Surgery 166 (2019) 593–600

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Opioid prescribing in minimally injured trauma patients: Effect of a state prescribing limit

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ARTICLE INFO

Article history:
Accepted 1 May 2019
Available online 17 July 2019

ABSTRACT

Background: Opioid-prescribing practices for minimally injured trauma patients are unknown. We hypothesized that opioid-prescribing frequency and morphine-equivalent doses prescribed have decreased in recent years, specifically surrounding an acute prescribing limit implemented in August 2017 mandating opioid prescriptions not exceed 210 morphine-equivalent doses.

Methods: A single-center retrospective study was performed in the month of May during the years 2015 to 2018 on minimally injured trauma patients in a level I trauma center. Minimally injured trauma patients included patients discharged within 2 midnights of trauma evaluation without surgical intervention. Primary outcomes were discharge opioid-prescribing frequency and dosing in morphine-equivalent doses. Secondary outcomes were occurrence and timing of postdischarge follow-up.

Results: For 673 minimally injured trauma patients, opioid-prescribing frequency and morphine-equivalent doses prescribed decreased between 2015 and 2017 (49.3% to 31.5%, $P = .006$, mean 229 to 146 morphine-equivalent doses, $P = .007$). Decreases between 2017 and 2018 were not statistically significant. Acute prescribing limit compliance was 97% in 2018. After the acute prescribing limit was implemented, outpatient opioid prescribing did not increase and time to earliest follow-up did not decrease.

Conclusion: Opioid-prescribing frequency and morphine-equivalent doses prescribed to minimally injured trauma patients decreased dramatically between 2015 and 2018. These changes occurred primarily before the implementation of an acute prescribing limit; however, incremental improvement and high compliance since implementation are demonstrated. Patients did not have significantly earlier follow-up encounters for pain or additional opioid prescriptions. Prospective research on pain control for minimally injured trauma patients is needed.

Introduction

The opioid epidemic in the United States is a major public health crisis and was declared a national public health emergency in 2017. According to the Centers for Disease Control and Prevention, almost 218,000 individuals in the United States died from overdoses related to prescription opioids between 1999 and 2017; death rates in 2017 were 5 times higher than those in 1999.[1] Ohio has been particularly affected, experiencing a rate of 32.9 opioid-related overdose deaths per 100,000 people in 2016, far exceeding the national rate of 13.3 opioid-related deaths per 100,000 people and having tripled from its own 2010 rate of 10.0 deaths per 100,000 people.[2] In August 2017, the State Medical Board of Ohio

Samuel J. Zolin performed the initial conceptualization of the project, literature review, research design, regulatory compliance, data collection, statistical analysis, and manuscript composition. Brian T. Young assisted with research design and data collection. Alexis R. Harvey and Kevin T. Beel assisted with data collection. Vanessa P. Ho, Esther S. Tseng, Laura R. Brown, and Jeffrey A. Claridge assisted with research design and project oversight. All authors assisted with critical revision.

Presented at the Central Surgical Association 76th Annual Meeting, Palm Harbor, FL.

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https://doi.org/10.1016/j.surg.2019.05.040
0039-6060/

implemented an acute opioid prescribing limit (APL) restricting initial acute pain–related opioid prescriptions (OPs) for adults to a duration of 7 days, with an average of 30 morphine equivalent doses (MEDs) per day. This 210-MED limit is equal to 28 tablets of 5 mg oxycodone. Physicians may prescribe in excess of this limit if a specific reason is documented.[3] The effectiveness of the APL at reducing OPs is unknown.

Despite widespread interest and efforts to reduce OPs for surgical patients, less focus has been placed on optimal pain management practices for trauma patients. For example, although evidence-based guidelines have proliferated to inform opioid-prescribing practices in the setting of elective general surgery operations,[4,5] such guidelines are lacking for postinjury prescribing, particularly for patients with minor injuries not requiring surgical intervention and with short hospital encounters. On review of our trauma registry, approximately 60% of patients evaluated as trauma activations are discharged within 2 days of presentation, suggesting that many trauma patients have minor injuries. Clearly, pain management practices in this population merit consideration as trauma systems aim to balance pain control with prevention of opioid-related complications and long-term dependence.

To assess historical and current pain management practices for minimally injured trauma patients (MITPs) and to evaluate the effect of the APL on OPs in this population, we analyzed OPs for MITPs at our institution for the years 2015 to 2018. We hypothesized that significant reductions in OP frequency and MEDs prescribed would be seen during the study period, specifically surrounding the introduction of the APL.

Methods

We performed a single-center, retrospective, time-based cohort study of minimally injured adult patients who were seen in the month of May during the years 2015 to 2018. Our center is a mature, urban, academic level 1 trauma center that evaluates and treats approximately 5,000 trauma patients annually. The month of May was selected owing to higher trauma volume and the mixture of blunt and penetrating injury mechanisms, with potentially decreased impact of any "July effect"[6,7] or resident physician inexperience affecting prescribing behavior. The years 2015 to 2018 were chosen to identify OP trends that preceded the APL. No specific institutional protocol for opioid prescribing in this patient population existed during the study period.

We included patients who were evaluated for trauma and discharged to their baseline living situations in fewer than 2 midnights within the above time periods. A 2-midnight length of stay was used as a cutoff because this is consistent with observation status rather than inpatient admission status. Patients with observation stays and patients discharged from the emergency department (ED) were included. Patients who underwent repair of injuries, such as lacerations under local anesthetic, were included. Patients who underwent operative intervention requiring general anesthesia within 30 days of presentation were excluded. Patients who left against medical advice, who were pregnant, who were taken into police custody at discharge or within 30 days, or who had no documented injuries were excluded. Figure 1 demonstrates the inclusion and exclusion criteria that led to our cohort.

The primary outcomes were OP frequency at initial hospital discharge and quantity of MEDs prescribed. Secondary outcomes included OP frequency and MEDs prescribed at 30-day follow-up, prescription of nonopioid adjunct pain medications (APMs) at hospital discharge, and occurrence and timing of postdischarge follow-up.

Injuries were categorized as closed head injuries (including concussions, intracranial injuries, and skull fractures), oral and maxillofacial fractures (including facial fractures and dental trauma), rib and sternal fractures, trunk fractures (including vertebral, scapular, clavicular, and pelvic fractures), extremity fractures, lacerations, and soft-tissue injuries (including significant contusions, abrasions, sprains, and strains). Injury severity score is not reported because this is only calculated for patients who are admitted to the hospital, which comprised <15% of our study population.

The study was approved by the MetroHealth Institutional Review Board. Data were collected in a REDCap (Vanderbilt University, Nashville, TN, USA) database. Bivariate comparisons of continuous variables were performed using unequal variances ANOVA with post hoc least-square means tests and Tukey adjustments for multiple comparisons for more than 2 groups, Kruskal-Wallis rank sum tests for comparisons of numbers of distinct injuries, and Fisher exact tests for categorical variables with Bonferroni correction for multiple comparisons. Subgroup analysis utilized Welch's t test for comparisons of continuous variables between two groups. Significance was defined as $P < .05$. Statistics were performed using R, version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 673 patients were included in the study. Demographics and presentation characteristics of this cohort are shown in Table I. Information regarding injuries, hospital discharge, and discharge OPs is found in Table II. A higher proportion of patients were admitted for observation in 2015 compared with 2017 and 2018; however, the years of 2016 to 2018 were statistically similar. Overall rates of specific injury patterns were similar between years. The total number of injuries per patient was higher in 2018 compared with 2017 (adjusted $P = .02$), whereas other between-year comparisons were not significantly different.

Discharge OP frequency decreased during each successive year. Prescribed MEDs decreased substantially during the study period (Fig 2). Adjusted for multiple comparisons, discharge MEDs prescribed decreased between 2015 and 2017 ($P = .007$) and 2015 and 2018 ($P < .001$), but no other between-year comparisons met statistical significance. The proportion of patients receiving more than 210 MEDs between 2017 and 2018 when the APL was implemented decreased significantly before adjustment for multiple comparisons, losing statistical significance once adjusted ($P = .06$). No significant changes in frequency of APM prescription or total APMs given at hospital discharge were seen.

Subgroup analysis was performed to compare patients discharged from the ED with patients who were admitted for observation (Table III). Considering the entire study period, patients who were admitted to the hospital were significantly more likely to receive discharge OPs (odds ratio 16.3, 95% confidence interval 8.5–31.3, $P < .001$); the likelihood of patients who were admitted were prescribed MEDs was also significantly higher overall ($P < .001$). The majority of historical OPs exceeding 210 MEDs occurred in the group of patients admitted to the hospital. From 2015 to 2018, there have been decreases in OP frequency and MEDs given for both groups. For the subgroup of patients being discharged directly from the emergency department, MEDs prescribed decreased significantly during the study period; however, after adjustment for multiple comparisons, no between-year changes in MEDs met statistical significance. Given the small sample sizes for each year in the subgroup of admitted patients, between-year statistical comparisons were not performed.

Table IV demonstrates 30-day outcomes for MITPs. Follow-up rates were similar across years, with the majority consisting of clinic visits. Few patients had phone calls, ED visits, or readmissions

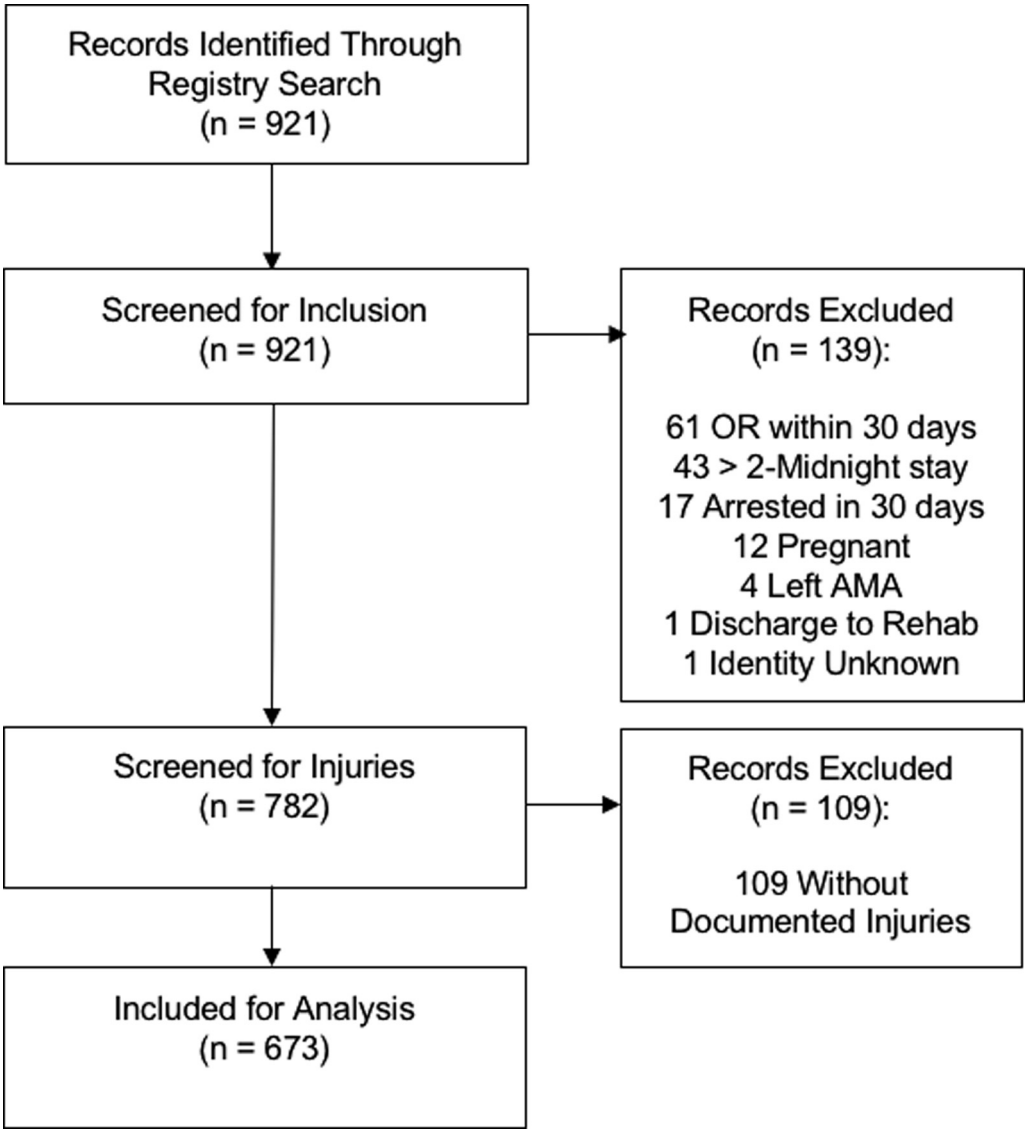

Fig 1. Flow diagram describing study inclusion. The flow diagram shows patients included for analysis and reasons for exclusions. *AMA*, against medical advice; *OR*, operating room.

for pain. Timing of earliest follow-up did not change during the study. Rates of postdischarge OPs paralleled discharge OPs, with decreasing frequency and MEDs prescribed over time, without significant difference between 2017 and 2018. There was a single instance in 2017 in which a patient who had been prescribed opioids presented to the ED and expired secondary to a presumed overdose. There were no other documented instances of serious opioid-related complications.

Discussion

For MITPs, defined as trauma patients with relatively short hospital stays and injuries not requiring operative intervention, discharge OP frequency and MEDs prescribed decreased substantially since 2015. These changes began before the Ohio APL and have not been associated with earlier follow-up or increased outpatient OPs. Our study does not demonstrate a statistically significant decrease in OP frequency or MEDs prescribed in this patient population that is directly attributable to the APL. Providers decreased OPs before initiation of the limit, which is likely related to increasing awareness about opioid addiction and risks. The primary effect related to the APL demonstrated in this study seems to be a standardized upper limit for MEDs prescribed, with high compliance.

As of November 2018, 32 states had enacted legislation limiting the duration of OPs to patients with acute pain or to patients new to opioids, with the majority of these limits implemented since 2017.[8,9] Characteristics of these limits vary significantly, with differences in duration and dosing of the initial OP, allowance of prescribing in excess of the limit at prescriber discretion, and whether medications other than opioids, such as benzodiazepines, are also restricted. The common rationale is that restricting the duration or MEDs of initial OPs, which are both associated with development of persistent opioid usage,[10,11] will reduce the likelihood of long-term opioid dependence and quantities of unused prescription opioids in circulation. Given that most states have implemented opioid-prescribing limits for acute pain, consideration of the effectiveness of such limits is warranted.

The APL effectively limited the maximum prescribed dose of opioids in MITPs. We noted 97% compliance with the 210-MED limit imposed by the APL in 2018. Before APL implementation, only 73% of initial OPs were $\leq$210 MEDs. Because prescribers seem to be

Table I
Demographics of MITPs

	Overall (n = 673)	2015 (n = 217)	2016 (n = 170)	2017 (n = 143)	2018 (n = 143)	*P* Value
Age (y)	42.7 (18.6)	41.3 (18.5)	44.6 (18.9)	42.0 (17.5)	43.3 (19.2)	.341
Sex						.277
Male	430 (63.9)	149 (68.7)	103 (60.6)	86 (60.1)	92 (64.3)	
Female	243 (36.1)	68 (31.3)	67 (39.4)	57 (39.9)	51 (35.7)	
Race						.338
White	380 (56.5)	104 (47.9)	104 (61.2)	79 (55.2)	93 (65.0)	
African American	237 (35.2)	94 (43.3)	53 (31.2)	51 (35.7)	39 (27.3)	
Unknown	37 (5.5)	12 (5.5)	9 (5.3)	8 (5.6)	8 (5.6)	
Hispanic	11 (1.6)	4 (1.8)	2 (1.2)	3 (2.1)	2 (1.4)	
Asian	4 (0.6)	1 (0.5)	1 (0.6)	1 (0.7)	1 (0.7)	
American Indian	3 (0.4)	1 (0.5)	1 (0.6)	1 (0.7)	0	
Pacific Islander	1 (0.1)	1 (0.5)	0	0	0	
Mechanism						
Blunt	589 (87.5)	183 (84.3)	154 (90.6)	131 (91.6)	121 (84.6)	.079
Penetrating	84 (12.5)	34 (15.7)	16 (9.4)	12 (8.4)	22 (15.4)	
Trauma Category						.079
1	56 (8.3)	27 (12.4)	9 (5.3)	8 (5.6)	12 (8.4)	
2	322 (47.8)	107 (49.3)	76 (44.7)	67 (46.9)	72 (50.3)	
3	295 (43.8)	83 (38.2)	85 (50.0)	68 (47.6)	59 (41.3)	
Transfer	186 (27.6)	56 (25.8)	48 (28.2)	46 (32.2)	36 (25.2)	.518

Data are counts (%) and means (standard deviation). Demographic information for MITPs who were found to have at least 1 injury at time of hospital evaluation. Fisher exact test was used for comparisons of categorical variables, and unequal variances ANOVA was used for comparisons of continuous variables. Trauma category ranges from 1 to 3, with 1 and 3 representing the highest and lowest acuity trauma activations, respectively.

Table II
Injuries and hospital discharge information for MITPs

	Overall (n = 673)	2015 (n = 217)	2016 (n = 170)	2017 (n = 143)	2018 (n = 143)	*P* Value
Injuries						
Closed head	196 (29.1)	74 (34.1)	40 (23.5)	37 (25.9)	45 (31.5)	.099
Laceration	232 (34.5)	68 (31.3)	65 (38.2)	44 (30.8)	55 (38.5)	.275
Soft tissue	390 (57.9)	120 (55.3)	106 (62.4)	80 (55.9)	84 (58.7)	.523
Intraabdominal	10 (1.5)	4 (1.8)	3 (1.8)	1 (0.7)	2 (1.4)	.867
Fractures						
OMFS	62 (9.2)	18 (8.3)	20 (11.8)	11 (7.7)	13 (9.1)	.602
Rib	45 (6.7)	16 (7.4)	13 (7.6)	7 (4.9)	9 (6.3)	.789
Trunk	61 (9.1)	19 (8.8)	9 (5.3)	17 (11.9)	16 (11.2)	.142
Extremity	43 (6.4)	14 (6.5)	13 (7.6)	6 (4.6)	10 (7.0)	.633
Distinct injuries	1 (1–2)	1 (1–2)	1 (1–2)	1 (1–2)	2 (1–2)	.023[*]
Hospital Admission	92 (13.7)	41 (18.9)	24 (14.1)	13 (9.1)	14 (9.8)	.027[†]
Discharge OPs	262 (38.9)	107 (49.3)	78 (45.9)	45 (31.5)	32 (22.4)	<.001[‡]
Discharge MEDs	187 (147)	229 (171)	183 (143)	146 (95)	117 (66)	<.001[§]
>210 MEDs	85 (32.4)	44 (41.1)	28 (35.9)	12 (26.7)	1 (3.1)	<.001[‖]
Discharge APM	321 (47.7)	98 (45.2)	76 (44.7)	77 (53.8)	70 (49.0)	.330
Total APMs given	0 (0–1)	0 (0–1)	0 (0–1)	1 (0–1)	0 (0–1)	.287

Data are counts (%) and means (standard deviation), except for the number of distinct injuries and total nonopioid APMs given, which are median (interquartile range). Discharge opioid-prescribing frequency is demonstrated for all patients, while discharge OP quantity in MEDs is presented only for patients who received OPs. Fisher exact test was used for comparisons of categorical variables, unequal variances ANOVA was used for comparisons of continuous variables, and Kruskal-Wallis rank sum test was used for comparisons of numbers of distinct injuries and total APMs.

[*] Statistically increased in 2018 compared with 2017. Other between-year comparisons were not significant.

[†] More patients were admitted for observation in 2015 compared with 2017 and 2018. Years 2016–2018 were statistically similar.

[‡] Years 2015–2016 were statistically similar, as were 2017 to 2018. All other interyear comparisons met adjusted statistical significance.

[§] Adjusted for multiple comparisons, MEDs were significantly different between 2015 and 2017 ($P = 0.007$) and 2015 and 2018 ($P < 0.001$). No other between-year comparisons met adjusted statistical significance.

[‖] Year 2018 was significantly decreased compared with years 2016 and 2018. No other between-year comparisons met adjusted statistical significance.

responsive to externally imposed prescribing limits, such limits may be a way of quickly accelerating changes and standardization in practice. However, the impact of the APL must also be considered in the context of the preexisting trend toward decreased MEDs given to MITPs. In 2017, for the 12 patients who received more than 210 MEDs at hospital discharge, the median quantity prescribed in excess of 210 MEDs was only 15 MEDs. This suggests that many patients received the equivalent of 30 tablets of 5 mg oxycodone before the APL, whereas they would have been limited to 28 tablets after the APL. Still, several patients in 2017 received over 300 MEDs at discharge. Based on a preexisting trend toward decreased OPs, we would conclude that the APL likely had a small impact on reducing OPs for most MITPs, with a potentially larger impact for a minority of MITPs.

Most of the changes in OPs that occurred between 2015 and 2018 cannot be attributed to the APL, suggesting many physicians independently decreased prescribing in response to increasing awareness about the opioid epidemic. Previous work has shown

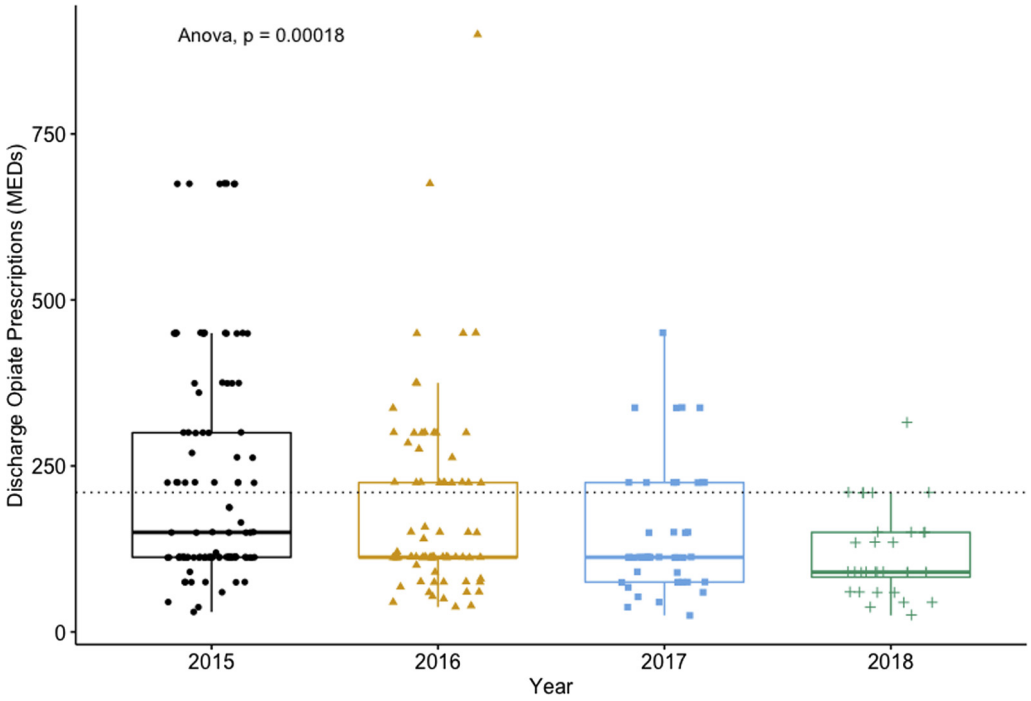

Fig 2. Discharge OPs in MEDs from 2015 to 2018. Quantities of discharge opioids prescribed in MEDs to trauma patients with minor injuries in the month of May during 2015 to 2018. Only patients receiving discharge opioids are shown (indicated by individual dots). The horizontal dotted line indicates the 210-MED limit imposed by the State Medical Board of Ohio in August 2017. Adjusted for multiple comparisons, OP MEDs were different between 2015 and 2017 ($P = 0.007$) and 2015 and 2018 ($P < 0.001$). No other between-year comparisons met adjusted statistical significance. There has been a substantial decrease in MEDs prescribed at discharge overall, with only one prescription in 2018 exceeding the 210-MED limit.

Table III
Subgroup analysis of discharge OP practices for MITPs based on ED disposition

	Overall	2015	2016	2017	2018	*P* Value
Discharge from ED (*n*)	581	176	146	130	129	
Discharge OPs	181 (31.2)	69 (39.2)	57 (39.0)	32 (24.6)	23 (17.8)	<.001*
Discharge MEDs	125 (87)	128 (62)	146 (128)	107 (50)	91 (48)	.009†
OPs > 210 MEDs	21 (11.6)	7 (10.1)	11 (19.3)	3 (9.4)	0	.092
Observation (*n*)	92	41	24	13	14	
Discharge OPs	81 (88.0)	38 (92.3)	21 (87.5)	13 (100)	9 (64.3)	—
Discharge MEDs	326 (158)	412 (152)	283 (137)	243 (110)	183 (60)	—
OPs > 210 MEDs	64 (86.5)	37 (97.4)	17 (81.0)	9 (69.2)	1 (11.1)	—

Data are counts (%) and means (standard deviation). The table represents a subgroup analysis demonstrating details of discharge opioid prescribing for MITPs based on ED disposition. Groups are presented as patients discharged from the ED and patients admitted for observation. Opioid-prescribing frequency (Discharge OP) is demonstrated for all patients, whereas OP quantity in MEDs (Discharge MEDs) is presented only for patients who received OPs. Fisher exact test was used for comparisons of categorical variables, unequal variances ANOVA was used for comparisons of continuous variables, and Kruskal-Wallis rank sum test was used for comparisons of numbers of distinct injuries and total APMs. Owing to small sample sizes for comparison, between-year statistical comparisons were not performed for patients in observation status.

* Significantly decreased in 2018 compared with 2015 and 2016. No other between-year comparisons met adjusted statistical significance.

† Although the overall change in MEDs was significant, owing to small sample size and adjustment for multiple comparisons, no between-year comparisons met adjusted statistical significance.

that opioid-prescribing practices in elective surgery are susceptible to a "spillover effect," wherein an evidence- or guideline-based change in one area of practice leads to changes in other areas of practice to which said evidence or guidelines do not apply directly.[12] Increasing awareness of the risks of opioids and strategies for reducing OP have likely influenced prescribing habits of both emergency medicine and surgery staff, even if such literature does not apply directly to MITPs. Although town halls on opioid prescribing and internal education were available at our institution during the study period, we know of no formal institutional prescribing guidelines that were implemented during this time.

Patients admitted for observation were significantly more likely to receive discharge OPs than patients discharged from the ED; despite comprising approximately 14% of the study population, admitted patients received >75% of OPs exceeding 210 MEDs. Given that this trend seemed to be relatively constant over time, we do not think that this is attributable to any single individual. It is possible that hospital admission served as a surrogate for injury severity, which we were otherwise unable to characterize for nonadmitted patients. However, our study population was limited to patients who were able to return to their baseline living situations within 2 midnights of presentation, suggesting that even the

Table IV
30-Day outcomes for MITPs

	Overall (n = 673)	2015 (n = 217)	2016 (n = 170)	2017 (n = 143)	2018 (n = 143)	*P* Value
Follow-up in 30 days	352 (52.3)	116 (53.5)	92 (54.1)	71 (49.7)	73 (51.0)	.843
Phone call for pain	42 (6.2)	19 (8.8)	12 (7.1)	4 (2.8)	7 (4.9)	.112
Emergency department return for pain	46 (6.8)	12 (5.5)	18 (10.6)	7 (4.9)	9 (6.3)	.186
Readmission for pain	5 (0.7)	4 (1.8)	1 (0.6)	0	0	.173
Clinic follow-up	292 (43.4)	98 (45.2)	71 (41.8)	63 (44.1)	60 (42.0)	.902
Days to earliest follow-up	8.9 (6.7)	9.8 (7.3)	8.2 (6.4)	9.1 (6.6)	8.1 (6.1)	.271
Postdischarge OPs	86 (12.8)	40 (18.4)	23 (13.5)	13 (9.1)	10 (7.0)	.006*
Total postdischarge MEDs	348 (325)	387 (364)	405 (351)	228 (179)	230 (186)	.079

Data are counts (%) and means (standard deviation). Fisher exact test was used for comparisons of categorical variables and unequal variances ANOVA was used for comparisons of continuous variables. Total postdischarge opioid prescribing in MEDs is presented only for patients who received OPs after discharge.
* The difference in postdischarge OP frequency between 2015 and 2018 met adjusted statistical significance, whereas other between-year comparisons did not.

most severely injured patients in our cohort still had relatively minimal extent of injury. Although it is possible that pain control led to both admission and discharge OPs, another interpretation is that once patients are admitted, providers may reflexively give OPs at discharge when more tailored approaches might be possible. Previous work has demonstrated that lowering or even removing default doses of opioids in electronic prescription systems is effective at reducing MEDs prescribed, suggesting that prescribers often act out of habit or according to external cues when writing OPs.[13,14] This is an area for additional study, and increased institutional protocolization to align inpatient and outpatient prescribing practices for MITPs, where appropriate, might be beneficial.

Common concerns regarding unintended consequences of decreased OPs and implementation of prescribing limits include the following: Patients might experience uncontrolled pain, might require increased outpatient follow-up, and physicians might routinely exceed formal prescribing limits if the option to do so exists. We have demonstrated high levels of compliance with the APL for MITPs and, importantly, have not demonstrated significantly increased rates of unplanned follow-up for pain, earlier follow-up, or increased outpatient OPs. These results suggest that the limit represented by the APL is appropriate for most MITPs and does not seem to place this patient population at significantly higher risk of having untreated pain. Additional prescriptions within 30 days for OPs and MEDs have decreased over time, concurrently with decreases in discharge OPs and MEDs. This would suggest that effective pain control can be achieved in most MITPs with limited or no opioids. More informed providers may be better at educating patients and setting realistic expectations about pain control. In addition, public awareness about opioid risks may also lead to fewer requests for prescriptions. Surprisingly, prescription of APMs has not changed over time. It is possible that patients are instructed to take APMs more commonly but do not receive prescriptions for over-the-counter medications, such as ibuprofen or acetaminophen.

MITPs comprise a substantial portion of our trauma population. Although we have identified at least 3 ongoing clinical trials of pain control for trauma patients, patients in observation status were excluded from all of them.[15–17] Lower research interest in MITPs is understandable—this population has heterogenous patterns of injury and may be viewed as having lower complexity of management, and follow-up rates may be marginal if these patients are judged not to have surgical needs. We would argue that these lower follow-up rates should prompt additional care when prescribing controlled substances because adverse events may not be apparent. We would also argue that prospective research in pain control, including patient-reported opioid consumption, is needed for this population so that standardized, evidence-based care can be provided and excessive OPs can be reduced.

As with any retrospective study, limitations exist. Although we can comment on provider behavior and rates of 30-day follow-up, we cannot comment on all patient-relevant outcomes, including MEDs consumed, opioids prescribed during the past 30 days, or illegal opioid use. Only half of our cohort had follow-up within 30 days, and postdischarge outcomes must be considered in this context. It is possible that patients followed-up in other health systems and received additional medications of which we are not aware. We did not collect the total number of follow-up visits and therefore cannot comment on whether patients had a greater number of follow-up visits in an era of more restrictive prescribing. However, patients did not follow-up earlier despite less frequent OPs and lower MEDs, and it is in this early time frame that we think an effect would be most likely to be seen if patients regularly experienced uncontrolled pain. Although it is encouraging that OP frequency has decreased over time, sample sizes for the comparison of OPs and MEDs were limited in 2017 and 2018. An additional limitation is that we only considered patients who met the criteria for MITPs, many of whom received no opioids. The limit may have had a greater effect for patients who underwent surgery or had longer hospital stays.

In conclusion, 9 months after its introduction, the APL seems to be effective at providing an upper limit for MEDs prescribed to MITPs, with high levels of prescriber compliance. However, the impact of the APL at decreasing OPs for this patient population was limited by substantial decreases in opioid-prescribing frequency and MEDs prescribed before its implementation. The majority of MITPs seem to have adequate pain control with $\leq$210 MEDs. Prospective research into pain control approaches for MITPs is needed to facilitate rational, evidence-based prescribing.

Funding/Support

No external funding was received for this work.

Conflict of interest/Disclosure

MetroHealth Medical Center currently has a grant from Cardinal Health to investigate the use of an educational video shown to trauma patients to reduce inpatient opioid administration. Vanessa P. Ho's spouse is a consultant for Medtronic, Atricure, and Zimmer Biomet. The authors report no proprietary or commercial interest in any product mentioned or concept discussed in this article.

References

1. Centers for Disease Control and Prevention. Opioid overdose: Prescription opioid data; 2018. https://www.cdc.gov/drugoverdose/data/prescribing.html. Accessed January 29, 2019.

2. National Institute on Drug Abuse, National Institutes of Health. Ohio opioid summary; 2018. https://www.drugabuse.gov/drugs-abuse/opioids/opioid-summaries-by-state/ohio-opioid-summary. Accessed January 28, 2019.
3. State Medical Board of Ohio. New limits on prescription opioids for acute pain: Phase 1 (effective August 31, 2017); 2017. https://www.med.ohio.gov/publications/recent-news/articleId/50/new-limits-on-prescription-opioids-for-acute-pain. Accessed January 29, 2019.
4. 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.
5. Opioid Prescribing Engagement Network. New opioid prescribing recommendations for 2019; 2019. http://michigan-open.org/new-opioid-prescribing-recommendations-for-2019/. Accessed March 23, 2019.
6. Claridge JA, Schulman AM, Sawyer RG, Ghezel-Ayagh A, Young JS. The "July phenomenon" and the care of the severely injured patient: Fact or fiction? *Surgery*. 2001;130:346–353.
7. Schroeppel TJ, Fischer PE, Magnotti LJ, Croce MA, Fabian TC. The "July phenomenon:" Is trauma the wxception? *J Am Coll Surg*. 2009;209:378–384.
8. Chua K-P, Brummett CM, Waljee JF. Opioid prescribing limits for acute pain: Potential problems with design and implementation. *JAMA*. 19;321:643-644.
9. Davis CS, Lieberman AJ, Hernandez-Delgado H, Suba C. Laws limiting the prescribing or dispensing of opioids for acute pain in the United States: A national systematic legal review. *Drug Alcohol Depend*. 2019;194:166–172.
10. Delgado MK, Huang Y, Meisel Z, et al. National variation in opioid prescribing and risk of prolonged use for opioid-naive patients treated in the emergency department for ankle sprains. *Ann Emerg Med*. 2018;72:389–400.e1.
11. Deyo RA, Hallvik SE, Hildebran C, et al. Association Between Initial Opioid Prescribing Patterns and Subsequent Long-Term Use Among Opioid-Naïve Patients: A Statewide Retrospective Cohort Study. *J Gen Intern Med*. 2017;32:21–27.
12. Howard R, Alameddine M, Klueh M, et al. Spillover Effect of Evidence-Based Postoperative Opioid Prescribing. *J Am Coll Surg*. 2018;227:374–381.
13. Chiu AS, Jean RA, Hoag JR, Freedman-Weiss M, Healy JM, Pei KY. Association of lowering default pill counts in electronic medical record systems with postoperative opioid prescribing. *JAMA Surgery*. 2018;153:1012–1019.
14. Santistevan J, Sharp B, Hamedani A, Fruhan S, Lee A, Patterson B. By default: The effect of prepopulated prescription quantities on opioid prescribing in the emergency department. *West J Emerg Med*. 2018;19:392–397.
15. Harvin JA, Green CE, Vincent LE, et al. Multi-modal Analgesic Strategies for Trauma (MAST): Protocol for a pragmatic randomized trial. *Trauma Surg Acute Care Open*. 2018;3, e000192.
16. Carver TW, Kugler NW. Ketamine infusion therapy for the management of acute pain in adult rib fracture patients; 2019. https://clinicaltrials.gov/ct2/show/NCT02432456. Clinicaltrials.gov identifier: NCT02432456. Accessed 29 January 2019.
17. Colloca, L. Relieving acute pain (RAP): A pilot study; 2019. https://clinicaltrials.gov/ct2/show/NCT03426137. Clinicaltrials.gov identifier: NCT03426137. Accessed 29 January 2019.

Discussion

Dr Jason Smith (Louisville, KY): I want to thank the Central for the opportunity to discuss this paper. I want to thank the authors for providing me the manuscript and for doing just a phenomenal amount of work on a topic that is underrepresented in surgical literature. One of the key factors bolstering the impact of this manuscript is the indepth analysis and the amount of data that were collated from a lot of disparate sources to try to get a more complete picture of what's going on with the minimally injured trauma patients.

The opioid epidemic is obviously not just impacting Ohio, where you are located. You can look through most of the Midwest and Southeast, if not the entire country, and find communities devastated by this epidemic. Kentucky, West Virginia, and many Appalachian states (including Ohio) have been particularly severely affected. With millions and millions of dollars spent on opiate-related overdose patients, opiate-related complications, opiate-related surgical complications, we as surgeons really have to start coming to the forefront and leading research into this and begin affecting change.

I have 3 questions for you. In your inclusion of minimally injured trauma patients, you really have (what I see as) 2 distinct groups of patients. The vast majority of these are what we call the treated-and-released patients. About 85% of your patients were seen in the emergency department, diagnosed with an injury, and sent home. But 15% of those patients were admitted to the hospital for some diagnosis. I would see those as relatively distinct individual populations. I think any patient that meets the threshold of hospital admission is really in a different group than the people we treat and release. How do you reconcile that? You do a good job of analyzing those groups in the paper, but I didn't see where you actually compared them. I would ask you, did you take a chance to look at that or would you consider looking at that in the future?

Secondly, in looking through the paper, I see 2 hypotheses here. The first, is prescribing limit an effective strategy? The second is, what are the things that could predict failure of the prescribing limit? I think you do a good job of addressing both of those premises, but the second is by far the more compelling question. If we can identify those patients where we can say, "You're at a higher risk for failure, so I want a quicker or more frequent follow-up" or perhaps, "I need to change what my prescribing limit is for you," that would be a phenomenal amount of research. I would love to hear your comments and what you think about that.

Finally, is the APL effective? You go through and show that you were already starting to decrease your prescribing limits in your own practice. Then, APL comes about and you demonstrated a reduction, but the state (Ohio) basically set a high limit and 97% of the patients were prescribed below that limit. What was the data that went into setting the initial APL? Was it simply a number of pills chosen and it made for good press that the lawmakers were passing this bill? Was there research behind this limit identifying the appropriate morphine equivalent doses you would need for pain control? Would you have gotten even better results if we would have gone at a more scientific progression of trying to understand how many morphine equivalents you need for X, Y, and Z condition, as opposed to setting an arbitrary limit of 28 5-mg oxycodone tablets and that's everyone's max limit? I think it raises an interesting question and welcome your comments. Thank you for your work; it is really very well done and provided a needed manuscript.

Dr Samuel Zolin: Thank you very much for the comments. Looking at comparisons between patients who were admitted and patients who were treated and released, patients who were admitted did tend to be a higher category of trauma activation. They did tend to be older by an average of 7 or 8 years. They were about 3 times more likely to have been transferred to our center. They were more likely to have rib, trunk, and facial fractures. I think probably there was an initial period where we treat their pain and monitor their response to that.

They had about an 88% rate of opioid prescribing compared to about 31.2% of treat-and-release patients and at higher median morphine equivalent doses. I tried to focus on this topic as a trauma systems question rather than comparing surgeon prescribing habits with emergency medicine physician prescribing habits. But the data would suggest that surgeons are responsible for a lot of this prescribing. As you alluded to, it's unclear whether this is a

significantly different population. It may be that once patients are admitted to the hospital, we don't do as good of a job as we could at individualizing our prescribing behavior for them.

I agree with you. I think the more important long-term question is trying to address what patients with what injuries need how much medication. That's a question I hope we can start to address in the trauma literature because, as you noted, it's highly relevant.

Is the limit effective at being a limit that people don't exceed? I would say yes. But is the limit effective at substantially reducing opioid prescribing for this population? I'd say, based on our results, probably not. The majority of patients receiving prescriptions in 2017 were already below the 210-MED limit. A fair number that were over 210 were just barely so, at 225, which is equivalent to 30 pills. So going from 30 to 28 I don't think is the type of impact that we're aiming to have. That being said, it might have a greater impact on other populations that typically get opioids at higher doses, patients undergoing open abdominal surgery, or major orthopedic surgery.

In terms of where these limits come from, many of the limits are based on data that shows that if you prescribe opioids beyond a limit, typically 225 MEDs, there is an increased rate of persistent opioid use. But, of course, the issue is that the limit is one size fits all. So, patients do need further tailoring of that based on individual and clinical characteristics. I think that's where establishing an evidence base for prescribing really comes into play.

I think what we didn't see is we didn't see that everyone was converging on 28 pills. We didn't see an increase in the lowest interquartile range in 2018. I think that is encouraging that people are still thinking about things and trying to reduce their prescribing. I just don't think that the limit is what drives most of that.

Dr Anthony Stallion (Bloomfield Hills, MI): I enjoyed your presentation and great work. I would challenge all of us and maybe a follow-up study for you. It is really controlled by the state. Having come from North Carolina to Michigan, both states have made it so onerous that if you prescribe essentially narcotics for anything over 3 days, you have to go online, fill out forms, check their prescription use, etc. So, essentially we've gone to, at least in the pediatric population, essentially prescribing no narcotics. We now rely on the nonsteroidals, alternating Tylenol and Motrin. I know of adult colleagues that have really cut back substantially.

I think one of the things that may be a challenge or a lead to a follow-up study for you is going with a minimum, as opposed to having a ceiling as high as 28. Try to go with something less and see what you can do. I think a lot of it has been around the education that we have for the families and setting expectations, for the individuals that you will be going home on Ibuprofen and Tylenol. It's interesting, most of the families don't want narcotics. Because of all the publicity, they don't want their family members on narcotics. So it hasn't been a tough sale.

Dr Samuel Zolin: I completely agree with you. I think we should try to address the problem by taking a minimalist approach to prescribing opioids and maximizing adjunct pain medications.

When we looked at adjunct medications, we didn't see a change in the overall number or prescribing rate over time in our study. I think that's certainly an area for improvement. I think, again, one of the challenges with this population is that we have relatively short encounters with them, so we may not have much of an opportunity to develop a relationship and to counsel patients on what to expect in terms of pain control.

Dr Gerald Larson (Louisville, KY): Thank you. This, of course, is a very timely topic. I have 2 questions. I may have missed it in your introduction, but it seems now that MED, morphine-equivalent dose, has become a standard term in this type of research and in this literature. Just to clarify it for me, how much is 30 MEDs per day, so if you're prescribing Percocet or if you're prescribing Demerol? How many Percocets is that per day?

Dr Samuel Zolin: The conversion is for every 5-mg dose of oxycodone or Percocet, it's 7.5 MEDs. So, 30 tablets of oxycodone would be equivalent to 225 MEDs.

Dr Gerald Larson (Louisville, KY): When this policy in Ohio was introduced, did it markedly change your prescription patterns that you used and your colleagues followed? Or, were you already at about that level or less?

Dr Samuel Zolin: I think for some operations we were already at fewer than that, at least in the setting of elective surgery. I think, for open abdominal surgery, that kind of has pushed the dial a little bit toward decreased prescribing. One feature of the acute prescribing limit is that if you document adequately, you can prescribe in excess of the limit. As we've shown, that, at least in this population, has not happened very often, but I do think it's something that needs to be tracked, and I do think we need to push ourselves to balance pain control with the avoidance of complications and dependence.