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ORIGINAL CONTRIBUTIONS

Impact of Enhanced Recovery After Surgery (ERAS) Combined with Bariatric Surgery Targeting Opioid Prescriptions (BSTOP) Protocol on Patient Outcomes, Length of Stay and Opioid Prescription After Bariatric Surgery

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Abstract

Background Evidence shows that 14.2% of opioid-naive patients have long-term opioid dependence after bariatric surgery. Enhanced recovery after surgery (ERAS) protocols are widely used in bariatric surgery, while bariatric surgery targeting opioid prescriptions (BSTOP) protocols were recently introduced. We will investigate the combined impact of ERAS and BSTOP protocols after bariatric surgery.

Methods We conducted a retrospective review for patients who underwent either a sleeve gastrectomy or Roux-en-Y gastric bypass at a tertiary care center. Pre-intervention and post-intervention data were compared. Primary outcomes were length of stay (LOS), 30-day readmission, 30-day complications, and discharge on opioids. Multivariate Poisson regression with robust standard error was used to analyze LOS.

Results There was no significant difference in 30-day emergency room visits (3.3% vs. 4.0%; p value = 0.631), 30-day readmission (4.4% vs. 5.4%; p value = 0.577) or 30-day complication rate (4.2% vs. 6.4%; p value = 0.199). LOS was significantly lower in the post-intervention group; mean (interquartile range) 2 (1–2) days vs. 1 (1–2) day, p value < 0.001. On multivariate analysis, the post-intervention group had 0.74 (95% confidence interval 0.65–0.85; p value < 0.001) times lower LOS as compared to pre-intervention group. Patients with DM had a significantly longer LOS (relative risk: 1.22; $p = 0.018$). No other covariates were associated with LOS (p value < 0.05 for all). BSTOP analysis found a significant difference between the two groups. Discharge on opioids decreased from 40.6% pre-intervention to 7.1% post-intervention.

Conclusion ERAS and BSTOP protocols reduced length of stay and opioid need at discharge without an increase in complication or readmission rates.

Keywords ERAS · BSTOP · Bariatric surgery

Key Points
Concurrent introduction of ERAS and BSTOP does not increase complications.
Introduction of ERAS and BSTOP protocols does not increase readmission rates.
ERAS and BSTOP protocols are associated with shorter length of stay.
BSTOP is associated with decreased need for opioids at discharge.
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Introduction

Enhanced recovery after surgery (ERAS) protocols have been shown to improve patient outcomes and decrease the length of stay (LOS) without an increase in morbidity

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[1, 2]. Specifically, after bariatric surgery, ERAS protocols have demonstrated improved post-operative pain and nausea control, and a reduction in LOS [1].

The opioid epidemic is a major public health crisis in the USA, and opioid overdose results in significant morbidity and mortality [3]. With the widespread adoption of ERAS protocols, one of the primary modes of pain control is the use of opioids. To mitigate the harmful consequences of opioid overuse in the bariatric population, the metabolic and bariatric surgery accreditation and quality improvement program (MBSAQIP) introduced the bariatric surgery targeting opioid prescriptions (BSTOP) protocol [4]. The major reason for its creation was evidence showing that new-onset opioid dependence in post-operative bariatric patients accounts for more deaths than all other complications of bariatric surgery combined [4].

Our MBSAQIP Bariatric Centers of Excellence implemented both bariatric ERAS and BSTOP protocols at approximately the same time. The purpose of this study was to evaluate the combined impact of ERAS and BSTOP protocols on outcomes of bariatric surgery and the need for opioids.

Methods

This is a retrospective review of our prospectively maintained database for patients who underwent either a sleeve gastrectomy or Roux-en-Y gastric bypass (RYGB) at our MBSAQIP Bariatric Center of Excellence in New York. Pre-intervention data were from August 2018 to July 2019, while post-intervention data were from August 2019 to October 2020. The new combined ERAS and BSTOP protocol is detailed in Fig. 1. Criteria for discharge at our center are toleration of clear liquid diet without nausea or vomiting, adequate oral intake to endure oral hydration at home, and adequate pain control. The comparison post-intervention period was longer due to the COVID-19 pandemic, which led to no elective surgeries being performed for a few months. Patients who underwent revisional bariatric surgery or concurrent hiatal hernia were not excluded from analyses.

The database was queried for information on demographic variables (age, gender, and race), comorbid conditions (obstructive sleep apnea [OSA], diabetes mellitus [DM], hypertension [HTN] and

Enhanced Recovery After Surgery Combined with Bariatric Surgery Targeting Opioid Prescriptions Protocol

Preoperative phase	Intraoperative phase	Postoperative phase
Carbohydrate drink - Up to 2 hours before surgery **Scopolamine patch** - 1.5mg for 72 hours behind the left ear on admission **Dexamethasone** - 200mg oral (unless contraindicated) 1 hour before surgery **Gabapentin** - 300mg liquid 1 hour before surgery **Decadron** - 4mg IV 30 minutes before surgery **Metoclopramide** - 30 minutes before surgery **Acetaminophen** - 1000mg IV on call **Low molecule weight heparin** - 30mg subcutaneous if BMI > 50 1 hour before surgery (40mg SQ if BMI > 60) **Cefazolin** - 2g IV on call for sleeve gastrectomy **Cefazolin + Metronidazole** - 2g IV + 500mg IV for gastric bypass at the time of induction of anesthesia x total of 3 doses before surgery (first dose to be given before incision and then subsequent 2 doses every 8 hours) **Levofloxacin** - 500mg IV one dose if allergic to penicillin **Clindamycin** - 600mg IV If allergic to Penicillin and Quinolone	**No induction opiates** **Lipid-soluble volatile anesthetics** **Lidocaine drip** **Total IV anesthesia** - reduce postoperative nausea and vomiting **Ondansetron** - 4m IV 30 min prior to emergence **Limit IV fluids to less than 2.5L** **Cefazolin** - 2 mg IV on call for sleeve gastrectomy **Laparoscopically guided Transversus Abdominis Plan (TAP) block with bupivacaine at the start of the procedure**	**Acetaminophen** - 1g IV (1 time dose) **Ondansetron** - 4mg IV every 6 hours standing for nausea **Pantoprazole** - 40 mg IV **Metoclopramide** - 10 mg IV every 6 hours standing for severe nausea not responding to ondansetron or breakthrough nausea **Pantoprazole** - 40 mg IV daily **Ketorolac tromethamine** - 15 mg every 6 hours IV x maximum of 6 doses standing until the resumption of oral intake for moderate to severe pain rating 4-7 **Acetaminophen** - 650 mg PO every 6 hours standing order, start 6 hours after last IV dose **Gabapentin** - 300 mg PO every 8 hours for 3 days standing, start 8 hours after arrival in recovery room, first 2 doses should be elixir, then change to PO form **Anesthesia** - manage glucose and pain in recovery room - breakthrough severe pain score of 7-9, not responsive to non-narcotic regimen, administer hydromorphone 0.5 mg IV for a maximum of 2 doses only 1 hour apart **Diet** - NPO for 4 hours followed by clear liquid diet. Revision or conversions: NPO for 4 hours followed by ice chips with upper GI study in on postoperative day 1.

Fig. 1 Enhanced Recovery After Surgery combined with Bariatric Surgery Targeting Opioid Prescriptions protocol

gastroesophageal reflux disease [GERD]), and anthropometric measures (weight, height; body mass index [BMI] was calculated). Data on post-operative emergency department visits and reoperations were retrieved. Primary outcomes of interest included length of stay, 30-day readmission, 30-day complications, and the proportion of patients discharged on opioids.

BSTOP data were collected by reviewing discharge medications and identifying patients discharged on opioids. Of note, the final implementation of BSTOP protocol was in October 2019 due to delay resulting from the COVID-19 pandemic. The proportion of patients discharged on opioids was compared between the pre- and post-intervention groups.

Demographic characteristics were summarized by pre- and post-intervention groups and presented as median (interquartile range [IQR]) or frequency (percentage), as appropriate. Baseline characteristics were compared between the groups using the Wilcoxon rank-sum test for continuous variables, and Chi-square or Fisher's exact test for categorical variables. Multivariate Poisson regression (adjusted for age, sex, BMI, race, hypertension, diabetes, GERD, OSA, and OA) with robust standard error was used to analyze LOS data (in days). Deviance statistic and Akaike information criterion (AIC) were used to assess the goodness-of-fit for this model.

Our combined ERAS and BSTOP protocols are detailed in supplemental data. SAS 9.4 was used to analyze all data. Statistical significance was assumed if p value < 0.05.

Results

Our data showed that the number of patients that underwent bariatric surgery in the pre- and post-intervention period were 360 and 297, respectively. Overall, the mean (range) age was 45 (36–54) years in study participants. In pre- and post-intervention groups, mean age was 44 years and 47 years respectively. Seventy-eight percent of all patients were female. The majority of patients (overall 58.8%; 57.9% and 59.9% in pre- and post-intervention groups, respectively) were Caucasians. The most common comorbid condition was GERD (68.0%), followed by OSA (59.7%). There was no significant difference between the groups in demographic characteristics, comorbid conditions, or preoperative BMI (p value > 0.05 for all comparisons), see Table 1.

In unadjusted analyses, there was no significant difference in 30-day emergency room visits (pre-intervention 3.3% [$n = 12/360$] vs. post-intervention 4.0% [$n = 12/297$]; p value $= 0.631$), 30-day readmission rate (pre-intervention 4.4% [$n = 16/360$] vs. post-intervention 5.4% [$n = 15/297$]; p value $= 0.577$) or 30-day complication rate (pre-intervention 4.2% [$n = 15/360$] vs. post-intervention 6.4% [$n = 19/297$]; p value $= 0.199$). LOS was significantly lower in the post-intervention group; mean (IQR) 2 (1–2) days vs. 1 (1–2) day, p value < 0.001. Table 2 details results for 30-day outcomes.

After adjusting for all other factors, patients in the post-intervention group were expected to have 0.74 (95% CI 0.65–0.85; p value < 0.001) times lower LOS compared to patients in the pre-intervention group. Overall, patients with

Table 1 Demographics and clinical characteristics

	Preintervention ($N = 360$)	Postintervention ($N = 297$)	Overall ($N = 657$)	P value[1]
Demographics				
Age (years)	44.0 (35.0–54.0)	47.0 (36.0–56.0)	45.0 (36.0–54.0)	0.128
BMI (kg/m^2)	45.7 (41.8–51.3)	44.7 (40.8–51.4)	45.4 (41.3–51.3)	0.281
Female gender	275 (76.4%)	235 (79.1%)	510 (77.6%)	0.403
Race				0.562
Caucasian	208 (57.9%)	178 (59.9%)	368 (58.8%)	
African American	99 (27.6%)	73 (24.6%)	172 (26.2%)	
Hispanic	47 (13.1%)	38 (12.8%)	85 (13.0%)	
Other	5 (1.4%)	8 (2.7%)	13 (2.0%)	
Hypertension	186 (51.7%)	142 (47.8%)	328 (49.9%)	0.326
Diabetes	97 (26.9%)	91 (30.6%)	188 (28.6%)	0.297
OSA	216 (60.0%)	176 (59.3%)	392 (59.7%)	0.847
GERD	256 (71.1%)	191 (64.3%)	447 (68.0%)	0.063
OA	111 (30.8%)	85 (28.6%)	196 (29.8%)	0.537
Postoperative ER visit	12 (3.3%)	12 (4.0%)	24 (3.7%)	0.631
Reoperation	9 (2.5%)	8 (2.7%)	17 (2.6%)	0.876

[1] p values are from Wilcoxon rank-sum test for continuous variables, and Chi-square or Fisher's exact test for categorical variables

Table 2 Unadjusted outcomes for pre and post intervention groups

Outcomes	Preintervention	Postintervention	*P* value
Length of stay (in days), median (IQR)	2.0 (1.0–2.0)	1.0 (1.0–2.0)	< 0.001
Readmissions	16 (4.4%)	16 (5.4%)	0.577
Complications	15 (4.2%)	19 (6.4%)	0.199

IQR interquartile range

In unadjusted analysis, there was no difference in readmission, and complication rates between pre and post intervention groups. However, length of stay was significantly lower in post-intervention compared to the pre-intervention group ($p < 0.001$)

Table 3 Multivariable Poisson regression model for length of stay

Factors	IRR(95% confidence interval)	*P* value
Group (postintervention vs. preintervention)	0.74 (0.65–0.85)	< 0.001
Age	1.01 (1.0–1.02)	0.145
BMI	0.99 (0.98–1.01)	0.255
Sex (female vs. male)	1.11 (0.96–1.29)	0.169
Race (White vs. other)	0.90 (0.76–1.05)	0.191
HTN	0.96 (0.81–1.14)	0.682
DM	1.22 (1.05–1.42)	0.018
OSA	0.97 (0.83–1.15)	0.745
GERD	1.07 (0.97–1.18)	0.19
OA	1.14 (0.95–1.36)	0.194

*IRR (incidence rate ratio) estimated via Poisson regression model with robust standard errors Adjusted for all other factors (age, sex, BMI, race, hypertension, diabetes, GERD, OSA, and OA), patients in the post-intervention group expected to have 0.74 times lower length of stay compared to patients in the pre-intervention group. In addition, patients with diabetes expected to have 1.22 times greater length of stay compared to their counterparts adjusting for other covariates. No other covariates were associated with length of stay

DM had a significantly longer LOS (RR: 1.22; $p = 0.018$). No other covariates were associated with LOS (p value < 0.05 for all) (Table 3).

BSTOP analysis found a significant difference between the two groups. In the pre-intervention group, 40.6% of patients ($n = 146/360$) were discharged on opioids, which decreased to 7.1% post-intervention ($n = 17/239$).

Discussion

Our results show that concomitant introduction and implementation of ERAS and BSTOP protocols results in reduced LOS without an increase in readmission or complication rates. Furthermore, it also results in a significant reduction in need for opioid medications at discharge.

Interestingly, our results showed a significantly longer length of stay in diabetic patients post-operatively. It is difficult to pinpoint exactly the reason for this finding. However, we believe this might be a result of residual confounding from lifestyle factors associated with diabetes, such as a sedentary lifestyle, decreased physiological reserve, poor exercise tolerance slowing down post-operative recovery, and return to baseline physical status. Other factors contributing to residual confounding may include unadjusted comorbid conditions such as depression and anxiety. Further, diabetes-associated gastroparesis and gut dysmotility may also contribute to poor post-operative oral intake and delayed discharge.

The effectiveness of ERAS protocols in decreasing LOS without an increased risk of complications or readmission is well-documented [1]. Data from 310 MBSAQIP accredited centers show that BSTOP protocols are effective in reducing the need for opioids both in inpatient setting and at discharge [5, 6]. However, this is the first study investigating the introduction of ERAS and BSTOP at the same time, and shows a major reduction in opioid use (7.1% vs. 40.6%) without an increase in complications. Of the small proportion of patients discharged on opioids post-intervention (7.1%), it is possible that a significant proportion of them had pre-existing conditions that predisposed them to poor postoperative pain control, necessitating the prescription of opioids at discharge.

The advantages of reducing opioid use in bariatric patients are well-documented. Opioid-induced respiratory depression in the setting of OSA, a condition common in the bariatric population, is especially associated with worse outcomes [7]. Importantly, data from the longitudinal assessment of bariatric surgery-2 cohort showed that in patients with no reported preoperative opioid prescriptions, 5.8% and 14.2% had regular prescribed opioid use at six months and seven years postoperatively, respectively [3], suggesting that bariatric patients are particularly prone to developing opioid dependence. Moreover, opioid dependence is the single most common cause of mortality in bariatric surgery patients and causes more deaths than all other bariatric surgery complications combined [4]. This highlights the need for evidence-based interventions to limit opioid use and dependence in the bariatric population. Conversely, inadequate postoperative pain management is associated with increased risk for chronic pain and thus opioid use, which underscores the need for a multimodal pain regimen to ensure adequate pain control, and use of opioids if necessary [8, 9].

Protocols such as BSTOP are also important from a health systems standpoint. Globally, around 580,000 individuals undergo bariatric surgery annually, a major

proportion of which, 198,651 people in 2020, occurs in the USA [10, 11]. The Center for Disease Control and Prevention (CDC) estimates the total cost of prescription opioid misuse in the United States to be $78.5 billion annually. Therefore, a reduction in opioid dependence in post-bariatric surgery patients may also have significant economic implications for the health system, especially in the USA [12].

Our protocols are strictly evidence-based and designed based on previously published guidelines [13]. Patients undergo extensive pre-operative education, and expectations are set for all phases of care. Multimodal pain and nausea control begin in the preoperative phase. In the intraoperative phase, opioid-free anesthesia, which is associated with a reduced risk of postoperative nausea and vomiting [14], is given, including on induction. Anesthetic gasses are also avoided due to their association with increased postoperative nausea [15]. Transversus abdominis plane (TAP) block, which has been shown to significantly decrease postoperative pain, and lower opioid use, nausea and vomiting, is performed on all patients under laparoscopic guidance [16–18]. Additionally, TAP block also promotes early ambulation and improves patient satisfaction [18, 19]. Post-operatively, multimodal pain and nausea control are continued while in the hospital and on discharge.

Importantly, part of our protocol includes only dosing breakthrough intravenous opioids after the patient has been evaluated by a provider. This aspect may be more difficult to implement in hospitals without in-house providers present 24 h a day. However, with proper education of patients and nurses, hospitals with this limitation may be able to overcome that hurdle.

Our study has several limitations. It does not investigate patient satisfaction or opioid use on long-term follow-up. Additionally, our BSTOP protocol was implemented in October 2019, 2 months after the introduction of ERAS; however, we believe that the huge difference in opioid use between the pre- and post-intervention periods still demonstrates the effectiveness of combined implementation of both protocols. Finally, a subgroup analysis investigating the combined impact of these protocols in sleeve gastrectomy and RYGB groups was not performed due to power considerations.

Conclusion

ERAS and BSTOP protocols reduced length stay and opioid need at discharge without an increase in complication or readmission rates. Their impact on other foregut surgery procedures should be evaluated.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Does not apply

Conflict of Interest The authors declare no competing interests.

References

1. Zhou J, Du R, Wang L, et al. The application of enhanced recovery after surgery (ERAS) for patients undergoing bariatric surgery: a systematic review and meta-analysis. Obes Surg. 2021;31(3):1321–31.
2. Cavallaro P, Bordeianou L. Implementation of an ERAS pathway in colorectal surgery. Clin Colon Rectal Surg. 2019;32(02):102–8.
3. Raebel MA, Newcomer SR, Reifler LM, et al. Chronic use of opioid medications before and after bariatric surgery. JAMA. 2013;310(13):1369–76.
4. Petrick AT, Gadaleta D. Raising the standard: bariatric surgery targeting opioids (BSTOP): the third MBSAQIP national quality improvement project. Bariatric Times. 2019;16(7):12.
5. Seu R, Pereira X, Goriacko P, et al. Effectiveness of bariatric surgery targeting opioid prescriptions (BSTOP) protocol on postoperative pain control. Surg Endosc. 2022;36(1):219–47.
6. Patrick A, Smith A, Gould JC, et al. Bariatric surgery targeting opioid prescribing (BSTOP); interim analysis of the 3rd MBSAQIP National Quality Improvement Project. https://2021.asmbsmeeting.com/abstract/bariatric-surgery-targeting-opioid-prescribing-bstop-interim-analysis-of-the-3rd-mbsaqip-national-quality-improvement-project. Accessed Dec 2022.
7. Sultana A, Torres D, Schumann R. Special indications for opioid free anaesthesia and analgesia, patient and procedure related: including obesity, sleep apnoea, chronic obstructive pulmonary disease, complex regional pain syndromes, opioid addiction and cancer surgery. Best Pract Res Clin Anaesthesiol. 2017;31(4):547–60.
8. Sinatra R. Causes and consequences of inadequate management of acute pain. Pain Med. 2010;11(12):1859–71.
9. Clarke H, Bonin RP, Orser BA, et al. The prevention of chronic postsurgical pain using gabapentin and pregabalin: a combined systematic review and meta-analysis. Anesth Analg. 2012;115(2):428–42.
10. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoluminal procedures: IFSO worldwide survey 2014. Obes Surg. 2017;27(9):2279–89.
11. American Society for Metabolic and Bariatric Surgery (ASMBS). Estimate of bariatric surgery numbers, 2011–2018. Published June 2018. Available at: https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers. Accessed 9 Sept 2022.
12. Florence C, Luo F, Xu L, et al. The economic burden of prescription opioid overdose, abuse and dependence in the United States, 2013. Med Care. 2016;54(10):901.
13. Thorell A, MacCormick AD, Awad S, et al. Guidelines for perioperative care in bariatric surgery: enhanced recovery after surgery (ERAS) society recommendations. World J Surg. 2016;40(9):2065–83.

14. Ziemann-Gimmel P, Goldfarb AA, Koppman J, et al. Opioid-free total intravenous anaesthesia reduces postoperative nausea and vomiting in bariatric surgery beyond triple prophylaxis. Br J Anaesth. 2014;112:906–11.
15. Apfel CC, Heidrich FM, Jukar-Rao S, et al. Evidence-based analysis of risk factors for postoperative nausea and vomiting. Br J Anaesth. 2012;109(5):742–53.
16. Ma N, Duncan JK, Scarfe AJ, et al. Clinical safety and effectiveness of transversus abdominis plane (TAP) block in post-operative analgesia: a systematic review and meta-analysis. J Anesth. 2017;31(3):432–52.
17. Grape S, Kirkham KR, Albrecht E. The analgesic efficacy of transversus abdominis plane block after bariatric surgery: a systematic review and meta-analysis with trial sequential analysis. Obes Surg. 2020;30(10):4061–70.
18. Földi M, Soós A, Hegyi P, et al. Transversus abdominis plane block appears to be effective and safe as a part of multimodal analgesia in bariatric surgery: a meta-analysis and systematic review of randomized controlled trials. Obes Surg. 2021;31(2):531–43.
19. Sinha A, Jayaraman L, Punhani D. Efficacy of ultrasound-guided transversus abdominis plane block after laparoscopic bariatric surgery: a double blind, randomized, controlled study. Obes Surg. 2013;23(4):548–53.

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