HHS Public Access

Author manuscript

Am J Obstet Gynecol. Author manuscript; available in PMC 2020 May 11.

Published in final edited form as:

Am J Obstet Gynecol. 2018 November ; 219(5): 495.e1–495.e10. doi:10.1016/j.ajog.2018.06.009.

Implementation of an Urogynecology-Specific Enhanced Recovery After Surgery (ERAS) Pathway

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Abstract

Objectives—ERAS protocols were developed for colorectal surgery to hasten post-op recovery. Variations of the protocol are being adopted for gynecologic procedures despite limited population and procedure-specific outcome data. Our objective was to evaluate if implementation of an ERAS pathway would facilitate reduced length of admission in an urogynecology population.

Materials and Methods—In this retrospective analysis of patients undergoing pelvic floor reconstructive surgery by 7 female pelvic medicine and reconstructive surgeons we compared same day discharge, length of admission and post-op complications before and after implementation of an ERAS pathway at a tertiary-care hospital. Groups were compared using $\chi 2$ and t-tests. Candidate variables that could impact patient outcomes with $p < .2$ were included in

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The authors report no disclosures.

multivariable logistic regression models. Satisfaction with surgical experience was assessed using a phone administered questionnaire the day after discharge.

Results—Mean age and BMI of 258 women (137 pre-ERAS and 121 ERAS) were 65.5±11.3 years and 28.2±5.0 kg/m^2. The most common diagnosis was pelvic organ prolapse (n=242, 93.8%) including stage III POP (n=61, 65.1%). Apical suspension procedures included: 58 (25.1%) transvaginal, 112 (48.8%) laparoscopic/robotic and 61 (26.4%) obliterative. Hysterectomy was performed in 57.4% of women. Demographic and surgical procedures were similar in both groups. Compared to pre-ERAS, the ERAS group had a higher proportion of same day discharge (25.9% vs 91.7%, p<.001) and a 13.8-hour shorter duration of stay (25.9±13.5 vs 12.1±11.2 hours, p<.001). Operative and post-surgical recovery room time were similar (2.6±0.8 vs 2.6±0.9 hours, p=.955; 3.7±2.1 vs 3.6±2.2 hours, p=.879). Women in the ERAS group were more likely to be discharged using a urethral catheter (57.9% ERAS vs 25.4% pre-ERAS, p=.005).

There were no group differences in total 30-day post-operative complications overall and for the following categories: UTIs, emergency room visits, unanticipated office visits and return to OR. However, ERAS patients had higher 30-day hospital readmission rates (n=8, 6.7% vs n=2, 1.5%, p=.048). Pre-ERAS patients were readmitted for myocardial infarction and chest pain. ERAS patients were admitted for weakness, chest pain, hyponatremia, wound complications, nausea/ileus, and ureteral obstruction. Three ERAS patients returned to the operating room for ureteral obstruction (n=1), incisional hernia (n=1), and vaginal cuff bleeding (n=1). ERAS patients also had more post-operative nursing phone notes (2.6±1.7 vs 2.1±1.4, p=.030).

On multivariable logistic regressions adjusting for age and operative time, same day discharge was more likely in the ERAS group (OR 32.73, 95%CI [15.23, 70.12]) while the odds of post-operative complications and emergency room visits were no different. After adjusting for age, operative time, and type of prolapse surgery, readmission was more likely in the ERAS group (OR 5.7, 95%CI [1.1–28.1]).

In the ERAS group, patient satisfaction (n=77/121) was reported as very good or excellent by 86.7% for pain control, 89.6% for surgery preparedness, and 93.5% for overall surgical experience; 89.6% did not recall any post-op nausea during recovery.

Conclusion—ERAS implementation in an urogynecology population resulted in a greater proportion of same day discharge and high patient satisfaction but with slightly increased hospital readmissions within 30 days.

Condensation

Amongst older women undergoing elective, pelvic floor reconstructive surgery, ERAS implementation reduced admission by 13 hours, increasing same day discharge with high satisfaction and surgery preparedness.

Keywords

enhanced recover after surgery; pelvic organ prolapse; pelvic floor reconstructive surgery; same day discharge

INTRODUCTION

Enhanced Recovery After Surgery (ERAS), a multi-disciplinary care pathway composed of evidence-based interventions, has challenged the traditional peri-operative care paradigm with a goal of enhancing recovery and improving peri-operative outcomes (1). Central to ERAS are the core components of patient education, pre-operative optimization, avoidance of pre-operative fasting, carbohydrate loading, intra-operative euvolemia, standardized opioid sparing anesthesia, prevention of post-operative pain and nausea, and early mobilization (1, 2). The first pathway was developed in Europe for colorectal surgery and has since been adapted for other surgical specialties, including gynecology (3, 4). The most studied population in gynecology are oncology patients undergoing laparotomies with hospitalizations greater than 2 days (5, 6). After ERAS implementation these patients experienced decreased length of admission, hastened return of bowel function, and decreased narcotic use resulting in better post-operative pain control and high patient satisfaction (1, 7, 8).

The benefits of ERAS are less clear in older patients undergoing prolapse procedures who are routinely admitted for 23-hour observation and experience low post-operative morbidity compared to gynecologic oncology patients. We hypothesized that adopting an ERAS protocol for the urogynecology service would lead to reduced length of stay and ultimately increase day of surgery discharges. While same day discharge has gained popularity for hysterectomy alone it has yet to be adopted in women undergoing major pelvic organ prolapse (POP) procedures. Studies examining the effects of ERAS after POP surgeries fail to demonstrate a reduced length of admission to less than one day (1, 9).

The objective of this study is to evaluate if implementation of a unique urogynecology ERAS pathway is associated with a reduction in the length of admission and increased same day discharge (SDD) after pelvic floor reconstructive surgery.

METHODS

We conducted a retrospective, observational cohort study of women who underwent elective major surgery by 7 surgeons of the urogynecology teaching service at Magee-Womens Hospital of UPMC, a tertiary care institution, before and after implementation of an urogynecology-specific ERAS pathway. Over a year period, a multi-disciplinary team within our health care system worked to create the ERAS pathway. Due to the scarcity of existing urogynecology or minimally invasive gynecologic surgery ERAS protocols at the time our protocol was developed, we created our own protocol adapted from colorectal surgery, urology, and gynecologic oncology data along with experiences of our ERAS leaders.

The core components of our ERAS protocol are listed in Table 1. Patients attended a pre-operative office visit or phone call 1–3 weeks before surgery. A Physician's Assistant, fellow, surgeon or nurse conducted these individual appointments. The overarching goal of the visit was to engage patients in their recovery process, provide education on pre-operative optimization, review the goals of ERAS including SDD, and identify patients' post-operative expectations. Avoidance of pre-operative fasting is a principle component of ERAS and one

of the largest changes in practice for our institution (10, 11). In our ERAS pathway, we adopted a liberalized fluid policy following the American Society of Anesthesiology recommendations of clear liquids up until 3 hours before surgery (12). In addition, we encouraged carbohydrate loading the day before and day of surgery to prevent insulin resistance seen with fasting (13, 14). Patients were advised to consume 20–40 ounces of an electrolyte supplemented sports drink with 45-grams of carbohydrates the day before surgery and 20 ounces of sports drink up to 3 hours prior to surgery. Patients were also encouraged to ambulate for 30 minutes daily. At the end of each visit patients were provided with an institutionally authored brochure outlining the principles of ERAS.

The cohort was created by merging two de-identified pre-existing databases which contained women who had surgery prior to and after implementation of the ERAS pathway. The pre-ERAS database included all consecutive patients who had elective major procedures by 7 surgeons board certified in female pelvic medicine and reconstructive (FPMRS) from January 1, 2016- June 31, 2016. Eligibility criteria were major pelvic floor reconstructive surgery including an apical suspension procedure or obliterative procedure and/or hysterectomy during the specified timeframe. Exclusion criteria were minor procedures, such as isolated anterior or posterior colporrhaphies, isolated incontinence procedures, or minor laparoscopic procedures such as salpingectomy or excision of endometriosis. Data were collected retrospectively in a previous study. Women were identified from the surgical services calendar and data were extracted from the electronic medical record (EMR) clinic notes, operative reports, anesthesia records, admission records, and emergency department records by chart review. The timeframe for data collection was from baseline pre-operative appointment through 30 days post-operatively. Variables collected were demographic factors, medical history, baseline exam findings, operative procedures, anesthesia, peri-operative medications, post-operative complications, unplanned visits, post-operative nursing calls and pain scores.

The 8-month period preceding ERAS implementation was excluded due to potential crossover influences of the ERAS planning meetings and the initiation of ERAS protocols for two other gynecologic surgery services (gynecologic oncology and minimally invasive gynecologic surgery) prior to urogynecology.

The post-ERAS implementation database included all consecutive patients who had elective major gynecologic surgery by one of 5 FPMRS surgeons from February 2, 2017 to July 31, 2017. Data were collected prospectively as part of a quality improvement initiative within our division to track outcomes after implementation of ERAS. Data collected were similar to the pre-ERAS database and were extracted from the EMR. In addition, two unique, non-validated, study-specific instruments were administered prospectively in this group. The first was a patient completed paper questionnaire administered in the pre-operative area the day of surgery to identify compliance with pre-operative ERAS education and specific pre-admission ERAS recommendations, such as exercise, hydration, nutrition, bowel preparation and fasting. The second questionnaire was administered by office nurses at the time of the standard post-operative call, typically the day after discharge, to assess satisfaction with the surgical experience and their recollection of nausea and pain control while in the hospital.

The post-operative questionnaire was developed 2 months after initiation of ERAS as part of a quality improvement initiative.

We hypothesized that ERAS implementation would increase the proportion of patients discharged on the day of surgery by 18% and 30-day complications would not increase by more than 10%. To be discharged from the PACU, patients had to meet all of the following criteria: pain < 3, tolerate juice and crackers, no nausea or emesis, ambulate independently, spontaneously voiding or with a catheter plan, and have a WAKE© score ≥ 9. The primary outcome was length of admission, which was measured in two ways. First, as a continuous variable comparing admission length in hours pre- and post- ERAS implementation. Then as a binary variable, overnight admission, comparing proportions of patients admitted overnight after surgery pre- and post- ERAS implementation. We also assessed 30-day complication rates pre- and post- ERAS implementation. Total 30-day complications were a composite of intra-operative complications, hospital complications, post-operative complications, ED visits, unanticipated office visits, readmission to the hospital, urinary tract infection, and re-operation within 30 days of the index surgery. Complications were defined as any aberration from the standard recovery course. Other important secondary outcomes were spontaneous void at discharge and patient post-operative calls. We performed multivariable regression for the following dependent variables to control for potential confounding variables: post-operative recovery unit time, length of admission, overnight admission, 30-day post-discharge complications, 30-day emergency visits, and 30-day readmission. Lastly, we assessed patient outcomes including satisfaction, pain control and post-operative nausea in the patients post ERAS implementation.

We hypothesized that ERAS would improve SDD rates, increasing the proportion of women discharged the day of surgery by 18% in the ERAS group. In November 2016 the overnight admission rate within our division was 63.1%. Therefore, multiple estimates were created based on the range of pre-ERAS proportions. Using the most conservative estimates, we estimated 97 women were required in each group to detect a decrease in overnight admission from 63.1% to 48.0% with 80% power at a two-sided alpha 0.05.

Results are presented as means ± standard deviation for continuous, normally distributed variables, medians (interquartile range) for nonnormal data, and frequencies (percentages) for categorical variables. Continuous variables were analyzed using Student’s t test for normally distributed data and Wilcoxon’s rank sum test for nonparametric data. Categorical variables were analyzed using $\chi 2$ or Fisher exact test, as appropriate. For both multivariable logistic and linear regression analyses candidate covariates tested were determined a priori due to their potential to impact or confound the outcomes. These variables included: type of prolapse procedure, concomitant hysterectomy, length of surgery, age, medical co-morbidities, and case order. Regression models were fit with backwards removal and confirmed with forward addition techniques. Results are presented as beta coefficients with p-values and odds ratios with 95% confidence intervals, for linear and logistic regressions, respectively. Strengthening the reporting of the observational studies in Epidemiology (STROBE) guidelines were strictly followed. This study was approved by the University of Pittsburgh Institutional Review Board (9/1/17). Analyses were performed using SAS Version 9.3, Carey SC.

RESULTS

During the study period, 258 women met inclusion criteria. There were 137 (53%) women pre-ERAS and 121 (47%) after ERAS implementation. Mean age and BMI were 65 ±11 years and 28.2±5.0 kg/m^2, respectively. Most were menopausal (n=224, 86.8%), non-smoking (n=239, 92.6%), and Caucasian (n=248, 96.1%). Women pre-ERAS were more likely to have cardiac disease, anxiety, and previous pelvic surgery (all p <.05) and less likely to have diabetes (5.8% vs 18.2%, p=.003). The most common indication for surgery was Stage III POP (n=168, 65.1%) followed by Stage II POP (n=52, 20.2%). Baseline characteristics for the pre- and post-ERAS groups are listed in Table 2.

Most patients (n=242, 93.8%) underwent major prolapse procedures, a concomitant hysterectomy was performed in 135 (55.8%). The most common procedure was a laparoscopic or robotic sacrocolpopexy followed by transvaginal obliterative procedures. Fourteen (5.4%) underwent a hysterectomy with minor POP procedures and 13 (5.0%) hysterectomy alone. There were no group differences in procedures performed, except for levator myorrhaphy which was more commonly performed in the ERAS group (Table 2). More patients in the ERAS group had general anesthesia (93.4% vs 83.2%, p=.037). Other surgical variables including operative and total procedure times, estimate blood loss (EBL), intravenous fluids, local anesthetic used for wound infiltration, and intra-operative complications were similar between groups (Table 2).

ERAS implementation significantly decreased length of hospital admission. Prior to ERAS, 25.9% (n=35) women were discharged the day of surgery compared to 91.7% (n=111) post-ERAS implementation (p<.001). The length of admission measured as the time from intake assessment to discharge decreased by 46.7% after ERAS implementation (12.1 ± 11.2 vs 25.9 ± 13.5 hours, Δ −13.8 hours, p<.001).

Total 30-day complications were similar pre- and post- ERAS implementation (Table 3). After analyzing each complication separately, we found urinary tract infection, ED visits, unplanned office visits, and re-operation rates were unchanged after ERAS implementation. Post-discharge complications, which reflected any aberrations from normal post-operative recovery were not different after ERAS (17 [14.3%] vs 12 [8.8%], p=.164). These included voiding dysfunction (n=7), wound complications (n=10), angina/cardiac arrhythmias (n=3), postoperative nausea/ileus (n=10), hematoma (n=3), vertigo (n=1), and ureteral obstruction (n=1).

More women in the ERAS group were readmitted to the hospital within 30 days of surgery (8 [6.7%] vs 2 [1.5%], p=.030). Pre-ERAS patients were readmitted for a myocardial infarction and chest pain. ERAS patients were admitted for weakness, chest pain, hyponatremia, wound complications (n=3), post-operative nausea/ileus, and ureteral obstruction. Three of the patients readmitted in the ERAS group returned to the operating room for ureteral obstruction (n=1), incisional hernia (n=1), and vaginal cuff bleeding (n=1). In addition, ERAS women were more likely to have urinary retention at the time of discharge (42.1% vs 23.6%, p=.005). When compared to the pre-ERAS group, the ERAS patients were more likely to have transient urinary retention at discharge managed with an

indwelling catheter as opposed to clean-intermittent self-catheterization, (17.7% vs 42.3%, p=.017).

Multivariable regressions were performed to determine which covariates impacted post-operative outcomes. We found after adjusting for age and operative time, same day discharge was more likely after ERAS implementation (OR 32.73, 95%CI [15.23, 70.12]; Table 4). In the regression for length of stay when we adjusted for age, BMI, medical co-morbidities and total operative time, ERAS implementation decreased length of admission by 13.62 hours (95%CI [−16.6, −.61]; Table 5). In another model that adjusted for age, operative time, and type of prolapse surgery, readmission was more likely after ERAS implementation (OR 5.7, 95%CI [1.1, 28.1]; Table 6). The odds of post-op complications and emergency room visits were no different in adjusted models.

Groups differed in the timing and frequency of post-operative nursing calls. The median day of the call was post-operative day 2 (IQR 2) in the pre-ERAS group and post-operative day 1 (IQR 1) in the ERAS group (p <.001), which reflects our standard practice of calling patients the day after discharge from the hospital. Mean patient reported pain scores at the post-operative call were similar between groups (3.63±1.85 pre-ERAS vs 3.37± 2.01 ERAS, p=.301). A questionnaire of patient perception regarding their surgical experience was administered to ERAS patients during the post-operative call. Due to the delay in development it was administered to 77 (63.6%) of the ERAS group. Most women reported very good or excellent overall surgical experience (n=72/75, 93.5%), very good or excellent pain control (n=65/75, 86.7%) and feeling prepared for their surgery (n=69/77, 89.6%). Approximately 90% (n=69/77) of women did not recall experiencing any nausea during their post-operative recovery.

COMMENTS

In the current study, we found implementation of an urogynecology-specific ERAS protocol reduced the duration of our surgical admissions by 13.8 hours. This reduction contributed to a commensurate increase in day of surgery discharge from 25.9% to 91.7%, an improvement well beyond the 18% hypothesized. Prior to our institutional launch of ERAS, it was routine for patients undergoing major POP procedures to have an overnight admission. Our urogynecology ERAS pathway is unique from others reported in literature in that one goal was to decrease length of admission to less than one day. In our review of ERAS, no study had demonstrated ERAS could meaningfully reduce the length of stay in women undergoing POP repairs. Kalogera and colleagues analyzed a subset of patients undergoing vaginal prolapse repair surgery. They reported a 0.5-day reduction in length of stay post-ERAS implementation, however total length of admission remained greater than 2 days which exceeded our pre-ERAS statistics (6). In a study by Modesitt, authors found there was no decrease in the 1 day length of admission after ERAS implementation in women undergoing minimally invasive hysterectomy (9).

We attribute the significant decrease in length of stay in our study to the universal adoption of all ERAS components by nursing, anesthesia, pharmacy, surgeons and support staff in conjunction with an ongoing departmental quality initiative to reduce surgically associated

morbidity and costs by increasing minimal access surgery and reducing laparotomies (15–19). The yearlong development of our ERAS pathways occurred in parallel with this quality improvement initiative. During that time, gynecologic surgeons identified nausea, somnolence, and urinary retention in the immediate recovery period as barriers to earlier discharge. ERAS which included pre-surgical education and patient optimization, euvolemia and avoidance of opioids through use of multi-modal pain interventions, was viewed as a potential solution to the hurdles challenging same day discharge (1). Though other studies of ERAS in urogynecology patients observed modest reductions in length of stay, none reported a goal of same day discharge. From the first discussion with patients regarding surgery, we presented prolapse repairs as “outpatient” surgery. This expectation was reiterated at pre-operative appointments and reinforced the day of surgery to the patient, their family, and the anesthesia staff. Adoption of ERAS changed the model of peri-operative care delivered within our institution by integrating all services. This change cannot be attributed to a single component or intervention but rather the universal and comprehensive adoption of ERAS at every level of care in the patient’s surgical experience from the time when surgery was introduced to the 4-week post-surgical office visit. Changing patient expectations along with the change in peri-operative care worked concomitantly as part of the same intervention resulting in significant decrease in length of stay.

The most important determinant of successful ERAS implementation was the leadership, teamwork, universal willingness to change established practices, along with institutional support. The leadership team had previously implemented a successful colorectal ERAS pathway at a sister hospital. We used their expertise along with insights from our group of local stakeholders in nursing, pharmacy, home health, social work to develop a subspecialty specific ERAS. To operationalize ERAS, we staggered launches for the various surgical specialties to allow for small, incremental changes to be made. The institution’s staged approach provided opportunity for refinement, which dampened the learning curve for each subsequent service brought onto ERAS. In addition, synergistic programs such as the delivery of medications to patients prior to discharge and reliable home health service the day after discharge provided patient convenience and safety nets. These complemented pre-operative education and establishment of expectations.

After ERAS implementation, we found 90% of women felt their preparation for surgery was very good or excellent based on the information they received from our office. A Cochrane meta-analysis found that there may be benefit to pre-operative formal education on post-operative outcomes of pain, length of stay, and recovery (20). Unfortunately, we do not have data on preparedness from the pre-ERAS group for comparison. Our results are similar to those found by Kalogera, who also found high rates of preparedness after receiving ERAS education pre-operatively (6).

Avoidance of pre-operative fasting and carbohydrate loading are principle components of ERAS (1). This was a radical change at our institution where NPO status was mandated from midnight the night before surgery. Our group comparisons are reassuring in that they did not identify any cases of aspiration pneumonia, the basis for the fasting mandate. This is consistent with a systematic review which found that fasting did not decrease aspiration,

regurgitation, or any other morbidities after elective surgery (11). In addition, pre-operative carbohydrate loading increased insulin sensitivity, slightly decreased hospital stay, and decreased time to flatus while rates of complications were unchanged (14).

ERAS was not associated with an increase in 30-day complications. However, we report 30% of women experience at least one complication, which is higher than reported in the literature (6, 9). This may reflect our broad definition of adverse events which included unplanned post-discharge outpatient visits. We found 1 in 5 women returned to office for an appointment other than their scheduled post-operative visit. Many studies report on emergency department visits and readmissions, but data is lacking on office visits. We included these as they result in an increased burden to the healthcare system and patients. Efforts are ongoing to better characterize the indications for extra visits and associated patient characteristics to inform on strategies to reduce this burden.

While length of admission decreased, readmissions increased by an additional 6 patients from 1.5% to 6.7% after implementation of ERAS. The rate of readmission is low and consistent with a similar sized cohort of ERAS women undergoing minimally invasive gynecologic surgery after ERAS implementation, which reported 6.8% (9). Our small dataset precludes our ability to assign attribution to specific components of ERAS, the abbreviated hospital admission, or other factors not accounted for in this observational study design. The indications for reoperation in 3 women cannot plausibly be related to ERAS. Further prospective research is needed using more robust data to identify patients that do not benefit from ERAS or are at greater risk for readmissions or reoperation after ERAS.

Our study is limited by its retrospective, observational design. As we mentioned one of the main goals for implementing ERAS at our institution was to enable more women to experience the benefits of shorter hospitalizations after elective surgery. We achieved this through a broad culture shift in peri-operative care. In addition to the ample nursing, pharmacy and social work resources, our practice instituted mandatory pre-operative appointments and preemptive phone calls after discharge. We recognize that this level of nursing support may not be available in some offices. Future cost effectiveness analyses may provide compelling support for broader adoption of these resources. We are unable to discretely account for the contributing influence of a concurrent department-wide initiative to decrease length of stay. Nor can we distinguish amongst all the ERAS elements, how much the establishment of patient expectations influenced our outcomes. Also, inherent to this design is the inability to distinguish correlation from association between the outcome and intervention. However, a randomized trial with the intervention being ERAS, a group of interventions, versus traditional care would be expensive and difficult as the benefits of ERAS are being widely reported and are likely influencing care. To control for selection bias, we included consecutive patients in each cohort and performed adjusted multivariable analyses. Lastly, we were not powered to detect small differences in secondary outcomes such as adverse events or perioperative morbidity.

In conclusion, we found that implementation of an urogynecology-specific ERAS pathway was associated with decreased length of admission, increase in the day of surgery discharge with high patient satisfaction and preparedness amongst older women undergoing pelvic

floor reconstructive surgery. Though we did not detect a difference in 30-day complications after implementation of ERAS, our observed increase in 30-day hospital readmissions in our small sample size warrants further scrutiny. We continue our surveillance of adverse sequelae in a quality improvement program to further assess potential risks of ERAS and same day discharge in our urogynecology population.

Acknowledgments

Funding sources: The project described was supported by the National Institutes of Health through Grant Number UL1TR001857.

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Implications and Contributions

A. This study aims to determine the clinical implications of adopting an urogynecology-specific ERAS pathway.

B. ERAS implementation reduced length of admission by 13.8 hours and increased same day discharge from 25.9% to 91.7%; while 30-day complications were unchanged

C. ERAS outcomes in this population have yet to be reported and add to the limited literature on ERAS after pelvic floor reconstructive surgery.

Table 1.

ERAS Components

PREOPERATIVE OPTIMIZATION	
Assessment	Pre-operative office visit or phone call Screen for chronic conditions and assess optimization for surgery Screen for tobacco & alcohol abuse Assess for weight loss & malnutrition Assess post-operative nausea and vomiting risk using simplified Apfel criteria
Education	Tobacco & alcohol cessation 4–6 weeks prior to surgery ERAS pathway Peri-operative expectations, reinforcing the patient's role in their own recovery Provide ERAS brochure and nutrition patient information
Exercise	30 minutes of walking daily until surgery
Diet	Protein and carbohydrate rich foods 1 week prior to surgery Regular diet until midnight the night before surgery Clear liquids until 3 hours prior to surgery - Clear liquids include: water, black coffee or clear tea, carbonated beverages, fruit juice without pulp, or Gatorade - Patients with diabetes – avoid sugar containing liquids
Verification	Preoperative phone call the day prior to surgery NPO instructions reviewed Medications reviewed Shower with soap the night before surgery
DAY OF SURGERY	
Pre-operative	Multimodal pain management: - Celecoxib 400 mg PO (200mg if age > 65); omit if GFR <60 - Acetaminophen 1000 mg PO (omit if hepatic dysfunction) - Morphine sulfate ER 30mg PO (15mg if age >65) Postoperative nausea and vomiting prevention: - Perphenazine 8 mg PO - Anesthesia can add scopolamine patch if age < 65 Antibiotic prophylaxis - Cefotetan 2 grams IV within 60 minutes of incision No routine fluid administration No IV opioid premedication
Intra-operative	Induction: - Propofol (1–2 mg/kg, or titrate to amnesia and anesthesia) - Ketamine 20 mg (20, 21) - Lidocaine 100–200 mg bolus - Muscle relaxant (no opioids) - Dexamethasone 4–5 mg IV (avoid if diabetes) Maintenance: - Ketamine 10mg q1 hour (avoid in final hour) - Lidocaine boluses q1 hour (1mg/kg) - Avoid opioids intra-op, unless patient c/o pain at emergence - Avoid routine use of NGT Fluid management: - Goal is euvolemia - Laparoscopic and vaginal cases: 2 mL/kg/hr - Boluses for MAP < 60 mmHg or 20% of baseline Emergence: - Propofol titration - Ondansetron 4 mg IV - No IV ketorolac (unless celecoxib not given pre-op) - No IV acetaminophen (unless not given pre-op)
Post-operative	Transition from IV to PO opioids for rescue pain management Avoid patient controlled anesthesia Ketorolac and acetaminophen scheduled Start ice chips/sips of clear liquids as tolerated IV fluids at 40ml/hour until tolerating po
Discharge checklist	Tolerating po w/o nausea and emesis Pain controlled (pain score < 5) Voiding trial complete

	Independent ambulation No signs of delirium (oriented to person, place, time, current events)
POST-OPERATIVE FOLLOW-UP	
Assessment POD 1	Phone call from office nurses Home Health if required (urinary retention, DVT prophylaxis)

Table 2:

Baseline Characteristics and Surgical Factors

	Pre-ERAS n=137	ERAS n=121	*P*-value
Age, years	66.6±11.2	64.4±11.4	**0.084**
Race			**0.001**
Caucasian	137 (100%)	112 (92.6%)	
African American	0	9 (7.4%)	
Current smoker	14 (10.2%)	5 (4.1%)	0.135
Post-menopausal	122 (89.1%)	102 (84.3%)	0.521
Medical co-morbidity †	77 (56.2%)	67 (55.4%)	0.893
History of diabetes	8 (5.8%)	22 (18.2%)	**0.003**
History of cardiac disease	20 (14.6%)	7 (5.8%)	**0.025**
History of abdominal surgery	95 (69.3%)	76 (62.8%)	0.268
Body mass index, kg/m^2	28.1±5.0	28.4±5.0	0.560
Prolapse organ prolapse stage			0.258
0	3 (2.9%)	8 (6.6%)	
I	0	1 (.83%)	
II	30 (21.9%)	22 (18.2%)	
III	88 (64.2%)	80 (66.1%)	
IV	16 (11.7%)	10 (8.3%)	
Anesthesia type			**0.037**
General	114 (83.2%)	113 (93.4%)	
Spinal	22 (16.1%)	8 (6.6%)	
Sedation	1 (0.7%)	0	
Local anesthetic infiltration	97 (70.8%)	92 (76.0%)	0.344
Intravenous fluids, mL	1,871.5±638.5	1,774.9±558.4	0.319
Estimated blood loss, mL	64.1±60.1	78.4±77.6	0.354
Hysterectomy type			0.442
Vaginal	38 (27.7%)	26 (21.5%)	
Supracervical	30 (21.9%)	34 (28.1%)	
Total Hysterectomy	11 (8.0%)	8 (6.6%)	
LAVH ‡	0	1 (0.83%)	
No hysterectomy	58 (42.3%)	52 (43.0%)	
Prolapse procedures			0.532
Abdominal #	60 (46.2%)	52 (51.5%)	
Vaginal +	32 (24.6%)	26 (25.7%)	
Obliterative ¥	38 (29.2%)	23 (22.8%)	
Minor prolapse procedures			
Anterior colporrhaphy	19 (19.2%)	21 (21.4%)	0.696
Posterior colporrhaphy	29 (29.2%)	33 (33.7%)	0.508

	Pre-ERAS n=137	**ERAS n=121**	***P*-value**
Levator myorrhaphy	11 (8.02%)	21 (17.35%)	**0.050**
Perineorrhpahy	23 (23.2%)	32 (32.6%)	0.141
Incontinence procedures [Π]	4 (2.9%)	3 (2.5%)	0.436
Intra-operative complications [€]	3 (2.2%)	0	0.250
Operative time, hours	2.6±0.8	2.6±0.9	0.955
Total operating room time, hours	3.3±0.9	3.3±1.0	0.813

[†]Medical co-morbidity is a composite variable for any of the following conditions: hypertension, diabetes, chronic obstructive airway, obstructive sleep apnea, cardiac disease and vascular disease.

[‡]LAVH, laparoscopic assisted vaginal hysterectomy

[#]Abdominal prolapse procedures include laparoscopic and robotic mesh augmented procedures and uterosacral ligament suspensions.

[+]Vaginal procedures include transvaginal mesh augmented procedures and native tissue apical suspension via uterosacral ligament suspensions and sacrospinous ligament fixations.

[¥]Obliterative prolapse procedures include colpocleisis and colpectomy.

[Π]Incontinence procedures include midurethral slings and peri-urethral bulking procedures.

[€]Intra-operative complications include cystotomy and ureteral injury.

Data are n (%) or mean ± standard deviation; Bolded values represent statistical significance.

Table 3:

Length of Stay, Same Day Discharge and 30-Day Complication Outcomes After ERAS Implementation

	Pre-ERAS	ERAS	*P*-value
Length of admission, hours	**25.9±13.5**	**12.1±11.2**	**< 0.001**
Same day discharge	**35 (25.9%)**	**111 (91.7%)**	**< 0.001**
Total 30-day complications †	43 (31.4%)	43 (35.5%)	0.480
Intra-operative complications ‡	3 (2.2%)	0 (0.0%)	0.250
Hospital complications #	7 (5.1%)	5 (4.1%)	0.775
Post-discharge complications +	12 (8.8%)	17 (14.3%)	0.164
Unplanned post-discharge office visits	29 (21.2%)	22 (19.0%)	0.761
Emergency department visits	11 (8.0%)	16 (13.5%)	0.159
Readmission ¥	**2 (1.5%)**	**8 (6.7%)**	**0.030**
Return to operating room	1 (0.7%)	4 (3.4%)	0.187
Urinary tract infection	9 (6.6%)	13 (10.9%)	0.265

† Total 30-day complication is a composite variable of intra-operative, hospital and postoperative complications.

‡ Intra-operative complications included cystotomy and ureteral injury.

Hospital complications included hypoxia, chest pain/arrhythmia, hyponatremia, uncontrolled pain, oliguria, nausea/ileus, and wound complications.

+ Post-discharge complications included voiding dysfunction, wound complications, angina/cardiac arrhythmias, nausea/ileus, hematoma, vertigo, and ureteral obstruction.

¥ Readmission indications include myocardial infarction, chest pain/arrhythmia, weakness, hyponatremia, wound complications, nausea/ileus, and ureteral obstruction.

Data are n (%) or mean ± standard deviation; Bolded values represent statistical significance.

Table 4:

Multivariable Logistic Regression for Variables Impacting Same Day Discharge After ERAS Implementation

	Unadjusted OR	95% CI	Adjusted OR	95% CI
After ERAS Implementation	**32.35**	**15.24–68.65**	**32.73**	**15.23–70.12**
Age	**0.97**	**0.95–0.99**	**0.97**	**0.94–0.99**
Total Operative Time	0.97	0.72–1.30	0.85	0.57–1.28

Data are unadjusted and adjusted odds ratios with 95% confidence intervals; Bolded values represent statistical significance.

Table 5:

Multivariable Linear Regression for Variables Impacting Length of Stay After ERAS Implementation, *hours*

	Unadjusted Beta	*P*-value	Adjusted Beta	*P*-value
After ERAS Implementation	**−13.78**	**<0.0001**	**−13.62**	**<0.0001**
Age	0.14	0.07	0.10	0.188
BMI	0.12	0.48	0.22	0.151
Medical Co-morbidity	**3.58**	**0.04**	3.10	0.059
Total Operative Time	**2.27**	**0.03**	**2.93**	**0.002**

Data are unadjusted and adjusted beta coefficients with p values; Bolded values represent statistical significance.

Table 6:

Multivariable Logistic Regression for Variables Impacting 30-Day Readmission After ERAS Implementation

	Unadjusted OR	95% CI	Adjusted OR	95% CI
After ERAS Implementation	**4.87**	**1.01–23.38**	**5.68**	**1.15–28.13**
Age	1.00	0.94–1.05	0.96	0.89–1.03
Vaginal Prolapse Procedure	1.19	0.21–6.67	1.76	0.28–11.19
Obliterative Prolapse Procedure	2.33	0.56–9.66	6.34	0.78–51.81

Data are unadjusted and adjusted odds ration with 95% confidence intervals; Bolded values represent statistical significance.