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Opioid E-Prescribing Trends at Discharge in a Large Pediatric Health System

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Abstract

Objective—Legitimate opioid prescriptions have been identified as a risk factor for opioid misuse in pediatric patients. In 2014, Pennsylvania legislation expanded a drug monitoring program (PDMP) to curb inappropriate controlled substance prescriptions. Our objective was to describe recent opioid prescribing trends at a large, pediatric health system situated in a region with one of the highest opioid-related death rates in the United States and examine the impact of the PDMP on prescribing trends.

Design: Quasi-experimental assessment of trends of opioid e-prescriptions, from 2012–2017. Multivariable Poisson segmented regression examined the effect of the PDMP. Period prevalence comparison of opioid e-prescriptions across the care continuum in 2016.

Results: There were 62,661 opioid e-prescriptions identified during the study period. Combination opioid/non-opioid prescriptions decreased, while oxycodone prescriptions increased. Seasonal variation was evident. Of 110,884 inpatient encounters, multivariable regression demonstrated lower odds of an opioid being prescribed at discharge per month of the study period

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($P<0.001$) and a significant interaction between passage of the PDMP legislation and time ($P=0.03$). Black patients had lower odds of receiving an opioid at discharge compared to white patients. Inpatients had significantly greater odds of receiving an opioid compared to emergency department (Prevalence Odds Ratio 7.1 [95% Confidence Interval 6.9–7.3]; $P<0.001$) and outpatient (398.9 [355.5–447.5]; $P<0.001$) encounters.

Conclusion: In a large pediatric health system, oxycodone has emerged as the most commonly prescribed opioid in recent years. Early evidence indicates that a state-run drug monitoring program is associated with reduced opioid prescribing. Additional study is necessary to examine the relationship between opioid prescriptions and race.

Keywords

Opioid; children; oxycodone; codeine; drug monitoring program

Introduction

The medical community's understanding of the safety profile and addictive potential of opioid medications has been rapidly evolving in recent years. The Centers for Disease Control and Prevention have labeled opioid misuse and related deaths an epidemic, with annual societal costs in the United States of approximately \$55.7 billion (2009 USD).^{1,2} Across all ages, the incidence of opioid-related deaths has quadrupled in the United States since 1999, with estimates indicating that 91 Americans die every day from opioid overdoses.³ This rise in mortality has paralleled an increase in opioid prescriptions, which have also quadrupled since 1999.³ Among both children and adolescents, a near two-fold increase in opioid overdoses was observed between 1997 and 2012.⁴ Rates of opioid overdoses tripled between 1999–2007 among adolescents ages 15 to 19, declined until 2014, then increased again in 2015.⁵ While illicit opioid prescriptions have contributed to this epidemic, legitimate opioid prescriptions have also been cited as a risk factor for subsequent opioid misuse.⁶ Adolescents who received a legitimate opioid prescription prior to graduation were 33% more likely to report opioid misuse following graduation between ages 19 and 23.⁷

Of all states affected by this national health crisis, Pennsylvania has experienced one of the highest overall death rates due to opioid overdoses and demonstrated one of the largest increases in death rate from 2015–2016 (44.1% increase).⁸ In recognition of this impending emergency, Pennsylvania passed Act 191 in October of 2014, expanding a state-wide drug monitoring program meant to aid both prescribers and law enforcement in detecting misuse of controlled substances, including opioids. Prescribers have been required to register for the Pennsylvania Prescription Drug Monitoring Program (PDMP) since January 1, 2017 and are mandated to query a state database before writing a new opioid prescription for a patient.⁹

Opioid prescribing patterns for children have been described in the ambulatory surgery and emergency department (ED) settings but less is known about opioid prescriptions for hospitalized children upon discharge.^{10–13} Additionally, evidence to date has been mixed with regards to the effectiveness of state-run drug monitoring programs and the influence of such programs on discharge opioid prescriptions is unknown.¹⁴ Understanding current

opioid prescribing patterns in children at our institution, which serves a region heavily affected by the opioid epidemic, is an essential step towards characterizing the iatrogenic contribution to childhood opioid misuse, dependence and adverse events. Our aims in this study were to describe opioid prescribing practices at our institution at the time of discharge, to assess whether a change in prescription volume was evident following implementation of the PDMP, and to perform an assessment of period prescription prevalence of opioid prescriptions across the continuum of care of the study system.

Methods

Study Design and Hypothesis

This is a quasi-experimental, time-series analysis examining opioid electronic (e-) prescriptions in a large pediatric health system. Approval for this project was granted by the institution's Quality Improvement (QI) Project Review Committee, an institutional oversight body responsible for ensuring that QI projects meet sufficient ethical standards. Data retrieval from the electronic medical record for research purposes was granted by the Institutional Review Board. The study center cares for admissions across all medical and surgical specialties and subspecialties and serves a principal region of approximately 5 million people that includes Western Pennsylvania, as well as segments of Ohio and West Virginia. Opioids are prescribed by trainees (residents and fellows), clinical extenders (nurse practitioners and physician assistants) and attending physicians across the continuum of care. Inpatient opioids are administered, titrated and weaned per the discretion of the ordering clinician. We hypothesized that the number of opioid prescriptions would decrease following implementation of the PDMP prescriber mandate on January 1, 2017.

Policy Changes

The PDMP was originally established in 1972 and provided a database of Schedule II substance use accessible by law enforcement.¹⁵ In October 2014, Act 191, also known as "Achieving Better Care by Monitoring All Prescriptions Program (ABC-MAP)" was passed by state legislators.¹⁶ This expansion captured Schedule II-V controlled substances in a state-run database accessible to prescribers and pharmacies. Beginning January 1, 2017 all licensed prescribers in Pennsylvania were mandated to register with the PDMP and query the database prior to prescribing a controlled substance, with the aim of improving recognition of patients abusing or diverting these medications.⁹

Data Retrieval

In January 2012, e-prescribing was implemented within the computerized physician order entry system, allowing clinicians to write prescriptions for medications at the time of discharge using computerized order entry. For the present study, an enterprise data warehouse was interrogated using the business intelligence platform SAP Business Objects (SAP, Walldorf, Germany) to identify all patients from January 2012 through December 2017 who had an encounter at our institution and were discharged with an opioid prescription. This included outpatient specialty clinics, urgent care, ambulatory surgery visits, emergency department visits, and inpatients. Populations were stratified according to whether the encounter was associated with a discharge summary (generally all inpatient

admissions at our institution exceeding 24 hours), whether the encounter was designated an emergency department (ED) visit (evaluated by emergency medicine with a length of stay less than 24 hours and no discharge summary) or all other visits, which included urgent care, specialty clinic and ambulatory surgery encounters. Encounters without an opioid prescription and associated with a discharge summary were identified for all study years and both emergency department and outpatient primary care encounters not receiving an opioid prescription were identified for 2016.

Demographic data extracted included patient age, race and sex. Clinical data included the discharging medical service, whether the patient had an intensive care unit (ICU) stay, final diagnoses and the medication prescribed. There were no institutional guidelines for opioid administration during the study period apart from the implementation of PDMP requirements. Discharging clinical services were grouped according to medical or surgical service. All non-intravenous formulations of opioids were searched, including medications consisting of a narcotic/non-narcotic combination. This included generic and brand names. All opioid e-prescriptions for all encounters in the study center's affiliated primary care clinics for the year 2016 were also examined to provide a period prescription prevalence comparison between identified inpatients, ED encounters and primary care encounters.

To examine whether a difference in pain outcomes was apparent before versus after the passage and implementation of the PDMP, we examined first and last pain scores during hospitalization in the first and last years of the study period, 2012 and 2017. Nursing staff at the study institution employ several different pain assessment tools, depending on patient age, development and the context of care (intensive care versus acute care). Scores for the three most commonly used tools were analyzed. These tools were a combined Numeric Visual Analog Scale, the Face, Legs, Activity, Cry and Consolability (FLACC) Scale, and the Wong-Baker Faces Pain Rating Scale.^{17–19} Encounters in which the first and last recorded pain score were assessed with the same scale were identified and the differences between first and last score calculated.

Statistical Analysis

The identified cohort was described for all years and for each study year. Plots were constructed with monthly data. Less than 1% of continuous variables were missing and were imputed with the median value. We specified a multivariate segmented Poisson regression in which the units of observation were individuals across per month of the study. The main outcome was prescription of an opioid to an inpatient at the time of discharge (those patients with a discharge summary). Age, gender, race, discharging medical service (medical versus surgical), and a final diagnosis of cancer or sickle cell disease based on International Classification of Diseases version 9 or 10 codes were included as covariates based on existing literature and clinical relevance.¹⁰ Two intervention variables were modeled, the first dichotomized the cohort before and after October 2014, when Act 191 of the PDMP was passed, and the second dichotomized before and after January 2017 to examine the effect of PDMP mandate for clinicians to query the state database prior to every opioid prescription. Likelihood ratio tests compared levels of categorical variables in the multivariable model. Unadjusted proportion data were analyzed using the chi-squared test,

as well as logistic regression, and are reported as odds ratio with 95% confidence interval (OR [95% CI]). Robust standard errors clustered by patient were used with logistic regression to account for patients with recurrent admissions. Results are listed as median (interquartile range) or average ($\pm$ standard deviation) for parametric and nonparametric continuous variables, respectively, and proportion (%) for categorical data. Mean differences in the first and last pain scores were compared between 2012 and 2017 using two-sample *t* tests, after first assessing variances with an *F* test. Significance was set at an alpha of 0.05 and all reported *P* values are two-tailed. All analyses were conducted using *R* (www.r-project.org) and R Studio Inc., Boston, MA, USA).

Results

There were a total of 62,661 e-prescribed opioids for 47,039 unique patients during the study period (Table 1). Age, sex and race were consistent for all patients across study years. Among those with an identified discharge summary, there were 66,134 unique patients responsible for 110,885 total encounters and 19,184 e-prescriptions for opioids. E-prescriptions for combination opioids decreased during the study period while oxycodone e-prescriptions increased between 2012 and 2017 for identified inpatient and ED encounters. Multivariable regression examining all opioid e-prescriptions demonstrated significantly lower odds of receiving an opioid e-prescription at discharge over time (OR 0.996 [0.994–0.998] per month; $P<0.001$) after adjusting for covariates (Table 2). Patient characteristics associated with greater observed odds of receiving an opioid at discharge were older age, white race, surgical discharging service, a final diagnosis of sickle cell disease, and a final diagnosis of cancer. Seasonal variation was evident, with the proportion of discharged patients receiving an opioid significantly greater in the Summer compared to other seasons (Figure 1). A significant reduction in the odds of receiving an opioid over time was evident following passage of the PDMP.

Focusing on only inpatient and ED encounters for the study period identified 482,455 total encounters, of which 371,570 were identified ED encounters with 10,970 opioid e-prescriptions and 110,885 were identified inpatients with 19,184 opioid e-prescriptions. For the study-center cohort, identified inpatient encounters were significantly more likely to receive an opioid e-prescription at discharge as compared to ED encounters (Prevalence OR 6.9 [6.7–7.05]; $P<0.001$ by both logistic regression with robust standard errors clustered by patient and chi-squared test). In 2016 there were 677,630 encounters identified in the study-center's network of primary care clinics, with 377 e-prescribed opioids and 62,346 identified ED encounters. Table 3 displays the odds of an encounter receiving an e-prescribed opioid by setting in 2016. The mean difference between first and last pain score was not significantly different between 2012 and 2017 for FLACC scores or Wong-Baker Faces Pain Rating Scale scores (both $P>0.05$). The mean difference between first and last Numeric Visual Analog Scale score was -1.1 in 2012 and -0.27 in 2017, a significant difference ($P<0.001$) mediated by a both significantly different lower first score (3.3 vs. 2.8; $P<0.001$) and higher last score (2.2 vs. 2.5; $P<0.001$).

Discussion

In this study, we describe trends in e-prescriptions of opioids in a large pediatric health system, which serves a region that is among the most heavily affected by the nationwide opioid epidemic. Several significant observations were apparent in these electronic record data. In this cohort, we observed a dramatic decline in combination opioid prescriptions, such as acetaminophen-hydrocodone, with a corresponding rise in prescriptions for oxycodone. Seasonality in opioid prescriptions was apparent, with a higher prevalence of prescriptions in the Summer months as opposed to other seasons. Patients of black race were observed to be significantly less likely to receive an opioid prescription compared to patients of white race after adjusting for covariates. The odds of an inpatient receiving an opioid prescription at discharge decreased with time during the study period and a significant decline in this trend was apparent after passage of the PDMP legislation. Identified inpatient encounters were significantly and substantially more likely to receive an opioid e-prescription compared to identified emergency department encounters and outpatient primary care encounters. These findings are an important step towards characterizing the iatrogenic contribution to childhood opioid exposure and, by association, potential misuse. Additionally, there is early evidence that a state-governed controlled substance monitoring program is influencing prescribing volume of opioids in the study center.

Recent years have brought additional clarity to the risks associated with opioids in pediatric patients. The contribution of legitimate opioid prescriptions to adolescents and future misuse has become evident.⁷ Children receiving opioids to facilitate invasive life support interventions during hospitalization, such as mechanical ventilation, may require an ongoing opioid taper at the time of discharge to mitigate withdrawal effects related to iatrogenic opioid dependency.^{20,21} Children's hospitals are also commonly regional referral centers for surgical services, as well as a range of childhood diseases associated with severe pain, such as cancer and sickle cell disease. Regimented inpatient opioid weaning strategies may reduce dependency at the time of discharge, though a recent systemic review and meta-analysis did not identify sufficient evidence to recommend a particular weaning strategy.^{22,23} We did not examine the volume of opioid tapers in the present study, as there is no consistent method for ordering a taper, and therefore distinguishing these prescriptions, within our e-prescribing system.

Seasonal variation has been demonstrated for a number of pediatric diseases and presenting complaints, including asthma, diarrhea, bronchiolitis, and abdominal pain.^{24,25} To the best of our knowledge, this is the first study to demonstrate seasonal variation in opioid prescriptions for children. This pattern is likely explained, in part, by expected seasonality of trauma and elective surgery admissions in children. While we attempted to control for this factor by including the discharging service and dichotomizing this covariate by medical or surgical specialties, this approach would not have captured children admitted for elective surgery who then transferred to a medical service for ongoing care during hospitalization. The overall decline in opioid prescriptions observed during the study period is consistent with national trends in declining opioid prescriptions since 2010, though recent volumes of prescribed opioids are still relatively greater than in 1999 in the United States.²⁶ Differences in the first and last Numeric Visual Analog Scale scores between the beginning and end of

the study period indicate the need to further study patient pain outcomes in the context of declining opioid utilization.

Several patient-level traits were significantly associated with the odds of receiving an opioid prescription at time of discharge in multivariable analysis. Older age, female sex and white race were associated with increased odds of receiving an opioid after adjusting for sickle cell disease and cancer, with the median age ranging from 9 to 11 years across all years of the study period. This likely reflects age-associated disease patterns and elective surgeries, developmental capabilities for articulating symptoms of pain, and clinician comfort regarding the likelihood of adverse effects of opioids in younger versus older children. That females have increased odds of receiving an opioid at discharge is compatible with evidence on sex differences in pain thresholds in children, in which male and female pain tolerances begin to diverge with the onset of puberty.²⁷ The apparent difference in the odds of receiving an opioid between black and white race in the present study aligns with previous evidence of opioid prescribing patterns according to race. Differences in opioid prescriptions by race have been described nationally for adults in several studies.^{28–30} Goyal et al. reported black children evaluated for appendicitis in United States emergency departments were less likely to receive any analgesia, including opioids, compared to white children.³¹ The opioid epidemic has been also been reported to disproportionately affect white patients and regions of the country with a lower mix of diversity, such as West Virginia.³² The findings of the present study warrant further investigation of the association between race and opioid utilization in pediatric patients.

Passage of PDMP legislation paralleled increasing attention in the lay media regarding the emergence of the national opioid epidemic. We modeled legislation passage and implementation of mandated querying of a state-run database separately, hypothesizing that the latter would have a more pronounced impact on prescribing patterns given the associated time requirements for clinicians. Contrary to our expectations, a significant decline in the odds of opioid prescriptions over time was observed post-legislation and no significant changes were observed following implementation of the clinician controlled substance database. This may be due to the relatively short observation period of 1-year post-mandate in the present data. In a recent scoping review, Finley et al. outline recommendations for PDMP study that include focusing on the incidence of opioid misuse in relation to program implementation.¹⁴ A separate, recent review noted existing studies provide low-strength evidence that PDMP's reduce fatal drug overdoses.³³ Misuse was not identifiable in the present data and follow-up analyses will be useful for drawing more definitive conclusions regarding the impact of the PDMP policy in Pennsylvania.

The federal rescheduling of hydrocodone combination analgesic products from schedule III to schedule II occurred concomitantly with passage of the PDMP in Pennsylvania and was associated with a substantial decrease nationally in prescriptions for hydrocodone combinations.³⁴ Hydrocodone combinations represented a relatively small proportion of prescriptions in all years of the present study, indicating that the rescheduling did not contribute substantially to trends observed in our system. In 2013, the United States Food and Drug Administration (FDA) issued a box warning for codeine and tramadol when it became apparent that children possessing additional functional copies of the gene *CYP2D6*

were prone to potentially catastrophic respiratory depression due to ultra-rapid metabolism of codeine to morphine.³⁵ In the years since the box warning, use of codeine-combination drugs at our institution has fallen more than 37-fold. While this trend likely reflects clinician mindfulness of the potentially detrimental impact of codeine, as well as the removal of codeine from the formulary in the Autumn of 2016, an unintended consequence appears to have been increased preference for oxycodone, which was not identified in the 2013 box warning. Subsequent guidelines have identified similar risk for certain *CYP2D6* genotypes and oxycodone use.³⁶ Point-of-care genotyping may eventually aid clinicians in optimizing individual patient safety when prescribing high-risk medications such as opioids.³⁷

Strengths of this study include the granular, patient-level data harbored by the electronic health record, the large cohort, and the inclusion of multiple settings of a large health system. To the best of our knowledge, this is the first study to examine trends in opioid prescriptions for children at discharge. The use of segmented regression modeling time and the PDMP intervention as continuous and dichotomous variables, respectively, identified trends that might otherwise not be apparent with simple before-after analyses. Greater odds of opioid prescriptions immediately following each PDMP intervention indicates a “level” change that might have otherwise obscured the observed change in trend evidence by the model interaction terms.³⁸ The significant relationship between legislation passage and time indicates a change in trend independent of other included factors, such as season.

This study is limited by its single-center design. It is possible that some prescriptions were not e-prescribed and therefore not included in the present study, though conventional practice in the study health system during the study period was to use electronic ordering, making it unlikely that these unrecognized prescriptions would influence the present results. Focusing on a single system’s data allowed direct comparison of opioid prescribing across the inpatient, ED and outpatient settings; however, significant variability in opioid prescribing patterns has been noted between different health systems. Botzenhardt et al. described inpatient use of analgesics among hospitalized children across five international centers in Europe and Asia and noted that opioids varied from 0% to 17.2% of all prescribed analgesics.³⁹ A recent examination of United States health claims data demonstrated substantial variability in opioid prescribing patterns for children following ambulatory surgery.⁴⁰

In conclusion, this study of opioid e-prescriptions in a large children’s health system identified a decline in combination-narcotic drugs over time, an increase in oxycodone prescribing, differences in opioid prescriptions by age, sex and race, and early indications that the PDMP is influencing opioid prescribing volume. That children being discharged from an inpatient stay face substantially higher odds of receiving an opioid prescription compared to other settings provides impetus for developing strategies to reduce inpatient opioid utilization and resultant dependence. A multi-center pharmacoepidemiologic study of pediatric opioid prescribing practices at time of inpatient discharge in the United States is necessary to determine the magnitude of variation in national practice.

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Figure 1. Percentage of opioid prescriptions per month from 2012 to 2017. Red dotted line indicates October 2014, when the Pennsylvania Drug Monitoring Program legislation was passed. The shaded area indicates the period from January 2017 onward when prescribers were mandated to query the state database prior to prescribing a controlled substance.

Table 1.

Characteristics of cohort and volume of opioid prescriptions by year of study period

	2012	2013	2014	2015	2016	2017	All Years
n (%) ^a or N	12,831 (20.5)	10,500 (16.8)	10,030 (16.0)	10,784 (17.2)	10,439 (16.7)	8,077 (12.9)	62,661
Unique Patients	11,112	8,835	8,371	9,000	8,978	7,157	47,039
Characteristic n (%) or median (IQR)							
Age (years)	9.0 (4.0, 14.0)	11.0 (5.0, 15.0)	11.0 (5.0, 15.0)	11.0 (6.0, 15.0)	10.0 (5.0, 15.0)	11.0 (6.0, 15.0)	10.0 (5.0, 15.0)
Sex							
Male	7,360 (56.6)	5,900 (56.2)	5,593 (55.8)	5,937 (55.1)	5,754 (55.1)	4,337 (53.7)	34,781 (55.5)
Female	5,570 (43.4)	4,600 (43.8)	4,437 (44.2)	4,847 (44.9)	4,685 (44.9)	3,740 (46.3)	27,879 (44.5)
Race							
White	10,287 (80.2)	8,213 (78.2)	7,914 (78.9)	8,489 (78.7)	8,070 (77.3)	6,422 (79.5)	49,395 (78.8)
Black	2,042 (15.9)	1,854 (17.7)	1,712 (17.1)	1,754 (16.3)	1,659 (15.9)	1,125 (13.9)	10,146 (16.2)
Other	502 (3.9)	433 (4.1)	404 (4.0)	541 (5.0)	710 (6.8)	530 (6.6)	3,120 (5.0)
Discharge Summary	3,337 (26.0)	3,181 (30.3)	3,071 (30.6)	3,602 (33.4)	3,195 (30.6)	2,798 (34.6)	19,184 (30.6)
LOS, days	2.9 (1.5, 5.2)	3.1 (1.6, 5.3)	2.7 (1.4, 5.1)	2.5 (1.3, 4.8)	2.3 (1.2, 4.1)	2.1 (1.2, 4.0)	2.6 (1.4, 4.9)
ICU Admission	595 (0.9)	577 (0.9)	426 (0.7)	637 (1.0)	485 (0.8)	411 (0.7)	3,131 (5.0)
Surgical service	2,440 (73.1)	2,363 (74.3)	2,278 (74.2)	2,765 (76.8)	2,431 (76.1)	2,268 (81.1)	14,545 (75.8)
ED Encounter	2,244 (17.5)	2,126 (20.2)	2,078 (20.7)	1,809 (16.8)	1,804 (17.3)	909 (11.3)	10,970 (17.5)
Opioid Rx Type							
Non-combination	3,201 (24.9)	3,904 (37.2)	5,908 (58.9)	9,543 (88.5)	9,562 (91.6)	7,473 (92.5)	39,591 (63.2)
Oxycodone	2,750 (21.4)	3,376 (32.1)	5,246 (52.5)	8,913 (82.7)	9,105 (87.2)	7,178 (88.9)	36,586 (58.4)
Methadone	202 (1.6)	239 (2.3)	292 (2.9)	281 (2.6)	183 (1.8)	139 (1.7)	1,336 (2.1)
Tramadol	69 (0.5)	98 (0.9)	176 (1.8)	138 (1.3)	85 (0.8)	47 (0.6)	613 (1.0)
Hydromorphone	64 (0.5)	72 (0.7)	49 (0.5)	92 (0.9)	91 (0.9)	36 (0.5)	404 (0.6)
Morphine	49 (0.4)	57 (0.5)	73 (0.7)	56 (0.5)	63 (0.6)	63 (0.8)	361 (0.6)
Other	67 (0.5)	62 (0.2)	72 (0.7)	63 (0.6)	35 (0.3)	10 (0.1)	306 (0.5)
Combinations	9630 (75.1)	6,596 (62.8)	4,122 (41.1)	1,241 (11.5)	877 (8.4)	604 (7.5)	23,070 (36.8)
Acetaminophen-oxycodone	6,313 (49.2)	5,198 (49.5)	3,275 (32.7)	719 (6.7)	512 (4.9)	384 (4.8)	16,401 (26.2)
Acetaminophen-codeine	2,886 (22.5)	743 (7.1)	415 (4.1)	308 (2.9)	148 (1.4)	46 (0.6)	4,546 (7.3)
Acetaminophen-hydrocodone	428 (3.3)	653 (6.2)	430 (4.3)	212 (1.9)	214 (2.1)	171 (2.1)	2,108 (3.4)

	2012	2013	2014	2015	2016	2017	All Years
Other	3 (0)	2 (0)	2 (0)	2 (0)	3 (0)	3 (0)	15 (0)

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Table 2.

Multivariable time series model for odds of inpatients receiving an opioid prescription at time of discharge

Characteristic	Odds Ratio [95% Confidence Interval]	P^*	$P^\dagger$
Age (years)	1.065 [1.051–1.079]	<0.001	-
Male	0.963 [0.933–0.994]	0.02	-
Race			
Black	0.867 [0.827–0.908]	<0.001	<0.001
Other	0.954 [0.889–1.024]	0.19	
White	Reference	-	
Service			
Surgical	10.217 [9.798–10.654]	<0.001	<0.001
Unknown	0.882 [0.331–2.353]	0.80	
Medical	Reference	-	
Sickle Cell Disease	8.160 [7.121–9.352]	<0.001	-
Cancer	1.579 [1.447–1.722]	<0.001	-
Seasonality			
Summer	1.048 [1.007–1.091]	0.02	0.004
Fall	1.019 [0.977–1.063]	0.38	
Winter	0.966 [0.927–1.006]	0.1	
Spring	Reference	-	
Intervention			
Legislation	1.325 [1.133–1.550]	<0.001	<0.001
Prescription Database Mandate	2.174 [0.995–4.751]	0.05	
Time	0.996 [0.994–0.998]	<0.001	-
Interaction			
Time *legislation	0.996 [0.992–1.000]	0.038	0.03
Time *intervention	0.988 [0.977, 1.000]	0.06	

* Represents P value for individual test † P value for likelihood ratio test across all levels of a category

Table 3.

Odds of receiving an opioid e-prescription by health system setting in 2016.

	Prevalence Odds Ratio [95% Confidence Interval]	<i>P</i>
Discharging inpatient: ED	6.4 [6.0–6.8]	<0.001
Discharging inpatient: outpatient primary care	398.9 [355.5–447.5]	<0.001
ED: outpatient primary care	62.1 [55.2–69.9]	<0.001