An enhanced recovery after surgery pathway for cesarean delivery decreases hospital stay and cost

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BACKGROUND: Enhanced recovery after surgery pathways provide a multidisciplinary, evidence-based approach to the care of surgical patients. They have been shown to decrease postoperative length of stay and cost in several surgical subspecialties, including gynecology, but have not been well-studied in obstetric patients who undergo cesarean delivery.

OBJECTIVE: We sought to determine whether the implementation of an enhanced recovery after surgery pathway for cesarean delivery would decrease postoperative length of stay and postoperative direct cost compared with historic controls.

STUDY DESIGN: We conducted a retrospective cohort study that compared postoperative length of stay and postoperative direct cost among women on the enhanced recovery after surgery cesarean delivery pathway in the first year of implementation (April 1, 2017, to March 31, 2018; n=531) compared with historic controls (March 1, 2016, to February 28, 2017; n=661). Literature review informed the development of a prototype enhanced recovery after surgery pathway for cesarean delivery based on best practices from previous enhanced recovery after surgery experience in obstetrics (if available) or from other surgical disciplines if there were no available data for obstetrics. When there was not relevant published evidence from obstetrics, the taskforce used clinical experience and expert opinion to develop the pathway. The enhanced recovery after surgery cesarean delivery pathway included preadmission patient education and preoperative, intrapartum, and postoperative elements. Some components reflected standard obstetric care, and others were specific to the enhanced recovery after surgery pathway. Women with pregestational diabetes mellitus who were receiving insulin therapy before pregnancy, women with preeclampsia with severe features, women with complex pain needs, and women with surgical complications were excluded from baseline and implementation groups. Enhanced recovery after surgery cesarean delivery pathway participation was determined by order set usage. Analysis was stratified for women who underwent planned (no labor; n=530) and unplanned (labor; n=662) cesarean delivery. Demographic and clinical characteristics, postoperative length of stay, postoperative direct cost, and readmission rates for the baseline and implementation groups were compared with the use of chi-square and *t*-tests.

RESULTS: During the first year of implementation, 531 of 640 eligible women (83%) were included in the enhanced recovery after surgery cesarean delivery pathway. Body mass index was marginally higher in the baseline group for unplanned cesarean delivery (32.5±7.1 vs 31.4±6.7 kg/m^2; P=.04). Otherwise there were no significant differences in demographic or maternal clinical characteristics between baseline or implementation groups overall or for planned or unplanned cesarean delivery. Compared with baseline, implementation of the enhanced recovery after surgery cesarean delivery pathway resulted in a significant decrease in postoperative length of stay by 7.8% or 4.86 hours overall (P<.001) and for both planned (P=.001) and unplanned (P=.002) cesarean delivery. Total postoperative direct costs decreased by 8.4% or $642.85 per patient overall (P<.001) and for both planned (P<.001) and unplanned (P<.001) cesarean delivery. There were no significant differences in readmission rates.

CONCLUSION: Implementation of an enhanced recovery after surgery pathway for women who had planned or unplanned cesarean delivery was associated with significantly decreased postoperative length of stay and significant direct cost-savings per patient, without an increase in hospital readmissions. Given that cesarean delivery is 1 of the most common surgical procedures performed in the United States, positively impacting postoperative length of stay and direct cost for women who undergo cesarean delivery could have significant healthcare cost-savings.

Key words: cesarean delivery, direct cost, enhanced recovery, ERAS, length of stay, obstetrics, patient education

Cesarean delivery is 1 of the most commonly performed surgeries in the United States, with nearly 1.3 million cesarean deliveries performed annually comprising almost one-third of all births.[1] Enhanced recovery after surgery (ERAS) is an interdisciplinary, evidence-based, standardized approach to improve the care of surgical patients.[2] Inherent to the ERAS pathways is the concept of improving recovery from the surgical catabolic and inflammatory response, with components such as minimizing preoperative fasting periods, providing a preoperative carbohydrate load, providing standardized multimodal pain management, and early mobilization and feeding postoperatively.[2] The first ERAS pathways were developed in colorectal surgery in 2001.[3] These principles have now been applied successfully in multiple surgical specialties, including gynecologic oncology[4–6] and benign gynecology,[6] with literature demonstrating that ERAS pathways have led to reductions in hospital length of stay and costs without an increase in complications or readmissions.[7–10] Given these benefits, use of an ERAS pathway for gynecologic surgery is encouraged by the American College of Obstetricians and Gynecologists.[11]

The field of obstetrics has been a late adapter of ERAS pathways for cesarean delivery (CD), and the literature is limited to planned (scheduled)

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AJOG at a Glance

Why was this study conducted?

Enhanced recovery after surgery pathways have been shown to decrease postoperative length of stay and cost but have not been well-studied in obstetric patients who undergo cesarean delivery.

Key findings

Implementation of an enhanced recovery after surgery pathway for women who have planned or unplanned cesarean deliveries was associated with a significant reduction in postoperative length of stay and postoperative direct cost, without an increase in readmission rate.

What does this add to what is known?

These findings suggest that the implementation of an enhanced recovery after surgery pathway is a feasible and effective means to improve the care of women who undergo planned and unplanned cesarean delivery.

procedures.[12–14] The authors have suggested similar results with decreases in length of stay and hospital cost, without an increase in readmissions. [12–14] There are no published studies that have evaluated the use of an ERAS pathway for CD in patients who undergo not only planned, but also unplanned cesarean deliveries during labor.

We developed, implemented, and tested an ERAS pathway for women who undergo both planned and unplanned cesarean deliveries. We hypothesized that women who undergo CD with an ERAS pathway would have a decreased postoperative length of stay and postoperative direct cost compared with women who were not on an ERAS pathway and that women with a planned CD would benefit more from an ERAS pathway than those having an unplanned procedure because those with the planned CD will have greater preoperative education and anticipatory guidance.

Materials and Methods

To develop the ERAS pathway for CD (ERAS CD), a PubMed literature review with combinations of search terms that included "cesarean delivery," "cesarean section," "enhanced recovery after surgery," "ERAS," "gynecologic oncology," "gynecology," and "obstetrics" was performed. We reviewed publications that pertained to the use of enhanced recovery pathways in several surgical specialties that included gynecology and those that pertained to the use of enhanced recovery pathways in obstetrics specifically. Additional publications on individual components of ERAS pathways were also reviewed.

An interdisciplinary taskforce that included specialists in Maternal-Fetal Medicine, Obstetric Anesthesia, Nursing, and Transformation of Care was formed to review the literature and design a local ERAS CD based on available published evidence and best practices from obstetrics and obstetric anesthesia. A Transformation of Care specialist is a University of Washington Medicine internal consultant who is tasked with helping providers drive change across the hospital system to improve the delivery of patient care and support the wise use of healthcare dollars. The taskforce relied on clinical experience and expert opinion when there was no relevant published evidence. Cost of pathway elements were also considered. The completed ERAS CD was then reviewed by obstetric, family medicine, obstetric anesthesia, and pediatric providers, clinic and hospital-based nurses, and representatives from the Pharmacy, Patient Education, and Information Technology Departments. A new order set was created for inpatient care. Order set usage was evaluated regularly to assess adherence to the pathway. There were several pathway champions who disseminated the information to all care providers through multiple avenues that included in-person information sessions, announcements at meetings, email messages, and posters in clinics and in the inpatient units. These champions had regular check-ins with the inpatient and outpatient teams.

The final ERAS CD included preadmission patient education and preoperative, intrapartum, and postoperative elements. Some components reflected standard obstetric care, and others were specific to the ERAS CD (Table 1). The Patient Education Department developed a slide show and patient care map with translation into Spanish, Chinese, Korean, and Arabic (Supplemental Materials). These materials were distributed and reviewed with patients preoperatively in the clinic for planned cesarean deliveries or provided postoperatively for unplanned cesarean deliveries. Additional preoperative pathway-specific elements included decreased fasting time with the use of a preoperative carbohydrate drink at 8 and 2 hours preoperatively. Intraoperative pathway-specific elements included patient warming, avoidance of uterine exteriorization when feasible, intravenous ketorolac after closing fascia, and limiting intraoperative fluid administration by using routine phenylephrine infusion to counter neuraxial afterload reduction. Vasopressor therapy and fluid administration were guided by the patient's vital signs and intraoperative blood loss to maintain euvolemia, rather than a standard intraoperative fluid rate. Postoperative pathway-specific elements included early feeding, early and frequent ambulation, and multimodal analgesia with scheduled acetaminophen and ibuprofen; opioids were available only as needed.

The ERAS CD was intended for women who were having a primary or repeat CD, both planned (scheduled, no labor) and unplanned (intrapartum decision, labor). Patients who were undergoing a planned CD were identified as ERAS CD candidates by their primary obstetric provider as an outpatient and received all the components of the

TABLE 1
Elements of the enhanced recovery after surgery cesarean delivery pathway

Preoperative elements
Preadmission patient education[a]: Formal nurse teaching includes a slide show presentation and patient care map, which is a 1-page document the describes what to expect pre-, intra-, and postoperatively.
Preadmission screening and optimization[b]: Individualized document including anesthesia consult if high risk.
Diet[a]: No solid foods 8 hours before delivery; clear liquids up to 2 hours before delivery; carbohydrate drink (apple juice) taken at 2 and 8 hours before surgery.
Premedications[b]: At the anesthesiologist's discretion; sodium citrate/citric acid given to all patients.
Intravenous fluid therapy[b]: 125 mL/hr.
Blood glucose monitoring[a]: Blood glucose checked 1 hour preoperatively.
Intraoperative elements
Antibiotics[b]: Intravenous antibiotics before skin incision per American College of Obstetricians and Gynecologists guidelines.
Anesthesia[b]: Regional anesthesia per anesthesiologist's discretion
Abdominal skin preparation[b]: Chlorhexidine-alcohol.
Intravenous fluid therapy therapy[a]: Goal-directed fluid therapy with noninvasive monitoring.
Analgesia[a]: Ketorolac 30 mg intravenously after fascia closure (at the discretion of the surgeon).
Intraoperative warming[a]: Warm blankets and/or bed warmer.
Venous thromboembolism prophylaxis[b]: Sequential compression devices.
Surgical technique[b]: Surgical technique was at the provider's discretion, but general principles are (1) blunt expansion of transverse uterine hysterotomy is performed; (2) hysterotomy is closed in 2 layers; (3) peritoneum is not closed; (4) for women with $\geq$2 cm of subcutaneous tissue, reapproximation of that tissue layer is performed, and (5) skin is closed with subcuticular sutures. •Pathway-specific change includes avoiding exteriorization of the uterus and limiting surgical duration as able.
Postoperative elements
Intravenous fluid therapy therapy[a]: Goal-directed therapy with intravenous fluids at 1 mL/kg/hr with target urine output of 0.3—0.5 mL/kg/hr; intravenous fluids were stopped once patient was tolerating 500 mL of fluid per hour or at 12 hours postoperatively.
Analgesia[b]: Round the clock/scheduled medication ibuprofen 600 mg every 6 hrs by mouth; round the clock/scheduled medication acetaminophen 1000 mg every 6 hrs by mouth; oxycodone 5—10 mg every 3 hrs as needed for severe pain. •Pathway-specific change included increased teaching of providers, nurses, and patients on minimizing opioid use.
Antiemetics[b]: Ondansetron 4—8 mg every 8 hrs as needed; metoclopramide 5—10 mg every 6 hrs as needed; prochlorperazine 5—10 mg intravenously every 6 hrs as needed.
Bowel regimen[b]: Polyethylene glycol 3350 17 g by mouth daily; senna 8.6 mg by mouth twice a day as needed; bisacodyl 10 mg rectal daily as needed; magnesium hydroxide 30 mL by mouth every evening as needed
Diet[a]: General diet beginning postoperative day 0.
Intravenous management[a]: Heplock intravenous line as soon as able, generally at arrival to postpartum floor.
Foley catheter[a]: Removed at 18 hours.
Mobilization[a]: Early and frequent ambulation includes sitting on edge of bed by 4 hours postoperatively, out of bed to chair by 8 hours postoperatively, ambulation by 12 hours postoperatively, and out of bed for all meals. Patients had daily ambulation goals. Barriers to ambulation (Foley catheter, intravenous line) were removed sooner.
Blood glucose monitoring[a]: Fasting blood glucose on postoperative days 1 and 2 for all patients. No change in monitoring for patients with diabetes mellitus.
Venous thromboembolism prophylaxis[b]: Sequential compression devices when in bed. Prophylactic low-molecular weight heparin if patient had additional risk factors for venous thromboembolism.
Criteria for discharge[b]: Patients had to be ambulating, urinating, tolerating general diet, and pain well controlled with oral medications before discharge.

[a] Elements that were new to this pathway; [b] Elements that were already standard of care at our institution.

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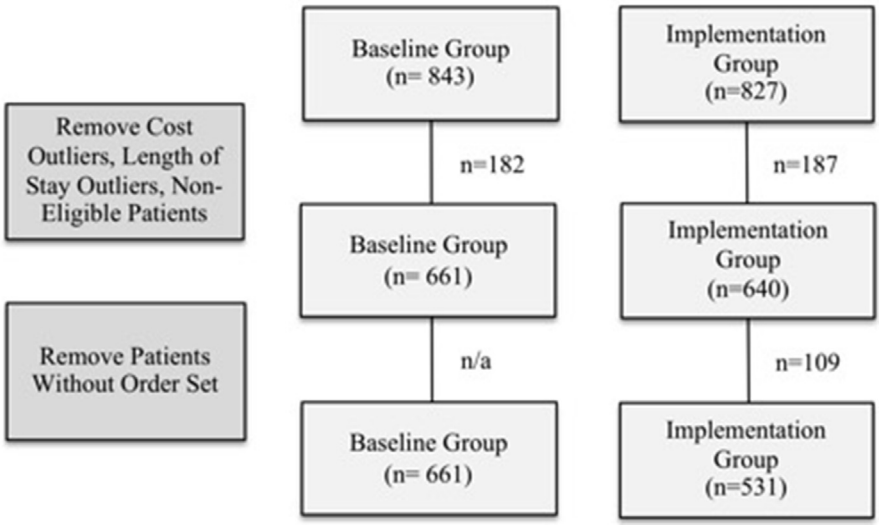
FIGURE 1
Summary of participants included in the final analysis



Summary of participants included in the final analysis in the baseline and implementation groups after removing cost and length of stay outliers, noneligible patients, and patients who did not receive the order set.

n/a, not applicable.

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pathway. Patients who were undergoing an unplanned CD received only the intraoperative and postoperative elements and were identified as ERAS CD candidates at the time of their CD. The ERAS CD was not intended for women with pregestational diabetes mellitus on insulin therapy before pregnancy, preeclampsia with severe features that required either postpartum magnesium sulfate or ≥2 antihypertensive medications, complex pain medication needs that included receiving a postoperative epidural, active opioid use, and/or chronic opioid substitution therapy, and/or those with significant intraoperative complications that included postpartum hemorrhage with estimated blood loss >1500 mL or bowel, bladder, or ureteral injury. All patients who underwent CD who did not meet these exclusion criteria were candidates for the ERAS CD. At the completion of the CD, after discussion with the obstetric resident(s) and attending physician, the decision to have the patient continue (for planned CD) or start (for unplanned CD) the ERAS CD was announced during the surgical safety checklist before leaving the operating room. Eligible patients were then placed on the ERAS CD by resident physicians with the use of the ERAS CD postoperative order set. The ERAS CD was initiated fully at the University of Washington Medical Center by April 1, 2017.

We compared outcomes for women who had cesarean deliveries during the year before implementation (baseline group: March 1, 2016 to February 28, 2017) and the first full year of the pathway (implementation group: April 1, 2017 to March 31, 2018), excluding March 2017 as a transitional period. The University of Washington Institutional Review Board approved the study and did not require written informed consent. Total and postoperative length of stay, total and postoperative direct cost, and hospital readmission rates within the first 30 days after delivery were obtained from hospital administrative data. University of Washington Finance uses a method of costing, inclusive of supply and pharmacy acquisition cost of item, relative value units for services, with a range of statistics and metrics to spread expense, and a ratio of cost to charge for some areas. Expenses are assigned to direct and indirect cost categories. Direct costs include labor (nursing, medical technicians, patient care coordinators, and patient services specialists), supplies, purchased services, and equipment. Indirect costs are the remaining costs that are incurred by the institution that include overhead costs such as building depreciation, environmental services, nutrition with patient meals, interpreter services, medical records, and more. The method for the determination of costs was the same during the baseline and implementation periods. Clinical variables that included maternal age, parity, history of CD, medical comorbidities, gestational age at delivery, neonatal weight, and neonatal intensive care unit (NICU) admission were abstracted from the medical record. Women were excluded from the baseline and implementation groups if they had pregestational diabetes mellitus that was managed with insulin therapy before pregnancy, preeclampsia with severe features, complex pain management needs, significant intraoperative complications, or were outliers for total length of stay or total direct cost (defined as >3 standard deviations from the mean). Additionally, women were excluded from the implementation group if they were not placed on the ERAS CD, as defined by pathway order set use.

The primary outcome measures were postoperative length of stay and postoperative direct cost. Analysis was stratified for women who underwent planned (scheduled, no labor) and unplanned (intrapartum decision, labor) CD, which was defined by hospital chart data. Baseline and implementation groups were compared for demographic and clinical characteristics, total and postoperative length of stay, total and postoperative direct costs, and hospital readmission rates with the use of chi-square and *t*-tests with an alpha level of .05, using statistical software

TABLE 2
Demographic and clinical information of patients in the baseline and implementation groups, stratified by planned or unplanned cesarean delivery

	Cesarean delivery								
	Overall			Planned			Unplanned		
Variable	Baseline (n=661)	Implementation (n=531)	*P* value	Baseline (n=281)	Implementation (n=249)	*P* Value	Baseline (n=380)	Implementation (n=282)	*P* value
Age, y[a]	31.6±5.5 (n=661)	31.9±5.6 (n=531)	.37	32.0±5.7 (n=281)	32.0±5.7 (n=249)	.49	31.3±5.3 (n=380)	31.7±3.5 (n=282)	.29
Parity[a]	0.9±1.2 (n=661)	0.9±1.1 (n=531)	.95	1.1±1.1 (n=281)	1.1±1.0 (n=249)	.86	0.7±1.2 (n=380)	0.7±1.2 (n=282)	.83
Body mass index, kg/m^2[a]	32.6±7.4 (n=639)	31.8±7.0 (n=521)	.05	32.7±7.6 (n=272)	32.2±7.2 (n=247)	.40	32.5±7.1 (n=367)	31.4±6.7 (n=274)	.04
Previous cesarean delivery, n (%)	225 (34.0)	200 (37.6)	.19	150 (53.3)	143 (57.4)	.88	75 (19.7)	57 (20.2)	.34
Hypertension, n (%)[b]	91 (13.7)	73 (13.7)	.99	42 (14.9)	37 (14.8)	.96	49 (12.8)	36 (12.7)	.97
Diabetes mellitus, n (%)[c]	81 (12.2)	64 (12.0)	.91	44 (15.6)	31 (12.4)	.41	37 (9.7)	33 (11.7)	.29
Gestational age, wk[a]	37.7±3.1 (n=650)	37.7±3.0 (n=476)	.86	37.0±3.1 (n=279)	37.4±2.7 (n=225)	.47	38.1±3.0 (n=371)	38.0±3.2 (n=251)	.16
Infant weight, g[a]	3108.9±809.2 (n=660)	3139.4±768.7 (n=531)	.50	3017.8±879.9 (n=281)	3120.9±746.0 (n=249)	.14	3176.5±746.6 (n=379)	3155.8±789.2 (n=282)	.73
Neonatal intensive care unit admission, n (%)	249 (37.9)	140 (28.6)	.001	120 (42.8)	70 (28.6)	.001	129 (34.2)	80 (28.5)	.12

[a] Data are given as mean±standard deviation; [b] These patients were eligible for the pathway with hypertension, which included chronic hypertension, gestational hypertension, or preeclampsia; it does not include women with preeclampsia with severe features receiving magnesium or those receiving ≥2 antihypertensives because these women were excluded from the pathway; [c] These patients were eligible for the pathway with diabetes mellitus, which included pregestational type 2 diabetes mellitus or gestational diabetes mellitus; it does not include women with pregestational diabetes mellitus receiving insulin before pregnancy because these women were excluded from the pathway.

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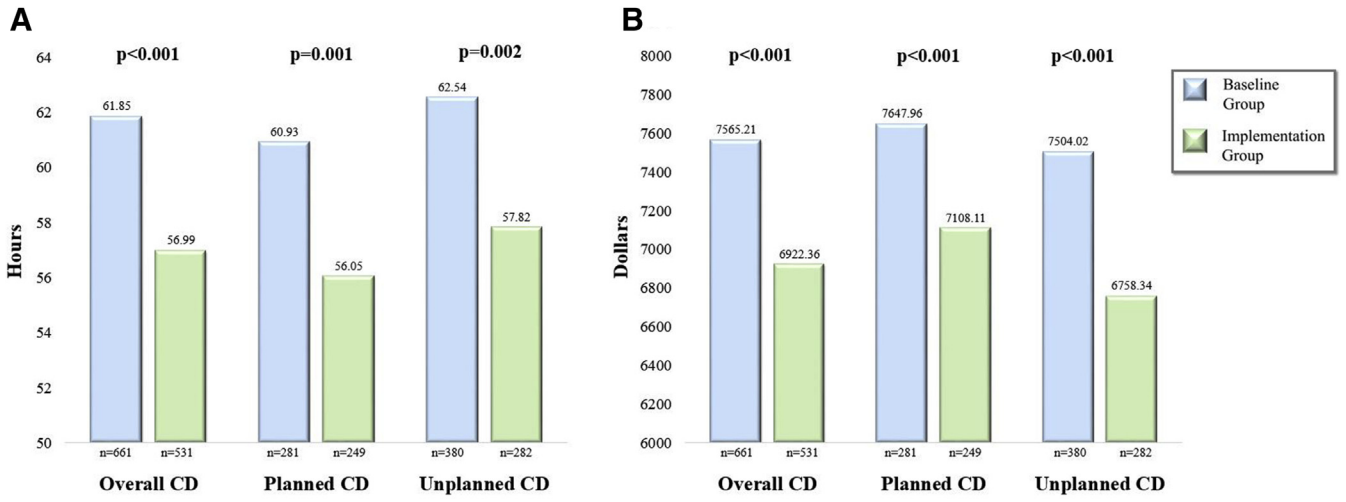
(version 13.1; STATA Corporation, College Station, TX). We performed multivariate logistic regression for our primary outcomes using the following covariates that were chosen a priori based on factors that may impact postoperative length of stay and hospital cost: maternal age, parity, body mass index, previous CD, diabetes mellitus, hypertension, and neonatal characteristics of gestational age and NICU admission. A post-hoc power analysis confirmed that there was adequate power to detect differences in our primary outcomes. It showed that we would need a sample size of 628 patients (314 in each group) for 90% power with an alpha level of .05 to detect a clinically relevant difference of 4 hours in postoperative length of stay; our sample size was substantially larger (n=1192, with 661 patients in the baseline group and 531 patients in the implementation group). Similarly, we found that we would need a sample size of 390 patients (195 in each group) for 90% power with an alpha level of .05 to detect a decrease of $600 dollars in postoperative direct costs; again our sample size was substantially larger.

Results

In the baseline and implementation time periods, there were 843 and 827 women with CD, of whom 661 and 640 were eligible for inclusion in the baseline and implementation groups, respectively (Figure 1). All 661 eligible women in the baseline group were included in the analysis; 531 of potentially eligible women(83%) in the implementation group received the ERAS CD order set and were included. The percentage of eligible women who received the order set did not differ throughout the implementation period. There were similar proportions of planned deliveries during the baseline (281/661; 42.5%) and implementation periods (249/531; 46.9%). Demographic characteristics and pregnancy outcomes are summarized in Table 2. Body mass index was marginally higher in the baseline group for unplanned CD (32.5±7.1 vs 31.4±6.7 kg/m^2; P=.04). There was also

FIGURE 2
Postoperative outcomes for baseline and implementation groups, stratified by planned and unplanned cesarean deliveries



A, Postoperative length of stay (in hours); **B,** postoperative direct cost (in dollars).

CD, cesarean delivery.

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a higher rate of NICU admission in the baseline group overall (37.9% vs 28.6%; *P*=.001) and in the planned CD group (42.8% vs 28.6%; *P*=.001). There were no other significant differences in demographic or clinical characteristics between groups.

As shown in Figure 2, A, compared with baseline, the implementation of the ERAS CD resulted in a significant decrease in postoperative length of stay by 7.8% or 4.86 hours overall (*P*<.001), with a similar decrease in length of stay in both planned (*P*=.001) and unplanned (*P*=.002) CD groups. The run chart in Figure 3 highlights the trend in decrease in length of stay in hours over time for overall, planned, and unplanned CD groups. When multivariate regression was applied, there was a similar decrease in postoperative length of stay by 4.52 hours overall (*P*<.001), and in both planned (*P*=.01) and unplanned (*P*=.003) CD groups. When postoperative length of stay is reported in days, there are similar results, with a significant decrease in postoperative length of stay by 0.2 days overall (*P*<.001), with a similar decrease in both planned (*P*=.002) and unplanned (*P*=.005) CD groups. The total length of stay (which includes preoperative and postoperative stay) in days was not different overall (3.77 vs 3.45; *P*=.08) or for those with unplanned CD (3.65 vs 3.82; *P*=.44) but was significantly shorter by nearly 1 day in the implementation group for those with planned CD (3.94 vs 3.06; *P*=.005).

As shown in Figure 2, B, postoperative direct costs decreased by 8.4% or $642.85 per patient overall (*P*<.001) and also decreased for both planned (*P*<.001) and unplanned (*P*<.001) CD groups. When multivariate regression was applied, there was a similar decrease in postoperative direct costs by $575.01 per patient overall (*P*<.001) and a decrease in both planned (*P*=.006) and unplanned (*P*<.001) CD groups. Compared with baseline after implementation, total direct cost decreased per patient overall by $834.71 (*P*<.001) and by $1243.00 (*P*<.001) for those with planned CD. There was no significant difference in total direct cost for unplanned CD ($9891.93 vs $9457.39; *P*=.17). There was no difference in readmissions overall (1.6% vs 1.5%; *P*=.83) or for those with planned (0.3% vs 0.0%; *P*=.34) or unplanned (2.6% vs 2.8%; *P*=.86) CD, respectively.

Comment

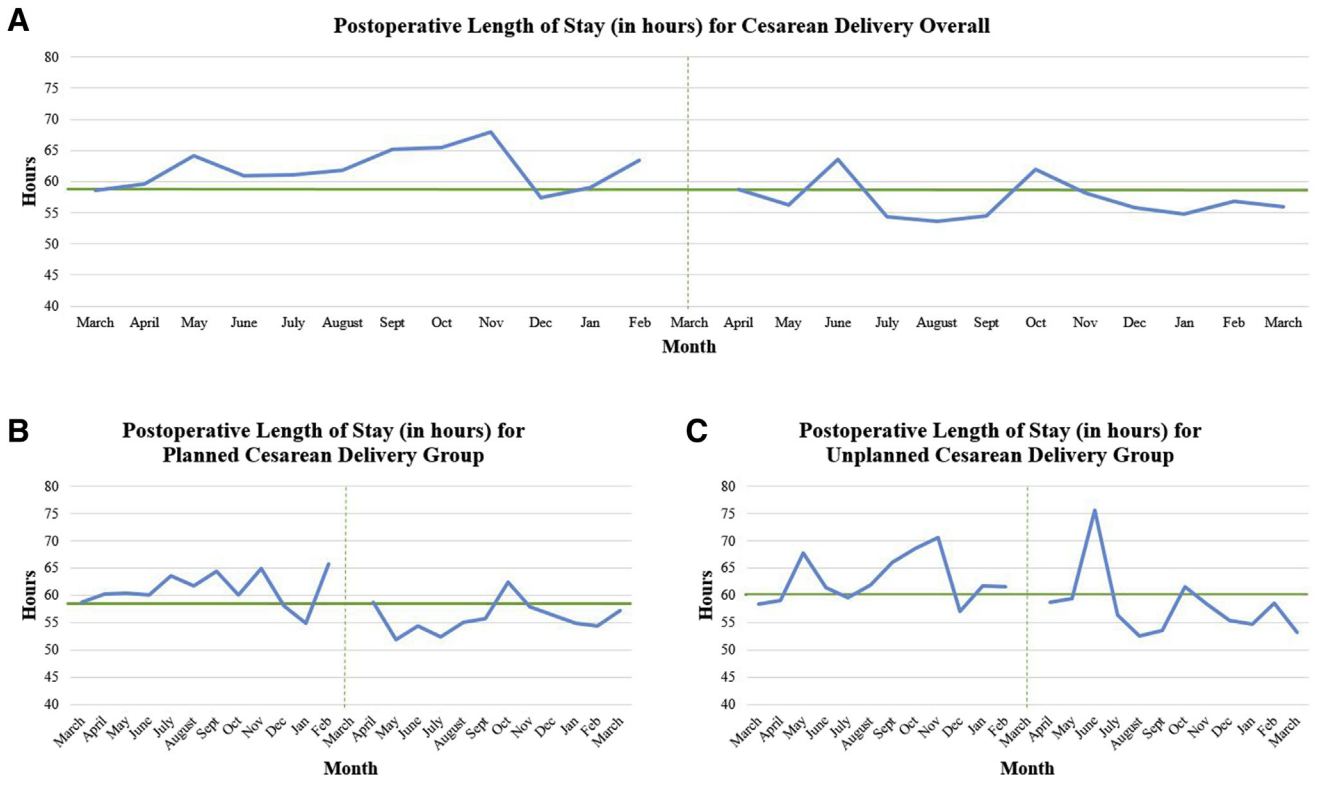
Principal findings

We found that our ERAS CD, for both planned and unplanned cesarean deliveries, was associated with decreased postoperative length of stay and postoperative direct cost savings, without any increase in readmission rates.

Results of the study in context

The finding of decreased postoperative length of stay and postoperative direct cost savings in patients on the ERAS CD supports our hypothesis and what has been found in the literature with the use of ERAS pathways in other surgical specialties.[2] This also aligns with the published literature of hospitals that have implemented ERAS pathways in obstetrics for patients who undergo planned CD that have also found decreases in length of stay, without increases in readmission rates.[12–14] Although our ERAS CD was developed before the recently published preoperative, intraoperative, and postoperative ERAS guidelines for patients who undergo CD by Wilson et al,[15] Caughey et al,[16] and Macones et al,[17] our pathway elements are similar in most respects. Our ERAS

FIGURE 3
Postoperative length of stay (in hours) over time (by month) for overall, planned, and unplanned cesarean delivery groups



Postoperative length of stay (in hours) over time (by month) for **A,** overall, **B,** planned, and **C,** unplanned cesarean delivery groups. The *dotted line* represents the transition month from baseline to implementation groups. The *solid line* is the mean of the observed data.

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CD differs in that we used preoperative fasting time of 8 hours (they recommend 6 hours), and this was based primarily on literature review and local consensus. Our patients routinely do not receive vaginal preparation with povidone-iodine solution. Additionally, the authors recommend intravenous fluid warming, which is not done routinely in our practice. Their pathway also includes a neonate pathway, which was not specifically included in our ERAS CD. However, the neonatal recommendations that they make are routine practice at our hospital, with the exception that we routinely perform delayed cord clamping for 45 seconds for both our preterm and term infants, not 30 seconds and 60 seconds for preterm and term infants, respectively, as recommended in their articles. The authors suggest immediate removal of the urinary catheter; however, our pathway differs in that we remove the urinary catheter at 18 hours after CD, based on local consensus. Finally, they suggest gum chewing if delayed oral intake is planned. Our pathway includes early oral intake, so the gum chewing is not necessary.

Clinical implications

Given that CD is 1 of the most common surgical procedures performed in the United States, positively impacting postoperative length of stay and direct cost for women who undergo CD could have significant healthcare cost-savings.

Research Implications

Although our study provides a practical approach to the implementation of an ERAS CD, future studies need to evaluate ERAS CDs in other care settings for obstetric patients. Additionally, a randomized controlled trial that would compare ERAS CDs would be the best approach to study this, with formal tracking of all elements of the ERAS CD used to determine adherence to the pathway.

Strengths and limitations

The particular strength of this project was that it was developed within a few months with the support of the hospital administration and stakeholders in multiple specialties and then implemented and tested within 1 year. The factors that limit the generalizability of this work include that it was performed at a single high-acuity, tertiary-care academic medical center. Additionally, we used historic controls as our

comparison, so there may have been other factors that differed between these 2 time periods that were not measured. For example, although the cost estimation method was the same between baseline and implementation groups, it is possible there were some unmeasured or unknown variables that impacted cost during this time that were not attributable directly to the ERAS CD, thereby impacting cost estimate. Moreover, there were 109 eligible patients in the implementation group who did not receive the ERAS CD order set. It is possible that, if these patients had received the ERAS CD order set, they could have impacted the results.

Another potential limitation is that the baseline and implementation groups differed on NICU admission, with higher NICU admissions in the baseline groups overall and for planned CD, which could have impacted postoperative length of stay. At our institution, mothers of neonates who were admitted to the NICU are treated the same as mothers who have neonates who are rooming-in with them and are discharged when discharge criteria are met. Our NICU has private rooms with cots that allow parents to stay with their neonates in the NICU once discharged. The neonates who are rooming-in with their mothers (ie, not in the NICU), are discharged typically when their mother is discharged. In rare instances in which the mother is meeting all discharge criteria, but her neonate who is rooming-in with her (ie, not in the NICU) has not been discharged, then occasionally these mothers will stay as patients until their neonate is discharged. Therefore, mothers with neonates rooming-in with them may stay longer as patients than those who have neonates in the NICU. Given this, if postoperative length of stay is impacted by NICU admission rates, we would have expected the baseline group to have a shorter length of stay compared with the implementation group because they have greater NICU admissions. We found the opposite result, with the implementation group having a shorter length of stay, despite lower rates of NICU admissions overall and for the planned CD group. Additionally, when multivariate analysis was applied, including the covariate of NICU admission, we found that ERAS CD use remained significantly associated with decreased postoperative length of stay. However, it is still possible that this difference in NICU admission between the groups impacted the postoperative length of stay in unanticipated ways that we did not measure.

Finally, although we performed regular assessments of use of the order set, it was difficult to measure adherence formally with all pathway components, and it is possible that some patients may not have received all components of the specified pathway. Despite these limitations, we found improvements in both postoperative length of stay and postoperative direct cost in women who underwent cesarean deliveries.

Conclusion

It may take up to 15 years between evidence-based demonstration of a clinical benefit and its incorporation into clinical practice.[18] Therefore, system factors are needed to support and guide practice change more efficiently. Factors that are associated with successful implementation of ERAS pathways include the formation of multidisciplinary teams with improved communication and collaboration, support by hospital administration, standardization of order sets and care processes, effective leadership, and visible clinical champions.[19–21] In our development and implementation of our ERAS CD, we found all of these to be critical components of the success of our pathway. The greatest challenge that we faced in the implementation of this ERAS CD was dissemination of the information. By having a multidisciplinary team, we were able to have champions from each aspect of care (outpatient and inpatient nursing, anesthesia, obstetrics) who reached out to their colleagues initially and on an ongoing basis to remind care providers of the ERAS CD. We used multimodal communication strategies that included posters, email messages, in-person education sessions, and discussion at department and management meetings. In summary, implementation of an ERAS CD at our tertiary-care academic medical center was possible after multidisciplinary planning and commitment to action that resulted in a decrease in postoperative length of stay and direct cost. ■

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