2017

Evaluation of an Enhanced Recovery After Surgery (ERAS) Pathway in Two Hospitals

Jennifer A. Janes
University of Kentucky, jen.kaeden04@gmail.com

DNP Final Project

Evaluation of an Enhanced Recovery After Surgery (ERAS) Pathway in Two Hospitals

Jennifer A. Janes

University of Kentucky

College of Nursing

November 29, 2017

Sheila Melander PhD, APRN, ACNP-BC, FAANP, FCCM, FAAN – Committee Chair

Katie Rogers MSN, APRN-Committee Member

Desiree Chappell MS, CRNA-Committee Member

Melanie Hardin Pierce DNP, RN, APRN-BC- Clinical Mentor

Dedication

This work and my final DNP project are dedicated to my son Kaeden, who through all of this has been very mature in sharing his time with school. I hope that one day my dedication and desire to strive for more gives him motivation to do the same. This is for my parents, who have taken on more than they imagined for me, yet have never been anything but supportive in me achieving my goals. This is for my brother and sister, who have always given me sibling encouragement and have stepped up to help me out whenever I have asked anything of them. I hope that this work will prove to better the nursing profession just as I desire to do with my future

Acknowledgements

I would like to thank my advisor Professor Dr. Sheila Melander; without your guidance and drive I would not have made my dream possible. You have been of great help not only as an advisor but also as a friend. I would also like to thank Katie Rogers and Desiree Chappell for taking the time to serve as my committee members. Katie, having you to talk to and bounce ideas off of is what kept me going through this program. Your thoughtful feedback was instrumental in the success of this project. I admire what you have done with your career and hope that one day someone can say the same about mine. Desiree, your research and feedback on this project shed a new light on the project. I appreciate the interest that you have to better the career of nursing. All of your advice was invaluable and I can't thank you enough for making time in your busy schedule. I would like to thank you all for letting my defense be an enjoyable moment, and for your brilliant comments, suggestions, and support.

I would like to say a special thanks to Norton Healthcare and the University of Kentucky for partnering together to make this cohort possible for me. Thanks to both these entities, I was able to achieve my DNP degree and better not only my career but also my life. A special thanks goes out to Dr. Kim Tharp-Barrie who was always there to listen and give honest feedback, Betty Hayes who kept us on track and took care of us, Dr. Amanda Wiggins who helped me finalize my project, and Whitney Kurtz-Ogilvie for helping to make my paper complete.

Norton Healthcare Scholarship Recipient: This Doctor of Nursing Practice project and program of study was fully funded through the University of Kentucky College of Nursing and Norton Healthcare academic-practice partnership.

Table of Contents

List of Tables

List of Figures

EVALUATION OF AN ENHANCED RECOVERY AFTER SURGERY

OBJECTIVE: The purpose of this study is to evaluate the Enhanced Recovery After Surgery (ERAS) pathway utilized at two Norton Healthcare facilities for colorectal and gynecological surgeries. The specific aim is to examine the impact on patient outcomes, clinical effectiveness, and costs.

METHODS: This was a multi-center, pre-post implementation retrospective study of the impact of ERAS pathways on colorectal surgery patients at Norton Audubon Hospital (NAH) and gynecological surgery patients at Norton Women's and Children's Hospital (NWCH). The sample included 399 patients including patients from both hospitals, pre- and post-ERAS.

RESULTS: The ERAS pathway lead to a significant reduction in length of stay in the colorectal group (pre 7 days, IQR 6-10.75; post 6 days, IQR 4-10). Overall cost savings were not significant in either population. There was a significant reduction in postoperative complications of anemia (3% vs 13%) and ileus (1% vs 9%) in the gynecological specialty. There was significant reduction in time to diet order (1.8 days vs 3.5 days) for the colorectal specialty. ERAS order sets were ordered on 40.4% of the colorectal specialty and 12% of the gynecological specialty.

CONCLUSION: A significant reduction was seen in LOS in the post-ERAS colorectal population. Having an ERAS order set on the chart of the colorectal patient correlated with a reduction in LOS, decreased time to diet order, and time to mobility. ERAS showed a reduction of some postoperative complications. Lack of adherence to ordering and documentation of the pathway was significant and could have impacted results.

Introduction

Evidence based medicine is a robust driving force for practice in today's healthcare arena. Evidence based practice can be laborious and can take many years to implement. An Enhanced Recovery After Surgery (ERAS) pathway is an example of evidence-based medicine that it is taking time to put into common practice. ERAS pathways consist of perioperative interventions that are aimed at standardizing and optimizing surgical patient care (Lemanu, Singh, Stowers, & Hill, 2013). The goal is to achieve fewer complication rates which leads to a more rapid postoperative recovery period (Roulin et al., 2013). About 310 million major surgeries are performed annually, yet few healthcare facilities in the United States have adopted the ERAS pathway (Lemanu, Singh, Stowers, & Hill, 2013). In a continued effort to stay current with evidence, Norton Healthcare has implemented multiple ERAS pathways for various surgical populations. The ERAS program at Norton Audubon was adopted in the spring of 2015. Initially the focus was with colorectal surgeries and now has expanded to include urological surgeries. The ERAS program at Norton Women's and Children's started in January 2016 and is currently being used for colorectal, urological, orthopedic, and gynecological surgeries.

The goal of these pathways is standardizing the care to all aspects of the patient's operative journey. With improvement in patient outcomes being the motivating factor, ERAS is also associated with reduction in length of stay (LOS), less postoperative complications, increased patient satisfaction, and reduced healthcare costs (Lemanu, Singh, Stowers, & Hill, 2013). Implementation of ERAS pathways could lead to a 10-20% reduction in complications and significantly reduces costs for both patients and the healthcare system (Ljungqvist, Scott, & Fearon, 2017).

Background

ERAS was developed in 1990 by Henrik Kehlet (Kehlet, 1997). ERAS is a multimodal perioperative care pathway designed to achieve early recovery after surgery by maintaining preoperative organ function and reducing the profound physiological and psychological stress responses following surgery (Fearon, Ljungqvist, & Von Meyenfeldt, 2005). A stress response following surgery can cause or exacerbate tissue injury, infection, hypovolemia, and hypoxia (Desborough, 2000). The main components of ERAS include preoperative counseling, optimization of nutrition, a standardized analgesic and anesthetic regimen, and early mobilization (Fleming, Garratt, & Kunst, 2016). The goals of ERAS are to decrease length of stay and; improve cardiopulmonary function, leading to less time on the ventilator, earlier return of bowel function, and earlier resumption of normal activities (Eskicioglu, Forbes, & Aartes, 2009). Optimization of nutrition includes avoidance of preoperative fasting, which increases metabolic stress, hyperglycemia, and insulin resistance (Melnyk, Casey, & Koupparis, 2011). Evidence has shown that poor nutrition preoperatively can lead to detrimental outcomes such as impaired wound healing for the patient (Melnyk, Casey, & Koupparis, 2011). Patients who receive a carbohydrate load up to two hours preoperatively have a change in metabolic state which decreases insulin resistance and protein loss and improves muscle function (Melnyk, Casey, & Koupparis, 2011). Decreasing ventilator time diminishes the potential for the patient to acquire a ventilator associated complication. The use of ERAS pathways can lead to earlier return of bowel function, which means patients are able to return to a diet more quickly and can lead to fewer post-operative ileus, improved wound healing, and increased patient satisfaction. Smoking cessation has also shown to lead to a faster and safer recovery as well as promotes improved wound healing (Berry, 2014).

Stakeholders that participate in the operative journey include surgeons, anesthesiologists, nurse anesthetists, nursing staff, physical/occupational therapy, respiratory therapy, and nutrition services (Roulin et al., 2013). A collaboration of care among these stakeholders is essential (Ljungqvist et al., 2017). Although all of these providers play a part in the ERAS pathway, the surgeon will have the most comprehensive view for guiding the patient. During each step of the journey, preoperative, intraoperative, postoperative, and unit level, each provider will affect what happens next. It is imperative that all providers, no matter what part of the operative journey they are involved in, agree as to the end points of management of the surgical patient (Ljungqvist et al., 2017).

Studies show that there is a decrease in length of hospital stay, decreased pain scores postoperatively, decreased readmission rates, and decreased complications with the implementation of ERAS in the colorectal surgery population. Although the United States has not had many early adopters of the ERAS pathway, it is a common pathway in other countries such as Germany, France, and London (ERAS, 2016). In one study following colorectal surgeries pre and post implementation of an ERAS pathway, LOS went from 7.7 to 4.9 days, post-operative complications went from 47.9% to 29.7%, and readmissions related to surgical complications went from 22.5% to 12.1% (Aggarwal & Young-Fadok, 2016). Readmissions due to surgical complications can cost around $31,000 to $61,000 (Roulin et al., 2013). In an observational, retrospective study at a single tertiary care center, there was a reduction in LOS from 7.0 to 5.3 days, readmission rates from 19.4% to 17.6%, and postoperative surgical site infections from 16.6% to 7.3% (Fabrizio et al., 2017). Outcomes such as these lead to a decrease in hospital costs for the patient. Research has shown a total annual savings up to $948,500 with net annual savings of $395,717 (Roulin et al., 2013).

A common barrier to implementation of ERAS is a lack of knowledge of what procedures and training are involved. All team members who care for the patient, preoperatively to postoperatively, must be motivated to carry out the program and overcome traditional practice patterns (Melnyk, Casey, & Koupparis, 2011). ERAS pathways may be difficult to adopt due to limited hospital resources such as financial, educational, and stakeholders. The implementation of an ERAS program can initially cost $552,783 with annual maintenance of $356,944 (Roulin et al., 2013). Other factors that inhibit early adoption of ERAS are active and passive resistance from members of the providing team, organizational environment, resistance to change, and lack of data and education (McLead et al., 2015).

Purpose

A review of the literature reveals, ERAS pathways can improve patient outcomes, clinical effectiveness, increase patient satisfaction scores, and decrease overall charges to the patient and facility. The focus of this study is to evaluate the ERAS pathway utilized at two Norton Healthcare facilities for colorectal and gynecological surgeries by examining the pre and post impact on patient outcomes, patient satisfaction, and patient/hospital charges. The goals of conducting this research are aimed at the following:

1.) At the completion of the project, there will be sufficient evidence to identify trends in clinical effectiveness when an ERAS pathway is initiated.

2.) At the completion of the project, there will be sufficient evidence to show how ERAS pathways improve patient outcomes.

3.) At the completion of the project, there will be sufficient evidence to develop recommendations for a plan to implement the ERAS pathway among other patient populations.

4.) At the completion of the project, there will be sufficient evidence to present to providers regarding the importance of the ERAS pathway for all surgery patients as compared to current practice.

5.) At completion of the project, there will be sufficient evidence to show the financial significance of the implementation of an ERAS pathway.

Methods

This study was a multi-center, pre-post implementation retrospective study of the impact for ERAS pathways on the colorectal surgery population at Norton Audubon Hospital and the gynecological surgery population at Norton Women's and Children's Hospital. Four groups of samples were collected: 100 colorectal surgical patients at Norton Audubon Hospital for the pre-implementation period, June to December 2014; 99 colorectal surgical patients at Norton Audubon Hospital for the post-implementation period, January to June 2016; 100 gynecological surgical patients at Norton Women's and Children's Hospital for the pre-implementation period, June to December 2015; 100 gynecological surgical patients at Norton Women's and Children's Hospital for the post-implementation period, June to December 2016. Prior to implementation of the ERAS pathway, there was no standard design that patients undergoing the same procedures followed. After the implementation of the ERAS pathway, the provider had a pathway to follow pre, intra, and post operatively for patients undergoing the same surgical procedures.

Setting

Norton Healthcare (NH) is one of Kentucky's largest healthcare systems. The hospital and health care system is Louisville area's third largest private employer, providing care at more than 140 locations throughout Greater Louisville and Southern Indiana. The Louisville-based not-for-profit system includes five Kentucky hospitals with 1,837 licensed beds. Of the five main hospitals, Norton Audubon and Norton Women's and Children's Hospital will be the focus of

this study. Norton Audubon is a 432 acute care hospital while Norton Women's and Children's is a 373 acute care hospital.

Sample

The sample consisted of the medical records of 100 patients at Norton Audubon Hospital for the pre-implementation period, 99 patients at Norton Audubon Hospital for the post-implementation period, 100 patients at Norton Women's and Children's Hospital for the pre-implementation period, and 100 patients at Norton Women's and Children's Hospital for the post-implementation period. The patients of interest were those who had undergone colorectal surgery at Norton Audubon Hospital or gynecological surgery at Norton Women's and Children's Hospital. Inclusion criteria for the patients records used in the study were: patients undergoing colorectal or gynecological surgery (please refer to Table 4 for a comprehensive list of DRG codes used for inclusion criteria at or during admission); admitted pre-implementation of the ERAS pathway between June and December 2014 at Norton Audubon Hospital; admitted pre-implementation of the ERAS pathway between June and December 2015 at Norton Women's and Children's Hospital; admitted post-implementation of the ERAS pathway between January and June 2016 at Norton Audubon Hospital; admitted post-implementation of the ERAS pathway between June and December 2016 at Norton Women's and Children's Hospital; age 18 or above; and adult inpatient. Exclusion criteria were patients less than 18 years old and outpatients.

The records were included for all patients who met the inclusion criteria between June 2014 and December 2014 at Norton Audubon Hospital and June 2015 to December 2015 at Norton Women's and Children's Hospital pre-ERAS implementation, as well as those who met the criteria between January 2016 and June 2016 at Norton Audubon Hospital and June 2016 to

December 2016 at Norton Women's and Children's Hospital, post-ERAS implementation. Both pre- and post-implementation outcomes were compared. The demographic variables included admission diagnosis, age, gender, ethnicity, smoker, and hospital where surgery occurred. The outcome variables included hospital LOS, amount of ventilator days, postoperative complications, mortality rate, readmission rate, and charges. The clinical variables included time to diet order, time to mobility, ERAS order set on chart, and ERAS education performed.

A one group pre and post design was conducted through a retrospective chart review of patients who underwent a colorectal surgery at Norton Audubon prior to the implementation of the ERAS pathway and post implementation of the ERAS pathway. Another one group pre and post design was conducted through a retrospective chart review of patients who underwent a gynecological surgery at Norton Women's and Children's prior to the implementation of the ERAS pathway and post implementation of the ERAS pathway. These were double difference research designs.

These designs compare the value of an outcome/indicator between recipients and non-recipients (1st difference); before and after the intervention (2nd difference). A process evaluation was conducted to collect data on the adherence to the different parts of the ERAS pathway at each facility.

Data Collection

Approvals from the University of Kentucky Institutional Review Board (IRB) and the Norton Healthcare Office of Research and Administration (NHORA) were obtained prior to the collection of data. This study was based on a retrospective chart review. Patient charts were obtained from the Norton Audubon and Norton Women's and Children's electronic patient database. Charts were identified using the DRG codes as listed in Table 4. During data

collection, patient records were accessed using the patient medical record number (MRN), data were abstracted based on the variables, and data were transferred to an electronic spreadsheet. Please refer to Tables 2 and 6 for a list of variables that were reviewed, which included demographic variables, outcome variables, clinical effectiveness variables, and financial expense to patient and hospital.

Data Analysis

Descriptive statistics, including frequency distributions, means, and standard deviations were used to describe patients' demographic characteristics. The Mann-Whitney *U*-test was used in the analysis of ordinal data between LOS and type of surgery pre and post-ERAS and between order set and LOS. Continuous variables were compared using the Independent Sample *t*-tests. For categorical variables the Chi-squared test for independent samples was used, or Fishers exact test if values were less than 5 in any cell. The Kruskal-Wallis test was performed to compare values on continuous variables from three or more groups. The Pearson's Correlation test was used to correlate continuous variables. The Spearman's Correlation test was used to correlate ordinal data. Data were analyzed using SPSS software version 23.0 for Windows; an [*alpha*] level of .05 was used for statistical significance throughout.

Results

Sample Characteristics

A total of 399 patient charts were reviewed: 100 prior to the ERAS pathway implementation at both Norton Audubon and Norton Women's and Children's Hospital, 100 post-ERAS pathway implementation at Norton Women's and Children's Hospital, and 99 post-

ERAS pathway implementation at Norton Audubon Hospital. The mean age was 48.3 years for NWCH pre-ERAS and 48.6 years post-ERAS. The mean age was 61.1 years for NAH pre-ERAS and 64.8 years post-ERAS. The majority of patients were White. Gender was 100% female in the gynecological group due to procedure type. Gender was evenly distributed in the colorectal group. The pre- and post-ERAS pathway demographic characteristics as to age, gender, and ethnicity are presented in Table 2 for NWCH and Table 6 for NAH.

Gynecological Surgery

One hundred patients underwent gynecological surgery using DRG 737, 738, 739, 740, 741, 742, and 743 (listed in Table 1) from June to December 2015, and 100 patients underwent ERAS gynecological surgeries in the same time interval in 2016. The mean age was 48.3 years (range 25-86) for the 2015 patients and 48.6 years (25-91) for the 2016 patients. There were no significant differences in baseline demographics between 2015 and 2016. All patients in both time intervals were female (Table 2).

Table 3 outlines the LOS for pre-ERAS in 2015 and post-ERAS in 2016 for gynecological surgery at NWCH. There was no significant difference in LOS between the pre-ERAS and post-ERAS group. LOS was not affected by whether or not the patient was a smoker (P = .826). The data did show that the mean LOS for smokers, nonsmokers, and former smokers was 2 days. The IQR for smokers was 2 to 5.5 days, nonsmokers was 2 to 4 days, and former smokers was 2 to 3 days. Whether the patient had an ERAS order set on their chart also did not affect LOS (P = .839). Age also did not affect LOS (P = .76).

Postoperative complications (Table 3) that showed significant difference in the pre-ERAS and post-ERAS group were anemia (13% vs 3%; P = .01) and ileus (9% vs 1%; P = .01). Other postoperative complications that did not show statistical significance included postoperative

nausea and vomiting (PONV; 2% vs 5%; P = .25), hypertension (HTN; 1% vs 1%; P = 1.0), atelectasis (2% vs 0%; P = .16), urinary retention (2% vs 7%; P = .09), urinary tract infection (UTI; 1% vs 0%; P = .32), deep vein thrombus/pulmonary embolus (DVT/PE; 2% vs 1%; P = .41), respiratory failure (2% vs 4%; P = .32), acute kidney injury (AKI; 1% vs 0%; P = .037), and "other" (4% vs 12%; P = .037). "Other" complications consisted of hemoptysis, hyponatremia, pneumonia, and thrombocytopenia. In the pre-ERAS group, 69% had no postoperative complications; that number was 75% in the post-ERAS group (Figure 1). There was statistical significance of .002 between age and postoperative complication. There were no mortalities. There was one readmission in the pre-ERAS group and five readmissions in the post-ERAS group (P = .003). The one readmission in the pre-ERAS group was for intestinal infection. In the post-ERAS group, two readmissions were for post procedural infection, one for post procedural pain, one for post procedural complications, and one for post procedural intestinal obstruction.

Having an ERAS order set entered in the patient's chart in the post-ERAS group held no significance on time to diet or time to mobility (P = .73 and P = .59, respectively). Age did show a correlation with total charges to the patient in the post-ERAS group (P = .01). For example, a person that had a gynecological procedure at twenty-nine years old was charged $25,483.62, a fifty-one year old was charged $56,316.50, and a seventy-five year old was charged $116606.92 in this study.

Colorectal Surgery

One hundred patients underwent colorectal surgery using DRG codes 329, 330, 331 (listed in Table 5) from June to December 2014, and 99 patients underwent ERAS colorectal surgeries using the same DRG codes from January to June 2016. The median age was 61.11 years for 2014 (ranging from 22-96) and was 64.78 years for 2016 (ranging from 21-95). Of the

100 pre-ERAS patients, 52% were female and 48% were male; of the 99 post-ERAS patients, 55.6% were female and 44.4% were male. There were no differences in baseline demographics between 2014 and 2016 (Table 6).

Table 7 outlines the LOS for the pre-ERAS in 2014 and post-ERAS in 2016 for colorectal surgery at NAH. There was a significant reduction in LOS in the post-ERAS group (median 6 days, IQR 4-10) compared to the pre-ERAS group (median 7 days, IQR 6-10.75). This has a P value of .033 significance. In the post-ERAS group, there was statistical significance between LOS and having an ERAS order set on the chart. The median LOS was 7 days with an IQR 5-10 for those without an ERAS order set on the chart. The median LOS was 5 days with an IQR 3-8.75 for those with an ERAS order set on the chart. This had a P value of .003 significance. Age and smoking was also compared to see if they affected LOS, but they did not show significance.

Postoperative complications, as shown in Table 7, showed significant differences between the pre-ERAS and post-ERAS groups fell into the "other" category and consisted of acute kidney injury, pleural effusion, peritonitis, hypotension, microperfusion, COPD exacerbation, transaminitis, lower extremity ischemia, thrombus, empyema, diarrhea, cardiac arrest, and gastrointestinal bleed (18% vs 36.4%; P = .004). Other postoperative complications that did not show any statistical significance were ileus (17% vs 16.2%; P = .87), anemia (12% vs 6.1%; P = .144); anastomotic leak (3% vs 6.1%; P = .299), arrhythmia (5% vs 4%; P = .75), surgical site infection (SSI, 6% to 1%; P = .06), respiratory failure (8% vs 7.1%; P = .80), pneumonia (4% vs 4%; P = .99), fever (1% vs 0%; P = .32), hypertension (HTN, 1% vs 1%; .99), sepsis (3% vs 4%; P = .69), and none (47% vs 41.4%; P = .43) (Figure 2). Of these postoperative complications, nine patients had an anastomotic leak. Of those nine, seven came

from the nonsmoking group, which is significant (P = .043). There were two mortalities in 2014 and four mortalities in 2016. Age did not show statistical significance with postoperative complications. More patients in the post-ERAS were extubated in the operating room or the PACU compared to on the floor, which could have affected the amount of ventilator associated complications (Table 7). Readmissions within thirty days of discharge went from 1 in the pre-ERAS group to 4 in the post-ERAS group (P =.211). The readmission reason in the pre-ERAS group was septicemia. The readmission reasons in the post-ERAS group were heart failure, acute kidney failure, diverticulitis, and fistula.

There was a significant reduction in the time it took for diet initiation in the post-ERAS group compared to the pre-ERAS group (1.78 days vs. 3.54 days; P = .02) (Table 8). In the post-ERAS group, statistical analysis was compared to see if there was a relationship between time to diet and order set on the chart. Having an order set on the chart had a mean of .78 days to diet initiation compared to 2.42 in those who did not have an order set (P = .017).

Although there was not a significant reduction in time to mobility in the pre and post-ERAS group, there was statistical significance when compared with order set on the chart. When a patient had an ERAS order set, time to mobility went from a mean of 1.67 days to 1.08, P = .042 (Table 8).

There was statistical significance with overall charges in the pre and post-ERAS group ($75,008.77 vs $80,096.62; P = .01) (Table 7). Although there were more costs to patients in the post-ERAS group, this could be due to the implementation of the new pathway. The financial costs however, are trending down so this could yield savings in future studies. Age to charges were looked at to see if there was a relationship between the two variables. It did show statistical significance with a P value of .005. For a colorectal surgery in 2016, it cost a twenty-five year

old $50,856.05, a fifty-one year old $52,183.50, a seventy-five year old $66,432.29, and an eighty-six year old $138,753.25. These charges could be affected by type of colorectal surgery and comorbidities.

ERAS to ERAS

Of the 100 gynecological surgeries, only 12% had an ERAS order set on the chart compared to 40.4% of the 99 colorectal surgeries (Table 9). Data collection sheets as shown in Appendix 1, were collected and filled out on 31 of the 99 colorectal ERAS patients. No data collection sheets were obtained or saved at Norton Women's and Children's Hospital. Due to the fact that the data collection sheet is merely used as a tool rather than a permanent part of the patient's record, statistical test were not able to be performed. The percentage of patients who received education regarding an ERAS procedure was significantly different between the two ERAS groups (21.2% vs 0%; P = 0.00) (Table 9).

Discussion

This studied aimed to better understand the impact that the implementation of an ERAS pathway can have on patient outcomes, clinical effectiveness, and costs. Common trends in the data show that when an ERAS pathway is implemented, there is a significant reduction in LOS. ERAS pathways can also lead to improvement in patient outcomes and increased patient satisfaction scores. Replacing the traditional surgical pathway with an ERAS pathway has shown some benefits to patient outcomes in this study. Overall the study results demonstrate that there needs to be a more efficient and effective way of monitoring the ERAS pathway and the elements involved. In order to see significant reductions in LOS and financial costs as seen in

the literature, the hospital needs to perform scheduled audits to ensure proper documentation and adherence to the ERAS pathway. Other reasons that could lead to the discrepancy of findings in this study compared to the findings in the literature could be due to lack of resources to run the ERAS program and an inefficient way to pull ERAS data from the electronic medical record.

Limitations

Several limitations were identified in the design of this study. In this initial comparison of multisite ERAS protocols, there were limitations to the ability to generalize the results. This study sampled patients over different time intervals. While the pre- and post-ERAS group at NWCH was collected from June to December of different years, the pre-ERAS group at NAH was collected from June to December 2014 and the post-ERAS group was collected from January to June 2016. This difference in time interval could be affected by season variance and could have skewed results.

Another limitation to the study was it examined ERAS across multiple disciplines with different ERAS pathways. As mentioned above, pathways for each procedure type can be different and what works for one surgical population, may not work for another. By comparing gynecological and colorectal surgeries, results could be different due to gender since all gynecological surgeries are female.

Another limitation of this study is that comorbidities were not evaluated. Comorbidities could have affected the LOS, postoperative complications, and overall charges to the patients. Complications and their severity are one of the strongest indicators for hospital charges (Roulin et al., 2013).

Total costs were another limitation of this study. Total costs consisted of charges to the patient from various disciplines during the entire hospital stay. It did not look specifically at the

time interval between pre-operative care to discharge postoperatively. Looking specifically at this time interval would give a more accurate assessment of total charges to the patient when using the ERAS pathway.

As seen in this study, lack of compliance and proper documentation are limitations to the results yielded. If information was entered into the electronic medical record incorrectly, results could be inaccurate, distorting the outcomes of either group. While the implementation of the ERAS pathway is feasible and provides some benefits demonstrated in this study, to ensure sustainability there must be ongoing investment in the education of staff, patients, and auditing.

Recommendations for Future Studies

Going forward, the literature recommends that systemic audits be performed at regularly timed intervals to allow for direct comparison of the ERAS data (Berry, 2014). As surgical populations and procedures change, so must the ERAS pathways. Some elements of the pathways will need to be modified to be more specific to procedure type. Through systemic auditing, problems with application or adherence can be addressed and improved upon in order to ensure the best results for the patients and the healthcare enterprise. Future studies of these audits are critical to show the impact that the ERAS pathway has on patient outcomes, clinical effectiveness, and healthcare costs. Identifying specific nurse interventions to study such as proper documentation of mobility performed, proper documentation of diet initiation, and performing/documenting ERAS education can demonstrate an even greater impact on the effectiveness of the ERAS pathway. Investigating causes that affect LOS such as hospital acquired infections and patient comorbidities would allow for a more in-depth representation of the impact of the implementation of the ERAS pathway. Charges to the patient should be

audited from time of preoperative care to discharge to accurately assess financial savings of implementation and maintenance of an ERAS pathway.

Conclusion

The goal of this study was to demonstrate the impact the ERAS pathway had on patient outcomes, clinical effectiveness, and costs. In the time interval reviewed, there was a reduction in LOS in the colorectal population when an ERAS pathway was initiated. This study did not show a reduction in costs for the patient. The data however for costs to the patient is trending downward which could show stronger impact in the future. The ERAS pathway did affect the amount of some postoperative complications. Time to diet initiation in the colorectal population post-ERAS was also significantly reduced. Lack of adherence to ordering and documentation of the pathway was significant and could have impacted results. When an ERAS order set was on the patient medical record, there was a significant reduction in LOS, time to diet initiation, time to mobility, and an increase in ERAS education to the patient.

Inclusion criteria list of colorectal surgery ICD-10 codes	
ICD-10 Codes	Diagnosis Definition
737	Uterine & Adnexa Proc for Ovarian or Adnexal Malignancy w CC MS
738	Uterine & Adnexa Proc for Ovarian or Adnexal Malignancy w/o CC/MCC MS
739	Uterine, Adnexa Proc for Non-Ovarian/Adnexal Malig w MCC MS
740	Uterine, Adnexa Proc for Non-Ovarian/Adnexal Malig w CC MS
741	Uterine, Adnexa Proc for Non-Ovarian/Adnexal Malig w/o CC/MCC MS
742	Uterine & Adnexa Proc for Non-Malignancy w CC/MCC MS
743	Uterine & Adnexa Proc for Non-Malignancy w/o CC/MCC MS

Table 1. Inclusion criteria list of gynecological ICD-10 codes

Demographic Variables by Gynecological Group at NWCH			
Variable	2015 n = 100	2016 n = 100	P
Age, mean (SD)	48.3 (11.4)	48.9 (13.1)	.76
Race, %			.17
White	69%	65%	
Black or African American	24%	27%	
Asian	3%	5%	
Hispanic	4%	0%	
Other	0%	2%	
Unknown	0%	1%	
Gender			
Male	0%	0%	
Female	100%	100%	
Smoker, %			.55
Yes	21%	16%	
No	54%	61%	
Former	25%	23%	
Notes: Standard deviation (SD)			

Table 2. Demographic Variables by Gynecological Group at NWCH

Outcome Variables by Gynecological Group at NWCH			
Variable	2015 n = 100	2016 n = 100	P
Postoperative Complications, %			
PONV	2%	5%	.25
HTN	1%	1%	1.0
Ileus	9%	1%	.01
Anemia	13%	3%	.01
Atelectasis	2%	0%	.16
Urinary Retention	2%	7%	.09
UTI	1%	0%	.32
DVT/PE	2%	1%	.56
Respiratory Failure	2%	4%	.41
AKI	1%	0%	.32
Other	4%	12%	.04
None	69%	75%	.35
Mortality	0%	0%	-
Extubation, %			.56
OR	99%	98%	
PACU	0%	0%	
Floor	1%	2%	
Length of stay, median (IQR)	2 (2-4)	2 (2-3)	.12
Total charges billed, (SD)	$37,295.92 (27,827.44)	$37,342.02 (27,639.73)	.92
Notes: Inter Quartile Range (IQR); Standard deviation (SD)			

Table 3. Outcome Variables by Gynecological Group at NWCH

Clinical Variables by Gynecological Group at NWCH			
Variable	2015 n = 100	2016 n = 100	P
Time to Diet, mean in days (SD)	.15 (.63)	.13 (.39)	.52
Time to Mobility, mean in days (SD)	.41 (.64)	.48 (.70)	.44
Notes: Standard deviation (SD)			

Table 4. Clinical Variables by Gynecological Group at NWCH

Inclusion criteria list of gynecological ICD-10 codes	
ICD-10 Codes	Diagnosis Definition
329	Major Small & Large Bowel Procedures w MCC MS
330	Major Small & Large Bowel Procedures w CC MS
331	Major Small & Large Bowel Procedures w/o CC/MCC MS

Table 5. Inclusion criteria list of colorectal surgery ICD-10 codes

Demographic Variables by Colorectal Group at NAH			
Variables	2014 n = 100	2016 n = 99	P
Age, mean (SD)	61.1 (16.3)	64.8 (14.0)	.09
Gender, %			.62
Female	52%	56%	
Male	48%	44%	
Race, %			.39
White	83%	85%	
Black or African American	12%	14%	
Asian	1%	1%	
Hispanic	3%	0%	
Unknown	1%	0%	
Smoker, %			.50
Yes	19%	13%	
No	39%	39%	
Former	42%	48%	
Notes: Standard deviation (SD)			

Table 6. Demographic Variables by Colorectal Group at NAH

Outcome Variables by Colorectal Group at NAH			
Variable	2014 n = 100	2016 n = 99	P
Postoperative Complications, %			
Ileus	17%	16%	.87
Anemia	12%	6%	.14
Anastomotic Leak	3%	6%	.30
Arrhythmia	5%	4%	.75
SSI	6%	1%	.06
Respiratory Failure	8%	7%	.80
Pneumonia	4%	4%	.99
Fever	1%	0%	.32
HTN	1%	1%	.99
Sepsis	3%	4%	.69
Other	18%	36%	.004
None	47%	41%	.43
Mortality	2%	4%	.40
Length of stay, median (IQR)	7 (6-10.75)	6 (3-10)	.03
Blood Sugar, (SD)			
Day of Surgery	135.91 (35.43)	155.47 (58.50)	.11
Postoperative Day 1	142.32 (66.38)	149.02 (50.22)	
Extubation, %			.37
OR	63%	71%	
PACU	24%	19%	
Floor	12%	7%	
Trached	1%	1%	
Never Intubated	0%	2%	
Total charges billed, (SD)	$75,008.77 (42,425.69)	$80,096.62 (60,719.62)	.01
Notes: Inter Quartile Range (IQR); Standard deviation (SD)			

Table 7. Outcome Variables by Colorectal Group at NAH

Clinical Variables by Colorectal Group at NAH			
Variable	2014 n = 100	2016 n = 99	P
Time to Diet, mean in days (SD)	3.54 (1.71)	1.78 (1.90)	.02
Time to Mobility, mean in days (SD)	1.58 (1.89)	1.40 (2.08)	.94
Notes: Standard deviation (SD)			

Table 8. Clinical Variables by Colorectal Group at NAH

ERAS Variables by Gynecological and Colorectal Group			
Variable	Gynecological n = 100	Colorectal n = 99	P
ERAS order set on chart	12%	40.4%	.00
ERAS education performed	0%	21.2%	.00

Table 9. ERAS Variables by Gynecological and Colorectal Group

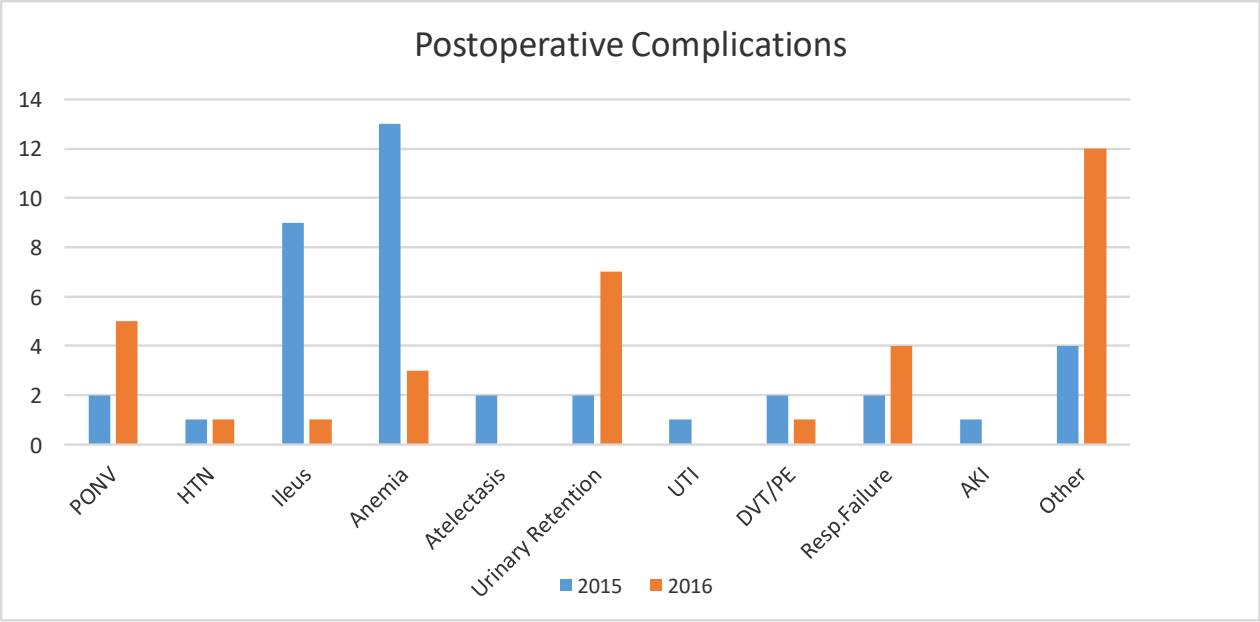

Figure 1. Comparison of postoperative complications before and after implementation of an ERAS pathway in gynecological surgeries at NWCH

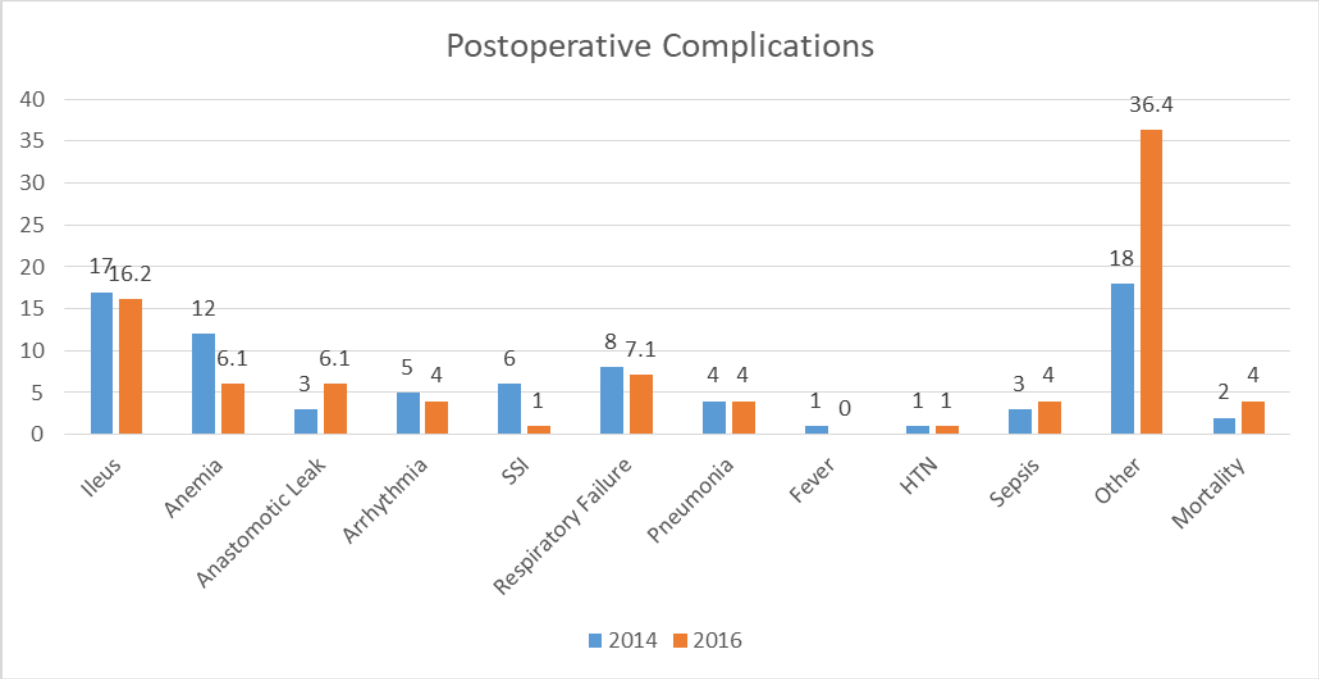

Figure 2. Comparison of postoperative complications before and after implementation of an ERAS pathway in colorectal surgeries at NAH

References

Aggarwal, P., Young-Fadok, T. (2016). Cost Benefit of Implementing Enhanced Recovery After Surgery (ERAS) Program in Colorectal Surgery: A Single Institution Study. Journal of American College of Surgeons, 223, e6-e7. Retrieved on March 21, 2017, from http://dx.doi.org/10.1016/j.jamcollsurg.2016.08.019

Berry, B. D. (2014). Enhanced Recovery After Surgery. *AANA Journal, 82,* 259-261. Retrieved from www.aana.com/aanajournalonline

Desborough, J. P. (2000). The Stress Response to Trauma and Surgery. *Britain Journal of Anesthesia, 85*, 109-117.

ERAS. (2016). Encare Providers of ERAS. Retrieved on April 21, 2017, from http://www.encare.net/healthcare-professionals/reference-locations

Eskicioglu, C., Forbes, S. S., & Aartes, M. A. (2009). Enhanced Recovery After Surgery (ERAS) Programs for Patients Having Colorectal Surgery: A Meta-Analysis of Randomized Trials. *J Gastrointestinal Surgery, 13*, 2321-2329.

Fabrizio, A. C., Grant, M. C., Siddiqui, Z., Alimi, Y., Gearhart, S. L., Wu, C., ... Wick, E. C. (2017, April 22). Is enhanced recovery enough for reducing 30-d readmissions after surgery? *Journal of Surgical Research, 217*, 45-53. https://doi.org/10.1016/j.jss.2017.04.007

Fearon, K., Ljungqvist, O., & Von Meyenfeldt, M. (2005). Enhanced Recovery After Surgery: A Consensus Review of Clinical Care for Patients Undergoing Colonic Resection. *Clinical Nutrition, 24*, 466-477.

Fleming, I. O., Garratt, C., & Kunst, G. (2016). Aggregation of Marginal Gains in Cardiac Surgery: Feasibility of a Perioperative Care Bundle for Enhanced Recovery in Cardiac

Surgical Patients. *Journal of Cardiothoracic and Vascular Anesthesia*, *30*, 665-670. http://dx.doi.org/10.1053/j.jvca.2016.01.017

Kehlet, H. (1997). Multimodal Approach to Control Postoperative Pathophysiology and Rehabilitation. *Br J Anesthesia*, *78*, 606-617.

Kenny, L., Pillay, T., & Kinnersley, D. (2013). The Enhanced Recovery Programme Pilot: Can We Achieve Better Outcomes and Shorter Stays For Cardiac Surgical Patients? *Journal of Cardiothoracic Surgery*, *8*. http://dx.doi.org/10.1186/1749-8090-8-S1-O1

Lemanu, D. P., Singh, P. P., Stowers, M. D., & Hill, A. G. (2013, November 27). A systematic review to assess cost effectiveness of enhanced recovery after surgery programmes in colorectal surgery. *The Association of Coloproctology of Great Britain and Ireland*, *16*, 338-346. https://doi.org/10.1111/codi.12505

Ljungqvist, O., Scott, M., & Fearon, K. (2017, March). 'Enhanced Recovery After Surgery' A Review. *JAMA Surgery*, *152*, 292-298

Logic Model for the Iowa Prevention Research Center 2014-2019. (2014). The University of Iowa, Retrieved from https://www.public-health.uiowa.edu/prc/ui-prc-logic-model

McLead, R., Aarts, M., Chung, F., Eskicioglu, C., Forbes, S., Conn, L., ... Wood, T. (2015,). Development of an Enhanced Recovery After Surgery Guideline and Implementation Strategy Based on the Knowledge-to-Action Cycle. *Annals of Surgery*, *262*(), 1016-1025. http://dx.doi.org/Retrieved from www.medscape.com/viewarticle/856004

McLead, R., Aarts, M., Chung, F., Eskicioglu, C., Forbes, S., Conn, L., ... Wood, T. (2015). Development of an Enhanced Recovery After Surgery Guideline and Implementation Strategy Based on the Knowledge-to-Action Cycle. *Annals of Surgery*, *262*, 1016-1025. Retrieved from www.medscape.com/viewarticle/856004

Melnyk, M., Casey, R. G., & Koupparis, A. (2011). Enhanced Recovery After Surgery (ERAS0 protocols: Time to Change Practice? *Can Urol Assoc, 5,* 342-348. http://dx.doi.org/10.5489/cuaj.11002

Roulin, D., Donadini, A., Gander, S., Griesser, A., Blanc, C., Hubner, M., ... Demartines, N. (2013, April 24). Cost-effectiveness of the implementation of an enhanced recovery protocol for colorectal surgery. *British Journal of Surgery*, *100,* 1108-1114. https://doi.org/10.1002/bjs.9184