The American Journal of Surgery 217 (2019) 605–612

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Association between postoperative opioid use and outpatient surgical adverse events

Elise A. Dasinger [a, *], Westyn Branch-Elliman [b, c, d], Steven D. Pizer [e, f], Hassen Abdulkerim [b], Amy K. Rosen [b, g], Martin P. Charns [b, f], Mary T. Hawn [h, i], Kamal M.F. Itani [d, g, j], Hillary J. Mull [b, g]

[a] VA Quality Scholars Program, Birmingham VA Medical Center, Birmingham, AL, United States
[b] Center for Healthcare Organization and Implementation Research (CHOIR), VA Boston Healthcare System, Boston, MA, United States
[c] Department of Medicine, VA Boston Healthcare System, Boston, MA, United States
[d] Harvard Medical School, Boston, MA, United States
[e] Partnered Evidence-based Policy Resource Center (PEPReC), Department of Veterans Affairs, Boston, MA, United States
[f] Department of Health Law, Policy and Management, Boston University School of Public Health, Boston, MA, United States
[g] Department of Surgery, Boston University School of Medicine, Boston, MA, United States
[h] Palo Alto VA Medical Center, Palo Alto, CA, United States
[i] Stanford University School of Medicine, Stanford, CA, United States
[j] Department of Surgery, VA Boston Healthcare System, Boston, MA, United States

ARTICLE INFO

Article history:
Received 23 October 2018
Received in revised form
26 December 2018
Accepted 31 December 2018

Keywords:
Ambulatory surgery
Opioids
Patient safety
Adverse events
Quality improvement
Veterans

ABSTRACT

Background: Opioid-related adverse drug events are common following inpatient surgical procedures. Little is known about opioid prescribing after outpatient surgical procedures and if opioid use is associated with short term risks of outpatient surgical adverse events (AEs).
Methods: VA Corporate Data Warehouse was used to identify opioid use within 48 h for FY2012-14 chart-reviewed cases from a larger VA study of AEs in outpatient surgeries. We estimated a multilevel logistic regression model to determine the effect of opioid exposure on risk of AEs between 2 and 30 days postoperatively.
Results: Of the 1730 outpatient surgical cases, 628 (36%) had postoperative opioid use and 12% had an AE. Opioid use following outpatient surgery was not significantly associated with higher surgical AE rates after controlling for relevant covariates (OR = 1.1 95% CI 0.79–1.54). Only procedure RVUs were associated with higher odds of postoperative AEs.
Conclusions: Postoperative opioid use following outpatient surgery is not a significant driver of postoperative AEs.

Published by Elsevier Inc.

Background

Opioids have been found to be one of the most common drug classes implicated in emergency department visits for adverse drug events.[1] Opioid-related adverse drug events (ORADE) are common in inpatient settings and are associated with worse clinical outcomes and increased healthcare costs.[2–4] The types of ORADE following inpatient surgical procedures range in frequency and severity, and postoperative prescribing rates for opioids vary significantly, even within a single type of procedure.[5,6] Although much of the literature on the impact of opioids on postoperative adverse events is focused on inpatient procedures, given the increasing prevalence of outpatient surgeries and high rates of pain reported by patients following outpatient surgery, there is a need for additional data on the impact of opioid prescribing in this setting. Some specific ORADEs, like falls from bed, dry mouth, and vertigo, are easier to detect during an inpatient stay and may not necessarily rise to the level of harm that would bring a patient back to the healthcare system following an outpatient surgical procedure.[7,8] Therefore, the relationship between opioids and inpatient care may be different in outpatient settings, where minor AEs may not be detected or lead to additional healthcare utilization.

* Corresponding author. Birmingham VA Medical Center, 700 South 19th Street (4714), Birmingham, AL, 35233, United States.
E-mail address: Elise.Dasinger@va.gov (E.A. Dasinger).

https://doi.org/10.1016/j.amjsurg.2018.12.068
0002-9610/Published by Elsevier Inc.

Identifying factors that contribute to adverse events (AEs) is crucial for improving patient safety. Long-term consequences of opioid use following surgery, including opioid dependence, are well established.[9] Little is known about opioid prescribing after outpatient surgical procedures and if opioid use is associated with increases in short term risks of outpatient surgical AEs. The care received directly after surgery is known to affect AE risk; however, the effect of medications prescribed in the outpatient surgical setting on AE risk is not clear.[10] Utilizing robust prescription data from the integrated electronic health record for the Veterans Health Administration (VA), we sought to describe postoperative opioid use for outpatient surgical procedures in the VA and identify any associations between opioid use and 30-day incidence of postoperative AEs. We also examined the types of AEs following outpatient surgery as these may differ from inpatient surgical ORADEs.

Methods

Data sources

Data are drawn from a larger study on AE surveillance in outpatient surgery.[11] A retrospective study of outpatient surgeries from FY2012-2014 (Oct. 1, 2011 – Sept. 30, 2014) across 131 VA surgical facilities (20 of these were freestanding ambulatory surgery centers (ASCs)) was conducted. Data on VA outpatient surgeries and postoperative medication use were identified in the VA Corporate Data Warehouse (CDW).[12] Chart review data on AEs were derived from patients' VA electronic health records (EHR) available through the research-approved national VistAWeb system.[13] The VA Boston Institutional Review Board approved this study with a waiver of informed consent.

Study sample

The study sample is previously described.[11] In brief, outpatient surgeries among all outpatient encounters in the VA CDW[12] were identified using Current Procedure Terminology (CPT) codes, the Centers for Medicare and Medicaid Services (CMS)'s Relative Value Unit (RVU) associated with the CPT code,[14] and the Agency for Healthcare Research and Quality (AHRQ)'s Healthcare Cost and Utilization Program (HCUP)'s 2014 Surgery Flag Software.[15] Surgeries that met the HCUP "narrow" definition of surgery ("involving incision, excision, manipulation, or suturing of tissue that penetrates or breaks the skin"[15]) were retained; surgeries on the CMS Inpatient Only list for 2014[16] and those classified by the VA National Surgery Office as inpatient only were excluded.[17] Eye surgeries were also excluded.

The larger study used chart review to develop and then validate an AE surveillance model.[11,18] FY12-14 outpatient surgeries were randomly selected for review based on whether the case had a trigger flag indicating a potential postoperative AEs; triggers focused on postoperative utilization and included 1–14 day admissions, emergency room visits, multiple visits to any surgical clinic, or multiple visits to the urology clinic within 30 days of surgery; this accounted for 80% of the sample.[19] An additional chart review sample was performed and included a randomly selected 20% of outpatient surgeries in patients assumed to have a low likelihood of an AE based on the absence of a trigger flag. Rates of postoperative opioids were compared between the total population of FY12-14 and the outpatient surgeries to determine whether the oversampling of cases with a potential AE was associated with higher rates of postoperative opioid use.

Postoperative opioid exposure

Postoperative opioid exposure was defined as a fill for an opioid within 48 h of the outpatient procedure by date and time stamp recorded in the CDW Pharmacy files. Qualifying opioids included only solid (tablet or capsule) oral dosage forms. We did not study intraoperative opioid use or whether patients filled additional opioid prescriptions after their initial postoperative opioid drug fill; these were outside the scope of our study.

Adverse events

Postoperative AEs in the chart review dataset were identified by a trained nurse abstractor using a previously validated chart review tool and *a priori* AE definitions.[11,18] AEs were limited to those occurring between 2 and 30 days postoperatively to ensure the AEs were potentially related to opioid exposure as opposed to the AE preceding an opioid prescribed to treat the complication. We did not explicitly look for evidence of substance use disorder or addiction in the 30-day postoperative period as these could not be reliably measured in our data.

Covariates

The objective was to isolate the effect of opioid exposure on postoperative AEs; thus, several other known risk factors for AE were included *a priori* in the multivariable regression model. Given the potential for patients with a history of opioid use to continue receiving opioids, a variable for opioid use in the 6 months before surgery was included. The analysis controlled for patient characteristics, including patient age, race, sex and a weighted comorbidity index based on 12-month prior secondary diagnoses codes in visits and hospitalizations (Elixhauser comorbidities and the Van Walraven composite).[20] Variation in procedural complexity was controlled for using the RVU associated with the procedure and the organ system involved. VA-defined facility complexity for high, intermediate and standard complexity hospitals and ambulatory surgery centers was also included in the model. Temporal effects were accounted for using the month and year of the procedure.

Analysis

Rates of postoperative opioid use and patient, procedure and facility characteristics between outpatient surgeries with and without AEs were examined and differences were assessed using chi-square and t-tests as appropriate. Leading CPT codes associated with postoperative opioid use were also reviewed. Logistic regression models were estimated with and without postoperative opioids controlling for prior opioid use, as well as patient, procedure and temporal characteristics to test the hypothesis that postoperative opioids were significantly associated with higher rates of AEs. Continuous variables (age, comorbidity index and RVU) were converted to quintiles for better interpretation in our model. Analyses were completed using SAS 9.2.

Results

Study sample versus population

There were 1730 outpatient surgeries in the chart review sample, drawn from 744,355 in the population. While the study sample

had higher rates of postoperative opioid use within 48 h of surgery compared to all outpatient surgeries between FY12-14 (36% versus 27%), there was no difference in patients with a prior history of opioid use (15% and 14%, respectively. See Appendix 1). Similarly, there was no difference between the chart review sample and the overall population in the rates of opioid types, with 49% of patients receiving a combination of hydrocodone and acetaminophen.

Sample characteristics

There were observed differences in the characteristics of patients with and without postoperative opioids in our chart reviewed sample of 1730 outpatient surgeries (see Table 1). Patients with postoperative opioid use were significantly younger (59 years versus 64 years in the total sample) and had lower comorbidity scores (1.5 versus 3.1 in the total sample). There was no difference between patients with postoperative opioid use and the total sample with respect to sex, race, and history of opioid use in the 6 months prior to surgery. Patients undergoing more complex surgeries, surgeries in complex facilities, and surgeries on the digestive or musculoskeletal organs had significantly higher rates of postoperative opioid use compared to the overall sample.

Postoperative opioid rates and timing

The days of opioid supplied varied; the most common duration of prescriptions were 5, 7, 10, 14 and 30 days (see Appendix 2). Over the three years of the study, there was a significant increase in the proportion of patients filling an opioid prescription, with an average of 27% in the first 3 months of the study compared to 47% in the final 3 months (see Fig. 1).

Table 1
Patient, procedure and facility characteristics of outpatient surgeries with postoperative opioid exposure.

Variable	Total (% of 1730)	Post-op Opioid
Total	1730	628 (36%)
Any Post-Op Adverse Event	214 (12%)	91 (14%)*
Patient Characteristics		
Age, years mean (std dev)	64 (13.6)	59 (14.3)***
Female	134 (8%)	54 (9%)
White	1295 (75%)	475 (76%)
Comorbidity score, mean (std dev)	3.1 (7.0)	1.5 (6.1) ***
History of Opioid Use in 6 Months prior	257 (15%)	101 (16%)
Procedure Characteristics		
RVUs mean (std dev)	5.6 (4.5)	8.4 (4.0)***
Organ System for Surgery		
Musculoskeletal	429 (25%)	212 (34%)***
Digestive	283 (16%)	145 (23%)***
Skin/soft tissue	373 (22%)	64 (10%)***
Urinary	218 (13%)	42 (7%)***
Cardiovascular	135 (8%)	47 (7%)
Nervous	94 (5%)	41 (7%)
Respiratory	57 (3%)	31 (5%)*
Male genital	70 (4%)	21 (3%)
Female genital	20 (1%)	6 (1%)
Hemic	19 (1%)	9 (1%)
Auditory	18 (1%)	5 (1%)
Endocrine	14 (1%)	4 (1%)
Facility Characteristics		
Ambulatory surgery center	127 (7%)	42 (7%)
Low complexity hospital	44 (3%)	14 (2%)
Intermediate complexity hospital	353 (20%)	114 (18%)
High complexity hospital	1206 (70%)	458 (73%)*

Notes: Data from 1730 chart reviewed outpatient surgeries performed in VA surgical facilities between FY12-14. Chi-square tests between variable and opioid exposure or two-tailed t-tests for continuous variables. P-values signified by the following symbols: *<0.05; ** <0.001; *** <0.0001.

Postoperative opioids and AEs

Out of 1730 cases, 214 had an AE that occurred 2–30 days postoperatively (12%); 91 AEs occurred in the 628 patients with postoperative opioid use (14%; $p = 0.04$). Table 2 shows the top 25 CPT-coded procedures in the sample and the proportion of each procedure type with postoperative opioids, postoperative AEs, and both postoperative outcomes. These procedures accounted for 56% of cases in the sample. Inguinal hernia was the most commonly performed procedure ($n = 100$, 6% of all chart reviewed surgeries) and 12% of patients had both postoperative opioids and AEs. Prostatectomy ($n = 31$, 2% of surgeries), AV fusion ($n = 19$, 1% of surgeries) and ventral hernia ($n = 18$, 1% of surgeries) had $\leq$10% of patients with postoperative opioids and AEs. Table 4 lists the types of AEs identified in outpatient surgeries with and without postoperative opioids; the most common AEs, wound dehiscence/disruption, other wound issues, hematoma, and urinary tract infections occurred at similar rates in both groups.

Model of postoperative opioids and AEs

In the unadjusted logistic regression model, patients who received a prescription for postoperative opioids had significantly higher odds of a postoperative AE (unadjusted odds ratio: 1.35, 95% confidence interval 1.01–1.8); however, the relationship was no longer significant after controlling for critical covariates (adjusted odds ratio: 1.1, 95% CI (0.79–1.54; see Table 3). The multivariable model included patient demographic data, procedure characteristics and facility complexity, but only procedure RVUs were associated with higher odds of postoperative AEs. The full model had better model discrimination than the null (c-statistic of 0.69 vs. 0.54).

Discussion

In this study of patients undergoing outpatient surgical procedures in the VA, we sought to determine the impact of postoperative opioid use on postoperative AEs. In this sample of outpatient procedures ranging in complexity from superficial skin procedures to hernia repair, we found that one third of patients filled an opioid prescription in the 48 h following surgery; the majority of these patients did not have a history of opioid use during the six-month window prior to the procedure. After adjusting for critical covariates known to be associated with increases in postoperative AE, postoperative opioid use was not found to be a significant driver of early AE in the outpatient surgical population.

Published rates of opioid prescribing following surgery vary widely, reflecting the differences by surgical procedures and the diversity of criteria used to define postoperative opioid use.[21–23] Waljee et al. examined opioid use following four outpatient upper extremity procedures using insurance claims data and found that approximately 59% filled an opioid prescription; however, their timeframe included prescriptions filled in the 6 weeks following the procedure as compared to our inclusion period of 48 h. When examining opioid fill rates based on procedures, their opioid fill rates for trigger finger release and carpal tunnel release were comparable to our findings despite their longer timeframe.[22]

We found that patients who filled an opioid prescription following surgery were younger in addition to a rising trend in the use of postoperative opioids from October FY12 through September

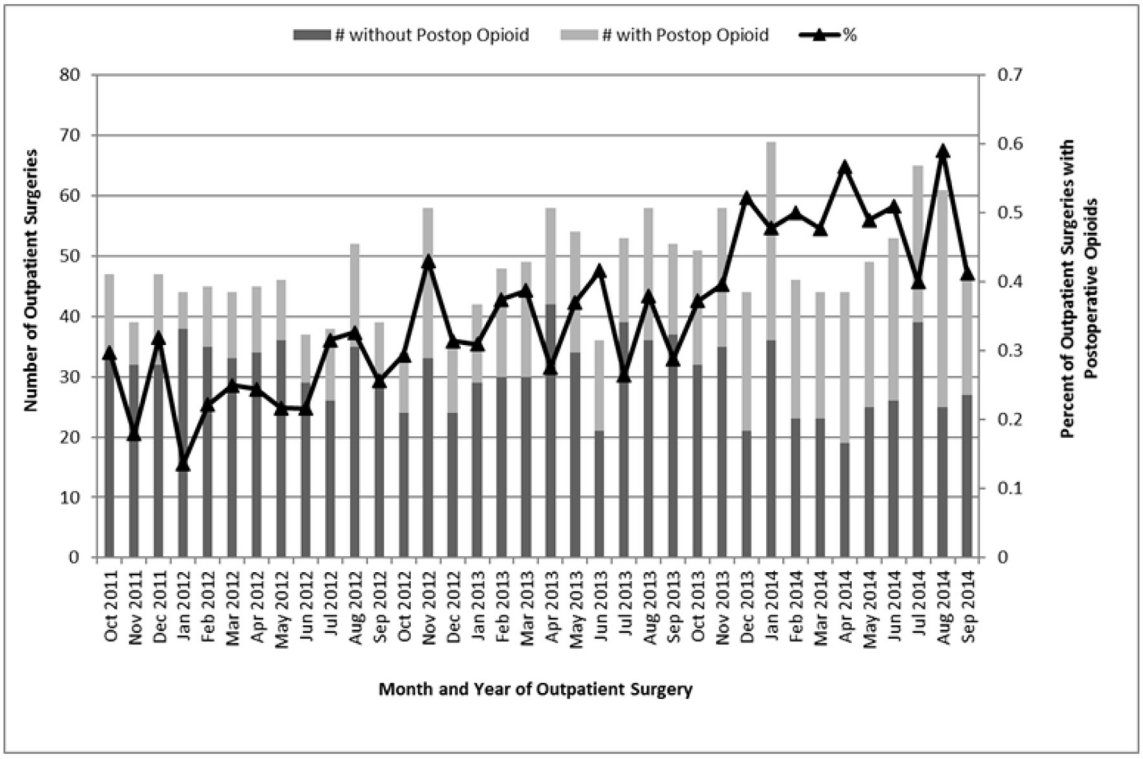


Fig. 1. Rate of Postoperative Opioid Use over Time in Chart Review Sample (FY12-14 VA Outpatient Surgeries, n = 1730).

Table 2
Top 25 outpatient surgeries with and without postoperative opioids.

Procedure and CPT Codes	N (% of 1730 Surgeries)	N (%) with Post-op Opioid*	N (%) with Post-op AE*	N (%) with both opioid and AE*
CPTs: 49505-49520, 49550-49553,49650-49651, inguinal hernia	100 (6%)	57 (57%)	21 (21%)	12 (12%)
CPTs: 52234-52281, 52310-52315, cystoscopy and treatment	85 (5%)	21 (25%)	7 (8%)	3 (4%)
CPTs: 29874-29888, knee arthroscopy/surgery	71 (4%)	45 (63%)	5 (7%)	4 (6%)
CPTs: 11403-11406; 11603-11606, excision/treatment of benign or malignant lesions>2 cm	71 (4%)	14 (20%)	11 (15%)	4 (6%)
CPTs: 11400-11402; 11600-11602, excision/treatment of benign or malignant legions <2 cm	68 (4%)	8 (12%)	2 (3%)	0
CPT: 64721, carpal tunnel surgery	60 (3%)	30 (50%)	9 (15%)	3 (5%)
CPT: 51701, insert bladder catheter	52 (3%)	0	7 (13%)	0
CPTs: 15271-15275, skin sub graft	49 (3%)	3 (6%)	6 (12%)	0
CPT 20605: Drain/injection into joint/bursa without ultrasound	42 (2%)	3 (7%)	0	0
CPTs: 47562-47564, laparoscopic cholecystectomy	34 (2%)	23 (68%)	3 (9%)	1 (3%)
CPTs: 49585-49587, umbilical hernia	32 (2%)	10 (31%)	1 (3%)	1 (3%)
CPT: 52601, prostatectomy (TURP)	31 (2%)	10 (32%)	8 (26%)	3 (10%)
CPT: 11750, removal of nail bed	31 (2%)	7 (23%)	1 (3%)	0
CPT: 11000, debride infected skin	28 (2%)	2 (7%)	1 (4%)	1 (4%)
CPT: 30520, repair of nasal septum	24 (1%)	16 (67%)	1 (4%)	1 (4%)
CPTs: 28290-29299, correction of bunion	22 (1%)	8 (36%)	4 (18%)	2 (9%)
CPTs: 15240-15260, skin full graft	20 (1%)	9 (45%)	2 (10%)	0
CPTs: 17311-17313, MOHS 1st stage	21 (1%)	1 (5%)	1 (5%)	0
CPTs: 29806-29824, shoulder arthroscopy/surgery	19 (1%)	14 (74%)	1 (5%)	1 (5%)
CPT: 36821, AV fusion, any site	19 (1%)	7 (37%)	5 (26%)	2 (11%)
CPT: 33249, insertion/replacement of permanent pacing cardioverter-defibrillator system w leads	19 (1%)	6 (32%)	3 (16%)	0
CPTs: 49561, 49566, 49651-49656, ventral hernia	18 (1%)	13 (72%)	3 (17%)	2 (11%)
CPTs: 20680-20670, removal of support implant	17 (1%)	5 (29%)	3 (18%)	
CPTs: 26040-26123, release palm contracture	17 (1%)	9 (53%)	1 (6%)	0
CPT: 64718, Revise ulnar nerve at elbow	16 (1%)	5 (31%)	4 (25%)	1 (6%)

NOTE: Top 25 surgeries represent 56% of the 1730 cases in the sample.
* Number of outpatient surgeries with postoperative opioids, adverse events, or both out of the total number of surgeries by that type.

Table 3
Logistic Regression Results for Post-Op Opioid Predicting Any AE (n = 1730 outpatient surgeries).

Variables	Unadjusted Model	Adjusted Model
	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Opioid within 48hr	**1.35 (1.01–1.8)**	1.1 (0.79–1.54)
Procedure Characteristics		
RVU: 1-2 RVUs		**ref**
2-5 RVUs		1.37 (0.78–2.4)
5-7 RVUs		**2.28 (1.29–4.02)**
7-10 RVUs		**2.05 (1.13–3.73)**
10-27 RVUs		**2.82 (1.6–4.95)**
Model Performance		
Intercept MLE (Std Err)	−2.07 (0.1)***	−1.56 (0.5)*
C-statistic	0.536	0.688

Note, insignificant variables included in the model but not shown include patient characteristics (age, sex, race), procedure characteristics (organ system), facility characteristics (facility complexity) and month/year of the procedure.

FY14, consistent with previous reports in the VA during an overlapping time period.[24,25] Current opioid prescribing rates in the VA are likely to be lower. Inadequate postoperative pain control has been considered an adverse outcome in some studies and leads to readmissions and emergency room visits.[7,8] Literature from the 2011–2014 period focused on the adverse outcome of inadequate postoperative pain control and this could explain the trend toward more opioids prescribed and filled over our study timeframe.[26,27] The VA has launched a number of system-wide initiatives to address opioid overuse, including the Opioid Safety Initiative (OSI) launched in October 2013 and a robust Academic Detailing Campaign implemented in May 2014, which utilizes specially trained clinical pharmacists to provide education and engage with individual opioid prescribers utilizing real-time dashboards with provider level opioid prescribing data.[25]

Our study did not find a relationship between opioids and AEs, but this lack of association may be partially explained by the focus on surgical-related AEs instead of specifically opioid related adverse events (ORADEs). In this study, we sampled for cases with a higher likelihood of any AE and did not sample specifically to detect AEs related to opioid use. Consequently, we may have missed cases with ORADEs, although we expect many opioid-specific AEs would have been detected in our chart review sample. By sampling for a larger set of AEs, we were able to look at the relationship between postoperative opioids and a much broader set of outcomes, including AEs that are not routinely considered related to opioid use. The most common AE in our chart reviewed sample was wound dehiscence. A previous study found a strong correlation between postoperative opioid exposure and AHRQ patient safety indicator (PSI-14) for wound dehiscence, suggesting that healing could be adversely impacted by opioid exposure during the postoperative period, although this event is not typically considered an ORADE.[28] We observed similar rates of wound dehiscence for those with and without postoperative opioids in our sample of outpatient surgical procedures.

The only factor associated with an increased risk of AEs was higher procedure RVUs. Procedure complexity has emerged as an important risk factor for AEs and is related to procedure RVUs. Previous studies demonstrated the association between postoperative AEs and procedure characteristics, including operative times which often serves as a surrogate for procedure complexity. Prolonged operative time for outpatient surgical procedures is a predictor for morbidity, mortality, and unanticipated admission following outpatient procedures.[29–31] Our findings are consistent with the findings of Sarin et al., who found that when looking at the single adverse event of postoperative nausea and vomiting (PONV) in ambulatory surgery patients, opioids were not the driving factor; however, procedure characteristics, including duration and type of surgery, were found to be two of the eleven independent predictors.[32] A systematic review by Wheeler et al. noted that suspected opioid related AEs may be related to other factors in the process of care besides postoperative opioid exposure, including type of surgery and duration of procedure.[33] As increasingly complex procedures are moving to the outpatient setting, this may pose a greater risk to surgical AEs than postoperative opioids.

Table 4
List of adverse events in FY12-14 VA outpatient surgical chart review sample with and without postoperative opioid exposure.

AE Type	Total (n = 214)	With Postop Opioid (n = 91)	Without Postop Opioid (n = 123)
Wound Disruption/Dehiscence	43 (20%)	17 (19%)	26 (21%)
Other Wound Occurrence	30 (14%)	12 (13%)	18 (15%)
Other, caused harm but did not meet *a priori* AE definitions	27 (13%)	13 (14%)	14 (11%)
Hematoma	26 (12%)	11 (12%)	15 (12%)
Urinary Tract Infection	26 (12%)	10 (11%)	16 (13%)
Superficial Incisional Surgical Site Infection (SSI)	14 (7%)	8 (9%)	6 (5%)
Urinary Retention	8 (4%)	3 (3%)	5 (4%)
Organ/Space SSI	7 (3%)	2 (2%)	5 (4%)
Allergy	5 (2%)	2 (2%)	3 (2%)
Deep Incisional SSI	5 (2%)	1 (1%)	4 (3%)
Deep Vein Thrombosis/Thrombophlebitis	5 (2%)	4 (4%)	1 (1%)
Persistent Nausea/Vomiting	3 (1%)	1 (1%)	2 (2%)
Sepsis	3 (1%)	0 (0%)	3 (2%)
Graft/Prosthesis/Flap Failure	2 (1%)	2 (2%)	0 (0%)
Other Urinary Occurrence	2 (1%)	0 (0%)	2 (2%)
Pneumonia	2 (1%)	2 (2%)	0 (0%)
Bleeding > 4 units red blood	1 (0%)	0 (0%)	1 (1%)
CVA/Stroke	1 (0%)	1 (1%)	0 (0%)
Cardiac Arrest req. CPR	1 (0%)	0 (0%)	1 (1%)
Clostridium difficile Colitis	1 (0%)	1 (1%)	0 (0%)
Intraoperative Iatrogenic Injury	1 (0%)	0 (0%)	1 (1%)
Pulmonary Embolism	1 (0%)	1 (1%)	0 (0%)

Note: Percentages are calculated out of the total number of surgeries in each column.

Several limitations should be considered when interpreting these results. This study focused on 30-day AEs related to surgery and did not consider longer-ranging consequences of outpatient surgery including whether patients developed opioid addictions. Only 15% of the patients with a postoperative opioid had filled an opioid prescription in the 6 months prior, suggesting many opioid-naïve patients may have been exposed to opioids following their outpatient surgery. Future research should consider whether initiation of opioids after outpatient surgery leads to long-term addiction and other adverse downstream consequences of opioid use. Another limitation is that we did not look at repeat opioid prescriptions over the 30-day postoperative period; this could indicate the patient was experiencing uncontrolled pain, a potential AE that was not explicitly defined in the chart review tool. We also considered the possibility that an opioid filled within the 48 h of discharge was part of a chronic use regimen and controlled for it 6-month prior opioid use in our analysis; this approach may have over counted the number of chronic opioid users but would not have changed our conclusions given the direction of the bias. Additionally, we cannot ascertain whether opioid medications were taken, only that they were dispensed. Research conducted on inpatient surgeries suggests that more than one-third of patients take fewer opioids than were filled in their postoperative prescription. Our conclusions would remain unchanged if this finding is similar for outpatient surgeries in the VA.[34] Lastly, this study was confined to the VA, which may limit the generalizability outside of the veteran population.

There are many strengths to this research. In addition to chart reviewed information on AEs, we were able to use the VA EMR data to link demographics and procedure characteristics with outpatient pharmacy data for opioids that were filled by the patient, rather than just documented as prescribed. Additionally, our study is unique from previous studies describing opioid use in that it is looking at a wide range of outpatient surgical procedures and specific types of opioids that exclude cough medication. We contributed to the literature by failing to support the prevailing hypothesis that immediate postoperative opioid use for pain control poses a patient safety risk using chart review data from FY12-14 VA outpatient surgeries; replication of this study in a non-veteran population or in a newer sample with more complex outpatient surgeries and different opioid prescribing rules might yield different results.

Improving patient safety requires identifying factors related to AEs. Our findings suggest that future research or quality improvement work related to opioid use in VA outpatient surgery may not lead to significant reductions in 30-day postoperative AEs, although we did not measure the impact on long-term opioid-related AEs, such as addiction. In this dataset, we found that any significant relationship between opioid use and surgical AEs disappeared when the relationship was adjusted for other factors, particularly surgical complexity. To the extent that we are trying to improve surgical safety, we did not find that 48-h postoperative opioid use was a suitable target. Quality improvement efforts should look beyond postoperative opioid use as a possible risk factor for outpatient surgical AEs.

Funding

This research was supported by the VA Health Services Research and Development Service (HSR&D) Career Development Award [grant number CDA 13-270, P.I. Mull]; EAD was supported by the VA Office of Academic Affiliations and VA Quality Scholars Program. WBE was supposed by a Veterans' Integrated Service Network-1 Career Development Award.

Acknowledgment

Statements contained in this article reflect the views of the authors and do not represent the official positions of the US Department of Veterans Affairs or other author affiliate organizations.

Appendix A. Supplementary data

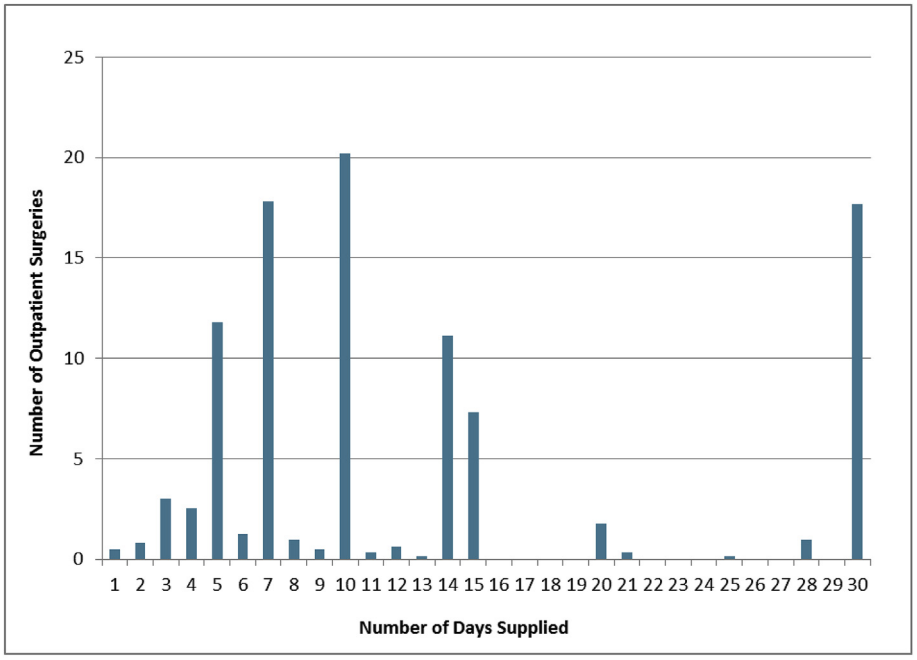
Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.12.068.

Appendix 1. Comparison of opioid history and exposure between population of FY12-14 outpatient surgeries and chart review sample

Variable	FY12-14 All Outpatient Surgeries, n (%)	FY12-14 Chart Review Sample of Outpatient Surgeries, n (%)
Total	744,355	1730
History of Opioids in prior 6 mo	105,144 (14%)	257 (15%)
Post-op Opioids within 48hrs	199,830 (27%)	628 (36%)
Drug Type*		
Hydrocodone/acetaminophen	98,383 (49%)	310 (49%)
Oxycodone/acetaminophen	52,239 (26%)	157 (25%)
Oxycodone	23,980 (12%)	85 (14%)
Codeine/acetaminophen	13,052 (7%)	37 (6%)
Tramadol	6953 (3%)	23 (4%)
Hydromorphone	2497 (1%)	7 (1%)
Morphine	2467 (1%)	7 (1%)
Codeine	255 (0%)	2 (0%)
Oxymorphone	2 (0%)	0 (0%)
Hydrocodone/ibuprofen	1 (0%)	0 (0%)
Tapentadol	1 (0%)	0 (0%)

*Percentages are out of surgeries with postoperative opioids.

Appendix 2. Number of days supplied of postoperative opioids within 48 h of outpatient surgery



Note: Represents 628, 36% of 1,730 chart reviewed outpatient surgeries performed in VA surgical facilities between FY12-14.

References

1. Shehab N, Lovegrove MC, Geller AI, Rose KO, Weidle NJ, Budnitz DS. US emergency department visits for outpatient adverse drug events, 2013-2014. *JAMA, J Am Med Assoc*. 2016. https://doi.org/10.1001/jama.2016.16201.
2. Shafi S, Collinsworth AW, Copeland LA, et al. Association of opioid-related adverse drug events with clinical and cost outcomes among surgical patients in a large integrated health care delivery system. *JAMA Surg*. 2018;153(8):757. https://doi.org/10.1001/jamasurg.2018.1039.
3. Oderda GM, Gan TJ, Johnson BH, Robinson SB. Effect of opioid-related adverse events on outcomes in selected surgical patients. *J Pain Palliat Care Pharmacother*. 2013;27(1):62–70. https://doi.org/10.3109/15360288.2012.751956.
4. Kessler ER, Shah MK, Gruschkus S, Raju A. Cost and quality implications of opioid-based postsurgical pain control using administrative claims data from a large health system: opioid-related adverse events and their impact on clinical and economic outcomes. *Pharmacother J Hum Pharmacol Drug Ther*. 2013;33(4):383–391. https://doi.org/10.1002/phar.1223.
5. 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(4):709–714. https://doi.org/10.1097/SLA.0000000000001993.
6. Thiels CA, Anderson SS, Ubl DS, et al. Wide variation and overprescription of opioids after elective surgery. *Ann Surg*. 2017;266(4):564–573. https://doi.org/10.1097/SLA.0000000000002365.
7. Mattila K, Toivonen J, Janhunen L, Rosenberg PH, Hynynen M. Postdischarge symptoms after ambulatory surgery: first-week incidence, intensity, and risk factors. *Anesth Analg*. 2005;101(6):1643–1650. https://doi.org/10.1213/01.ANE.0000184189.79572.28.
8. Wu CL, Berenholtz SM, Pronovost PJ, Fleisher LA. Systematic review and analysis of postdischarge symptoms after outpatient surgery. *Anesthesiology*. 2002;96(4):994–1003. https://doi.org/10.1097/00000542-200204000-00030.
9. Brummett CM, Waljee JF, Goesling J, et al. New persistent opioid use after minor and major surgical procedures in us adults. *JAMA Surg*. 2017;152(6). https://doi.org/10.1001/jamasurg.2017.0504. e170504.
10. Mull HJ, Rosen AK, Charns MP, Itani KMF, Rivard PE. Identifying risks and opportunities in outpatient surgical patient safety. *J Patient Saf*. 2017;4:1. https://doi.org/10.1097/PTS.0000000000000311.
11. Mull HJ, Itani KMF, Pizer SD, et al. Development of an adverse event surveillance model for outpatient surgery in the veterans health administration. *Health Serv Res*. August 2018. https://doi.org/10.1111/1475-6773.13037.
12. Noël PH, Copeland L. *Using VA Corporate Data Warehouse for Health Services Research*; 2012. http://www.hsrd.research.va.gov/for_researchers/cyber_seminars/archives/vdm-060412.pdf.
13. VA Office of Information and Technology. *VistAWeb Overview. Veterans Health Administration*; 2011. http://vista.med.va.gov/vistaweb/. Accessed May 3, 2011.
14. Centers for Medicare and Medicaid Services. *Physician Fee Schedule Relative Value Files*; 2013. http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeeSched/PFS-Relative-Value-Files.html#. Accessed March 19, 2015.
15. Healthcare Cost and Utilization Project (HCUP). *Surgery Flag Software. Agency for Healthcare Research and Quality*; 2015. https://www.hcup-us.ahrq.gov/toolssoftware/surgflags/surgeryflags.jsp. Accessed May 6, 2015.
16. Centers for Medicare and Medicaid Services. *Hospital Outpatient Prospective Payment, Regulation No. CMS-1601-FC*; 2014. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalOutpatientPPS/Hospital-Outpatient-Regulations-and-Notices-Items/CMS-1601-FC-.html?DLPage=1&DLSort=2&DLSortDir=descending. Accessed June 16, 2016.
17. VA National Surgery Office (NSO). Surgical Services Homepage. http://vaww.dushom.va.gov/surgery/index.asp. Accessed June 10, 2015.
18. Mull HJ, Itani KMF, Charns MP, et al. The nature and severity of adverse events in select outpatient surgical procedures in the veterans health administration. *Qual Manag Health Care*. 2018;27(3):136–144. https://doi.org/10.1097/QMH.0000000000000177.
19. Mull HJ, Borzecki AM, Hickson K, Itani KMF, Rosen AK. Development and testing of tools to detect ambulatory surgical adverse events. *J Patient Saf*. 2013;9(2):96–102. https://doi.org/10.1097/PTS.0b013e31827d1a88.
20. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care*. 1998;36(1):8–27. https://doi.org/10.1097/00005650-199801000-00004.
21. Fujii MH, Hodges AC, Russell RL, et al. Post-discharge opioid prescribing and use after common surgical procedure. *J Am Coll Surg*. 2018;226(6):1004–1012. https://doi.org/10.1016/j.jamcollsurg.2018.01.058.
22. Waljee JF, Zhong L, Hou H, Sears E, Brummett C, Chung KC. The use of opioid analgesics following common upper extremity surgical procedures: a national, population-based study. *Plast Reconstr Surg*. 2016;137(2):355e–364e. https://doi.org/10.1097/01.prs.0000475788.52446.7b.

23. Wunsch H, Wijeysundera DN, Passarella MA, Neuman MD. Opioids prescribed after low-risk surgical procedures in the United States, 2004-2012. *J Am Med Assoc*. 2016;315(15):1654. https://doi.org/10.1001/jama.2016.0130.
24. Mosher HJ, Krebs EE, Carrel M, Kaboli PJ, Weg MWV, Lund BC. Trends in prevalent and incident opioid receipt: an observational study in veterans health administration 2004–2012. *J Gen Intern Med*. 2015;30(5):597–604. https://doi.org/10.1007/s11606-014-3143-z.
25. Gellad WF, Good CB, Shulkin DJ. Addressing the opioid epidemic in the United States: lessons from the department of veterans Affairs. *JAMA Intern Med*. 2017;177(5):611. https://doi.org/10.1001/jamainternmed.2017.0147.
26. Morone NE, Weiner DK. Pain as the fifth vital sign: exposing the vital need for pain education. *Clin Therapeut*. 2013;35(11):1728–1732. https://doi.org/10.1016/j.clinthera.2013.10.001.
27. Gan TJ, Habib AS, Miller TE, White W, Apfelbaum JL. Incidence, patient satisfaction, and perceptions of post-surgical pain: results from a US national survey. *Curr Med Res Opin*. 2014;30(1):149–160. https://doi.org/10.1185/03007995.2013.860019.
28. Shanmugam VK, Fernandez SJ, Evans KK, et al. Postoperative wound dehiscence: predictors and associations HHS public access. *Wound Repair Regen*. 2015;23(2):184–190. https://doi.org/10.1111/wrr.12268.
29. Mathis MR, Naughton NN, Shanks AM, et al. Patient selection for day case-eligible surgery. *Anesthesiology*. 2013;119(6):1310–1321. https://doi.org/10.1097/ALN.0000000000000005.
30. Whippey A, Kostandoff G, Paul J, Ma J, Thabane L, Ma HK. Predictors of unanticipated admission following ambulatory surgery: a retrospective case-control study. *Can J Anesth*. 2013;60(7):675–683. https://doi.org/10.1007/s12630-013-9935-5.
31. De Oliveira GS, Holl JL, Lindquist LA, Hackett NJ, Kim JYS, McCarthy RJ. Older adults and unanticipated hospital admission within 30 Days of ambulatory surgery: an analysis of 53,667 ambulatory surgical procedures. *J Am Geriatr Soc*. 2015;63(8):1679–1685. https://doi.org/10.1111/jgs.13537.
32. Sarin P, Urman RD, Ohno-Machado L. An improved model for predicting postoperative nausea and vomiting in ambulatory surgery patients using physician-modifiable risk factors. *J Am Med Inf Assoc*. 2012. https://doi.org/10.1136/amiajnl-2012-000872.
33. Wheeler M, Oderda GM, Ashburn MA, Lipman AG. Adverse events associated with postoperative opioid analgesia: a systematic review. *J Pain*. 2002;3(3):159–180. https://doi.org/10.1054/jpai.2002.123652.
34. Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription opioid analgesics commonly unused after surgery. *JAMA Surg*. 2017;152(11):1066. https://doi.org/10.1001/jamasurg.2017.0831.