feedback or suggestions for this policy:

APPENDIX F –IRB Approval Letter

Office of
Research Integrity



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NOTICE OF INSTITUTIONAL REVIEW BOARD ACTION

The project below has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services regulations (45 CFR Part 46), and University Policy to ensure:

- The risks to subjects are minimized and reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered involving risks to subjects must be reported immediately. Problems should be reported to ORI via the Incident template on Cayuse IRB.
- The period of approval is twelve months. An application for renewal must be submitted for projects exceeding twelve months.

PROTOCOL NUMBER: IRB-19-318

PROJECT TITLE: Preoperative Fluid Management for Elective Colorectal Surgery Patients Utilizing an ERAS Protocol; A Best Practice Recommendation

SCHOOL/PROGRAM: School of LANP

RESEARCHER(S): Nicole Mason, Callie Polk, Mary Jane Collins,

IRB COMMITTEE ACTION: Exempt

CATEGORY: Exempt

Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).

The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

APPROVED STARTING: July 10, 2019

Donald Sacco, Ph.D.
Institutional Review Board Chairperson

APPENDIX G – Literature Matrix

Author/Title/Journal	Date of Publication	Type of Evidence/Level of Research	Summary
<p>Conn, L.G., et al. Successful implementation of an enhanced recovery after surgery program for elective colorectal surgery: a process evaluation of champions' experiences.</p>	<p>July 2015</p>	<p>Qualitative Review Article/Level 4</p>	<p>Qualitative insight of implementation process of adopting an ERAS protocol. Purpose of this article is to understand what influences the success of an ERAS implementation based on information collected from ERAS champions.</p>
<p>Gustafsson, U.O., et al. Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS) Society Recommendations: 2018.</p>	<p>November 2018</p>	<p>Journal Article/Level 1</p>	<p>ERAS protocol guidelines for improvement of perioperative care in elective colorectal surgery. This article provides graded recommendations for preoperative, intraoperative, and postoperative patient management.</p>
<p>Miller, T.E., et al. Fluid management and goal-directed therapy as an adjunct to Enhanced Recovery After Surgery (ERAS).</p>	<p>October 2014</p>	<p>Review Article/Level 3</p>	<p>A review of evidence-based practices of fluid management, this article provides a condensed analysis of ERAS fluid management protocols in common procedures such as</p>

			laparoscopic surgery.
Nelson, G., et al. Implementation of Enhanced Recovery After Surgery (ERAS) Across a Provincial Healthcare System: The ERAS Alberta Colorectal Surgery Experience.	February 2016	Review Article/Level 4	Report of findings from an Alberta, Canada healthcare system from the implementation of an ERAS protocol. Length of stay, complications, and readmission rates were evaluated along with costs. The study showed cost savings that ranged from \$2,806-\$5,898 per patient.
Trinooson, C.D. & Gold, M.E. Impact of goal-directed perioperative fluid management in high-risk surgical procedures.	October 2013	Literature Review/Level 2	Randomized control trials were reviewed which measures the impact of goal-directed fluid therapy in patients undergoing high-risk surgery. The review showed that goal-directed fluid therapy provides a decreased length of stay and reduced number of postoperative complications.

APPENDIX H - Executive Summary

Executive Summary of Perioperative Fluid Management for Elective Colorectal Surgery Patients Utilizing an ERAS Protocol: A Best Practice Recommendation

Callie Bridges and Nicole Mason

The University of Southern Mississippi

The Student Registered Nurse Anesthetists convened a panel of experts to evaluate the collective literature and evidence-based clinical policy recommendation on the most appropriate perioperative fluid management of elective colorectal surgical patients. Presented is the executive summary of the full report, “Perioperative Fluid Management for Elective Colorectal Surgery Patients Utilizing an ERAS Protocol: A Best Practice Recommendation,” which will be printed and presented at the University of Southern Mississippi College of Nursing in September 2019.

Available Knowledge

ERAS protocols in elective colorectal surgery has the potential to decrease perioperative stress, improve gut function, decrease postoperative complications, improve patient satisfaction, and provide cost savings. Within the ERAS protocol, intraoperative fluid therapy is one modality certified registered nurse anesthetists (CRNAs) could use to implement evidence-based practice into their anesthetic plan. However, there is a lack of literature about the education of CRNAs regarding the fluid therapy component of an ERAS protocol for elective colorectal surgery. The purpose of this Doctor of Nursing Practice (DNP) project is to address the knowledge deficit among CRNAs by providing an educational module on perioperative fluid therapy utilizing an ERAS protocol.

Informal interviews with CRNAs at affiliated clinical sites together with the lack of current literature regarding the education of CRNAs utilizing ERAS fluid therapy protocols for elective colorectal surgery suggests a need for an educational module to optimize patient care. ERAS protocols are currently considered best practice and utilizing evidence-based practice to decrease perioperative stress, improve gut function, decrease postoperative complications, improve patient satisfaction, and provide cost savings.

Traditionally, fluid therapy is administered by performing outdated calculations, possibly leading to fluid volume overload. This fluid volume overload could lead to further complications such as gut edema, postoperative ileus, or pulmonary edema. These complications may influence patient satisfaction and costs. Implementation of an ERAS protocol potentially could have economic impacts that affect patients and hospitals. The benefits an ERAS protocol provides, for instance, decreased the length of hospital stays and decreased postoperative complications rates, could lead to increased hospital reimbursement. Furthermore, in today's healthcare, patient satisfaction is directly related to hospital reimbursement. Ly, Shao, and Zhou (2012) suggests that patient satisfaction encompasses the length of hospital stay, postoperative pain, and complications from surgery. Utilizing an ERAS fluid therapy protocol has shown to decrease the length of hospital stays and complications following major surgery.

Process

The authors of this project compiled a body of evidence-based practice literature regarding ERAS protocols for fluid management. From that literature, the authors synthesized an educational module and policy proposal for CRNAs on an expert panel to

review. After reviewing the module and proposed policy, the CRNAs were given a chance to provide feedback and suggestions for modifications via an anonymous online survey. This information was collected and reviewed by the authors. Because the expert panel members supported the module and policy as they were written, they were then forwarded to the USM affiliate hospitals' anesthesia administration for consideration of implementation.

Policy Recommendation

Based on current evidence relevant to colorectal surgery, suggested ERAS guidelines for fluid therapy include a) use of goal-directed or “near-zero” fluid therapy to maintain normovolemia, not to exceed 2.5 kg weight gain; b) use of minimally invasive cardiac output monitors to target individualized fluid requirements; c) usage of balanced crystalloids are preferred over 0.9% normal saline; d) optimizing stroke volume with fluid challenges (i.e. 250 mL fluid bolus if MAP falls below 60 mm Hg) and repeating every 10 minutes until no further change is noted; e) usage of maintenance fluids of balanced crystalloid delivered at 1-4 mL/kg/hr based on patient's IBW.

Proposed Policy

Policy Area: Anesthesia Department
Title of Policy: Perioperative Fluid Replacement utilizing an ERAS protocol for elective colorectal surgical patients
Effective Date:
Approved Date:
Supersedes:
Approved by:

1. Rationale or background to policy: Enhanced Recovery After Surgery (ERAS) protocols in elective colorectal surgery have the potential to decrease perioperative stress, improve gut function, decrease postoperative complication, improve patient satisfaction, and provide cost savings for both the hospital and the patient. ERAS protocols are currently considered best practice in the operative setting.
2. Policy: All anesthesia providers will follow ERAS guidelines for elective colorectal surgery patients. This is to include:
 - a. Goal-directed or “near-zero” fluid therapy to maintain normovolemia, not to exceed 2.5 kg weight gain.
 - b. Use of minimally invasive cardiac output monitors to target individualized fluid requirements, if available.
 - c. Use of balanced crystalloids instead of 0.9% normal saline.

- d. Optimize stroke volume with a fluid challenge (250 mL fluid bolus if MAP drops below 60 mmHg) and repeat every 10 minutes until no further change is noted.
- e. Infuse maintenance fluids at 1-4 mL/kg/hr based on patient's IBW with a balanced crystalloid solution.

Post-Educational Module Questions

- 1) What is the preferred type of fluid to be administered when utilizing an ERAS protocol for elective colorectal surgery?
 - a. D5W
 - b. 3% Normal Saline
 - c. Lactated Ringers
 - d. 0.9% Normal Saline

- 2) Weight gain of _____ kg should be avoided to maintain normovolemia.
 - a. 1.2 kg
 - b. 2.5 kg
 - c. 2 kg
 - d. 3.5 kg

- 3) How should stroke volume be optimized when administering fluid therapy when an ERAS protocol is applied to the anesthetic plan?
 - a. Administer fluids based on the 4-2-1 rule.
 - b. Give 2 liters of fluid within the first hour of surgery.
 - c. Provide a fluid challenge by administering 250 ml of fluid and assess changes in stroke volume.
 - d. Stroke volume is not important when administering fluids for an ERAS protocol.

Post-Educational Module Answers

- 1) C
- 2) B
- 3) C

References

- American Association of Colleges of Nursing (AACN). (2006). The essentials of doctoral education for advanced practice nursing. Retrieved from <http://www.aacn.nche.edu/dnp/Essentials.pdf>
- Adams, P., Gelman, S., Reves, J.G., Greenblatt, D.J., Alvis, M., & Bradley, E. (1985). Midazolam pharmacodynamics and pharmacokinetics during acute hypovolemia. *Anesthesiology*, *63*, 140-146.
- Bradney, L., Domeck, K., Mehaffey, G., Preston, M.A., Mizell, J.S. Mustain, W.C., Laryea, J.A. (2018). Cost impact of implementing an Enhanced Recovery After Surgery Protocol: An institutional review. *Journal of the American College of Surgeons*, *227*, 4. doi: 10.1016/j.jamcollsurg.2018.08.280
- Butterworth, J.F., Mackey, D.C., & Wasnick, J.D. (2013). *Morgan & Mikhail's clinical anesthesiology* (5th ed.). New York, NY: The McGraw-Hill Companies.
- Camach-Navarro, L. H., Bloomstone, J. A., Costa-Auler Jr, J. O., Desebbe O, Cannesson, M., Rocca, G. D., Gan, T. J., & Miller, T. E. (2015). Perioperative fluid therapy: a statement from the international Fluid Optimization Group. *Perioperative Medicine*, *4*:3. doi: 10.1186/s13741-015-0014-z
- Carmichael, J. C., Keller, D. S., Baldini, G., Bordeianou, L., Weiss, E., Lee, L., . . . Feldman, L. S. (2017). Clinical practice guideline for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons (ASCRS) and Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). *Surgical Endoscopy*, *31*(9), 3412-3436. doi:10.1007/s00464-017-5722-

- Cesur, S., Cardakozu, T., Kus, A., Turkeyilmaz, N., Yavuz, O. (2018) Comparison of conventional fluid management with PVI-based goal-directed fluid management in elective colorectal surgery. *Journal of Clinical Monitoring and Computing*, 33, 249-257. doi: 10.007/s10877-018-0163-y
- Conn, L.G., McKenzie, M., Pearsall, E.A., & McLeod, R.S. (2015). Successful implementation of an enhanced recovery after surgery program for elective colorectal surgery: A process evaluation of champions' experiences. *Implementation Science*, 10, 1-11. doi: 10.1186/s13012-015-0289-y
- Feldheiser, A., Aziz, O., Baldini, G., Cox, W., Fearon, H., Feldman, L.S., Gan, T.J., Kennedy, R.H., Ljungqvist, O., Lobo, D.N., Miller, T., Radtke, F.F., Garces, T.R., Schricker, T., Scott, M.J., Thacker, J.K., Ytrebo, L.M., & Carli, F. (2015). Enhanced recovery after surgery (ERAS) for gastrointestinal surgery, part 2: consensus for anesthesia practice. *Acta Anaesthesiologica Scandinavica*, 60, 289-334. doi: 10.1111/aas.1265
- Gustafsson, U. O., Scott, M. J., Hubner, M., Nygren, J., Demartines, N., Francis, N., & Ljungqvist, O. (2018). Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018. *World Journal of Surgery*, 43(3), 659-695. doi:10.1007/s00268-018-4844-y
- Holte, K., Sharrock, N.E., & Kehlet, H. (2002). Pathophysiology and clinical implications of perioperative fluid excess. *British Journal of Anaesthesia* (89), 622-632. doi: 10.1093/bja/aef220
- Horattas, M.C., Horattas, S.A., Heib, N., Brandstetter, S., Bahr, K., & Reissig, J. (2017) Enhanced recovery after surgery results in enhanced patient satisfaction. *Journal*

of the American College of Surgeons, 225, 67-68. doi:

10.1016/j.jamcollsurg.2017.07.704

Joshi, G. P. (2018, October 30). Intraoperative Fluid Management. Retrieved November 13, 2018, from <https://www.uptodate.com/contents/intraoperative-fluid-management>

Kaye, A. D. (2011). Fluid management. In R. D. Miller & M. C. Pardo (Eds.), *Basics of anesthesia* (6th ed., pp. 364-371). Philadelphia, PA: Saunders

Lambert, C. (2014). Technology and Adult Students In Higher Education: A Review of the Literature. *Issues and Trends in Educational Technology*, 2(1).
doi:10.2458/azu_itet_v2i1_lambert

Lassen, K., Soop, M., Nygren, J., Boris, P., Cox, W., Hendry, P.O., Spies, C., Meyenfeldt, M., Fearon, K., Revhaug, A., Norderval, S., Ljungqvist, O., Lobo, D., & Dejung, C. (2009). Consensus review of optimal perioperative care in colorectal surgery: Enhanced recovery after surgery (ERAS) Group recommendations. *The Journal of the American Medical Association*, 144, 961-969. doi: 10.1001/archsurg.2009.170

Ljungqvist, O., Scott, M., & Fearon, K. C. (2017). Enhanced Recovery After Surgery. *JAMA Surgery*, 152(3), 292. doi:10.1001/jamasurg.2016.4952

Lv, L., Shao, Y., & Zhou, Y. (2012). The enhanced recovery after surgery (ERAS) pathway for patients undergoing colorectal surgery: an update of meta-analysis of randomized controlled trials. *International Journal of Colorectal Disease*, 27, 1549-1554. doi: 10.1007/s00384-012-1577-5

- Lynn, R. R., & Winner, L. A. (2014). Fluids, electrolytes, and blood component therapy. In J. J. Nagelhout & K. L. Plaus (Eds.), *Nurse Anesthesia* (5th ed., pp. 382-402). St. Louis, MO: Elsevier.
- Lyons, A., Solomon, M.J., & Harrison, J.D. (2014). A qualitative study assessing the barriers to implementation of Enhanced Recovery After Surgery. *World Journal of Surgery*, 38, 1374-1380. doi: 10.1007/s00268-013-2441-7
- Miller, T. E., Roche, A. M., & Mythen, M. (2014, October 28). Fluid management and goal-directed therapy as an adjunct to Enhanced Recovery After Surgery (ERAS). *Canadian Journal of Anesthesia*, 62, 158-168. doi:10.1007/s12630-014-0266-y
- Miller, T. E., Thacker, J. K., White, W. D., Mantyh, C., Migaly, J., Jin, J., ... Enhanced Recovery Study Group. (2014, May). Reduced length of hospital stay in colorectal surgery after implementation of an enhanced recovery protocol. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/24781574>
- Morris, M., & Chu, D. (2017, October 3). The New Standard for Surgical Recovery: Enhanced Recovery After Surgery (ERAS). Retrieved from <http://www.aqaf.com/qf/201710.eras.pdf>
- Nelson, G., Kiyang, L.N., Crumley, E.T., Chuck, A., Nguyen T., Faris, P., Wasylak, T., Hammond-Basualdo, C., McKay, S., Ljungqvist, O., & Gramlich, L.M. (2016). Implementation of enhanced recovery after surgery (ERAS) across a provincial healthcare system: The ERAS Alberta colorectal surgery experience.
- Paton, F., Chambers, D., Wilson, P., Eastwood, A., Craig, D., Fox, D., Jayne, D., & McGinnes, E. (2014). Effectiveness and implementation of enhanced recovery

after surgery programs: a rapid evidence synthesis. *BMJ Open*, 4, 1-10.

doi:10.1136/bmjopen-2014-005015

Popkin, B. M., D'Anci, K. E., & Rosenberg, I. H. (2010). Water, Hydration and Health.

Nutrition Reviews, 68(8), 439–458. doi:10.1111/j.1753-4887.2010.00304.x

Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to

Reduce the Risk of Pulmonary Aspiration. (2017). *Anesthesiology*, 126(3), 376-

393. doi:10.1097/aln.0000000000001452

Rawlinson, A., Kang, P., Evans, J., & Khanna, A. (2011). A systematic review of

enhanced recovery protocols in colorectal surgery. *Annals of the Royal College of*

Surgeons of England, 93(8), 583–588. doi:10.1308/147870811X605219

Rollins, K.E., & Lobo, D.N. (2016). Intraoperative goal-directed fluid therapy in elective

major abdominal surgery: A meta-analysis of randomized controlled trials. *Annals*

of Surgery, 263, 465-476. doi: 10.1097/SLA.0000000000001366

Sackett, D. L., Rosenberg, W. M., Grey, J. A., Haynes, R. B., & Richardson, W. S.

(1996). Evidence-based medicine: What it is and what it isn't. *The BMJ*,

312(7023), 71-72. Retrieved November 8, 2018, from

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2349778/?page=2>.

Spring, B. (2007). Evidence-based practice in clinical psychology: What it is, why it

matters; what you need to know. *Journal of Clinical Psychology*, 63(7), 611-631.

doi:10.1002/jclp.20373

Stolt, M., Leino-Kilpi, H., Ruokonen, M., Repo, H., & Suhonen, R. (2018). Ethics

interventions for healthcare professionals and students: A systematic review.

Nursing Ethics, 25(2), 133–152. doi: 10.1177/0969733017700237

- Thanh, N.X., Chuck A.W., Wasylak, T., Lawrence J., Faris, P., Ljungqvist, O., Nelson, G., & Gramlich L.M. (2016). An economic evaluation of enhanced recovery after surgery (ERAS) multisite implementation program for colorectal surgery in Alberta. *Canadian Journal of Surgery*, 59, 415-421. doi: 10.1503/cjs.006716
- Thiele, R. H., Rea, K. M., Turrentine, F. E., Friel, C. M., Hassinger, T.E., Goudreau, B. J., ...Mcmurry, T. L. (2015). Standardization of Care: Impact of an Enhanced Recovery Protocol on Length of Stay, Complications, and Direct Costs after Colorectal Surgery. *Journal of the American College of Surgeons*, 220(4), 430-443. doi: 10.1016/j.jamcollsurg.2014.12.042
- Trinooson, C.D., & Gold, M.E. (2013). Impact of goal-directed perioperative fluid management in high-risk surgical procedures: A literature review. *AANA Journal*, 81, 357-368.

REFERENCES

- American Association of Colleges of Nursing (AACN). (2006). The essentials of doctoral education for advanced practice nursing. Retrieved from <http://www.aacn.nche.edu/dnp/Essentials.pdf>
- Adams, P., Gelman, S., Reves, J.G., Greenblatt, D.J., Alvis, M., & Bradley, E. (1985). Midazolam pharmacodynamics and pharmacokinetics during acute hypovolemia. *Anesthesiology*, *63*, 140-146.
- Bradney, L., Domeck, K., Mehaffey, G., Preston, M.A., Mizell, J.S. Mustain, W.C., & Laryea, J.A. (2018). Cost impact of implementing an Enhanced Recovery After Surgery Protocol: An institutional review. *Journal of the American College of Surgeons*, *227*, 4. doi: 10.1016/j.jamcollsurg.2018.08.280
- Butterworth, J.F., Mackey, D.C., & Wasnick, J.D. (2013). *Morgan & Mikhail's clinical anesthesiology* (5th ed.). New York, NY: The McGraw-Hill Companies.
- Camach-Navarro, L. H., Bloomstone, J. A., Costa-Auler Jr, J. O., Desebbe O, Cannesson, M., Rocca, G. D., Gan, T. J., & Miller, T. E. (2015). Perioperative fluid therapy: a statement from the international Fluid Optimization Group. *Perioperative Medicine*, *4*, 3. doi: 10.1186/s13741-015-0014-z
- Carmichael, J. C., Keller, D. S., Baldini, G., Bordeianou, L., Weiss, E., Lee, L., . . . Feldman, L. S. (2017). Clinical practice guideline for enhanced recovery after colon and rectal surgery from the American Society of Colon and Rectal Surgeons (ASCRS) and Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). *Surgical Endoscopy*, *31*(9), 3412-3436. doi:10.1007/s00464-017-5722-

- Cesur, S., Cardakozu, T., Kus, A., Turkeyilmaz, N., & Yavuz, O. (2018) Comparison of conventional fluid management with PVI-based goal-directed fluid management in elective colorectal surgery. *Journal of Clinical Monitoring and Computing*, *33*, 249-257. doi: 10.007/s10877-018-0163-y
- Conn, L.G., McKenzie, M., Pearsall, E.A., & McLeod, R.S. (2015). Successful implementation of an enhanced recovery after surgery program for elective colorectal surgery: A process evaluation of champions' experiences. *Implementation Science*, *10*, 1-11. doi: 10.1186/s13012-015-0289-y
- Feldheiser, A., Aziz, O., Baldini, G., Cox, W., Fearon, H., Feldman, L.S., Gan, T.J., Kennedy, R.H., Ljungqvist, O., Lobo, D.N., Miller, T., Radtke, F.F., Garces, T.R., Schricker, T., Scott, M.J., Thacker, J.K., Ytrebo, L.M., Carli, F. (2015). Enhanced recovery after surgery (ERAS) for gastrointestinal surgery, part 2: consensus for anesthesia practice. *Acta Anaesthesiologica Scandinavica*, *60*, 289-334. doi: 10.1111/aas.1265
- Gustafsson, U. O., Scott, M. J., Hubner, M., Nygren, J., Demartines, N., Francis, N., Ljungqvist, O. (2018). Guidelines for Perioperative Care in Elective Colorectal Surgery: Enhanced Recovery After Surgery (ERAS®) Society Recommendations: 2018. *World Journal of Surgery*, *43*(3), 659-695. doi:10.1007/s00268-018-4844-y
- Holte, K., Sharrock, N.E., & Kehlet, H. (2002). Pathophysiology and clinical implications of perioperative fluid excess. *British Journal of Anaesthesia*, *89*, 622-632. doi: 10.1093/bja/aef220
- Horattas, M.C., Horattas, S.A., Heib, N., Brandstetter, S., Bahr, K., & Reissig, J. (2017) Enhanced recovery after surgery results in enhanced patient satisfaction. *Journal*

of the American College of Surgeons, 225, 67-68. doi:

10.1016/j.jamcollsurg.2017.07.704

Joshi, G. P. (2018, October 30). Intraoperative Fluid Management. Retrieved November 13, 2018, from <https://www.uptodate.com/contents/intraoperative-fluid-management>

Kaye, A. D. (2011). Fluid management. In R. D. Miller & M. C. Pardo (Eds.), *Basics of anesthesia* (6th ed., pp. 364-371). Philadelphia, PA: Saunders

Lambert, C. (2014). Technology and Adult Students In Higher Education: A Review of the Literature. *Issues and Trends in Educational Technology*, 2(1).
doi:10.2458/azu_itet_v2i1_lambert

Lassen, K., Soop, M., Nygren, J., Boris, P., Cox, W., Hendry, P.O., Spies, C., Meyenfeldt, M., Fearon, K., Revhaug, A., Norderval, S., Ljungqvist, O., Lobo, D., & Dejung, C. (2009). Consensus review of optimal perioperative care in colorectal surgery: Enhanced recovery after surgery (ERAS) Group recommendations. *The Journal of the American Medical Association*, 144, 961-969. doi: 10.1001/archsurg.2009.170

Ljungqvist, O., Scott, M., & Fearon, K. C. (2017). Enhanced Recovery After Surgery. *JAMA Surgery*, 152(3), 292. doi:10.1001/jamasurg.2016.4952

Lv, L., Shao, Y., & Zhou, Y. (2012). The enhanced recovery after surgery (ERAS) pathway for patients undergoing colorectal surgery: an update of meta-analysis of randomized controlled trials. *International Journal of Colorectal Disease*, 27, 1549-1554. doi: 10.1007/s00384-012-1577-5

- Lynn, R. R., & Winner, L. A. (2014). Fluids, electrolytes, and blood component therapy. In J. J. Nagelhout & K. L. Plaus (Eds.), *Nurse Anesthesia* (5th ed., pp. 382-402). St. Louis, MO: Elsevier.
- Lyons, A., Solomon, M.J., & Harrison, J.D. (2014). A qualitative study assessing the barriers to implementation of Enhanced Recovery After Surgery. *World Journal of Surgery*, 38, 1374-1380. doi: 10.1007/s00268-013-2441-7
- Miller, T. E., Roche, A. M., & Mythen, M. (2014, October 28). Fluid management and goal-directed therapy as an adjunct to Enhanced Recovery After Surgery (ERAS). *Canadian Journal of Anesthesia*, 62, 158-168. doi: 10.1007/s12630-014-0266-y
- Miller, T. E., Thacker, J. K., White, W. D., Mantyh, C., Migaly, J., Jin, J., ... Enhanced Recovery Study Group. (2014, May). Reduced length of hospital stay in colorectal surgery after implementation of an enhanced recovery protocol. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/24781574>
- Morris, M., & Chu, D. (2017, October 3). The New Standard for Surgical Recovery: Enhanced Recovery After Surgery (ERAS). Retrieved from <http://www.aqaf.com/qf/201710.eras.pdf>
- Nelson, G., Kiyang, L.N., Crumley, E.T., Chuck, A., Nguyen T., Faris, P., Wasylak, T., Hammond-Basualdo, C., McKay, S., Ljungqvist, O., & Gramlich, L.M. (2016). Implementation of enhanced recovery after surgery (ERAS) across a provincial healthcare system: The ERAS Alberta colorectal surgery experience. *World Journal of Surgery*, 40, 1092-1103. doi: 10.1007/s00268-016-3472-7

- Paton, F., Chambers, D., Wilson, P., Eastwood, A., Craig, D., Fox, D., Jayne, D., McGinnes, E. (2014). Effectiveness and implementation of enhanced recovery after surgery programs: a rapid evidence synthesis. *BMJ Open*, *4*, 1-10.
Doi:10.1136/bmjopen-2014-005015
- Popkin, B. M., D'Anci, K. E., & Rosenberg, I. H. (2010). Water, Hydration and Health. *Nutrition Reviews*, *68*(8), 439–458. doi:10.1111/j.1753-4887.2010.00304.x
- Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration. (2017). *Anesthesiology*, *126*(3), 376-393. doi:10.1097/aln.0000000000001452
- Rawlinson, A., Kang, P., Evans, J., & Khanna, A. (2011). A systematic review of enhanced recovery protocols in colorectal surgery. *Annals of the Royal College of Surgeons of England*, *93*(8), 583–588. doi:10.1308/147870811X605219
- Rollins, K.E., & Lobo, D.N. (2016). Intraoperative goal-directed fluid therapy in elective major abdominal surgery: A meta-analysis of randomized controlled trials. *Annals of Surgery*, *263*. 465-476. doi: 10.1097/SLA.0000000000001366
- Sackett, D. L., Rosenberg, W. M., Grey, J. A., Haynes, R. B., & Richardson, W. S. (1996). Evidence-based medicine: What it is and what it isn't. *The BMJ*, *312*(7023), 71-72. Retrieved November 8, 2018, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2349778/?page=2>.
- Spring, B. (2007). Evidence-based practice in clinical psychology: What it is, why it matters; what you need to know. *Journal of Clinical Psychology*, *63*(7), 611-631. doi:10.1002/jclp.20373

- Stolt, M., Leino-Kilpi, H., Ruokonen, M., Repo, H., & Suhonen, R. (2018). Ethics interventions for healthcare professionals and students: A systematic review. *Nursing Ethics, 25*(2), 133–152. doi: 10.1177/0969733017700237
- Stone, A.B., Grant, M.C., Roda, C.P., Hobson, D., Pawlik, T., Wu, C.L., & Wick, E.C. (2016). Implementation costs of an enhanced recovery after surgery program in the United States: A financial model and sensitivity analysis based on experiences at a quaternary academic medical center. *Journal of the American College of Surgeons, 222*(3), pp. 219-225. Retrieved from: <https://www.sciencedirect.com/science/article/abs/pii/S107275151501738X>
- Thanh, N.X., Chuck A.W., Wasylak, T., Lawrence J., Faris, P., Ljungqvist, O., Nelson, G., & Gramlich L.M. (2016). An economic evaluation of enhanced recovery after surgery (ERAS) multisite implementation program for colorectal surgery in Alberta. *Canadian Journal of Surgery, 59*, 415-421. doi: 10.1503/cjs.006716
- Thiele, R. H., Rea, K. M., Turrentine, F. E., Friel, C. M., Hassinger, T.E., Goudreau, B. J., ...Mcmurry, T. L. (2015). Standardization of Care: Impact of an Enhanced Recovery Protocol on Length of Stay, Complications, and Direct Costs after Colorectal Surgery. *Journal of the American College of Surgeons, 220*(4), 430-443. doi: 10.1016/j.jamcollsurg.2014.12.042
- Trinooson, C.D., & Gold, M.E. (2013). Impact of goal-directed perioperative fluid management in high-risk surgical procedures: A literature review. *AANA Journal, 81*, 357-368.