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Effect of an Enhanced Recovery After Surgery Program on Opioid Use and Patient-Reported Outcomes

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Abstract

Objective: To investigate the effect of an enhanced recovery after surgery (ERAS) program on perioperative outcomes with an emphasis on opioid consumption and patient-reported outcomes in the immediate and extended postoperative period.

Methods: We initiated our ERAS program as part of a quality improvement initiative in November 2014. We compared clinical outcomes among a cohort of 607 women undergoing open gynecologic surgery before or after implementation of ERAS. For 293 patients, patient reported outcomes were compared using the MD Anderson Symptom Inventory-Ovarian Cancer (MDASI-OC).

Results: Median age was 58 years (18–85). Median length of stay decreased by 25% for patients in the ERAS pathway, ($p<.001$). Overall, patients in the ERAS group had a 72% reduction in

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median opioid consumption and 16% were opioid-free during admission up to postoperative day 3 ($p<.001$). There was no difference in pain scores, ($p=.80$). Patients on ERAS reported less fatigue ($p=.01$), interference with walking ($p=.003$), and total interference (composite score of physical and affective measures) during hospitalization, ($p=.008$). After discharge, those on the ERAS pathway demonstrated a significantly shorter median time to return to no or mild fatigue (10 vs 30 days, $p=0.03$), mild or no interference with walking (5 vs. 13 days, $p=.003$), and mild to no total interference (3 vs. 13 days, $p=.02$). There were no significant differences in complications, rates of readmission or reoperation between the pre- and post-ERAS groups.

Conclusion: Implementation of an ERAS program was associated with significantly decreased opioid use after surgery and improvement in key patient-reported outcomes associated with functional recovery after surgery without compromising pain scores.

Précis

Participation in an enhanced recovery program was associated with decreased intraoperative and postoperative opioid intake and improved functional recovery in the hospital and after discharge.

Introduction:

Surgical care reflects a significant component of national health-care utilization and expenditures with an estimated 8.4 million discharges associated with a surgical procedure, and a cost estimate of greater than 157-billion dollars.¹ Enhanced Recovery After Surgery (ERAS) is a multidisciplinary, multi-modal approach to perioperative care that aims to reduce the effects of surgical stress, and to avoid traditional aspects of perioperative care that have documented harm.² Recent data suggest wide variation and over prescription of opioids after elective surgery.³ Rates of new persistent opioid use after surgical procedures is estimated at 6%.⁴ Implementation of evidence-based clinical guidelines for pain management is an important component of prevention of substance use disorders involving prescription drugs.⁵

Kehlet, an early pioneer, developed an ERAS protocol in 2001.⁶ Subsequently, ERAS has continued to evolve with guidelines for multiple surgical disciplines, including the recently published guidelines for gynecologic surgery.^{2,7,8} While prior studies involving ERAS have demonstrated improvements in traditional metrics, they have not captured crucial outcomes such as symptom burden and functional recovery, from a patient's perspective. With the growing focus on patient-centered care, patient-reported outcomes are increasingly important in comparative effectiveness research.^{9,10,11} Patient reported symptom monitoring during routine cancer care has been associated with improvements in survival and has the potential to improve postsurgical outcomes.^{12,13} Our objective was to compare perioperative outcomes, with a focus on intra- and postoperative opioid consumption, as well as patient-reported symptom burden and functional recovery in women undergoing surgery pre- and post- implementation of an ERAS program.

Materials and Methods:

Our previous practice and current ERAS program have been previously described.¹⁴ Our ERAS program included interventions that can be categorized into preoperative,

intraoperative and postoperative phases.¹⁴ These include but are not limited to preoperative medical optimization of chronic disease, nutritional counseling, allowing oral intake of clear fluids up to 2 hours before induction of anesthesia, carbohydrate loading, avoidance of mechanical bowel preparation; pre-, intra-, and post-operative euvoemia via goal directed fluid therapy, intraoperative and postoperative opioid-sparing multi-modal analgesia, restrictive use of surgical drains, and an emphasis on early ambulation and feeding.

Cohort 1 includes all consecutive patients who underwent open elective gynecologic surgery on our ERAS pathway between 11/6/2014 and 10/26/2016. Cohort 2 is a subset of patients from Cohort 1 who consented to participate in a separate research protocol to collect patient reported outcomes and symptom burden in the perioperative period. To minimize bias from changes in practice over time, patients who underwent open surgery in the 6 months prior to the start of our ERAS program (May-October 2014) and participated in the collection of patient reported outcomes served as historical controls. To be included in cohort 2 or the historical control group, patients had to have at minimum a preoperative baseline patient reported outcomes assessment in addition to assessments on the first and second postoperative days.

Clinical and demographic information collected from the medical record included age, body mass index (BMI), ethnicity, race, tumor type (primary or recurrent disease, and designation as malignant, benign, tumor of uncertain malignant potential) as well as indication for surgery. Ovarian, fallopian tube, and primary peritoneal cancer were combined into one primary disease site given their clinical similarity. Other sites were designated as cervix, uterine (non-sarcoma), and uterine sarcoma. American Society of Anesthesiologists (ASA) classification of physical health¹⁵ and Charlson Comorbidity Index (CCI)¹⁶ were used to assess comorbidities. The current malignancy was not included in the calculation of the CCI in order to more accurately reflect pre-cancer comorbid conditions. For participants with ovarian, fallopian tube or primary peritoneal cancer, a surgical complexity score¹⁷ was assigned.

The Dindo-Clavien grading system was used to characterize the 30-day complication rates.¹⁸ Specifically, we evaluated gastrointestinal (GI), genito-urinary (GU), central nervous system (CNS) and hematologic complications within 30 days of the surgery date. Specifically, the number of patients with any post-operative complications within 30 days of surgery was identified, and then categorized as either mild (grade 1–2), or severe (grade 3–4). A patient was characterized according to their highest grade post-operative complication of a given type (GI, GU, or CNS).

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools¹⁹ hosted at MD Anderson as part of an institutionally approved quality improvement study (QI-6033).

Perioperative patient-reported symptom burden was collected on a separate IRB approved protocol (BS99–094) where patients provided written informed consent. Women from the historical control group and cohort 2 were given the MD Anderson Symptom Inventory-Ovarian Cancer module (MDASI-OC), a 27-item validated tool plus two additional

questions on diarrhea and heartburn.²⁰ For the MDASI symptom components, individuals were asked to rank symptom severity during the previous 24 hours on a scale of 0–10, with 0 being “not present” and 10 being “as bad as you can imagine.” Interference is also assessed on a 0–10 scale, with 0 being “did not interfere” and 10 being “interfered completely.”²⁰ The MDASI-OC was administered preoperatively, daily while hospitalized after surgery, on days 3 and 7 post discharge and weekly for 7 additional weeks postoperatively. The MDASI-OC was administered on paper, by interactive voice recorded (IVR) telephone system, or electronically via email link.

Pain medication data were collected on the day of surgery (POD 0) and on the first three days after surgery. Patient reported pain was assessed via the MDASI-OC as described above. Post-anesthesia care unit (PACU) pain scores were assessed using the 11-point pain scale (range 0–10).

Descriptive statistics were used to summarize the demographic and clinical characteristics. Categorical variables were compared between the pre-ERAS and ERAS groups with Fisher’s exact test. The Wilcoxon rank-sum test was used to compare medians between continuous variables. Opioid medication data were collected for the first 4 days of the hospitalization and converted into morphine equivalent daily doses (MEDD). The patient cohorts were determined using convenience sampling. However, considering that the standard deviation for pain at its worst is 2.5, utilizing the criteria of half a standard deviation, the minimally important difference is 1.2 points on the MDASI. Thus, we would estimate that each group would need a minimum of 67 patients.²¹

Linear mixed-effects modeling was used to examine the longitudinal change of symptom burden from pain, fatigue and symptom interference during hospitalization (from day of surgery to day 5 post-surgery). To control for other factors that might influence patient reported outcomes, age, performance of cytoreductive surgery, cancer site, estimated blood loss, and surgical complexity score were included in all models. The Wilcoxon test was used to compare the pre-ERAS and ERAS groups with respect to the median time to return to mild or no symptom burden, defined as a score <4 at two consecutive assessments. Kaplan-Meier curves were used to illustrate the time to return to mild or no symptom burden for the two groups.

Compliance with the ERAS pathway was defined as adherence to the recommendations in the published guidelines.^{7,8} We estimated the percent of patients compliant with each of the 20 components of the compliance measure with 95% exact binomial confidence intervals, and we estimated the overall percent compliance with a 95% confidence interval. All statistical analyses were performed using SAS 9.3 for Windows (Copyright © 2002–2010 by SAS Institute Inc., Cary, NC).

Results:

A total of 533 patients (cohort 1), participated in the enhanced recovery pathway compared to 74 patients in the historical control (Table 1) The median age of both groups was 58 years (range; 18–85). There was no difference between the two groups in terms of ethnicity, ASA

or CCI score, BMI, tumor type or indication for surgery. Additionally, there was no difference in receipt of prior chemotherapy or radiation, or history of chronic opioid use. There were racial differences noted between the two groups ($p=0.04$). In the ERAS group, there were more black women (11.2% vs. 2.7%) and more Asian women (4.9% vs. 1.4%). There were fewer white women in the ERAS group (79.9% vs. 96%).

Cohort 2, the subset of patients on ERAS who participated in the collection of patient reported outcomes, ($n=226$) was compared to 67 historical controls (Appendix 1, available online at <http://links.lww.com/xxx>). Similarly, there was no difference in ethnicity, ASA or CCI scores, tumor type or indication for surgery. In the sub-group analysis with cohort 2, there were also no significant differences in history of prior chemotherapy or radiation, or history of chronic opioid use. Similarly to cohort 1, there were differences in race between the two groups with more black women in the ERAS group (13.3% vs. 1.5%). There were fewer intraoperative complications in the ERAS group (3.1% vs. 10.5%, $p=.02$), but no difference between the groups in GI, GU, CNS or hematologic postoperative complications. Estimated blood loss was lower in the ERAS group (250 cc vs 350cc, $p=.04$).

Median operating time for the all patients was 219 minutes, with a median of 236 (range; 98–575 min) for the historical controls and 216 minutes for the ERAS group (range 33–885 min, $p=.02$). Median estimated blood loss for the group was 250 ml, with a median of 400 ml (range; 40–5250 ml) for the control group and 250 ml (range; 5–5500 ml) for the ERAS group, ($p=.01$). The distribution of low, intermediate or high surgical complexity scores did not differ between the ERAS and control groups. There was no significant differences between groups with respect to intraoperative complications.

There was a 25% reduction in median length of stay after surgery for patients in the ERAS pathway (3 vs. 4 days, $p<.001$). There were no significant differences in overall, grade 1–2, or grade 3–4 GI, GU, CNS or hematologic complications between the pre- and post-ERAS patient groups. Reoperation ($p=.12$), readmission ($p=.86$) and 30 day mortality ($p=.99$) rates were similar (Table 1).

Intraoperative and postoperative opioid use was significantly lower in the ERAS group (Table 2 for cohort 1, Appendix 2, available online at <http://links.lww.com/xxx>, for cohort 2). The median intraoperative MEDD for the pre-ERAS group was 102.5 (range; 0–544.5) compared to 62.5 (range; 0–1407.5), representing a 39% reduction ($p<.001$). The reduction in opioid intake was even greater post-operatively (Figure 1a). There was an 83.8% reduction in median MEDD on POD 0 for the ERAS group (49.3 vs. 8, $p<.001$). Median PACU pain scores were improved in the ERAS group (4 vs. 6, $p<.001$). The decreased opioid requirement persisted with an 80.2% reduction on postoperative day 1 with median MEDD (50.6 vs. 10, $p<.001$), a 71.2% reduction on day 2 (26 vs. 7.5, $p<.001$), and a 50% reduction on day 3 (15 vs. 7.5, $p=.003$). Despite the overall 72% reduction in median daily MEDD from POD 0 to POD3 in the ERAS group, pain scores were not significantly higher in the ERAS group ($p=.80$) (Appendix 3, available online at <http://links.lww.com/xxx>). Notably, 86 patients, or 16% of patients on the enhanced recovery pathway were opioid free from the first to third post-operative day, compared to none of the patients in the pre-ERAS cohort, $p<.001$.

Longitudinal assessments of patient reported outcomes were analyzed in the hospital (Figures 2a-c) and after hospital discharge (Figures 3a-c). After pain, fatigue is the most highly ranked symptom in the hospital and rises to the highest ranking symptom after hospital discharge. Fatigue during the hospital stay was significantly lower in the ERAS group, (Figure 2a, $p=.01$). After discharge from the hospital, patients on the enhanced recovery care pathway had a significantly shorter median return to no or mild fatigue, 10 days, (95% CI 6.6 – 13.4 days) vs. 30 days (95% CI 7.6 – 52.4 days), $p=.03$, (Figure 3a).

Self-reported interference with walking during hospitalization was significantly lower in the ERAS group with the greatest difference in the mean seen on post-operative day 1 (Figure 2b, $p=.003$). Total interference score is a calculated composite endpoint of both physical and emotional interference and includes interference scores with work, activity, walking, enjoyment of life, mood, and relations with others. Mean total interference after surgery was also lower in the ERAS group during hospital, (Figure 2c, $p=.008$). After hospital discharge, patients in the ERAS group returned to no or mild (<4) interference with walking at a median of 5 days, (95% CI 2.2–7.8 days) compared to 13 days (95% CI 4.5–21.5 days, $p=.003$) in the pre-ERAS group (Figure 3b). Similar improvements were seen in total interference scores, with the ERAS group reporting a median return to mild or no interference in 3 days, (95% CI 0.54–5.4 days) compared to 13 days, (95% CI 3.6–22.4 days, $p=.02$, Figure 3c).

Compliance with ERAS protocol elements was based on the published guidelines.^{7,8} Details on compliance with any individual element can be seen in Table 3. Overall, 75.2% of patients were compliant with at least 70% of the elements. Only 6 patients (1.1%) were compliant with 50% or fewer of the elements. Although minimally invasive surgery (MIS) is recommended in the guidelines when appropriate and surgical expertise is available, our group of patients included only those undergoing open gynecologic surgery, so compliance with use of MIS is by design nil in this study cohort.

Discussion:

Implementation of a robust ERAS program requires a team approach with active involvement of surgeons, anesthesiologists, nurses, dietitians, pharmacists, along with active engagement of the patient and their non-clinical caregivers. While there are inherent limitations when using historical controls, we did not believe a randomized trial of ERAS would be feasible because of the extensive culture and practice shifts that occur with successful implementation. Therefore, we implemented a multidisciplinary quality-improvement (QI) initiative based on ERAS principles for all patients undergoing laparotomy for gynecologic indications. Initially, only patients undergoing open surgery were included, with a plan to expand to patients undergoing minimally invasive surgery at a later date.

Implementation of ERAS programs coupled with a continuous performance audit represents an effective approach to embracing multi-disciplinary changes aimed to improve the delivery of surgical care. We have demonstrated how implementation of an enhanced recovery program for patients undergoing open abdominal surgery for gynecologic indications can

improve patient reported outcomes and significantly decrease the rate of intraoperative and postoperative opioid consumption without compromising pain control. Increasing compliance with individual ERAS protocol elements has been associated with reductions in length of stay and other postoperative complications.²² We demonstrated a high level of compliance with the ERAS pathway which decreased length of stay without increasing complications. A significant proportion of patients undergoing open surgery for gynecologic malignancies will require post-operative chemotherapy or radiation. Delays in initiating adjuvant therapy have been associated with decreased survival in multiple cancer types, including gynecologic cancers.^{23–25} In colorectal surgery, improvements in 5-year survival were documented in patients who had high levels of compliance with ERAS protocols.²⁶ Therefore, improvements in postoperative recovery may be especially meaningful in an oncologic patient population.

Multiple studies across disease sites and procedures have demonstrated improvements to patients on enhanced recovery programs, including decreased length of stay (LOS), complications, cost,^{27–30} as well as an association with improved survival.^{26,31} While our findings such as 25% reduction in length of stay with no increase in complication or readmission rates are similar to other findings and contribute to the growing literature on the affects of ERAS programs, the unique contribution of our study lies in the demonstration of “enhanced recovery” from the patient perspective, with improvement in patient reported outcomes such as fatigue, walking and total interference after surgery. The MDASI interference score has been validated as a measure of symptom-related functional impairment in cancer patients after surgery.³² Interference with walking has been further described as a sensitive marker for functional recovery after surgery.³³ We found significant improvements both in the hospital and faster return to mild or no symptoms after hospital discharge for both walking, and total interference score, a composite score that includes interference with work, activity, walking, enjoyment of life, mood, and relations with others.

A possible contributing factor to the demonstrated “enhancement” in recovery may be the decrease in opioid use and the effect it had on patients’ symptoms and functional recovery. In our patient population, we demonstrated a striking 72% reduction in median opioid intake in patients on our ERAS pathway without an increase in patient-reported pain scores. Additionally, 16% of our patients who underwent a laparotomy on an ERAS pathway were opioid free during their hospital stay from the day of surgery up to POD 3. This reduction in opioid intake and its related side effects likely contributed to the improvements identified in symptom burden and functional recovery. The Surgeon General has named the opioid epidemic as a major public health concern.³⁴ Data suggests that those who receive an opioid prescription after surgery are 44% more likely to become long-term opioid users.³⁵ For certain individuals with opioid overuse disorder, opioid pain medications prescribed after surgery provided their first exposure that develops into addiction.³⁶ Implementation of multi-modal analgesia through our enhanced recovery program was associated with both statistically and clinically meaningful decreases in opioid use and aligns with guidelines for safe and effective postoperative pain management.³⁷ The Center for Medical Technology Policy has called for an “order-of-magnitude” change in U.S. adoption of enhanced recovery programs in order to dramatically reduce preventable complications and deaths for future surgical patients.³⁸ Our findings suggest that not only can an ERAS program be safe and

effective in the immediate and extended postoperative period, but from a patient's point of view, physical and affective aspects of recovery are improved. The reduction in opioid use within an enhanced recovery pathway is also an important contribution to multi-pronged efforts aimed to address the growing opioid epidemic³⁹ and improved symptoms and functional recovery after surgery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Morphine equivalent dose (postanesthesia care unit and inpatient unit). The median is shown as a *bold horizontal bar* across the waist of the box, while the *top of the box* represents the third quartile of the distribution, and the *bottom of the box* represents the first quartile of the distribution. The *notches on the box* represent the 95% CI for the median. The *whiskers for each box* extend to $1.5 \times \text{IQR}$ above and below the box, with a lower limit of 0. Outliers are represented by *small circles* beyond the whiskers. For aesthetic reasons, the extreme outliers beyond 250 are omitted from the figures. The width of a box is proportional to the sample size of the distribution represented by the box. For postoperative day 1 and 2 ($P < .001$), and for postoperative day 3 ($P = .003$).

A **B** **C**

Figure 2. Longitudinal assessment of fatigue during hospital stay ($P=.01$) (A), in-hospital interference with walking ($P=.003$) (B), and daily total interference composite score during hospital stay ($P=.008$) (C). Line with bar represents mean and 95% CI. P values calculated from mixed effect model. ERAS, enhanced recovery after surgery.

Figure 3.

Time to recovery. **A.** Return to mild or none (<4) of fatigue level after discharge after surgery ($P=.03$). **B.** Return to mild or none (<4) of interference with walking after discharge after surgery ($P=.003$). **C.** Return to mild or none (<4) of composite total interference score after discharge after surgery ($P=.02$). ERAS, enhanced recovery after surgery.

Table 1.

Demographics, clinical characteristics, and perioperative outcomes

	Pre-ERAS (N=74)	ERAS (N=533)	p-value
Age-yr, median (min-max)	58 (32–85)	58 (18–84)	0.67
BMI (kg/m ²)- no.(%)			0.58
< 18.5	1 (1.4)	7 (1.3)	
18.5 – 24.9	17 (23.0)	170 (31.9)	
25.0 – 29.9	27 (36.5)	155 (29.1)	
30.0 – 34.9	13 (17.6)	95 (17.8)	
35.0 – 39.9	8 (10.8)	45 (8.4)	
40	8 (10.8)	61 (11.4)	
Ethnicity-no.(%)			0.73
Not Hispanic or Latina	61 (82.4)	432 (81.0)	
Hispanic or Latina	13 (17.6)	83 (15.6)	
Not Reported	0 (0.0)	18 (3.4)	
Race-no.(%)			0.04
American Indian / Alaska Native	0 (0.0)	3 (0.6)	
Asian	1 (1.4)	26 (4.9)	
Native Hawaiian or Other Pacific Islander	0 (0.0)	1 (0.2)	
Black or African American	2 (2.7)	60 (11.2)	
White	71 (96.0)	426 (79.9)	
Not Reported	0 (0.0)	17 (3.2)	
ASA Score -no.(%)			0.11
I	0 (0.0)	2 (0.4)	
II	14 (18.9)	51 (9.6)	
III	58 (78.4)	451 (84.6)	
IV	1 (1.4)	11 (2.0)	
Not Reported	1 (1.4)	18 (3.4)	
Charlson Comorbidity Index-no.(%)			0.98
0	6 (8.1)	44 (8.3)	
1 – 2	28 (37.8)	206 (38.6)	
3	40 (54.1)	283 (53.1)	
Tumor Type-no.(%)			0.06
Malignant – Primary	50 (67.6)	329 (61.7)	
Malignant – Recurrent	10 (13.5)	82 (15.4)	
Neoplasm UMP – Primary	2 (2.7)	35 (6.6)	
Neoplasm UMP – Recurrent	3 (4.1)	1 (0.2)	
Benign	8 (10.8)	80 (15.0)	
None	1 (1.3)	6 (1.1)	

	Pre-ERAS (N=74)	ERAS (N=533)	p-value
Indication for surgery * -no.(%)			
Benign	8 (10.8)	80 (15.0)	0.30
Cervical Cancer	2 (2.7)	23 (4.3)	0.76
Ovarian/Fallopian Tube/ Primary Peritoneal Cancer	48 (64.9)	288 (54.0)	0.08
Uterine cancer (non-sarcoma)	7 (9.5)	82 (15.4)	0.22
Uterine sarcoma	2 (2.7)	19 (3.6)	0.99
Other	11 (14.9)	54 (10.1)	0.23
Chronic Opioid User	3 (4.1)	25 (4.7)	0.99
Prior Chemotherapy	31 (41.9)	239 (44.8)	0.71
Prior Radiation	3 (4.1)	24 (4.5)	0.99
Surgical complexity score †-no.(%)			0.07
Low	23 (47.9)	179 (62.2)	
Intermediate	21 (43.8)	100 (34.7)	
High	4 (8.3)	9 (3.1)	
Operating Time (min)-median (min-max)	236 (98–575)	216 (33–885)	0.02
Estimated Blood Loss (ml)-median (min-max)	400 (40–5250)	250 (5–5500)	0.01
Length of Stay (days) -median (min-max)	4 (2–29)	3 (1–57)	< 0.001
Readmission-no.(%)	10 (13.5)	70 (13.1)	0.86
Reoperation -no.(%)	4 (5.4)	12 (2.3)	0.12
Intra-Operative Complications-no.(%)	7 (9.5)	27 (5.1)	0.17
Mortality within 30 Days-no.(%)	0 (0.0)	1 (0.2)	0.99
GI Complications within 30 Days-no.(%)	22 (29.7)	133 (25.0)	0.39
Grade 1–2	20 (27.0)	121 (22.7)	0.46
Grade 3–4	2 (2.7)	12 (2.3)	0.68
GU Complications within 30 Days-no.(%)	16 (21.6)	102 (19.1)	0.64
Grade 1–2	15 (20.3)	97 (18.2)	0.53
Grade 3–4	1 (1.4)	5 (0.9)	0.54
CNS Complications within 30 Days-no.(%)	4 (5.4)	10 (1.9)	0.08
Grade 1–2	4 (5.4)	9 (1.7)	0.06
Grade 3–4	0 (0.0)	1 (0.2)	0.99
Hematologic Complications within 30 Days-no.(%)	12 (16.2)	68 (12.8)	0.46
Grade 1–2	12 (16.2)	66 (12.4)	0.36
Grade 3–4	0 (0.0)	2 (0.4)	0.99

* Patients may have had more than one indication for surgery

† Reported for patients with indication for surgery of Ovarian, Fallopian Tube or Primary peritoneal cancer.

Table 2.**Opioid Use (Including Chronic Opioid Users)**

	Pre-ERAS	ERAS	p-value	% Reduction
<u>Intra-Operative</u>				
POD 0				
N	74	533		
Median	102.5	62.5	< 0.001	39.0%
Min – Max	0 – 544.5	0 – 1407.5		
<u>PACU</u>				
POD 0				
N	74	532		
Median	5.0	5.0	0.78	0.0%
Min – Max	0 – 62.5	0 – 65.0		
POD 1				
N	9	52		
Median	0	0	0.54	0.0%
Min – Max	0 – 15	0 – 68.2		
Total				
N	74	532		
Median	5.0	5.0	0.68	0.0%
Min – Max	0 – 62.5	0 – 98.5		
NOTE: One patient (298) discharged to ICU rather than PACU is excluded from PACU opioids.				
<u>Inpatient Unit</u>				
POD 0				
N	74	533		
Median	41.0	0	< 0.001	100.0%
Min – Max	0 – 637.5	0 – 362.3		
POD 1				
N	74	533		
Median	50.6	7.5	< 0.001	85.2%
Min – Max	0 – 843.0	0 – 529.1		
POD 2				
N	74	510		
Median	26.0	7.5	< 0.001	71.2%
Min – Max	0 – 752.6	0 – 250.9		
POD 3				
N	70	338		
Median	15.0	7.5	0.003	50.0%
Min – Max	0 – 481.0	0 – 205.0		
<u>PACU + Inpatient Unit</u>				
POD 0				
N	74	533		

	Pre-ERAS	ERAS	p-value	% Reduction
Median	49.3	8.0	< 0.001	83.8%
Min – Max	0 – 637.5	0 – 362.3		
POD 1				
N	74	533		
Median	50.6	10.0	< 0.001	80.2%
Min – Max	0 – 843.0	0 – 529.1		
POD 2				
N	74	510		
Median	26.0	7.5	< 0.001	71.2%
Min – Max	0 – 752.6	0 – 250.9		
POD 3				
N	70	338		
Median	15.0	7.5	0.003	50.0%
Min – Max	0 – 481.0	0 – 205.0		
MED per Day				
N	74	533		
Median	38.3	10.6	< 0.001	72.3%
Min – Max	1.9 – 633.7	0 – 310.6		

Table 3.

Percent of Patients Compliant with ERAS Components

Compliance Component	% Compliant		
	%	95% CI	
Preoperative Counseling	40.9	36.7	45.2
Preoperative Optimization	1.3	0.5	2.7
No Solid Food Past Midnight	99.8	99.0	100.0
No Bowel Preparation	99.8	99.0	100.0
Preoperative Antibiotics	99.1	97.8	99.7
Preoperative Heparin	94.6	92.3	96.3
No Midazolam *	27.6	23.8	31.6
Short Acting Anesthetics	28.1	24.4	32.2
Surgical Approach (MIS)	0.0	0.0	0.7
No Drains at Surgery	86.3	83.1	89.1
Goal Directed Therapy	62.5	58.2	66.6
Maintenance of Normothermia	99.8	99.0	100.0
Preoperative PONV Prophylaxis	99.3	98.1	99.8
No Nasogastric Tube	99.3	98.1	99.8
Postoperative Glucose Control	99.4	98.4	99.9
Avoidance of Salt and Water Overload	70.9	66.9	74.7
Urinary Catheter Placed & Removed within 1 Day	85.9	82.7	88.8
Days to Ambulation 1	87.4	84.3	90.1
Days to Intake of Regular Diet 1	63.6	59.4	67.7
Multimodal Postoperative Analgesia	97.8	96.1	98.8

* Includes patients who did not receive midazolam or was contraindicated