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S136-operationalizing an enhanced recovery protocol after bariatric surgery: single institutional pilot experience forging data-driven standard work

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Abstract

Background Enhanced recovery protocols (ERPs) after metabolic and bariatric surgery (MBS) may help decrease length of stay (LOS) and postoperative nausea/vomiting but implementation is often fraught with challenges. The primary aim of this pilot study was to standardize a MBS ERP with a real-time data support dashboard and checklist and assess impact on global and individual element compliance. The secondary aim was to evaluate 30 day outcomes including LOS, hospital readmissions, and re-operations.

Methods and procedures An ERP, paper checklist, and virtual dashboard aligned on MBS patient care elements for pre-, intra-, and post-operative phases of care were developed and sequentially deployed. The dashboard includes surgical volumes, operative times, ERP compliance, and 30 day outcomes over a rolling 18 month period. Overall and individual element ERP compliance and outcomes were compared pre- and post-implementation via two-tailed Student's t-tests.

Results Overall, 471 patients were identified (pre-implementation: 193; post-implementation: 278). Baseline monthly average compliance rates for all patient care elements were 1.7%, 3.7%, and 6.2% for pre-, intra-, and post-operative phases, respectively. Following ERP integration with dashboard and checklist, the intra-operative phase achieved the highest overall monthly average compliance at 31.3% ($P<0.01$). Following the intervention, pre-operative acetaminophen administration had the highest monthly mean compliance at ≥ 99.1%. Overall TAP block use increased 3.2-fold from a baseline mean rate of 25.4–80.8% post-implementation ($P<0.01$). A significant decrease in average intra-operative monthly morphine milligram equivalents use was noted with a 56% drop pre- vs. post-implementation. Average LOS decreased from 2.0 to 1.7 days post-implementation with no impact on post-operative outcomes.

Conclusion Implementation of a checklist and dashboard facilitated ERP integration and adoption of process measures with many improvements in compliance but no impact on 30 day outcomes. Further research is required to understand how clinical support tools can impact ERP adoption among MBS patients.

Keywords Bariatric surgery · Enhanced recovery · Quality improvement · Standard work

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Metabolic and bariatric surgery (MBS) is a well-established tool for achieving significant weight loss and resolution of obesity-associated medical comorbidities. Many MBS centers employ enhanced recovery protocols (ERPs) to optimize the delivery of peri-operative care and with the anticipation of improving patient and provider satisfaction. Some of the key tenets of ERPs include pre-operative education and counseling, intra-operative mitigation of opioid use, proactive post-operative management of pain, nausea, oral intake progression, and ambulation as well as a multidisciplinary team approach to implementing standardized care pathways. The ERP concept, in part, originated from "fast-track" surgery protocols that were pioneered in the 1990s among cardiac [1] and colorectal surgery [2] patients with a heavy focus on accelerating post-operative recovery. The application of these principles among MBS patients did not emerge in the literature until almost a decade later [3, 4] with one of the first randomized controlled trials comparing enhanced recovery protocols versus standard care following sleeve gastrectomy in 2013 [5]. In 2016, the international ERAS® society published their first peri-operative MBS guidelines and evidence-based recommendations [6]. Several years later, the United States' metabolic and bariatric surgery accreditation and quality improvement program (MBSAQIP) reported results of the national employing enhanced recovery goals in bariatric surgery (ENERGY) initiative and the impact on outcomes from length of stay (LOS) to bleeding and readmissions [7].

Recent ERP meta-analyses involving MBS patients have shown variable application in the volume and category of included elements with of lack of standardization. While there is evidence to support decreased length of stay (LOS) and improved post-operative nausea and vomiting (PONV) with ERP pathways, there has been limited impact on improving 30 day outcomes among MBS patients [8–10]. While ERPs are commonly accepted as standard of care, implementation of these protocols is often fraught with issues relating to adoption, adherence, and sustainability [8–10]. In a 2018 systematic review by Stone and colleagues, it was identified that 10% of ERP articles included for final analysis addressed barriers and facilitators to implementation highlighting a major gap in the literature; key obstacles identified were lack of resources and frontline provider engagement as well as complicating patient and/or hospital-level factors [11]. It is imperative to understand the processes involved in successful ERP implementation and adoption of these bundled practices by providers.

The primary aim of this pilot study was to standardize an existing institutional ERP for MBS procedures with real-time clinical tools and data support and assess impact on global and individual element compliance. Furthermore, a secondary aim was to evaluate 30 day outcomes including length of stay (LOS), hospital readmissions, and re-operations.

Materials and methods

Design, setting, and implementation phases

A retrospective review was performed of patients aged ≥ 18 years who underwent elective primary or revisional MBS at a 532-bed mixed community and academic hospital before and after the implementation of an institutional ERP with a checklist and virtual dashboard. The planning stage or pre-implementation phase was May 2019–April 2020; the active stage or post-implementation phase was May 2020–July 2021. Exclusion criteria included adjustable gastric band placement or removal procedures. Our study was exempt by the Institutional Review Board as it was deemed non-human subjects research as a quality improvement (QI) initiative. All procedures were conducted in accordance with the institution's requirements for ethical standards.

Stakeholder engagement, ERP development, and use of checklist

Informal meetings and electronic communications amongst MBS stakeholders began in May 2019 to assist with planning. The peri-operative elements of our institutional ERP have been previously described [12]. A multidisciplinary team of MBS providers (surgery, obesity medicine, anesthesiology, care coordination, nursing) convened during August 2019 to update the ERP based on the most current literature and guidelines. The updated ERP was reviewed in monthly team meetings and shared electronically; individual stakeholders contributed their expertise and opinions by engaging in round table discussions. The final ERP was deployed in May 2020, during the COVID-19 pandemic, following no elective MBS procedures across April 2020. The following timeframes and settings were included in the protocol: (1) Pre-operative MBS clinic (6–12 weeks prior to surgery), (2) Pre-operative Anesthesia clinic (1–2 weeks prior to surgery), (3) Pre-operative Holding Area or POHA (day of surgery), (4) Operating Room (day of surgery), (5) Post-operative Anesthesia Care Unit (day of surgery), (6) Nursing Unit (day of surgery until discharge), and (7) Post-operative Outpatient Care Coordination Phone Call (within 7 days of discharge from hospital). A paper-based checklist was developed alongside the updated ERP to function as a daily management tool for nursing and other clinical staff to execute patient care elements (Fig. 1) [13]. The checklist remained with the patient during index MBS hospitalization from the chart in POHA to the bedside on nursing units.

Metabolic & Bariatric Surgery Enhanced Recovery Quality Improvement Program

Please keep checklist with patient

PATIENT STICKER

PREOPERATIVE

Preoperative Anesthesia Clinic	YES	If not completed, please explain
Enhanced recovery program identification placed on patient chart	☐	
Chlorohexidine wipes education	☐	
Diabetes Mellitus medication discussion, if applicable	☐	
Pain management expectation discussed	☐	
Postoperative nausea/vomiting expectation discussed	☐	

Preoperative Holding Area	YES	If not completed, please explain
Weigh patient	☐	
Scopolamine patch	☐	
Liquid acetaminophen	☐	
Gabapentin elixir	☐	
Celecoxib	☐	
Heparin 5000 units subcutaneous for deep vein thrombosis prophylaxis (administer 5 minutes before rollback)	☐	
Transversus abdominis plane block (when requested)	☐	

INTRAOPERATIVE

Operating Room	YES	If not completed, please explain
Enhanced recovery program patient discussed during surgical time-out	☐	
Address subcutaneous Heparin during time-out (have circulator check MAR summary)	☐	
Intraoperative transversus abdominis plane block	☐	
Total intravenous anesthesia	☐	Why/why not?
Dexamethasone	☐	
Diphenhydramine	☐	
Ondansetron	☐	
Ketamine	☐	
Magnesium infusion	☐	
Goal directed fluid monitor	☐	
Reversal of neuromuscular block with Sugammadex	☐	
Ketorolac given	☐	Why/why not? If yes, what dose:
Opioids given	☐	If yes, please write drug + dose: Drug Dose

POSTOPERATIVE

Postoperative Anesthesia Care Unit	YES	If not completed, please explain
Importance of postoperative nausea/vomiting and pain control discussed	☐	
Scheduled Ondansetron 4mg IV every 6-8 hours (first dose given before transfer)	☐	
PRN rescue anti-emetic 1) Droperidol 2) Diphenhydramine 3) Promethazine 4) Dexamethasone 5) Haloperidol	☐	List rescue anti-emetic used:
PRN rescue non-opioid analgesics needed? If yes, choose from: • Methocarbamol 1000mg IV once • Magnesium sulfate 2gm IV once (if not already used intraoperatively • Dexmedetomidine 0.25-0.5mg/kg IV over 5 to 10 minutes	☐ ☐ ☐ ☐	
Crystalloid at 150ml per hour (adjust pending renal &/or cardiac function)	☐	
Communication to patient about self-transfer from stretcher to bed	☐	
If patient in postoperative anesthesia care unit >2 hours, start on ice chips 1 ounce per hour	☐	
Stretcher >45° for transfer	☐	
Nursing hand off discussion of postoperative nausea/vomiting and pain	☐	

Nursing Unit	YES	If not completed, please explain
Postoperative day 0 (Day of surgery)		
Self-transfer from stretcher to bed	☐	
Patient receives 'Diet Progression' handout	☐	
Unit clerk faxed paper prescriptions to the pharmacy. Note: Oxycodone may be e-prescribed to our onsite pharmacy. Ondansetron and pantoprazole are typically paper prescriptions. *Charted in nursing note*	☐	
Ambulate halls within 2 hours of getting to floor *Charted in IVIEW*	☐	
Bariatric clear liquids (drink 1 ounce per hour) *Charted in IVIEW*	☐	Ounces per hour consumed:
Lidocaine patch (avoid if transversus abdominis plane block performed)	☐	
Acetaminophen, Gabapentin, and Ketorolac scheduled (contact provider if not ordered)	☐	Indicate if not ordered:
Use opioids as needed for breakthrough pain	☐	Note if opioids given:
Heparin 5000 units subcutaneous every 8 hours for deep vein thrombosis prophylaxis (contact provider if patient refuses)	☐	
Postoperative day 1		
Morning labs drawn	☐	Delay in phlebotomy: Yes No
Ambulate *at least* three times a day *Charted in IVIEW (Intervention→Activity/Mobility*	☐	
Bariatric clear liquids *Charted in IVIEW* Advance 1 ounce per hour to goal of 6-8 ounces per hour	☐ ☐	
Heparin 5000 units subcutaneous for deep vein thrombosis prophylaxis	☐	Time given:
2nd round of paper prescriptions faxed to our onsite pharmacy after pharmacy consult		
DISCHARGE		
Contact physician when patient is meeting discharge requirement (drink 4-6 ounces per hour, ambulating)	☐	
Medications reviewed with patient	☐	
All prescriptions filled and picked up before discharge *Charted in Nursing DC Note*	☐ ☐	
Provide copy of checklist to bariatric coordinator in bariatric drawer (do NOT scan into chart)	☐	
Was there a delay in discharge? Check if YES and indicate reason	☐	Reason for delay (circle): Ride Prescription refill D/C Order Other: ____________:

Fig. 1 Enhanced recovery protocol checklist for metabolic and bariatric surgery patients**.** MBS metabolic and bariatric surgery

Surgical trainees (residents, fellows) typically placed peri-operative orders for MBS patients. Specific guidance and instructions for ERP adherence were added to a centralized patient resource guide used by surgical trainees in May 2020. While the standard peri-operative MBS order set was updated to align with our ERP, these changes were not formally implemented until June 22, 2021 due to information technology constraints. Ad hoc communication (i.e., email, phone calls) with surgeons, trainees, or other team members was done during the study period for additional concerns related to ERP non-compliance**.** To improve patient engagement, ERP elements were discussed in a mandatory preoperative education class, typically completed 1–2 weeks prior to index operation (starting March 2020).

Dashboard development

A virtual dashboard was deployed in June 2020 to provide real-time data support for assessing surgical volumes, ERP compliance during index MBS hospitalization, and 30 day outcomes. The dashboard displays data over a rolling 18-month period. Data are automatically pulled from the clinical data warehouse (CDW) which contains pertinent patient electronic medical record (EMR) (i.e., Medication Administration Records, nursing notes, procedure notes, intraoperative record) and institutional surgery scheduling information. MBS index procedures are identified with CPT codes 43775, 43644, and/or 43659 along with descriptors referencing sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), or revisional surgery. Unique financial identification numbers are used to calculate the total number of MBS cases. Median total operating room (OR) time (minutes) is calculated using the difference between "patient in" and "patient out" time stamps while median operating time (minutes) uses the difference between "surgery start" and "surgery stop" as documented in the intraoperative record. Total monthly MBS procedure volumes are displayed on a run chart. Median LOS (days) is calculated using the difference between "patient admission" and "patient discharge" time stamps. Hospital readmissions are defined as any inpatient return to the index procedure hospital or 4 affiliated satellite campuses within 30 days of MBS. Re-operations are defined as any non-elective operation within 30 days of index MBS. Readmissions, re-operations, and LOS are displayed on monthly bar charts with raw numbers and percentages.

In addition, the dashboard has three sections displaying overall and individual element compliance on monthly run charts across inpatient care phases (pre-, intra-, and post-operative); compliance was calculated at the patient-level with raw numbers and percentages. MBS "start" and "stop times" are used to determine completion of elements in the correct timeframe (i.e., pre-operative use of heparin). Pre-operative elements included were as follows: PONV expectations discussion, documentation of Chlorhexidine Gluconate wipe distribution, weight, Scopolamine patch, Acetaminophen, Gabapentin, subcutaneous (SC) Heparin, and Celecoxib. Intra-operative elements were as follows: Transversus abdominis plane (TAP) block (anesthesiology- or surgeon-performed), Dexamethasone, Ondansetron, Ketamine, Lidocaine, Sugammadex, Ketorolac, and Diphenhydramine. Finally, multiple post-operative elements are included as follows: Heparin or Enoxaparin use on postoperative day 0 (POD 0) to 1, Acetaminophen POD 0, Gabapentin POD 0, Ketorolac POD 0, and Ondansetron. A manual chart review for patients without a TAP block was done by the MBS coordinator to confirm accuracy. In addition, median morphine milligram equivalents (MME) use was separately evaluated during the study period for the intra-operative and post-operative phases of care. A select list of centers for disease control and prevention (CDC) opioids were pulled from the CDW along with conversion factors from CDC guidelines to calculate MME [14].

Statistical analysis

Dashboard data visualizations were built using Tableau Desktop Professional Edition (Version 2020.4.1 (2020), Tableau Software LLC, A Salesforce Company, Seattle WA USA) and shared through a Tableau server (Version 2021.2.6 (2021), Tableau Software LLC, A Salesforce company, Seattle WA USA). All data was originally stored before processing in an Oracle database (Version 19C 19.3.0.0 (2020), Oracle Corporation, CA USA) and accessed through MicroStrategy Web (Version 2021 update 4), MicroStrategy Incorporated, Virginia USA). All data cleaning was done in R programming language (Version 4.0.3 (2020), R Core Team, Vienna Austria) [15].

Patient variables, operative characteristics, and 30 day outcomes were abstracted from the EMR and institutional MBSAQIP database. Pre- and post-implementation comparisons were performed using two-tailed Student's t-tests for the following: (1) monthly average compliance rates for completion of all ERP elements based on phase of care, (2) monthly average compliance rates for individual ERP element completion based on phase of care, and (3) overall 30 day outcomes. When appropriate, a single outlier was removed when identified via Grubbs' outlier test. A P-value < 0.05 was considered significant.

Results

A total of 471 MBS patients were identified ($n = 193$ pre-implementation; $n = 278$ post-implementation); 468 patients were included for final analysis as they had complete demographic and morbidity data as displayed in Table 1. Overall, the mean age was 43.5 ± 11.3 years with 84.6% female patients and a mean BMI of 46.0 ± 8.0 kg/m^2. The majority of patients identified as Black or African American ($n = 326$, 69.7%) and Caucasian or White ($n = 129$, 27.6%). Of these patients, 88.7% identified as non-Hispanic with only 3.6% as Hispanic or Latino and 7.7% did not report ethnicity. The top three obesity-related medical comorbidities were Hypertension, Obstructive Sleep Apnea, and Non-insulin-dependent diabetes mellitus. The case mix heavily favored SG at 71.6% ($n = 335$, 71.6%) followed by RYGB procedures ($n = 129$, 27.6%). The majority of MBS cases were done laparoscopically ($n = 345$, 73.7%) with 26.3% ($n = 123$) completed robotically.

An 18-month representative portion of our study period from February 2020 to July 2021 is displayed in Fig. 2; during this time frame, only 3 months were in the pre-implementation phase with 15 months post-implementation. Accordingly, 298 MBS cases were reported with a median total OR time at 172 min, median operating time at 115 min, and median LOS at 1.4 days. The average monthly MBS volume was 18 cases. The average monthly 30 day readmission rate and re-operation rates were 2.6–1.7%, respectively. Figure 3 displays the drop-down menus for select metrics or patient care elements for each phase of care in descending order as follows: (1) pre-operative, (2) intra-operative, and (3) post-operative. The pre-operative phase showed excellent monthly and overall compliance for acetaminophen use with an average monthly compliance rate ≥ 94.7% while the intra-operative phase had steady improvements in TAP block usage by the surgical team peaking at 100% compliance in December 2020. There was inconsistent monthly postoperative MME use throughout the study period.

Implementation of the ERP bundle (updated protocol, dashboard, and checklist) was associated with improvements in overall compliance with patient care elements across all phases of care (Fig. 4**)**. In the pre-implementation period, monthly average compliance rates for completion of all elements were 1.7%, 3.7%, and 6.2% for the pre-, intra-, and post-operative phases, respectively; in the post-implementation period, the intraoperative phase achieved the highest overall ERP monthly average compliance rate at 31.3% ($P < 0.01$) followed by the pre-operative phase at 21.4% ($P < 0.01$) and the post-operative phase at 17.2% ($P = 0.01$).

Patient-level average monthly percentage compliance with ERP elements pre- vs. post- Implementation

Table 1 Patient and surgical characteristics

Characteristic	Overall[b] ($n=468$)	Pre-ERP implementation[c] ($n=192$)	Post-ERP implementation[d] ($n=276$)
Age (years)[a]	43.5 ± 11.3	44.6 ± 11.6	42.8 ± 10.9
BMI (kg/m^2)[a]	46.0 ± 8.0	45.2 ± 8.5	46.6 ± 7.5
Gender, female, *n* (%)	396 (84.6)	165 (85.9)	231 (83.7)
Race, *n* (%)	–	–	–
African American or Black	326 (69.7)	125 (65.1)	201 (72.8)
Caucasian or White	129 (27.6)	64 (33.3)	65 (23.6)
Asian	1 (0.2)	0	1 (0.4)
Native Hawaiian/Other Pacific Islander	2 (0.4)	0	2 (0.7)
Unknown	10 (2.1)	3 (1.6)	7 (2.5)
Ethnicity, n (%)	–	–	–
Hispanic or Latino	17 (3.6)	6 (3.1)	11 (4.0)
Non-Hispanic or non-Latino	415 (88.7)	176 (91.7)	239 (86.6)
Unknown	36 (7.7)	10 (5.2)	26 (9.4)
Medical comorbidities, n (%)	–	–	–
Hypertension	254 (54.3)	109 (56.8)	145 (52.5)
Diabetes mellitus (Insulin dependent)	28 (6.0)	14 (7.3)	14 (5.1)
Diabetes mellitus (Non-insulin dependent)	108 (23.1)	50 (26.0)	58 (21.0)
Hyperlipidemia	94 (20.1)	42 (21.9)	52 (18.8)
Obstructive sleep apnea	202 (43.2)	81 (42.2)	121 (43.8)
Surgical approach, n (%)	–	–	–-
Laparoscopic	345 (73.7)	150 (78.1)	195 (70.7)
Robotic	123 (26.3)	42 (21.9)	81 (29.3)
Case type, n (%)	–	–	–
Sleeve gastrectomy	335 (71.6)	144 (75.0)	191 (69.2)
Gastric bypass	129 (27.6)	48 (25.0)	81 (29.3)
Other	4 (0.9)	0	4 (1.4)

[a]Mean ± Standard Deviation

[b]Overall (May 2019–July 2021)

[c]Pre-ERP (enhanced recovery protocol) implementation (May 2019–April 2020)

[d]Post-ERP (enhanced recovery protocol) implementation (May 2020–July 2021)

is displayed in Table 2. During the pre-operative phase of care, the greatest improvements in compliance were noted in Scopolamine patch use as well as administration of Celecoxib and SC Heparin injections for venous thromboembolism prophylaxis. Post-implementation, ≥ 94% monthly compliance was achieved in POHA for use of Scopolamine patches, Acetaminophen, Gabapentin, and SC Heparin. During the intra-operative phase of care, the administration of Dexamethasone, Ketamine, and Diphenhydramine significantly increased pre- vs. post-implementation along with use of surgeon-performed TAP blocks. Concomitantly, a significant decrease in average monthly MME use was also noted with a 56% drop pre- vs. post-implementation (64.1 ± 39.6 vs. 35.9 ± 30.9, respectively, $P < 0.001$; data not shown). Of note, total TAP block usage (surgeon- or anesthesiology-performed) increased 3.2-fold from a baseline mean rate of 25.4% to 80.8% post-implementation ($P < 0.01$) (data not shown). In the post-operative phase of care, only modest improvements were seen in Acetaminophen and Gabapentin use with stable Ketorolac administration and inconsistent MME use trends. Regarding 30 day outcomes, there was a trend toward decreased average LOS from 2.0 days pre-implementation to 1.7 days post-implementation with no significant change in readmissions or re-operations.

Discussion

Progression of technology and minimally invasive surgical techniques have promoted steady growth in MBS volumes and accelerated post-operative recovery for patients, paving the way for ERPs to flourish with the demand for expeditious peri-operative care [10]. Given the need for more clarity

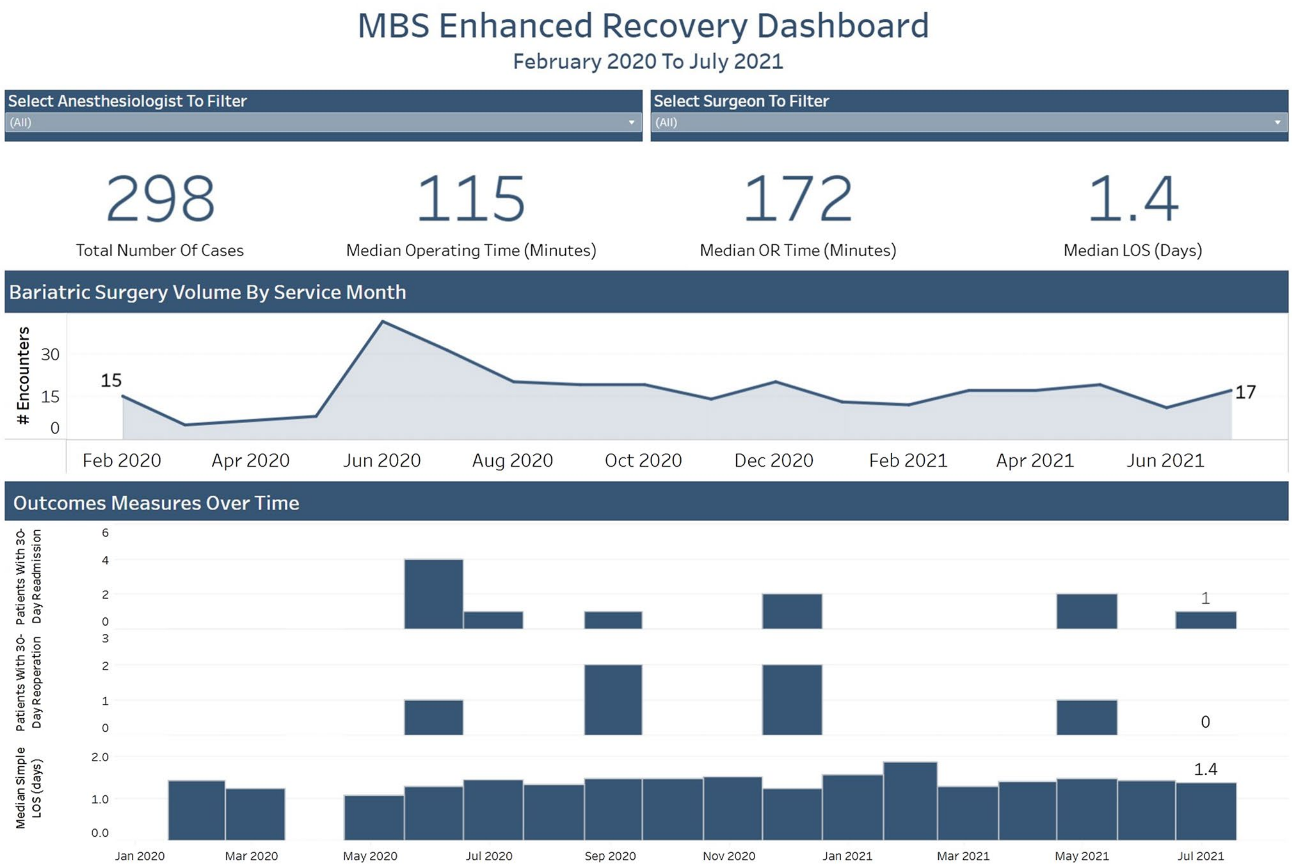

Fig. 2 Enhanced recovery dashboard with overall surgical volumes, timing characteristics, and outcome measures**.** MBS metabolic and bariatric surgery, OR operating room, LOS length of stay

and transparency in our institutional practices, an ERP was supplemented with a formal checklist and data collection dashboard to facilitate standard work for peri-operative MBS care. Standard work (SW) is defined as the most efficient methodology for executing a process and is used in many settings from healthcare to the airline industry and manufacturing. SW is predicated on consistent, standardized processes which facilitates measurement and evaluation of targeted interventions with the goal of reducing waste and errors in execution [16]. ERP supplementation with clinical tools (checklist, dashboard) has led to significant improvements in compliance with many of the individual peri-operative care elements with less dramatic increases in overall compliance. Review of ERP data and dissemination to the MBS team has required a core group of stakeholders (surgical director, program coordinator, data analyst) to lead these efforts of uniting a large group of providers toward more consistent, standardized processes.

The protocol and dashboard did require an upfront time investment for completion but are currently reviewed on a quarterly basis for continuous improvement and thus do not impact the daily workload of providers. Dashboard findings are shared in monthly MBS multidisciplinary team meetings along with links provided for remote access; however, providers are not required to access the dashboard to review engagement and compliance metrics. In addition, the dashboard has been used to delve into individual process measures like intra-operative TAP block usage and analyze early surgeon adopters whose patients were noted to have decreased post-operative MME use; this data was shared with stakeholders to promote TAP block usage, provide formulation and procedural techniques, and ultimately drive change. Despite inconsistent post-operative MME use over the study period, the dashboard has facilitated awareness of practice variations for targeting pain control and identified areas for further improvements in our protocol.

The addition of clinical tools to our ERP has had a positive cultural and operational impact with frontline providers in key patient care phases, particularly with the checklist. The checklist is completed predominantly by nursing staff and used as a visual management tool to support daily workflow. Nursing providers and managers in POHA, PACU, and our main MBS unit supported the checklist from its inception and proactively collaborated

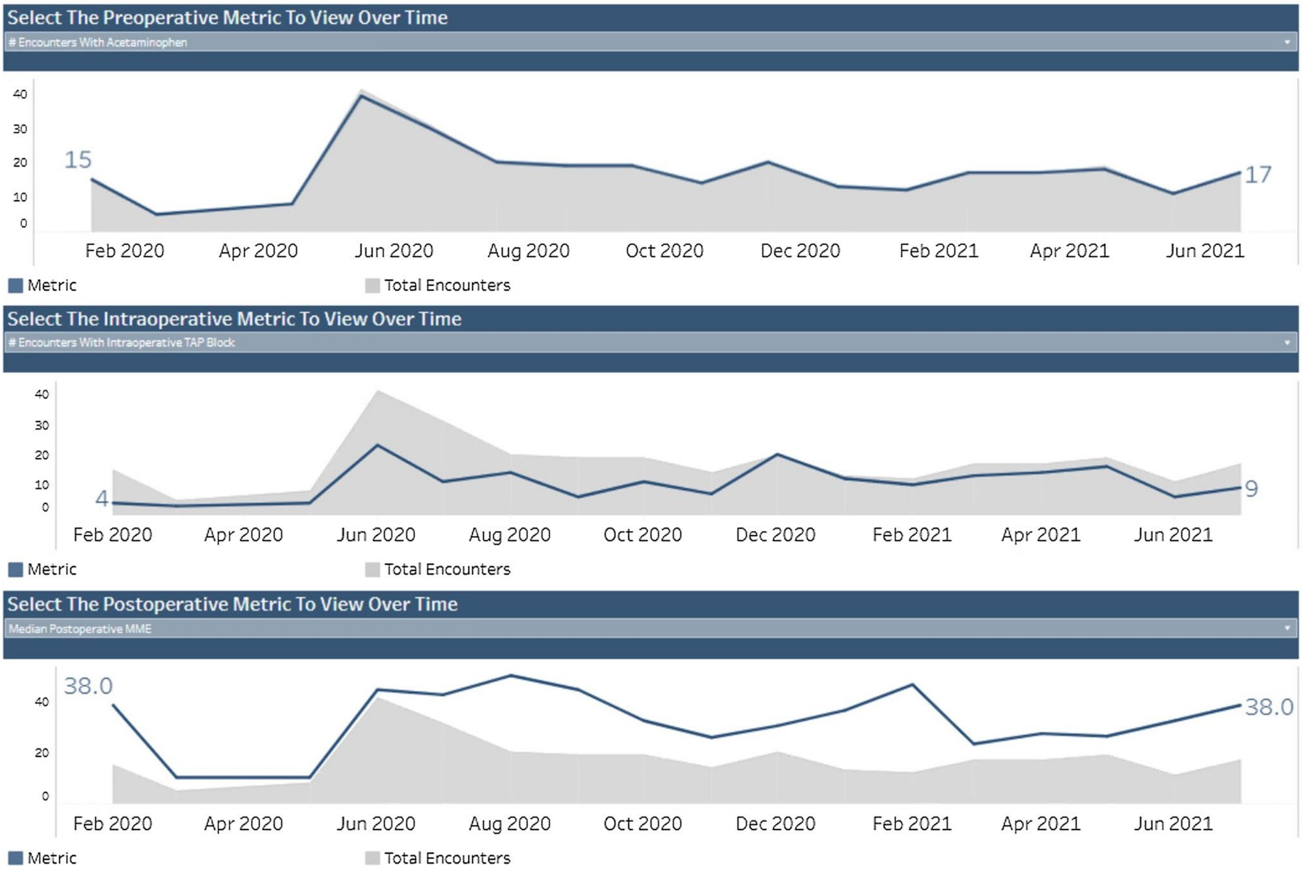

Fig. 3 Enhanced recovery dashboard with select patient care element compliance based on phase of care. TAP transversus abdominis plane, MME morphine milligram equivalents

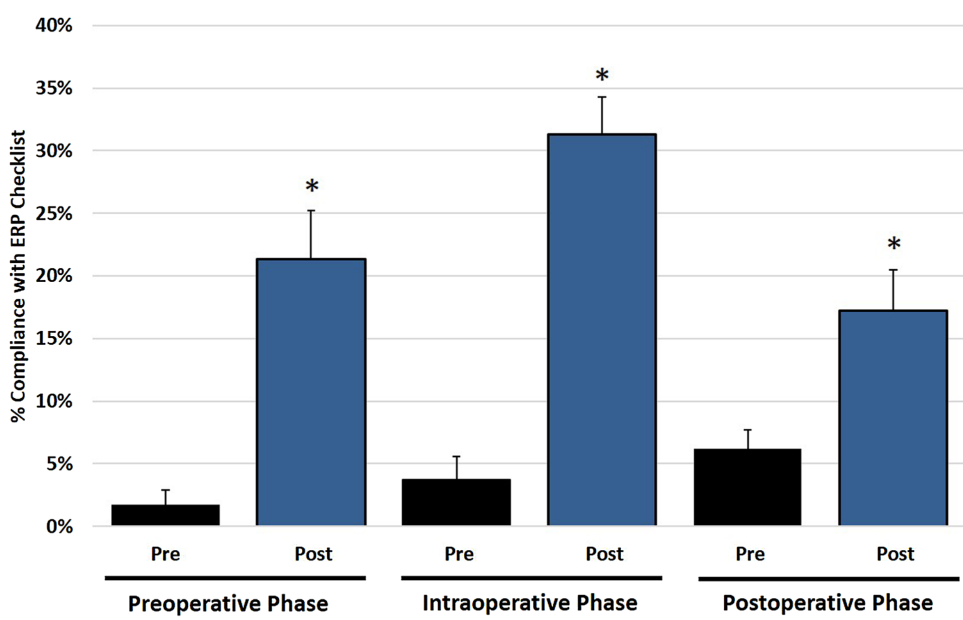

Fig. 4 Overall compliance with enhanced recovery protocol elements based on phase of care. ERP enhanced recovery protocol, Pre pre-implementation, Post post-implementation. All values are expressed as mean ± SEM (standard error of the mean). *P-value < 0.05

Table 2 Average monthly percentage compliance with individual patient care elements pre- vs. post-implementation based on phase of care

Enhanced Recovery Protocol (ERP) Element	Pre-implementation (*n* = 192)	Post-implementation (*n* = 276)	*P*-value
Pre-operative phase of care (average monthly % compliance ± SD)			
PONV[b] discussed	88.7 ± 9.0	84.1 ± 9.4	0.227
CHG[a] wipe documentation	72.6 ± 14.8	89.4 ± 5.9	0.001
Scopolamine patch	73.9 ± 21.8	95.9 ± 7.4	0.001
Acetaminophen	94.2 ± 4.5	99.1 ± 1.9	0.001
Celecoxib	4.1 ± 5.3	39.4 ± 23.0	< 0.001
Gabapentin	92.3 ± 5.6	97.1 ± 4.8	0.030
Subcutaneous Heparin	57.9 ± 23.5	94.8 ± 7.2	< 0.001
Intra-operative phase of care (average monthly % compliance ± SD)			
Dexamethasone	62.9 ± 11.1	83.3 ± 11.1	< 0.001
Ondansetron	93.4 ± 5.9	94.0 ± 7.4	0.844
Ketamine	40.3 ± 32.8	88.1 ± 8.7	< 0.001
Lidocaine	98.8 ± 3.1	98.2 ± 2.8	0.628
Sugammadex	94.5 ± 6.6	97.4 ± 3.3	0.144
Ketorolac	39.7 ± 17.8	54.7 ± 18.3	0.049
Diphenhydramine	57.7 ± 14.5	86.2 ± 10.8	< 0.001
TAP[c] block	18.3 ± 8.8	65.6 ± 20.5	< 0.001
Post-operative phase of care (average monthly % compliance ± SD)			
Acetaminophen	49.5 ± 23.4	63.9 ± 18.6	0.093
Gabapentin	37.4 ± 24.4	54.5 ± 19.7	0.060
Ketorolac	76.2 ± 10.8	75.7 ± 18.9	0.940
Ondansetron	60.3 ± 14.2	80 ± 14.4	0.002
VTE[e] prophylaxis POD[f] 0	92.7 ± 8.0	96.6 ± 5.0	0.138
VTE prophylaxis, POD 1	48.9 ± 16.8	53.3 ± 17.6	0.526

[a]CHG = chlorhexidine gluconate

[b]PONV = Postoperative nausea and vomiting

[c]TAP = Transversus abdominis plane

[d]MME = Morphine milligram equivalents, average monthly absolute numbers not percent usage per patient

[e]VTE = venous thromboembolism (includes subcutaneous heparin or enoxaparin)

[f]POD = postoperative day

in its design; it has become an invaluable tool during the COVID-19 pandemic with unprecedented staff turnover and many traveler nurses who are unfamiliar with our institutional practices. Moreover, nuances to the efficient care of MBS patients are captured on our checklist, but not on our post-operative orders sets, including a line item for addressing bedside prescription delivery from the institutional outpatient pharmacy prior to hospital discharge. As a result, this has helped standardize prescription ordering practices and discharge prescription errors have reduced from an average monthly rate of 24% pre-implementation to 10% post-implementation (data not shown).

While many aspects of promoting ERP integration have been successful, there have been barriers to compliance with peri-operative care elements; this is in part due to the volume of elements required in each phase of care as well as the need for individualized care. Surgeons and anesthesiologists are encouraged to follow ERP components but this is not mandated and thus provider discretion naturally leads to variation in adherence for MBS patients. Similarly, Brethauer and colleagues reported marked variability in compliance with ENERGY protocol measures; only 21% of patients achieving 85% compliance with all measures post-implementation which was the highest distribution of adherence scores achieved throughout the study [7]. An additional barrier to compliance included the role of surgical trainees; 95% of peri-operative MBS orders are placed by residents and/or fellows who rotate on a monthly basis at our institution. To streamline educational needs, a bariatric resource guide was created for trainees to reinforce the ERP and their role in executing orders. Rotating staff at hospitals has been previously highlighted as a barrier to ERP implementation [17]. Furthermore, there have been EMR technology constraints such that the MBS peri-operative order set could not be updated to reflect the ERP changes until the end of the study; the checklist did temporarily help overcome this barrier by reinforcing the protocol as a daily workflow tool for providers. When the order set was finally updated to align with the ERP in June 2021 further increases in adherence were observed but only one month of data was captured after implementation.

Traditional surgical dogma has heavily focused on 30 day outcomes with less emphasis placed on process measures. Measuring surgical outcomes concomitantly necessitates systematic evaluation of process measures. Standardized processes allow for similar peri-operative care, measurement, and ultimately QI interventions. Among surgical cohorts like MBS, implementation of ERPs is one method for creating standard work. As demonstrated in our study, supplementation of ERPs with a virtual dashboard, checklist, and additional educational resources can improve compliance and provide a framework for increasing awareness in practices that need targeted improvement. To that end, dashboard compliance metrics will now be summarized and included on a standardized provider scorecard that has been utilized at our institution for over 18 months to share MBSAQIP data. The scorecard will be distributed to ERP stakeholders to increase transparency of process measures, facilitate dashboard engagement, support the use of SW, and help promote a culture of accountability.

The results of this ERP implementation study have to be interpreted with caution given the QI design and thus inability to control for patient-, surgical-, or hospital-level factors.

In addition, this was a single-institution retrospective study with a relatively small number of patients. While all patients received the same ERP bundle, there was room for individualized care based on anesthesiologist and surgeon preferences thus limiting the post-implementation impact. In conclusion, while clinical and data collection tools can support ERP progress and compliance, this must be weighed against barriers to implementation. Further research is required to understand best practices for optimizing ERP integration and how standardized care pathways can be leveraged to add value at the patient- and hospital-level.

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Declarations

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