Length of Stay and Opioid Dose Requirement with Transversus Abdominis Plane Block vs Epidural Analgesia for Ventral Hernia Repair

Jeremy A Warren, MD, FACS, Alfredo M Carbonell, DO, FACOS, FACS, Lauren K Jones, BS, Aaron Mcguire, BS, William R Hand, MD, Vito A Cancellaro, MD, Joseph A Ewing, PhD, William S Cobb, MD, FACS

BACKGROUND: Major abdominal operations often requires postoperative opioid analgesia. However, there is growing recognition of the potential for abuse. We previously reported a significant reduction in opioid consumption after implementation of an Enhanced Recovery after Surgery protocol after ventral hernia repair focusing on opioid reduction. Epidural use was routine for postoperative pain control in this protocol. Recently, we have transitioned to transversus abdominis plane (TAP) block instead of epidural analgesia. We hypothesize that this modification reduces length of stay and lowers opioid use in ventral hernia repair.

METHODS: All patients undergoing open ventral hernia repair were recorded prospectively in the Americas Hernia Society Quality Collaborative database. All patients receiving either TAP or epidural between February 2015 and March 2018 were identified. Additional review was performed to quantify opioid use in morphine milligram equivalents (MMEs). Primary outcomes were length of stay and opioid use.

RESULTS: Epidural was used in 172 patients and TAP block in 74. There were no significant comorbidity differences between groups. The TAP group had a slightly higher BMI (33.6 kg/m^2 vs 28.3 kg/m^2) and slightly smaller hernias (8.8 cm vs 10.8 cm). There was no difference in 30-day surgical site infections. Hospital length of stay was significantly shorter with TAP block (2.4 vs 4.5 days; $p < 0.001$). Total MME requirements for patients receiving TAP block were lower than those with epidural during postoperative days 1 and 2 (mean 40 vs 54.1 MMEs; $p = 0.033$ and 36.1 vs 52.5 MMEs; $p = 0.018$).

CONCLUSIONS: Use of TAP block significantly reduces length of stay and decreases opioid dose requirements in the early postoperative period compared with epidural analgesia. (J Am Coll Surg 2019; 228:680–686. © 2019 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Appropriate perioperative pain control is an integral part of postoperative recovery after major abdominal operations. Opioid analgesics have been the mainstay of therapy for decades. However, with the mounting opioid crisis, much of which is fueled by misuse, abuse, and diversion of prescription opioids, physician efforts to provide alternate

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From the Department of Surgery (Warren, Carbonell, Cobb) Summer Undergraduate Research Program (Mcguire) and Department of Anesthesiology (Hand, Cancellaro), University of South Carolina School of Medicine Greenville (Jones), and Department of Quality Management, Greenville Health System (Ewing), Greenville, SC.

Correspondence address: Jeremy A Warren, MD, FACS, Department of Surgery, University of South Carolina School of Medicine Greenville, 701 Grove Rd, Suite 3, Greenville, SC 29607. email: jwarrenmd@ghs.org

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Abbreviations and Acronyms
ERAS = Enhanced Recovery after Surgery
LOS = length of stay
MME = morphine milligram equivalent
POD = postoperative day
TAP = transversus abdominis plane
VHR = ventral hernia repair

analgesia are critical. Enhanced Recovery after Surgery (ERAS) protocols can have a substantial impact on perioperative opioid use by incorporating multimodal analgesia as adjuncts or alternatives to traditional opioids. These protocols, along with increased physician and patient awareness and education, can significantly reduce opioid consumption both in the hospital and after hospital discharge.[1-3]

We previously published our early outcomes after adoption of a multimodal approach to postoperative pain management.[2] In brief, our protocol involves a preoperative "cocktail" of pregabalin 75 mg, celecoxib 400 mg, and acetaminophen 1,000 mg, given within 1 to 2 hours of operation. We initially included a long-acting oxycontin as well, which has since been abandoned. Intraoperative opioids are reduced or eliminated. Postoperative management includes IV ketamine infusion at a subanesthetic dose, NSAIDs, acetaminophen, and selective use of epidural catheters. Using this approach, we virtually eliminated the use of patient-controlled analgesia, and substantially reduced overall opioid use during postoperative days (PODs) 0, 1 and 2, although length of stay (LOS) was no different. Since our initial publication, additional data have emerged indicting epidural catheter use in prolonging LOS after ventral hernia repair (VHR),[4] along with increased support for use of regional anesthesia in the form of transversus abdominis plane (TAP) block.[5-8] Our ERAS protocol transitioned from selective use of epidural analgesia to the use of TAP block in early 2017. We hypothesize that the use of regional anesthesia with TAP block has significantly reduced hospital LOS and in-hospital opioid consumption.

METHODS

Data from the Americas Hernia Society Quality Collaborative was queried for all patients undergoing open VHR with mesh in the absence of parastomal hernia or concurrent enterostomy reversal between February 2015 and March of 2018 at the Greenville Health System. The Americas Hernia Society Quality Collaborative is a prospectively maintained, surgeon-entered, hernia-specific registry containing all relevant demographic, comorbidity, operative, and outcomes data.[9] After identification of the study population, additional retrospective review was performed to determine perioperative opioid and nonopioid analgesic, and antiemetic use. Primary end points were LOS and total opioid dosage in morphine milligram equivalents (MMEs) during the first 2 PODs. This time point was chosen based on findings of our earlier study, which found significant differences in opioid consumption using our ERAS protocol only through POD 2. Secondary end points were use of nonopioid analgesic and antiemetic use.

All patients were treated using a standard ERAS protocol. This consists of preoperative oral administration of 1,000 mg acetaminophen, 400 mg celecoxib, and 75 mg pregabalin in the preoperative area, along with 300 mL carbohydrate-rich beverage 2 to 4 hours before scheduled operation. Patients receiving epidurals had them placed in the preoperative area. The TAP blocks were placed primarily in the operative theater after induction of anesthesia. Block solution consisted of 200 mg ropivacaine, 100 μg epinephrine, and 100 μg clonidine in 60 mL saline, with 30 mL injected on each side under ultrasound guidance. Intraoperatively, attempts were made to limit opioid use, particularly fentanyl. Ketamine bolus was given during induction, followed by infusion at 0.5 mg/kg/h. Lidocaine IV infusion at 2 to 3 mg/min was used at the discretion of the anesthesiologist. Postoperatively, beginning in the postanesthesia care unit, patients received a ketamine infusion at 8 to 16 mg/h. This was continued for 24 to 48 hours. Intravenous ketorolac 15 to 30 mg every 8 hours and acetaminophen 1,000 mg every 6 hours were administered, with oral tramadol, oxycodone, or hydrocodone ordered for additional pain control as needed. Intravenous opioids were used for breakthrough pain only and were not ordered routinely. No patient-controlled analgesia was used. Epidural infusions with 0.125% bupivacaine were initiated shortly before emergence from anesthesia and continued at 8 to 12 mL/h. No narcotic was included in epidural infusions. Epidurals were discontinued variably in 24 to 72 hours. A dedicated acute pain management team managed ketamine and epidural dose adjustments. Discontinuation was at the discretion of the surgical team in conjunction with the pain management team.

Continuous variables are reported as mean ± SD or median (interquartile range) and differences between the groups were tested using Student's *t*-test or Mann-Whitney test, respectively. Discrete variables are reported as n (%) and tested using chi-square test or Fisher's exact test for small sample sizes ($n < 5$). A p value < 0.05 was considered statistically significant. Opioid dosing was calculated as MMEs using the Opioid Equianalgesic Calculator (https://clincalc.com/opioids/). All analyses

were carried out using R statistical software, version 3.4.3 (R Foundation for Statistical Computing).

RESULTS

A total of 246 patients underwent open VHR with either TAP block or epidural analgesia during the study period. Of these, 172 patients had epidural analgesia and 74 had a TAP block. Patient comorbidities were similar between groups (Table 1). Hernia width in the epidural group was larger, and this difference was significant (median 10 cm vs 8 cm; p = 0.002). Surgical technique was similar, with the majority (79.7%) of patients undergoing retromuscular repair. Use of additional myofascial release was different between groups (25.7% in TAP group, 41.9% in epidural group; p = 0.016). Transversus abdominis release was used in 29.7% of epidural patients and 21.6% of TAP block patients, and external oblique release was used in 12.2% and 4.1%, respectively. Hernias were recurrent in 48.8% of patients, with no difference between groups. Patients receiving epidural analgesia had longer operative times. Operative data are shown in Table 2. Surgical outcomes were also similar between groups. Surgical site infection rate was 1.3% in TAP block patients and 2.9% of epidural patients (p = 0.468), and surgical site occurrence complicated 18.9% and 18.6%, respectively (p = 0.954). Hospital LOS was significantly shorter in patients after TAP block, with discharge at a median of 2 days compared with a median of 4 days for patients receiving epidural analgesia (p <0.001) (Table 3).

Mean duration of ketamine infusion was 39.5 hours in the epidural group and 30.7 in the TAP group (p = 0.119). Mean duration of epidural infusion was 49.5 hours. Mean daily MMEs required in the TAP block group were significantly lower on both POD 1 (40 vs 54.1 MMEs; p = 0.03) and POD 2 (36.1 vs 52.5 MMEs; p = 0.018), despite a greater number of patients in the epidural group were treated with no opioid (54.1 vs 15.9%; p < 0.001). A greater number of patients in the TAP block group received nonopioid medications as adjuncts for pain control. Ketorolac was given to 42.9% of patients receiving TAP blocks, and only 21.5% of epidural patients (p < 0.001). Acetaminophen was also used more frequently after TAP block, although this difference was not statistically significant. There was no difference seen in antiemetic use. Perioperative medication use is detailed in Table 4. A total of 82 patients had a history of opioid use within 30 days before VHR (33.7% of epidural patients, 32.4% of TAP block patients). Patients with earlier opioid use required higher MMEs postoperatively. This difference reached significance in the patients receiving epidural on both PODs 1 and 2, but was not statistically significant in TAP block patients (Table 5).

Table 1. Patient Characteristics

Characteristic	Transversus abdominis plane	Epidural	p Value
n	74	172	
Age, y, mean ± SD	57.3 ± 13.9	59.1 ± 12.9	0.311
BMI, kg/m^2, mean ± SD	33.6 ± 6.4	32.5 ± 7.0	0.250
Sex, n (%)			0.866
Male	36 (48.65)	80 (46.51)	
Female	38 (51.35)	92 (53.49)	
Hypertension, n (%)	45 (60.81)	111 (64.53)	0.681
Diabetes mellitus, n (%)	16 (21.62)	47 (27.33)	0.421
COPD, n (%)	8 (10.81)	15 (8.72)	0.792
Smoker, n (%)	19 (25.68)	28 (16.28)	0.123

Table 2. Operative Characteristics

Characteristic	Transversus abdominis plane	Epidural	p Value
n	74	172	—
Recurrent, n (%)	36 (48.65)	84 (48.84)	1.000
Wound class, n (%)			0.240
Clean	68 (91.89)	141 (81.98)	
Clean-contaminated	5 (6.76)	24 (13.95)	
Contaminated	0 (0)	3 (1.74)	
Dirty	1 (1.35)	4 (2.33)	
Hernia width, cm, median (IQR)	8 (5–11)	10 (6–14)	0.002*
Hernia length, cm, median (IQR)	11 (6–18)	15 (10–21)	0.004*
Mesh placement, n (%)			
Onlay	5 (6.76)	15 (8.72)	0.793
Retromuscular	55 (74.32)	141 (81.98)	0.232
Polypropylene	14 (18.92)	16 (9.3)	0.057
Myofascial release, n (%)	19 (25.67)	72 (41.89)	0.016*
Transversus abdominis release	16 (21.62)	51 (29.65)	0.215
External oblique release	3 (4.05)	21 (12.21)	0.081
Anterior rectus sheath	0 (0)	2 (1.16)	1.000
Concomitant procedure, n (%)	15 (20.27)	41 (23.84)	0.656
Operative time, n (%)			<0.001*
<60 min	1 (1.35)	0 (0)	
60–119 min	28 (37.84)	24 (13.95)	
120–179 min	23 (31.08)	59 (34.3)	
180–239 min	8 (10.81)	42 (24.42)	
240+ min	14 (18.92)	47 (27.33)	

*Statistically significant difference.
IQR, interquartile range.

Table 3. Operative Outcomes

Outcome	Transversus abdominis plane	Epidural	p Value
n	74	172	—
SSI, n (%)	1 (1.35)	5 (2.91)	0.672
Superficial	1 (1.35)	5 (2.91)	0.672
Deep	0 (0)	0 (0)	—
Organ space	0 (0)	0 (0)	—
SSI requiring procedural intervention, n (%)	1 (1.35)	5 (2.91)	0.672
SSO, n (%)	12 (16.22)	29 (16.86)	1.000
SSO requiring procedural intervention, n (%)	4 (5.41)	12 (6.98)	0.860
Length of stay, median (interquartile range)	2 (1−3)	4 (3−5)	<0.001*

*Statistically significant difference.
SSI, surgical site infection; SSO, surgical site occurrence.

DISCUSSION

Regional anesthesia using TAP block provides an effective alternative to epidural analgesia or opioid use alone for perioperative pain control. In a randomized controlled trial comparing TAP block with liposomal bupivacaine and epidural analgesia for colorectal operation, Felling and colleagues[7] demonstrated a significant reduction in opioid consumption postoperatively. No difference was seen in return of bowel function or LOS, however.[7] Another recent randomized controlled trial demonstrated a 0.5-day reduction in LOS for TAP block with liposomal bupivacaine compared with epidural.[5] The TAP block was found to be superior to epidural after major abdominal oncologic resections, reducing the required MMEs in the meta-analysis demonstrated reduced opioid consumption on POD 1 and sooner return of bowel function, but no impact on LOS.[10] In contrast, evidence from the Americas Hernia Society Quality Collaborative comparing epidural analgesia with no epidural demonstrated a prolonged LOS when an epidural was used.[4] Use of TAP block in the hernia literature also demonstrates the effectiveness of this approach. A trial comparing TAP block with opioid analgesia alone demonstrated reductions in total narcotic consumption and opioid-associated side effects using TAP block.[11] A retrospective evaluation of patients undergoing abdominal wall reconstruction also demonstrated reductions in pain scores and opioid consumption, as well as a significantly shorter LOS (2.7 vs 4 days; $p < 0.001$).[6] The reduction in median LOS by half was highly significant in our study as well.

Many pharmacologic agents can be used for TAP block. We used a combination of clonidine, epinephrine, and ropivacaine. Clonidine and epinephrine have long been used to prolong the duration of action of the local anesthetics used for regional anesthesia.[12,13] However, evidence now suggests that this might not be effective, and we are transitioning away from these agents to dexamethasone as an additive, which was been shown to prolong the effect of local anesthetic in regional blocks.[14,15] Liposomal bupivacaine is another formulation that can have a significantly longer duration of action and has been used for TAP block in multiple studies.[5-8,16] There are no clinical data comparing TAP block with liposomal bupivacaine to other local anesthetics alone or in combination with adjunctive medications that can prolong their action. Recent randomized trials in both orthopaedic and gynecologic surgery suggest there is no benefit to the extended-release liposomal bupivacaine in early postoperative pain control.[17,18] Given the higher cost of liposomal bupivacaine, this is an important area for future study. In addition, the most effective technique for TAP block administration has yet to be determined. The block can be performed preoperatively under ultrasound guidance, intraoperatively under direct visualization, or with directed catheters for continuous postoperative infusion. A retrospective study of intraoperative direct visualization vs ultrasound-guided preoperative TAP block demonstrated superiority of the surgeon-administered intraoperative block in reducing narcotic requirements during the hospital stay.[8] Still, preemptive analgesia can provide an advantage. Blockade of the neurogenic and inflammatory mediators of pain before any painful stimuli can alter the pain perception and result in less postoperative pain and opioid requirement.[19] This gate theory of pain perception is the basis for our preoperative pain "cocktail" and in theory supports the use of TAP block before abdominal incision. However, high-level clinical data are lacking, and significant heterogeneity in TAP block technique and block solution limits the generalizability of the existing data. In our study, TAP block was performed before abdominal incision under ultrasound guidance. Using this approach, LOS was reduced by half compared with epidural analgesia. This is likely due to several factors. Early ambulation in epidural patients is often impaired due to lower extremity paresthesia or hypotension and there is a higher risk of urinary retention. Additionally, the decision of when to discontinue epidural analgesia in our series was left to the judgment of the pain management and surgical teams based on reporting of patient pain, rather than duration determined by a protocol, which can confound our results.

The impact of TAP block on LOS is significant. However, the potential reduction in narcotic use might have the greater impact. Opioid analgesics have been the mainstay of postoperative analgesia for decades, which is now being critically evaluated in light of the opioid epidemic. Implementation of "pain as the fifth vital sign," inclusion of pain standards by The Joint Commission, and use of the Hospital Consumer Assessment of

Table 4. Postoperative Opioid Use

Variable	Transversus abdominis plane	Epidural	p Value
n	74	172	—
Intraoperative medication			
Patient receiving any intraoperative opioid, n (%)	54 (72.97)	63 (36.63)	<0.001*
Total intraoperative MME, mean ± SD	22.1 ± 9.0	30.3 ± 12.4	0.575
Lidocaine, n (%)	43 (58.11)	38 (22.09)	<0.001*
Lidocaine, mean ± SD	312.9 ± 174.5	354.6 ± 250.2	0.394
Toradol, n (%)	2 (2.7)	0	0.09
Tylenol, n (%)	13 (17.57)	7 (4.07)	<0.001*
PACU medication			
Patient receiving any opioid in PACU, n (%)	36 (48.65)	59 (34.3)	0.048
Total PACU MME, mean ± SD	22.2 ± 13.1	21.3 ± 16.4	0.75
Median (IQR)	20 (12–29)	18 (10–24)	0.323
Toradol, n (%)	9 (12.16)	11 (6.4)	0.207
Tylenol, n (%)	8 (10.81)	11 (6.4)	0.353
Zofran, n (%)	10 (13.51)	22 (12.79)	1
Phenergan, n (%)	1 (1.35)	6 (3.49)	0.613
POD 0 medication			
n (%)	63 (85.14)	172 (100)	
Patient receiving any opioid on POD 0, n (%)	38 (60.32)	50 (29.07)	<0.001*
Total POD 0 MME, mean ± SD	18.0 ± 13.1	23.6 ± 26.0	0.193
Median (IQR)	15 (8–23)	15 (10–21)	0.668
Toradol, n (%)	27 (42.86)	37 (21.51)	<0.001*
Tylenol, n (%)	20 (31.75)	27 (15.7)	0.299
Zofran, n (%)	11 (17.46)	23 (13.37)	0.562
Phenergan, n (%)	0	0	NA
POD 1 medication			
n (%)	63 (85.14)	172 (100)	
Patient receiving any opioid on POD 1, n (%)	53 (84.13)	79 (45.93)	<0.001*
Total POD 1 MME, mean ± SD	40.1 ± 29.1	54.1 ± 45.8	0.033*
Median (IQR)	30 (20-48)	40 (15-74)	0.188
Toradol, n (%)	35 (55.56)	53 (30.81)	<0.001*
Tylenol, n (%)	21 (33.33)	45 (26.16)	0.358
Zofran, n (%)	13 (20.63)	34 (19.77)	1
Phenergan, n (%)	0	0	NA
POD 2 medication			
n (%)	48 (64.86)	166 (96.51)	
Patient receiving any opioid on POD 2, n (%)	43 (89.58)	100 (60.24)	<0.001*
Total POD 2 MME, mean ± SD	36.1 ± 31.7	52.5 ± 48.6	0.018*
Median (IQR)	30 (15–46)	38 (15–68)	0.060
Toradol, n (%)	11 (22.92)	31 (18.67)	0.656
Tylenol, n (%)	9 (18.75)	33 (19.88)	0.967
Zofran, n (%)	5 (10.42)	33 (19.88)	0.682
Phenergan, n (%)	0	0	NA

*Statistically significant difference.
IQR, interquartile range; MME, morphine milligram equivalent; NA, not applicable; PACU, postanesthesia care unit; POD, postoperative day.

Healthcare Providers and Systems in Value-Based Purchasing models of reimbursement have contributed to increased opioid prescribing since the early 1990s.[20-23] Total number of prescriptions, prescribed doses, and pharmacy distribution all rose significantly between 2000 and 2009,[22] and opioid-related deaths increased

Table 5. Postoperative Opioid Use in Patients with and Without Earlier (Within 30 Days of Operation) Opioid Use

	Patients with preoperative (within 30 d) opioid use				
	Yes		No		p
Variable	n	MME	n	MME	Value
POD 0					
TAP	15	19.6 ± 16.8	23	17.1 ± 9.7	0.56
Epidural	25	24.8 ± 28.9	25	22.5 ± 23.2	0.758
POD 1		74		172	
TAP	22	44.5 ± 31.1	31	36.9 ± 27.6	0.354
Epidural	32	66.7 ± 48.4	47	45.5 ± 42.4	0.004*
POD 2		74		172	
TAP	18	36.0 ± 30.5	25	36.2 ± 33.3	0.983
Epidural	35	71.9 ± 60.5	65	42.1 ± 37.4	0.003*

*Statistically significant difference.
MME, morphine milligram equivalent; POD, postoperative day; TAP, transversus abdominis plane.

nearly 3-fold between 1999 and 2014.[24] In a study of Medicare beneficiaries, 14.9% of all hospital admissions resulted in a new opioid prescription claim. Of those with 90-day follow-up, 42.5% of these new opioid recipients still had claims for opioids at 90 days, indicating a significant increase in new persistent users after initial therapy.[25] By reducing initial exposure of opioids by using multimodal analgesia, along with changes in narcotic prescribing at the time of discharge, surgeons can significantly impact this crisis.

Use of TAP block has demonstrated a reduction in opioid consumption during abdominal wall reconstruction.[6,8] During laparoscopic VHR, TAP block was again shown to reduce opioid use postoperatively.[26] Other studies of patients undergoing major abdominal oncologic resections,[27] laparoscopic bariatric procedures,[16] and many other abdominal procedures,[28] have shown similar results. In light of these findings, use of TAP block should be strongly considered as an adjunct to abdominal procedures. In addition to the use of regional anesthesia, increased focus must be placed on postoperative opioid prescribing. There is currently no generally accepted standard for dosing in-hospital postoperative analgesia. Using our ERAS protocol, we effectively eliminated patient-controlled analgesia use in 2015. Multiple recent studies of discharge opioid prescribing indicate that most patients require dramatically less medication than prescribed.[20,29-31] These findings have led us to critically evaluate both in-hospital and discharge analgesia. We currently do not order routine IV narcotic postoperatively, and this is only given if patients have persistent severe pain after nonopioid and oral opioid administration. For outpatient procedures, most patients are discharged with a total of 40 MMEs, with 75 MMEs prescribed for some more complex procedures. For hospitalized patients, discharge prescriptions are based on in-hospital opioid use, similar to the protocol proposed by Hill and colleagues.[29] Prescriptions are also given for ibuprofen 800 mg and acetaminophen 1,000 mg, and patients are encouraged to use opioids for severe pain only. Anecdotally, this has been an effective strategy, though data collection and analysis are ongoing.

There are several limitations to this study. First, it is retrospective, and the study period encompasses a relatively early experience with our full ERAS protocol and the transition from epidural to TAP block. This creates significant potential for selection bias, and temporal change in analgesic prescribing based on growing personal experience. Additionally, although most patient characteristics were similar between the epidural and TAP groups, patients receiving epidural had hernias that were significantly larger, required more myofascial releases, and had longer operative times, indicating a higher degree of complexity that can influence the need for longer hospitalization and greater opioid use. Our mean opioid consumption was significantly lower in the TAP group, but the median difference did not reach statistical significance. The relatively small sample size with wide inter-patient variation in total MMEs explains this finding. We also found suboptimal compliance with our ERAS protocol, with more patients receiving intraoperative opioids and fewer receiving postoperative nonopioids than expected. This is multifactorial and correction involves increased education, ongoing monitoring, and better system integration of our electronic medical record. This study does present many opportunities for future study. Block technique, timing, choice of local anesthetic, and block solution adjuncts all have potential impact of the efficacy of TAP block. A study of prescribed opioids after discharge would be another valuable addition to this study to better assess pain control and narcotic use after discharge.

CONCLUSIONS

Use of TAP block as part of a multimodal analgesic ERAS protocol significantly reduces LOS compared with epidural analgesia and can reduce opioid consumption.

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REFERENCES

1. Hartford LB, Van Koughnett JAM, Murphy PB, et al. Standardization of Outpatient Procedure (STOP) narcotics:

a prospective non-inferiority study to reduce opioid use in outpatient general surgical procedures. J Am Coll Surg 2019; 228:81−88.e1.
2. Warren JA, Stoddard C, Hunter AL, et al. Effect of multimodal analgesia on opioid use after open ventral hernia repair. J Gastrointest Surg 2017;21:1692−1699.
3. Wick EC, Grant MC, Wu CL. Postoperative multimodal analgesia pain management with nonopioid analgesics and techniques: a review. JAMA Surg 2017;152:691−697.
4. Prabhu AS, Krpata DM, Perez A, et al. Is it time to reconsider postoperative epidural analgesia in patients undergoing elective ventral hernia repair?: an AHSQC Analysis. Ann Surg 2018; 267:971−976.
5. Torgeson M, Kileny J, Pfeifer C, et al. Conventional epidural vs transversus abdominis plane block with liposomal bupivacaine: a randomized trial in colorectal surgery. J Am Coll Surg 2018;227:78−83.
6. Fayezizadeh M, Majumder A, Neupane R, et al. Efficacy of transversus abdominis plane block with liposomal bupivacaine during open abdominal wall reconstruction. Am J Surg 2016; 212:399−405.
7. Felling DR, Jackson MW, Ferraro J, et al. Liposomal bupivacaine transversus abdominis plane block versus epidural analgesia in a colon and rectal surgery enhanced recovery pathway: a randomized clinical trial. Dis Colon Rectum 2018;61:1196−1204.
8. Doble JA, Winder JS, Witte SR, Pauli EM. Direct visualization transversus abdominis plane blocks offer superior pain control compared to ultrasound guided blocks following open posterior component separation hernia repairs. Hernia 2018;22:627−635.
9. Poulose BK, Roll S, Murphy JW, et al. Design and implementation of the Americas Hernia Society Quality Collaborative (AHSQC): improving value in hernia care. Hernia 2016;20:177−189.
10. Hain E, Maggiori L, Prost A, et al. Transversus abdominis plane (TAP) block in laparoscopic colorectal surgery improves postoperative pain management: a meta-analysis. Colorectal Dis 2018;20:279−287.
11. Chesov I, Belîi A. Postoperative analgesic efficiency of transversus abdominis plane block after ventral hernia repair: a prospective, randomized, controlled clinical trial. Rom J Anaesth Intensive Care 2017;24:125−132.
12. Singh R, Kumar N, Jain A, Joy S. Addition of clonidine to bupivacaine in transversus abdominis plane block prolongs postoperative analgesia after cesarean section. J Anaesthesiol Clin Pharmacol 2016;32:501−504.
13. Kitayama M, Wada M, Hashimoto H, et al. Effects of adding epinephrine on the early systemic absorption kinetics of local anesthetics in abdominal truncal blocks. J Anesth 2014;28:631−634.
14. Akkaya A, Yildiz I, Tekelioglu UY, et al. Dexamethasone added to levobupivacaine in ultrasound-guided tranversus abdominis plain block increased the duration of postoperative analgesia after caesarean section: a randomized, double blind, controlled trial. Eur Rev Med Pharmacol Sci 2014;18:717−722.
15. Albrecht E, Kern C, Kirkham KR. A systematic review and meta-analysis of perineural dexamethasone for peripheral nerve blocks. Anaesthesia 2015;70:71−83.
16. Robertson TC, Hall K, Bear S, et al. Transversus abdominis block utilizing liposomal bupivacaine as a non-opioid analgesic for postoperative pain management. Surg Endosc 2018;11: S105−S106.
17. Schroer WC, Diesfeld PG, LeMarr AR, et al. Does extended-release liposomal bupivacaine better control pain than bupivacaine after total knee arthroplasty (TKA)? A prospective, randomized clinical trial. J Arthroplasty 2015;30:64−67.
18. Iwanoff C, Salamon C. Liposomal bupivacaine vs. bupivacaine hydrochloride with lidocaine during midurethral sling placement: a randomized controlled trial. J Minim Invasive Gynecol 2018 Nov 22 [Epub ahead of print].
19. Cillo JE, Dattilo DJ. Pre-emptive analgesia with pregabalin and celecoxib decreases postsurgical pain following maxillomandibular advancement surgery: a randomized controlled clinical trial. J Oral Maxillofac Surg 2014;72: 1909−1914.
20. Tan WH, Yu J, Feaman S, et al. Opioid medication use in the surgical patient: an assessment of prescribing patterns and use. J Am Coll Surg 2018;227:203−211.
21. Pletcher MJ, Kertesz SG, Kohn MA, Gonzales R. Trends in opioid prescribing by race/ethnicity for patients seeking care in US emergency departments. JAMA 2008;299:70−78.
22. Kenan K, Mack K, Paulozzi L. Trends in prescriptions for oxycodone and other commonly used opioids in the United States, 2000-2010. Open Med 2012;6[2]:e41−e47.
23. Baker DW. History of The Joint Commission's pain standards: lessons for today's prescription opioid epidemic. JAMA 2017;317:1117−1118.
24. Rudd RA, Seth P, David F, Scholl L. Increases in drug and opioid-involved overdose deaths—United States, 2010-2015. Morb Mortal Wkly Rep 2016;65:1445−1452.
25. Jena AB, Goldman D, Karaca-Mandic P. Hospital prescribing of opioids to Medicare beneficiaries. JAMA Intern Med 2016; 176:990−997.
26. Fields AC, Gonzalez DO, Chin EH, et al. Laparoscopic-assisted transversus abdominis plane block for postoperative pain control in laparoscopic ventral hernia repair: a randomized controlled trial. J Am Coll Surg 2015;221:462−469.
27. Shaker TM, Carroll JT, Chung MH, et al. Efficacy and safety of transversus abdominis plane blocks versus thoracic epidural anesthesia in patients undergoing major abdominal oncologic resections: a prospective, randomized controlled trial. Am J Surg 2018;215:498−501.
28. 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;31:432−452.
29. Hill MV, Stucke RS, Billmeier SE, et al. Guideline for discharge opioid prescriptions after inpatient general surgical procedures. J Am Coll Surg 2018;226:996−1003.
30. Hill MV, McMahon ML, Stucke RS, Barth RJ. Wide variation and excessive dosage of opioid prescriptions for common general surgical procedures. Ann Surg 2017;265:709−714.
31. Fujii MH, Hodges AC, Russell RL, et al. Post-discharge opioid prescribing and use after common surgical procedure. J Am Coll Surg 2018;226:1004−1012.

Discussion

DR J SCOTT ROTH (Lexington, KY): In this paper, Dr Cobb reviews their institution's ventral hernia repair outcomes using an enhanced recovery protocol during a time in which they transitioned from the use of epidural catheters to the use of a transversus abdominis plane block as a component of a multimodal