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ORIGINAL SCIENTIFIC REPORT

Enhanced REVENUE After Surgery? A Cost-Standardized Enhanced Recovery Pathway for Mastectomy Decreases Length of Stay

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Abstract

Background Enhanced recovery after surgery (ERAS) protocols have been shown to improve surgical, anesthetic, and economic outcomes in intermediate-to-high-risk surgeries. Its influence on length of stay and cost of low-risk surgeries has yet to be robustly studied. As value-based patient care comes to the forefront of anesthesiology research, the focus shifts to strategies that maintain quality while effectively containing cost.

Methods In July 2016, we implemented an ERAS for mastectomy protocol consisting of limiting fasting state, preoperative multimodal analgesia, and pectoralis I and II blocks. After 1 year, patient records were retrospectively reviewed for length of stay, opioid consumption, pain scores, and hospital charges.

Results Implementation of an ERAS protocol for mastectomies led to a decrease in opioid consumption, and statistically significant decrease in length of stay (1.19 vs. 1.44, $p = 0.01$). No significant change in hospital charges was observed ($25,787 vs. $25,863, $p = 0.97$); however, the variance of charges was significantly decreased (6.8×10^7 vs. 1.5×10^8, $p = 0.002$). The decrease in length of stay translated to an extra 100 hospital bed days which can provide up to an additional $2,100,000 in gross patient service revenue from additional mastectomy volume.

Conclusion ERAS protocols for mastectomies may prove beneficial by allowing growing hospitals to increase bed capacity and consequently surgical volume. Despite no change in hospital charges, we predict a potential increase in gross patient service revenue of $2.1 million due to saved hospital bed days.

Introduction

Enhanced recovery after surgery (ERAS) is a multidisciplinary, standardized approach combining evidence-based surgical and anesthetic techniques. The prior literature has shown anesthesiologists and surgeons to contribute greatly to execution of ERAS pathways. ERAS protocols have provided a unique opportunity to provide value-based care by improving outcomes and decreasing cost [1].

Over the past 10 years, ERAS protocols have been increasingly used in abdominal, thoracic, and orthopedic procedures. Implementing ERAS protocols in these specialties has notably resulted in decreased cost, shorter length of stay (LOS), fewer complications, and a decrease

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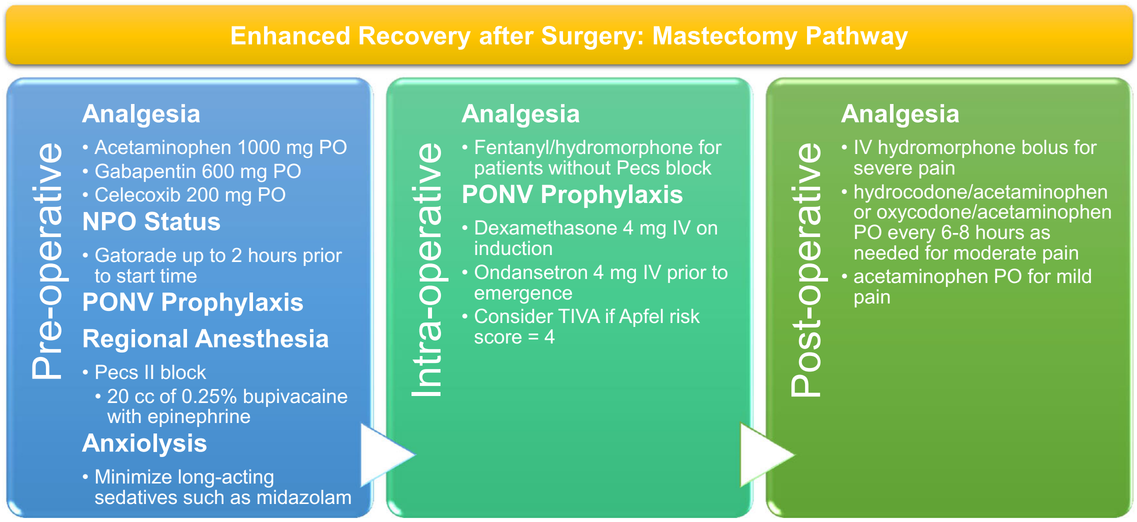


Fig. 1 ERAS for mastectomy. Perioperative features of the enhanced recovery protocol are listed below

in readmissions [2, 3]. Most of the cost saving with larger procedures was attributed to a reduction in length of stay [4].

It is unknown what the initial impact of an ERAS protocol is on length of stay and hospital charges for a low-risk procedure such as mastectomy which is traditionally performed as an outpatient or an overnight stay [5, 6]. To date, few ERAS mastectomy programs have been reviewed in the literature. The majority of published data for ERAS in breast surgery is for microvascular breast reconstruction and focuses mostly on pain, LOS, and postoperative complications [7, 8]. Our high-volume breast oncology program allowed a unique opportunity for implementation of an ERAS mastectomy program.

The goal of the current study is to examine length of stay, narcotic consumption, and pain control after creating an ERAS protocol for mastectomy. Secondary outcomes of interest include a cost analysis of charges and examination of increased revenue potential after implementation of an ERAS protocol.

Materials and methods

Through collaboration with our surgical and anesthesia teams, a multidisciplinary ERAS protocol was designed for patients undergoing mastectomy. Prior to July 2016, patients received a nonstandardized general anesthetic without regional anesthesia. Postoperative pain was controlled primarily with intravenous hydromorphone patient-controlled analgesia (PCA). The PCA was usually discontinued at 6 a.m. on postoperative day one. Discharge could subsequently be planned for late morning or early afternoon if the patient's pain was well controlled. Starting July 2016, the protocol implemented consisted of drinking clear liquids up to two hours before surgery, preoperative multimodal analgesia, standardized antiemetic administration, and pectoralis I and II block [9–11]. This included preoperative gabapentin 600 mg po, acetaminophen 1000 mg po, and celecoxib 200 mg po. Postoperative nausea and vomiting (PONV) control consisted of utilizing the Apfel risk score to guide antiemetic administration which included 4 mg dexamethasone on induction and 4 mg intravenous ondansetron prior to emergence. Postoperative pain was managed with oral acetaminophen for mild pain, oral oxycodone or hydrocodone with acetaminophen for moderate pain, and intravenous hydromorphone for severe pain (Fig. 1). After 1 year of implementation, institutional review board (IRB) approval was obtained to retrospectively review charts of the traditional treatment and ERAS protocol groups. Requirement for written informed consent was waived by the IRB.

Demographics and preoperative characteristics including age, ASA class, use of neoadjuvant chemotherapy, use of radiation therapy, and weight of breast were reviewed.

Patients treated with the ERAS pathway were compared to patients treated with traditional (TRAD) anesthetic and surgical care. The primary outcomes measured were LOS, total intravenous opioid usage, and pain scores. Opioid consumption was measured after conversion to intravenous morphine equivalents (ivMEQ) which were calculated based on 1 mg morphine = 0.2 mg hydromorphone, 10 mcg fentanyl [12]. Pain scores were measured with a 0–10 pain intensity numeric rating scale.

Average length of stay and opiate consumption (represented as ivMEQ) were calculated and compared for mean difference between cohorts with two-tailed t tests. In addition, the median and mean floor and PACU pain scores were calculated and applied in t tests for assessment of significance of mean difference. Alpha was set at 0.05 for determination of statistical significance. Individual charges were compared per sample population for variance using F-tests and Q–Q plots and mean difference with t tests. Histogram and box-and-whisker plots were also created to further characterize the differences between groups. In addition, individual charges were stratified into related categories and compared between cohorts using a two-tailed t test to analyze for differences between cost types. The statistical analyses were primarily conducted in Microsoft Excel.

Potential gross patient service revenue (GPSR) was estimated by calculating the number of hospital bed days gained after ERAS implementation (400 mastectomies/year × 0.25 days saved/mastectomy = 100 days). Allocating those bed days to additional mastectomies (100 days/1.19 day per mastectomy) yields an additional 84 mastectomies can be performed per year. Estimating hospital charges as $25,000/mastectomy, we are able to calculate the projected increase in revenue from additional mastectomy volume.

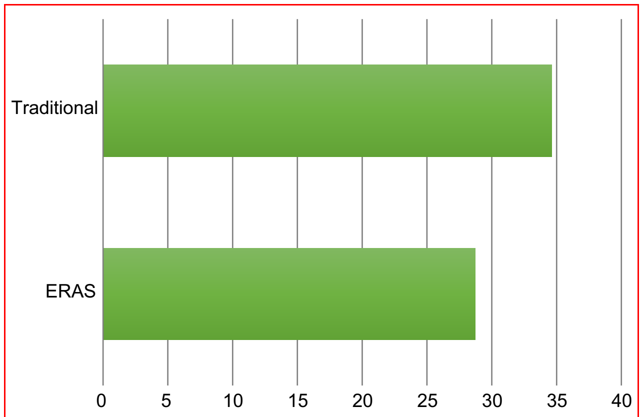


Fig. 2 Length of stay. A gross comparison of mean length of stay for both cohorts, in hours. $p = 0.0133$

Table 1 Compliance to enhanced recovery after surgery interventions for mastectomy

	E ERAS RAS
Preoperative carbohydrate drink	Unable to obtain
Multimodal analgesia	48/51 (94%)
Pectoralis I/II block	51/51 (100%)
PONV prophylaxis	51/51 (100%)

Results

A total of 103 patients were analyzed; the ERAS cohort consisted of 51 patients, and the TRAD cohort contained 52 patients. Compliance to the ERAS pathway is described in Table 1. Demographics of the two groups were compared and found to be similar (Table 2). Average age was similar in both groups (62.4 vs. 60.5, $p = 0.43$). American Society of Anesthesiology physical status classification was also similar (2.2 vs. 2.3, $p = 0.27$). Other baseline characteristics examined included average BMI (29.2 vs. 27.9, $p = 0.29$), patients receiving neoadjuvant chemotherapy (18% vs. 23.5%, $p = 0.46$), patients

Table 2 Demographics

Variables Mean ± SD or n (%)	ERAS	Traditional	p value
Gender, female	49 (96.1)	47 (90.4)	0.23
Prophylactic bilateral surgery	17 (33.3)	16 (30.1)	0.83
Neoadjuvant chemotherapy	9 (18.0)	12 (23.5)	0.46
Age	62.4 ± 12.5	60.5 ± 12.4	0.43
BMI	29.2 ± 6.7	27.9 ± 5.7	0.29
XRT	15 (29.4)	15 (28.9)	0.66
ASA class	2.2 ± 0.4	2.3 ± 0.5	0.27
Weight of breast	936.8 ± 446.9	786.2 ± 407.6	0.077
Tumor size	2.39 ± 2.40	2.58 ± 1.91	0.66
Positive nodes	1.41 ± 4.90	1.76 ± 4.55	0.71
Total nodes	6.02 ± 8.82	5.90 ± 7.51	0.94
Operative time (h)	1.64 ± 0.51	1.76 ± 0.62	0.28

Key characteristics of the sample groups are listed below, none of the examined factors deemed as statistically significant between the two groups

Fig. 3 Total charge distribution. Box-and-whisker plots of distribution of the total mastectomy costs of the ERAS (blue) and traditional (gray) cohorts are shown below

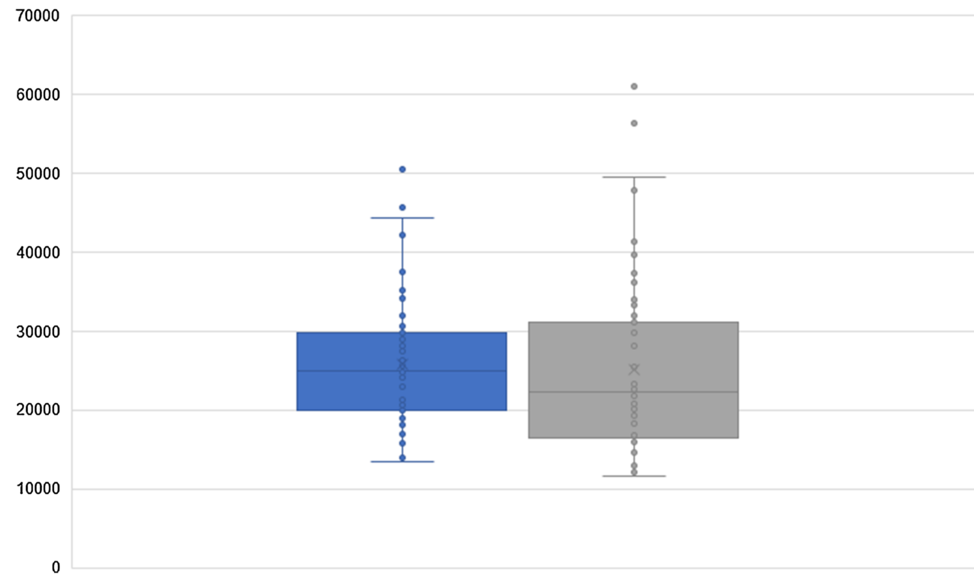


Table 3 Intraoperative opioids and postoperative pain scores

	ERAS	Traditional	*p* value
Intraoperative opioids (as mg IV morphine)	19.66 ± 9.43 mg (10.23, 29.09)	22.45 ± 8.17 mg (14.27, 30.62)	0.17
PACU mean pain score	2.50 ± 2.10 (0.40, 4.60)	2.84 ± 1.99 (0.85, 4.83)	0.46
PACU median pain score	2.42 ± 2.07 (0.35, 4.49)	2.79 ± 2.10 (0.69, 4.89)	0.44
Floor mean pain score	3.09 ± 1.57 (1.52, 4.66)	2.32 ± 1.20 (1.12, 3.52)	0.0039*
Floor median pain score	3.06 ± 1.80 (1.26, 4.86)	2.14 ± 1.40 (0.74, 3.54)	0.0031*

A comparison of post-anesthesia care unit (PACU) and ward median and mean pain scores is shown in relation to total intra-operative opioids administered (as mg IV morphine equivalents)

* = statistically significant, $\alpha = 0.05$. Listed below as mean ± standard deviation

receiving radiation therapy (15% vs. 15%, $p = 0.66$), and operative time (1.64 h vs. 1.76 h, $p = 0.283$).

LOS was slightly reduced in the ERAS group (1.19 vs. 1.44, $p = 0.01$) (Fig. 2). Mean intraoperative opioid consumption was decreased, however not statistically significant (19.66 mg vs. 22.45 mg, $p = 0.17$). Similarly, mean pain score in the recovery room was decreased, yet not statistically significant (2.5 vs. 2.84, $p = 0.46$). Of note, the ERAS patients tended to have a slightly increased pain score on the floor (3.09 vs. 2.32, $p = 0.0039$) (Table 3).

The two groups had similar total charges in the perioperative period ($25,783 vs. $25,863, $p = 0.97$). The ERAS group total charge distribution had a smaller standard deviation ($8252 vs. $12,421) and statistically significant smaller variance when compared to the TRAD group (6.8×10^7 vs. 1.5×10^8, $p = 0.002$). The two-sample *F*-test for variances demonstrated an *F* value greater than the critical and a *p* value of 0.0022, representing a statistically significant inequality in variances (Fig. 3).

Using the LOS saved with each mastectomy, we were able to estimate a potential increase in GPSR of $2.1 million (Fig. 4).

Discussion

ERAS protocols uniquely provide an opportunity for optimization of existing resources by instituting a standardized approach to anesthesia and surgery-related challenges. When compared to the literature, our existing LOS for mastectomy was already shorter than normal [13, 14] (Fig. 5). Our results showed that we were able to further reduce the LOS with ERAS principles. Even though immediate postoperative pain scores and opioid consumption were not improved to a statistical significance, their moderate improvement may have been what led to the

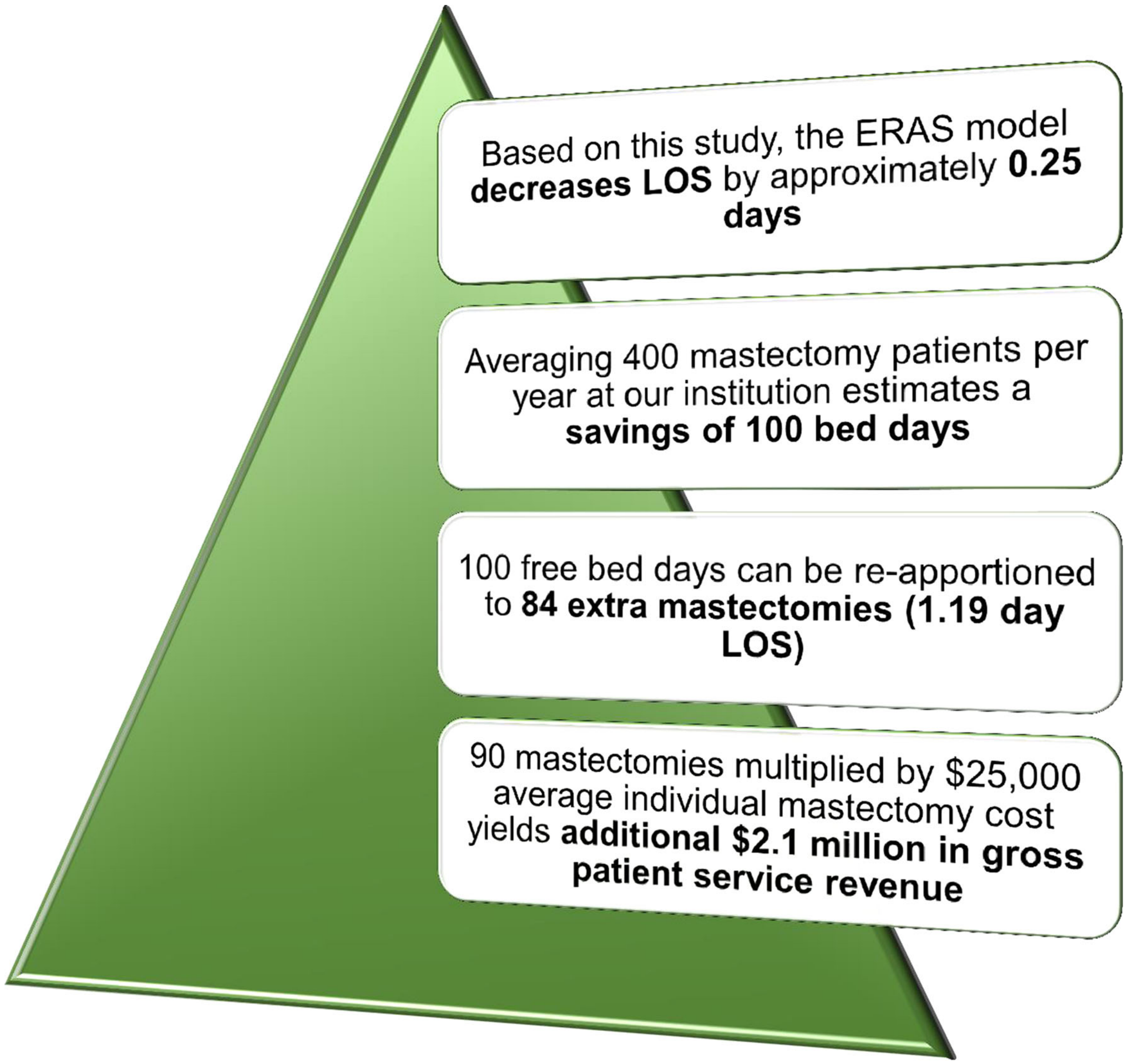


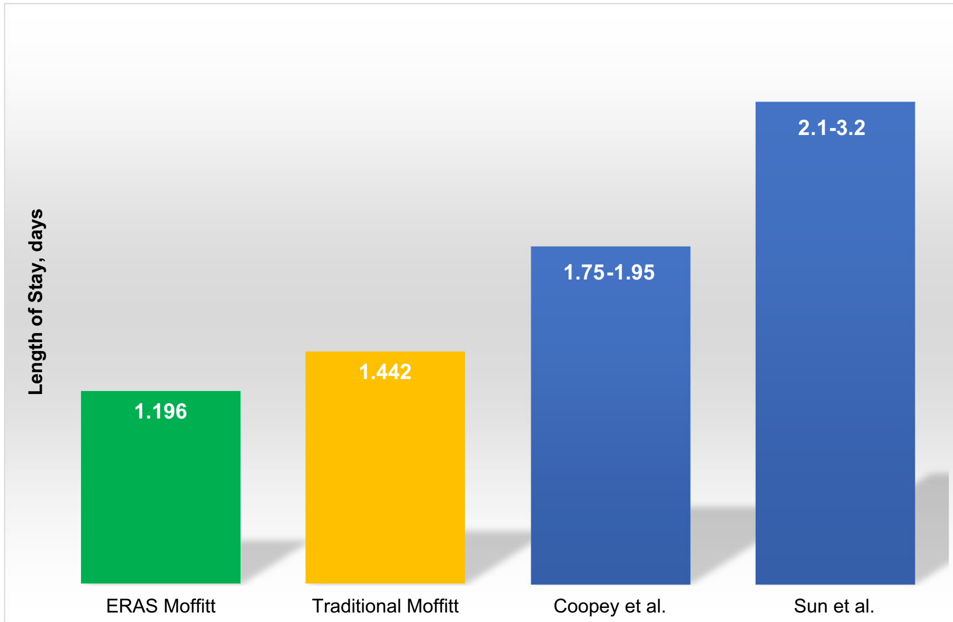
Fig. 4 Potential increase in hospital capacity after implementing ERAS Protocol

decrease in LOS. Decreased opioid use may have led to less sedation and improved ability to meet functional goals for discharge. The slight increase in pain score on the floor may be due to removal of the intravenous hydromorphone PCA from the postoperative order set. This minor increase did not seem to have any significant consequences. Our results lead us to believe that an ERAS mastectomy protocol may contribute to other unexamined factors which may help a patient feel ready for discharge such as normal food intake and ability to achieve preoperative mobility state.

In addition to optimizing pain control, we believe that setting expectations as a team contributed significantly to the decrease in LOS. The nursing, surgical, and anesthesia teams each played distinct roles in preparing the patient for what to expect after surgery and when to expect to be discharged if the patient met all necessary milestones. This was established by meeting with the breast surgeons and nurses in the preoperative holding, post-anesthesia care unit, and on the floor.

Our protocol did not show a decrease in charges, as was expected due to a minimal reduction in length of stay. However, we did demonstrate a significant decrease in variation of charges in patients receiving mastectomy. These results highlight the improvement in resource utilization with standardization of care. We have previously demonstrated a similar finding with implementation of ERAS techniques in our radical cystectomy population [15]. Being able to decrease charge variability within a certain procedure can be seen as an even more significant finding than a decrease in charges. Improving charge variation in common operative procedures provides an

Fig. 5 Average length of stay for mastectomies. A comparison of the LOS for the ERAS and traditional cohorts is made between other reported LOS in the surgical literature



opportunity to promote value while balancing cost and quality [16]. Furthermore, this allows better predictability of charges when negotiating contracts in a bundled payment model. New targets and specific opportunities for adjustment and may lead to even better cost control and reduction. Ultimately, improving variation in charges via standardization of care can encourage efficient, quality, patient-centered care.

Finally, with our improvement in length of stay we have been to create approximately an additional 100 hospital bed days. For a medium-sized, growing cancer hospital such as ours, this can translate to 84 more mastectomies (LOS 1.19 days) and subsequently an increase in gross patient service revenue by $2,100,000 ($25,000 × 84 mastectomies). We argue that the financial efficiency of ERAS is not only in the cost saving per procedure, but in the increase in hospital capacity. After implementation of ERAS, we were encouraged to shift our patients to our surgery center with a 23 h observation unit. Patients who are not ready for discharge within 23 h are admitted as an inpatient.

Future expansion of ERAS for mastectomy includes incorporation of preoperative interventions such as prehabilitation [17] and examination of long-term outcomes such as post-mastectomy pain syndrome (PMPS) and other patient-reported outcomes. PMPS has been known to be attenuated with gabapentin and local anesthetics [18] and may be attenuated with use of ERAS techniques.

As demonstrated in our study, anesthetic interventions can contribute to cost-effective surgeries. Anesthesiologists and surgeons should continue to collaborate to lead cost-effective research. Even with minimal LOS reduction, we have demonstrated a significant increase in potential revenue. Our results should encourage further ERAS implementation in low-risk, low-LOS procedures.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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