OPEN

Original Research

Improved Outcomes With an Enhanced Recovery Approach to Cesarean Delivery

Luciana Mullman, MPH, Patrick Hilden, MS, Jan Goral, MD, Nnamdi Gwacham, DO, Caitlin Tauro, BS, Kristen Spinola, RN, Kim Rosales, MSN, Sheila Collier, MSN, Lynice Holmes, MSN, Janice Maccione, MSN, Richard Pitera, MD, Richard Miller, MD, and Paul Yodice, MD

OBJECTIVE: To examine the results of a quality-improvement study that implemented an enhanced recovery after surgery (ERAS) program for cesarean delivery.

METHODS: A pre–post design was used to assess changes in opioid use, length of stay, and costs among all patients undergoing cesarean delivery before and after implementation of an evidence-based ERAS pathway for the preoperative, intraoperative, and postoperative management of patients beginning December 2018.

RESULTS: A total of 3,679 cesarean deliveries (scheduled and emergent) were included from January 1, 2018, through August 31, 2019, of which 2,171 occurred before implementation on December 17, 2018, and 1,508 occurred postimplementation. Eighty-four percent of patients received opioids as inpatients after cesarean delivery during the preimplementation period, as compared with 24% in the postimplementation period (odds ratio [OR] 16.8, 95% CI 14.3–19.9). Among patients who required any opioids, the total morphine milligram equivalents also significantly decreased (median 56.5 vs 15.0, mean relative change 0.32, 95% CI 0.28–0.35). Compared with the preimplementation period, those in the postimplementation period had a shorter postcesarean length of stay (3.2 vs 2.7 days, mean relative change 0.82, 95% CI 0.80–0.83, median 3 days in both periods), lower median direct costs by $349 (mean relative change 0.93, 95% CI 0.91–0.95), and no change in the 30-day readmission rate (1.4% vs 1.7%, OR 0.83, 95% CI 0.49–1.41).

CONCLUSION: An ERAS approach for the cesarean delivery population is associated with improved outcomes including decreases in opioid use, length of stay, and costs.

(Obstet Gynecol 2020;136:685–91)
DOI: 10.1097/AOG.0000000000004023

Enhanced recovery after surgery (ERAS) has become a widely adopted model to increase the quality of patient care through enhanced management of surgical patients in the perioperative period.[1,2] Enhanced recovery after surgery pathways have been adopted in a variety of surgery settings, including colorectal, bariatric, and gynecologic procedures; hip and knee replacement; and, most recently, cesarean delivery.[3–7] These pathways have been shown to significantly reduce length of stay, costs, and in-hospital mortality while increasing the quality of patient care.[8–10]

The primary goal of an ERAS pathway is to blunt the response to surgical stress through optimization of patient care, and it requires multidisciplinary teams of professionals to work together throughout the perioperative period.[11] Although individual ERAS programs differ, the majority address this goal through the limitation of preoperative fasting, individualized fluid management, opioid-sparing analgesia, minimally invasive surgery, and early postoperative ambulation and feeding. These components facilitate a faster return to the patient's preoperative functional state.[12–14]

The cesarean delivery rate in the United States is estimated to be 32% of all births, with more than 1.27

From the Departments of Clinical Excellence, Biostatistics, Obstetrics and Gynecology, Nursing, Anesthesia, Medicine, and CIS Informatics, Saint Barnabas Medical Center, RWJBarnabas Health, Livingston, New Jersey.

Each author has confirmed compliance with the journal's requirements for authorship.

Corresponding author: Luciana Mullman, MPH, Clinical Excellence and Effectiveness Saint Barnabas Medical Center, Livingston, NJ; email: Luciana.Cinicolo@rwjbh.org.

Financial Disclosure
Richard Miller reports receiving funds from Coventus Professional Liability Insurance: Risk Management Committee and the New Jersey Board of Medical Examiners. The other authors did not report any potential conflicts of interest.

ISSN: 0029-7844/20

million procedures performed annually.[15] The majority of women undergoing cesarean delivery tend to be young and healthy and, therefore, have the potential for rapid recovery after delivery. Although the benefits of ERAS programs have been shown, up to this point, little research has highlighted their effectiveness in the cesarean delivery population or shown their effectiveness in reducing opioid use. The adoption of an ERAS program focused on the cesarean delivery population represents an important opportunity to significantly improve patient care.

Saint Barnabas Medical Center in Livingston, New Jersey is a tertiary care institution that facilitates more than 5,800 live births each year. To increase the quality of care provided to patients undergoing cesarean delivery, our Clinical Excellence and Effectiveness team led a multidisciplinary effort to create an ERAS pathway for all cesarean deliveries at our center. We hypothesized that an ERAS-based approach to the management of cesarean deliveries would have a positive effect on patient outcomes. Our primary outcome of interest was a patient's requirement of any opioids. Secondary outcomes included total inpatient opioid use, length of stay, costs, and readmission.

METHODS

We used a pre–post study design. Before implementation of our ERAS program, no formal or consistent educational program was provided to patients in preparation for anticipated cesarean delivery. As has been a traditional component of preoperative patient care, patients were asked to avoid eating and drinking starting at midnight before their surgery day. Postoperatively, they were maintained nonambulatory before urinary catheter removal (often 18–24 hours postsurgery) and received a postoperative diet consisting of clear liquids introduced at 6 hours with solid foods at 12 hours postsurgery. Pain management was left to the treating physician's discretion and typically consisted of acetaminophen 650 mg every 8 hours as needed, ibuprofen 600 mg every 6 hours as needed, and oxycodone–acetaminophen 5–325 mg every 4 hours as needed, with no standing scheduled doses of postoperative analgesics. Patients were typically discharged home on postoperative day 3 or 4, once they were able to ambulate and retain food and oral medication and had control of postoperative pain.

A multidisciplinary team, organized by the Clinical Excellence and Effectiveness group, was composed of members from obstetrics, pediatrics, anesthesia, nursing, pharmacy, administration, electronic medical record (EMR) support, and current obstetrics and gynecology residents. This team reviewed our standard cesarean delivery approach and management to identify improvement opportunities. We reviewed publications from the ERAS Society as well as other relevant medical societies and identified literature for the management of cesarean deliveries as well as that specific to ERAS in obstetrics and other fields and developed best practice pathways. Standardized order sets were created in our EMR platform, and daily chart audits were performed by an ERAS coordinator.

The ERAS strategy for cesarean delivery incorporates three major components: preoperative strategy, intraoperative management, and postoperative care (Table 1). Preoperative features include patient education, by which each patient receives a detailed, descriptive guidebook and meets with our maternal health nurse at the preoperative visit. The guidebook details all three stages of the ERAS pathway, and the personal meeting helps to align expectations of the preoperative and postoperative experience as well as provide an opportunity to address any questions. At this meeting, patients are provided a chlorhexidine body scrub, instructed on its application both the evening before and the morning of surgery, and encouraged to drink clear liquids up to 2 hours before their scheduled surgery. Women identified with anemia on early third-trimester laboratory evaluation are referred to our blood management program for hemoglobin optimization, as is standard of care for all pregnant patients.

Intraoperative features include minimizing intravenous opioids in favor of neuraxial opioids. Attention is directed to active body core warming with warm circulated air, multimodal prophylactic antiemetics, and balanced fluid administration with a focus on euvolemia. Patients are also provided with time for skin-to-skin contact with the newborn after pediatric evaluation and before transfer to the nursery. Postpartum pain control begins intraoperatively with IV acetaminophen and ketorolac administration near the conclusion of the procedure. Transversus abdominis plane blocks are administered in the operating room under ultrasound guidance, with 0.3% Ropivacaine injected bilateral with 30 mL volume on each side. This procedure is performed by attending anesthesiologists before transfer to the recovery areas as a routine element in the ERAS pathway.

Postoperatively, urinary catheters are removed in the recovery room before transfer to postpartum floors, unless contraindicated based on patient status. A clear liquid diet resumes within 1 hour

Table 1. Cesarean Delivery Enhanced Recovery After Surgery Pathway Components

Perioperative Period	Pathway Component
Preoperative	Patient-individualized counseling with RN and alignment with descriptive guidebook; intended to reduce anxiety, involve patients in their care, and improve compliance
	Hemoglobin optimization starting at 27 wk of gestation for patients with hemoglobin less than 11.5 (standard of care for all pregnant patients); this is to reduce the need for blood transfusion during or after surgery
	Chlorohexidine body scrub to be used night before and morning of surgery to minimize risk of infection; given to patients during individualized counseling session.
	Clear liquids to continue up to 2 h before surgery
Intraoperative	Active warming to control body temperature using warm blankets or bed warmer, with a goal of maintaining patient body temp to 36.0°C
	Maintain fluid balance to avoid overhydration or underhydration
	Standardized anesthesia and avoidance of long-acting opioids
	Postoperative nausea and vomiting prophylaxis: ondansetron 4 mg IV at start of cesarean delivery
	Bilateral TAP block at completion of cesarean delivery done by anesthesiologist with 0.3% ropivacaine 30 mL each side
	Postpartum anesthesia communication tool for timing of medication
Postoperative	Removal of urinary catheter in the recovery room; supports mobility and patient comfort
	Early oral intake of clear liquids within 1 h postoperatively, with solid foods at 6 h
	Out of bed within 6 h postsurgery and walk 3 times daily around nursing unit; this is to support return of normal movement and reduce the likelihood of complications such as pneumonia or blood clots
	Use of around-the-clock multimodal analgesia to minimize opioid administration
	Routine audit of compliance to improve outcomes and maintain sustainability

RN, registered nurse; TAP, transverse abdominis plane.

postoperatively, and a regular diet 6 hours after surgery. Patients are started on an oral pain regimen of scheduled acetaminophen 1,000-mg tablet every 8 hours, ibuprofen 600-mg tablet every 6 hours, and dextromethorphan 30 mg/mL every 8 hours. Oral oxycodone 5 mg is administered for breakthrough pain after in-person physician evaluation whenever possible, with additional evaluation required for any order of oxycodone as needed. Pregabalin 25 mg every 8 hours is added for patients reporting neuropathic-type (incisional burning) pain. Patients are ambulatory within 4–6 hours postoperative, with a minimum of three scheduled walks around the postpartum unit per day.

All patients with cesarean delivery scheduled were enrolled in the ERAS pathway and received the preoperative, intraoperative, and postoperative components; patients with emergent cesarean deliveries received only the intraoperative and postoperative components. Standard discharge criteria remained unchanged across the study periods.

Standardized order sets for cesarean delivery according to the ERAS pathway were implemented at our institution on December 17, 2018. We queried our administrative billing database and identified all patients undergoing cesarean delivery at our institution (scheduled and emergent) from January 1, 2018, through August 31, 2019. This time period was selected to provide a year's worth of preimplementation data, as well as include all available postimplementation data at the time of analysis. We compared preimplementation and postimplementation length of stay, direct costs, readmission rate, and opioid use. Length of stay was defined as the time from cesarean delivery to discharge. Any opioid use was treated as a binary outcome and defined as any opioid taken after surgery (hydromorphone, morphine, oxycodone, acetaminophen-hydrocodone, and acetaminophen-oxycodone). Overall opioid use was treated as a continuous outcome, defined in terms of the total morphine milligram equivalents given inpatient. Additional covariates of interest included patient age, race (African American, White, other), as well as whether the cesarean delivery was scheduled or emergent.

Differences in patient characteristics and outcomes across preimplementation and postimplementation periods were assessed using the Wilcoxon rank-sum test for continuous variables and the χ^2 or Fisher exact test for categorical variables, as appropriate. Owing to skewness in the distributions of length of stay, costs, and morphine milligram equivalents, these values were log transformed before estimating differences and CIs, and the results exponentiated and presented as the mean relative change. To assess potential bias, we conducted subgroup analyses based on scheduled or emergent cesarean delivery. Four patients with missing race data were excluded when assessing differences in race across the preintervention and postintervention periods. There were no other missing data. All analyses were done using R 3.6.1. This study was approved by the Saint Barnabas Medical Center Institutional Review Board.

RESULTS

We identified 3,685 cesarean deliveries (scheduled and emergent) from January 1, 2018, through August 31, 2019. Five patients with unclear admission, cesarean delivery, or discharge dates were excluded, along with one inpatient death. A total of 3,679 deliveries were included in our analysis, with 2,171 in the preimplementation period and 1,508 in the postimplementation period. The median (range) age in the preimplementation and postimplementation periods was 34.1 (17.2–55.3) and 34.0 (18.4–53.8) years respectively (P=.476). Sixty-seven percent of cesarean deliveries were scheduled in the preimplementation period and 63% in the postimplementation period (P=.052). There were no differences in racial distributions between periods.

Outcomes are presented in Table 2. Opioid use decreased significantly in the post–ERAS implementation period. Before ERAS pathway implementation, 84% of patients received opioids, whereas, post–ERAS implementation, only 24% of patients received opioids (odds ratio [OR] 16.8, 95% CI 14.3–19.9, P<.001, Fig. 1). Among those patients who did require opioids, total morphine milligram equivalents was significantly lower in the postimplementation period with a median (range) of 15.0 (2.0–338.0) compared with 56.5 (2.0–1,520.0) morphine milligram equivalents in the preimplementation period (mean relative change 0.32, 95% CI 0.28–0.35, P<.001).

Length of stay from completion of the cesarean delivery to discharge decreased significantly postimplementation, from an average (SD) length of stay of 3.2 (1.0) days to 2.7 (0.8) days postimplementation (mean relative change 0.82, 95% CI 0.80–0.83, P<.001, Fig. 2, median 3 days in both periods). Further, the percentage of patients discharged within 2 days improved from 9% preimplementation to 49% postimplementation, with the percentage of patients staying 4 days or more decreasing from 22% to 12%. Median direct costs in the postimplementation period decreased by $349 per cesarean delivery (mean relative change 0.93, 95% CI 0.91–0.95, P<.001), with no difference observed in 30-day readmission rates (1.4% vs 1.7%, OR 0.83, 95% CI 0.49–1.41, P=.562).

Among patients with scheduled cesarean deliveries, 85% and 27% required opioids in the preimplementation and postimplementation periods, respectively (OR

Table 2. Outcomes Comparison, Overall and by Scheduled and Emergent Cesarean Delivery Subsets

Outcome	Preimplementation	Postimplementation	*P*
Length of stay (d)			
Overall	3.2±1.0	2.7±0.8	<.001
Scheduled	3.2±0.9	2.7±0.9	<.001
Emergent	3.1±1.2	2.5±0.7	<.001
Direct cost ($)			
Overall	3,970 (2,511–123,918)	3,621 (1,995–56,569)	<.001
Scheduled	4,101 (2,518–66,613)	4,066 (2,439–56,569)	.001
Emergent	3,487 (2,511–123,918)	3,346 (1,995–19,998)	<.001
Patients requiring opioids (%)			
Overall	84.0	23.8	<.001
Scheduled	84.6	26.9	<.001
Emergent	82.9	18.5	<.001
Total MME (among opioid users)			
Overall	56.5 (2.0–1,520.0)	15.0 (2.0–338.0)	<.001
Scheduled	59.0 (2.0–1,520.0)	15.0 (2.0–338.0)	<.001
Emergent	56.5 (2.0–708.5)	15.0 (2.0–142.5)	<.001
30-d readmission rate (%)			
Overall	1.4	1.7	.562
Scheduled	1.5	1.7	.902
Emergent	1.2	1.8	.546

MME, morphine milligram equivalents.
Data are average±SD, median (range), or % unless otherwise specified.

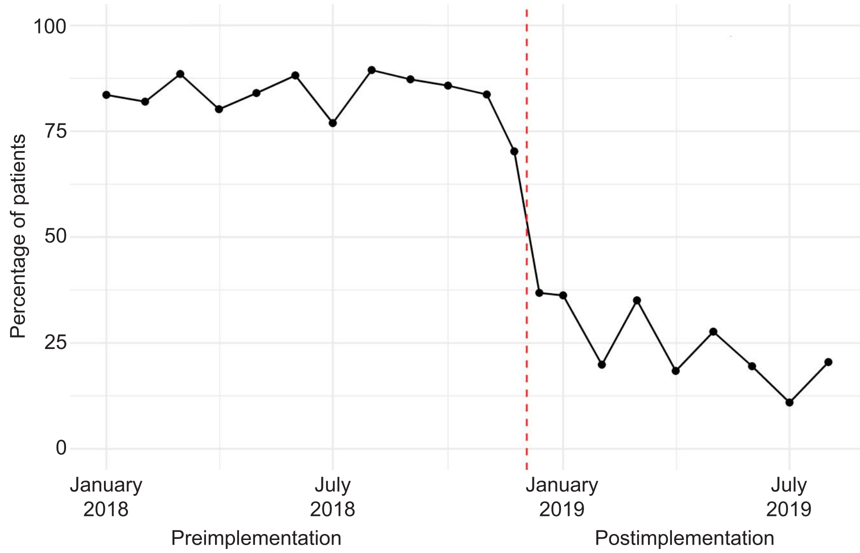

Fig. 1. Percentage of patients requiring any inpatient opioids by month. Separate averages are provided in December for preimplementation and postimplementation. *Red line* indicates implementation date

Mullman. Enhanced Recovery for Cesarean Delivery. Obstet Gynecol 2020.

14.9, 95% CI 12.2–18.3, $P<.001$); the median (range) total morphine milligram equivalents was 59.9 (2.0–1,520.0) and 15.0 (2.0–338.0) (mean relative change 0.31, 95% CI 0.27–0.36, $P<.001$). Average length of stay was shorter in the postimplementation period among patients with scheduled cesarean deliveries (3.2 vs 2.7 days, mean relative change 0.83, 95% CI 0.81–0.85, $P<.001$), with no significant difference in readmission rate at 30 days (1.5% vs 1.7%, OR 0.91, 95% CI 0.48–1.77, $P=.902$).

Among patients with emergent cesarean deliveries, 83% and 19% required opioids in the preimplementation and postimplementation periods, respectively (OR 21.4, 95% CI 16.1–28.7, $P<.001$); the median (range) total morphine milligram equivalents was 56.5 (2.0–708.5) and 15.0 (2.0–142.5) (mean relative change 0.95, 95% CI 0.89–1.01, $P<.001$). Average length of stay was shorter in the postimplementation period among patients with emergent cesarean deliveries (3.1 vs 2.5 days, mean relative change 0.80, 95% CI 0.77–0.82, $P<.001$), with no significant difference in readmission rate at 30 days (1.2% vs 1.8%, OR 0.68, 95% CI 0.27–1.70, $P=.546$).

DISCUSSION

Our implementation of an ERAS program for women delivering by cesarean was associated with an overall reduction in the percentage of patients requiring opioids as inpatients. We also noted a significant reduction in the total morphine milligram equivalents provided when opioids were needed and decreases in length of stay and direct costs without an increase in hospital readmissions. Over the course of the study period there were no significant changes in care for patients or newborns outside of the ERAS program, further strengthening these results. Importantly, the benefits of the ERAS program were noted among patients with both scheduled and emergent cesarean deliveries, even though those with emergent cesarean deliveries did not receive the preoperative components. With cesarean delivery being one of the most common procedures in the United States, our study highlights the critical effect on outcomes that can occur when adopting an ERAS approach within the cesarean delivery population.

Our ERAS protocol includes the use of transverse abdominis plane blocks as postoperative analgesia; several studies have noted benefit as a postoperative pain management strategy within the cesarean delivery population,[16–20] whereas others have noted no benefit within the cesarean delivery population[21] and other gynecologic surgeries.[22,23] The transverse abdominis plane blocks have typically taken no longer than 5 minutes at the completion of each cesarean delivery and have not lead to any issues in procedure timing in the operating room. Additionally, to date we have not had any patient refuse their use.

Variance in the care of patients has been identified as a contributor to disparate hospital length of stay, medication utilization, outcomes, and costs. In an effort to improve the quality of care provided, initiatives that seek to decrease the variability in practice, such as that of our ERAS program, are an intuitive first step. Medical societies, such as the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine, organize leaders within their chosen areas to develop best practice guidelines based on medical evidence and

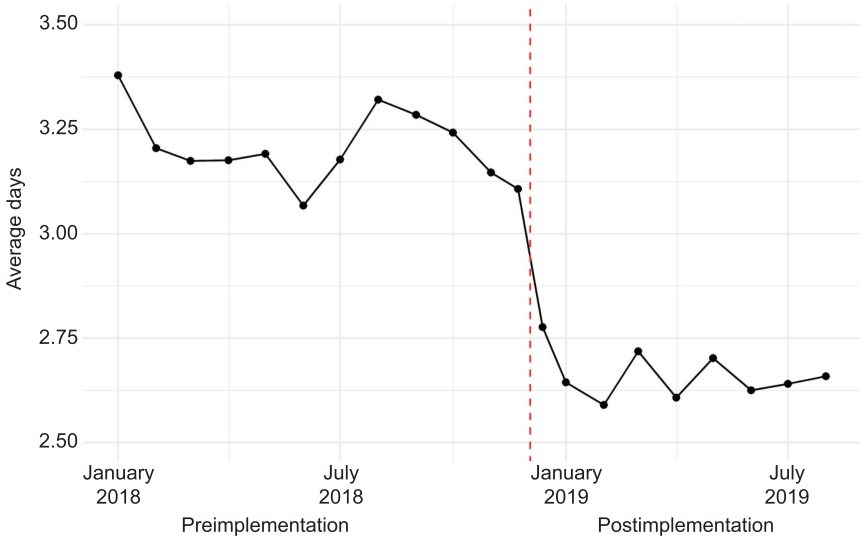

Fig. 2. Average length of stay by month. Separate averages are provided in December for preimplantation and postimplementation. *Red line* indicates implementation date

Mullman. Enhanced Recovery for Cesarean Delivery. Obstet Gynecol 2020.

then publish these guidelines for practitioners to review, consider, and adopt. Enhanced recovery after surgery programs use these same principles and, when available, incorporate guidelines to improve all aspects of patient care. This is accomplished by identifying the evidence-based best practices, removing barriers to implementation, education of staff not only of the program but its value to the patient, and regular auditing for compliance with these best practices. Many surgical practices with robust ERAS programs have demonstrated the value of such processes to patients and to the institutions and clinicians who have adopted them, and we continue to see the development of new ERAS programs in novel areas such as cesarean delivery.

The success of our program was driven by our multidisciplinary approach to patient care with buy-in across a multitude of specialty areas, including administration, nursing, physicians, as well as commitment from our residents in providing care in line with our program. Of note, we have observed strong overall compliance with the ERAS protocol since its inception, with an average of 98%, 80%, and 74% of cesareans adhering to transverse abdominis plane block use after cesarean delivery, urinary catheter removal in the recovery room, and ambulation within 6 hours postsurgery, respectively. To ensure the continued success of the ERAS program, we continue to perform regular audits of care team compliance with all aspects of the ERAS program. We employ a full time ERAS coordinator who tracks compliance and communicates any issues with the multidisciplinary care team. An ERAS coordinator with experience in a hospital setting or clinical background is a key support person in ensuring the continued monitoring and success of any ERAS program. As new improvements and opportunities develop, we look to incorporate them within our program to enhance its benefit. Given the success of our program in the cesarean delivery population, we are currently working to take advantage of the benefits recognized in this program for pain management and apply them to the vaginal delivery population to reduce opioid use in this population.

Our results are strongly supported by our robust sample size of 2,171 patients in the preimplementation and 1,508 in the postimplementation period. Although our study showed a significant decrease in inpatient opioid use, our conclusions are limited to the inpatient setting, because opioid use after discharge was not assessed. Additionally, our data did not include more detailed demographic or treatment information including body mass index, prior cesarean delivery, or operative blood loss, among other potential confounders. As with all retrospective analyses, we also acknowledge the possibility of other unobserved confounding variables that may be associated with our observed changes in outcomes.

Although ERAS programs have demonstrated improvements in quality of care, outcomes, and costs for a variety of surgical procedures, their application and adoption for the cesarean delivery population have been limited. As has been shown across a multitude of ERAS programs, we demonstrated improvements in both patient care and hospital resource utilization. Women went home safely sooner and required less opioids, avoiding all of the associated side effects.

REFERENCES

1. Ljungqvist O, Scott M, Fearon KC. Enhanced recovery after surgery: a review. JAMA Surg 2017;152:292–8.
2. Paton F, Chambers D, Wilson P, Eastwood A, Craig D, Fox D, et al. Effectiveness and implementation of enhanced recovery after surgery programmes: a rapid evidence synthesis. BMJ open 4:2014:e005015.
3. Adamina M, Kehlet H, Tomlinson GA, Senagore AJ, Delaney CP. Enhanced recovery pathways optimize health outcomes and resource utilization: a meta-analysis of randomized controlled trials in colorectal surgery. Surgery 2011;149:830–40.
4. Mortensen K, Nilsson M, Slim K, Schäfer M, Mariette C, Braga M, et al. Consensus guidelines for enhanced recovery after gastrectomy: enhanced Recovery after Surgery (ERAS®) Society recommendations. Br J Surg 2014;101:1209–29.
5. Kalogera E, Bakkum-Gamez JN, Jankowski CJ, Trabuco E, Lovely JK, Dhanorker S, et al. Enhanced recovery in gynecologic surgery. Obstet Gynecol 2013;122:319–28.
6. Kaye AD, Urman RD, Cornett EM, Hart BM, Chami A, Gayle JA, et al. Enhanced recovery pathways in orthopedic surgery. J Anaesthesiol Clin Pharmacol 2019;35:S35–9.
7. Ituk U, Habib AS. Enhanced recovery after cesarean delivery. F1000Res 2018;7:F1000.
8. Teeuwen PH, Bleichrodt RP, Strik C, Groenewoud JJ, Brinkert W, van Laarhoven CJ, et al. Enhanced recovery after surgery (ERAS) versus conventional postoperative care in colorectal surgery. J Gastrointest Surg 2010;14:88–95.
9. Aarts MA, Okrainec A, Glicksman A, Pearsall E, Victor JC, McLeod RS. Adoption of enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic teaching hospitals and impact on total length of hospital stay. Surg Endosc 2012;26:442–50.
10. Sammour T, Zargar-Shoshtari K, Bhat A, Kahokehr A, Hill AG. A programme of enhanced recovery after surgery (ERAS) is a cost-effective intervention in elective colonic surgery. New Zealand Med J (Online) 2010;123:1319.
11. Thorell A, MacCormick AD, Awad S, Reynolds N, Roulin D, Demartines N, et al. Guidelines for perioperative care in bariatric surgery: enhanced recovery after surgery (ERAS) society recommendations. World J Surg 2016;40:2065–83.
12. Beverly A, Kaye AD, Ljungqvist O, Urman RD Essential elements of multimodal analgesia in enhanced recovery after surgery (ERAS) guidelines. Anesthesiol Clin 2017;35:e115–43.
13. Melloul E, Hübner M, Scott M, Snowden C, Prentis J, Dejong CH, et al. Guidelines for perioperative care for liver surgery: enhanced recovery after surgery (ERAS) society recommendations. World J Surg 2016;40:2425–40.
14. Lassen K, Soop M, Nygren J, Cox PB, Hendry PO, Spies C, et al. Consensus review of optimal perioperative care in colorectal surgery: Enhanced Recovery After Surgery (ERAS) Group recommendations. Arch Surg 2009;144:961–9.
15. Martin JA, Hamilton BE, Osterman M, Driscoll AK, Drake P. Births: final data for 2016. Natl Vital Stat Rep 2018;67:1–55.
16. Baker BW, Villadiego LG, Lake YN, Amin Y, Timmins AE, Swaim LS, et al. Transversus abdominis plane block with liposomal bupivacaine for pain control after cesarean delivery: a retrospective chart review. J Pain Res 2018;11:3109–16.
17. Abdallah FW, Halpern SH, Margarido CB. Transversus abdominis plane block for postoperative analgesia after caesarean delivery performed under spinal anaesthesia? A systematic review and meta-analysis. Br J Anaesth 2012;109: 679–87.
18. Fusco P, Scimia P, Paladini G, Fiorenzi M, Petrucci E, Pozone T, et al. Transversus abdominis plane block for analgesia after cesarean delivery. A systematic review. Minerva Anestesiol 2015;81:195–204.
19. Jadon A, Jain P, Chakraborty S, Motaka M, Parida SS, Sinha N, et al. Role of ultrasound guided transversus abdominis plane block as a component of multimodal analgesic regimen for lower segment caesarean section: a randomized double blind clinical study. BMC Anesthesiol 2018;18:53.
20. Buluc H, Yildirim A, Turan G, Karadogan F, Sargin MA, Akgun N. The efficacy of transversus abdominis plane block for post-operative analgesia after the cesarean section performed under general anesthesia. North Clin İstanbul 2019;6:368–73.
21. McKeen DM, George RB, Boyd JC, Allen VM, Pink A. Transversus abdominis plane block does not improve early or late pain outcomes after cesarean delivery: a randomized controlled trial. Can J Anaesth 2014;61:631–40.
22. Hachem L, Small E, Chung P, Moshier EL, Friedman K, Fenske SS, et al. Randomized controlled double-blind trial of transversus abdominis plane block versus trocar site infiltration in gynecologic laparoscopy. Am J Obstet Gynecol 2015;212: 182.e1–9.
23. Kane SM, Garcia-Tomas V, Alejandro-Rodriguez M, Astley B, Pollard RR. Randomized trial of transversus abdominis plane block at total laparoscopic hysterectomy: effect of regional analgesia on quality of recovery. Am J Obstet Gynecol 2012;207: 419.e1–5.

PEER REVIEW HISTORY

Received January 30, 2020. Received in revised form April 29, 2020, and May 19, 2020. Accepted June 4, 2020. Peer reviews and author correspondence are available at http://links.lww.com/AOG/B995.