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Authors

Elder, Joshua W

Gu, Zheng

Kim, Jeehyoung

et al.

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Assessing Local California Trends in Emergency Physician Opioid Prescriptions from 2012 to 2020: experiences in a large academic health system

Joshua Elder, MD, MPH, MHS^a, Zheng Gu, MS^b, Jeehyoung Kim, MD^c, Aimee Moulin, MD^a, Heejung Bang, PhD^{b,d}, Aman Parikh, MD^a, Larissa May, MD, MPH, MSHS^a

^a-Assistant Professor (JE) & Professor (AM, AP, LM), Department of Emergency Medicine, University of California, Davis, School of Medicine, Sacramento, CA

^b-Analytic Programmer, Department of Research & Evaluation, Southern California Permanente Medical Group, Kaiser Permanente Research, Pasadena, CA

^c-Attending Surgeon, Department of Orthopedic Surgery, Seoul Sacred Heart General Hospital, Seoul, Korea

^d-Professor, Division of Biostatistics, Department of Public Health Sciences, University of California, Davis, CA

Abstract

Objectives: There has been increased focus nationally on limiting opioid prescriptions. National data demonstrates a decrease in annual opioid prescriptions among emergency medicine physicians. We analyzed data from 2012 to 2020 from a large academic health system in California to understand trends in opioid prescribing patterns for emergency department (ED) discharged patients and assessed the potential impact of two initiatives at limiting local opioid prescriptions.

Methods: In 2012-2020, monthly ED visit data was used to evaluate the total number of outpatient opioid prescriptions and percent of ED visits with opioid prescriptions (as primary outcomes). Descriptive statistics, graphic representation, and segmented regression with interrupted times series were used based on two prespecified time points associated with intensive local initiatives directed at limiting opioid prescribing—1) comprehensive emergency medicine resident education and 2) electronic health record (EHR)-based intervention.

Results: Between March 2012 and July 2020, a total of 41,491 ED discharged patients received an opioid prescription. The three most commonly prescribed drugs were hydrocodone (84.1%), oxycodone (10.8%), and codeine (2.8%). After implementing comprehensive emergency medicine resident education, the total number of opioid prescriptions, the percentage of opioid prescriptions

Corresponding author: Joshua Elder, MD., Address: Department of Emergency Medicine, University of California, Davis, School of Medicine, 2315 Stockton Blvd., Sacramento, CA 95817. jelder@ucdavis.edu; Phone: 916-500-8511; Fax: 530-752-3239.
Contributors

LM contributed to study conception and design. AM, AP and LM contributed to data collection.

JE wrote the first draft. ZG, JK and HB performed all of the analyses. All authors commented on previous versions of the manuscript. All authors edited and approved the final manuscript.

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over total ED visit numbers and the total tablet number showed decreasing trends (p 's < 0.01), in addition to the natural (pre-intervention) decreasing trends. In contrast, later interventions in the EHR tended to show attenuated decreasing trends.

Conclusions: From 2012 to 2020, we found that total opioid prescriptions decreased significantly for discharged ED patients. This trend is seen nationally. However, our specific interventions further heightened this downward trend. Evidence-based legislation, policy changes, and educational initiatives that impact prescribing practices should guide future efforts.

Keywords

Opioid epidemic; Opioid prescriptions; Emergency medicine; Emergency physicians

1. Introduction

Every 19 minutes in the U.S., someone dies from unintentional drug overdose, the majority from opioids[1]. From 1997 to 2007, the average milligram (mg)-per-year use of opioids per person in the U.S. increased approximately 400%, from 74mg to 369mg, highlighting the public health crises[2]. Along with treating the consequences of opioid-related illness and overdose, Emergency Departments (EDs) are viewed as sources of opioid prescriptions and have been a target of efforts to limit prescriptions for opioids[3]. While a majority of opioid prescriptions written from the ED are of shorter duration and lower doses than those from office-based practices, there is evidence that EDs are a source of opioid prescriptions for opioid-naïve patients[4–6]. The Centers for Disease Control and Prevention (CDC) and the American College of Emergency Physicians have released opioid prescribing guidelines that focus on safe prescribing practices balancing adequate pain control, while limiting the risks associated with opioid[7,8].

While there has been a national decrease in opioid prescriptions since 2010, there remains significant variation across the country with an average three times higher than in 1999[9]. Given significant regional variations in prescribing practices, it is important to further investigate the potential effect of local and health system interventions targeted at various aspects of opioid overprescribing[10]. Here, we explored the potential impact of local initiatives on opioid prescribing practices among emergency care providers. We analyzed data (2012-2020) to understand trends in our Sacramento, CA Health System's opioid prescribing patterns for ED discharged patients and assessed potential roles of two initiatives at limiting local opioid prescriptions, as a quality improvement (QI) project.

2. Methods

2.1 Study Design

This is a single-center, retrospective study of all adult patients who received an opioid prescription on discharge from the ED of our large quaternary referral academic health system serving a mixed urban-rural/underserved population from March 2012 through July 2020.

2.2 Study Setting and Population

We searched hospital CLARITY databases that contain data for our EPIC electronic health record (EHR) system from March 2012-July 2020 (minus September 2016, where the database did not copy correctly). Eligible subjects included adult patients (≥ 18 years old) who received an opioid prescription and were discharged from ED. Our ED sees >80,000 patient visits per year, where ~60,000 are adult patients.

2.3 Study Protocol

During the study time-period, the ED implemented several quality interventions. In July 2015, an intensive educational intervention for emergency medicine (EM) residents and attendings on opioid prescribing and adverse events was conducted (we call, “change point 1”). This included a presentation geared towards beginning interns on July 2 on pain assessment and management which has continued each July since 2015. This was followed by small group sessions on opioid selection and dosing and adverse events on September 15, 2015 during academic forum sessions which faculty attend. In addition, information was presented during faculty meetings. Externally in March 2016, the CDC released “The CDC Guideline for Prescribing Opioids for Chronic Pain, United States, 2016” to help primary care providers ensure the safest and most effective treatment for patients. In September 2016, ED implemented an EHR-based intervention using choice architecture to reduce the duration of outpatient oral opioid prescriptions to a default of 3 days, limiting the default to 12 days or under for opioid prescriptions (“change point 2”).

2.4 Data Analysis

We used descriptive statistics to summarize data; mean/standard deviation (SD) for continuous variables, and frequency/percentages for categorical variables. We used line charts for counts and visualized the most commonly utilized drugs and trends over time. To examine the trend of the outcomes of our interest—total opioid prescriptions and percent of ED visits prescribed an opioid—over time, and the potential impact of important events including resident education and the change in default opioid prescription duration, we employed segmented regression with interrupted time series, where the two *pre-specified* change points, lagged effects, autocorrelation and seasonality are addressed [11,12]. These models estimate the intercept, the level of change in the outcome variable at change point, and the slopes (e.g., baseline trend and ‘increment’ in slope) before and after each change point, along with a 95% confidence interval and statistical significance. The first and second change points were specified respectively as July 2015 when the intensive educational intervention was introduced as part of EM resident education and as September 2016 when the ED implemented changes to the default duration of opioid prescriptions to 3 days maximum in the EHR. Baseline trend and intercept are estimated as in usual simple linear regression; intercept being the mean of the outcome at time 0, and baseline trend as slope parameter which reflects how much the outcome increases per-1-unit increase in time (1 year) before intervention/change point, i.e., natural trend or pre-change point slope. We used SAS/R/Microsoft Excel for data analysis and visualization.

3. Results

Over the course of our study (March 2012-July 2020), 41,491 ED discharged patients received an opioid prescription. The mean patient age (of the whole population) was ~43.3 years old, and ~50.2% were female. In 2012-2013 (first 12 months), the monthly average of opioid prescriptions was 618 (± 75) in mean (\pm SD), and decreased to 87 (± 10) in 2019-2020 (last 12 months). Moreover, the percentage of ED patients discharged with an opioid prescription decreased from 13.5% to 1.7%. Study and patient characteristics in the first and last years are summarized in Table 1.

The three most commonly prescribed drugs were found to be Hydrocodone (84.1%), Oxycodone (10.8%) and Codeine (2.8%); Hydrocodone 5mg-Acetaminophen 325mg was most frequently prescribed (69%). Quarterly prescription patterns in 2012-2020 are further presented; see Table S1 and Figure S1.

There was a natural decrease in opioid prescribing *before* implementing any study-specific interventions, reflected in the negative slope. When we implemented EM resident education (change point 1), there was a significant decrease in the trend/slope of the total number of opioid prescriptions; $-7.4/\text{year}$ pre vs. $-7.4-289.2/\text{year}$ post, $p = 0.0001$. Similarly, we observed a significant decrease in the fraction of ED visits with an opioid prescription; -0.7% pre vs. $-0.7-6\%$ post, $p = 0.0001$, and in total tablet number; -0.48 pre vs. $-0.48-1.34$ post, $p=0.01$. Interestingly, all 3 outcomes showed increases in the level of the outcome at change point 1, implying no immediate impact; see Table 2 for the models fitted.

After implementing an EHR-based intervention, we did not observe decreasing trends of the outcomes, possibly due to already greatly reduced outcome values; after change point 2, we observed slightly increasing trends, which reflect still decreasing trends but attenuated; e.g., the estimated slope for total opioid prescriptions after change point 2 is $-7.4-289.2+171.7$. The findings in Table 2 are presented in Figure 1 (crude summary statistics then connecting the dots), with changes before vs. after each change point and time trends. Notably, there is a decrease in the number of patients prescribed an opioid, despite the increased total number of patients to ED per month.

4. Discussion

We found the percentage of ED patients discharged with an opioid prescription decreased significantly in our ED from 13.5% of ED discharges in 2012 to 1.7% in 2020. While we implemented two interventions in our ED (resident education starting in July 2015 and a change to default pill counts/duration for all opioids prescribed in September 2016), the trends noted here partly represent overall changes in practice mirroring national trends[13], with some heightened effects from the two specific interventions.

This finding is consistent with trends in practice around opioid prescribing over time. The CDC National Ambulatory Medical Care Survey 2005-2015 showed that opioid prescriptions fell 5.8% for adults 18-64 years old when comparing 2005-2006 vs. 2014-2015, with the sharpest decline for adults under 65[14]. The Medical Expenditure Panel Survey 1996-2012 confirms a decrease in ED visits with a discharge prescription for

opioids from 7.4% to 4.4% of total ED visits despite ~470% increase in the quantity of opioids (total mg of morphine equivalent) prescribed over that time-period, with an increase in office prescriptions from 71% to 83% of total visits[15].

While we implemented an opioid prescribing guideline in 2011, opioid use was high during the baseline period of data availability. We saw some change in the number of opioid prescriptions after implementing the prescribing guidelines. A study in Staten Island that implemented a prescribing guideline for opioids found a drop in total prescriptions from 1756 to 1128 between 2012-2014 without a meaningful change in the average number of pills (12.8 vs. 12.4) or average total dose prescribed (69.4 vs. 69.0mg) of morphine equivalent per prescription[16].

It is likely multiple factors contributed to the dramatic reduction in opioid prescriptions from this single-center with a mixed urban/rural population. Prior work has found that there are many factors that contribute to ED physician opioid prescribing patterns, including assessment of pain, patient-centric factors (including concerns about patient satisfaction), and practice environment. Factors related to the practice environment include hospital policy, legislation, and guidelines[17]. In our setting, it is likely that local guidelines and culture change in the setting of a national focus on reducing opioid overdose led to a substantial reduction. While other studies have shown significant effects from individual interventions, our results suggest that this substantial decrease cannot be attributed to intervention(s) alone. The effects of local interventions should consider baseline shifts in practice patterns. Given the diverse array of efforts that are being deployed including criminal justice procedures, health policies, funding allocations, and reforms in clinical practice, understanding the impact of these efforts is critical in building consensus regarding best practices in prescribing opioid medications[9].

While there is much recent focus and literature proposing interventions to reduce opioid prescribing in various settings, EDs prescribe <5% of total opioid prescriptions and are unlikely to be significant contributors to opioid overuse[15,20]. Nonetheless, resident education may play a role in reducing opioid prescribing in a variety of settings where opioids are frequently prescribed for acute pain. The significant reduction in opioid prescribing for discharged patients also likely reflects regional and national trends in prescribing, rather than or in addition to an attributable success to any one intervention.

Limitations of our study include the retrospective evaluation at a single medical center, as well as missing data (September 2016) when our EPIC database failed to copy properly to CLARITY databases right after instituting the default opioid pill duration. Also, given that this was a single-group, retrospective observational study, not quasi-experimental design (permitting difference-in-difference analysis with an adequate control), we were unable to estimate the “true” effect of individual planned interventions on outcomes. We also could not assess secular trends in prescribing given the national attention to the opioid crisis including the release of the 2016 CDC Opioid Prescribing Guideline; how education and knowledge of the opioid epidemic or training fit into this outside of the two interventions could not be addressed. Future analysis to break down quantities by prescriber type (e.g., PGY level vs. faculty) during the key periods would provide additional clinically relevant

and actionable insights from the intervention(s); however, this analysis was not in the scope of this QI study. Nonetheless, our study provides preliminary data and lessons for designing rigorous studies that are prospective and include a control group. Given inherent limitations, our statistical methods, interrupted times series analysis, might still elucidate useful insights, addressing various methodology issues. Finally, toward/after the end of 2018, we see noticeable plateaus. This plateau or bounce back pattern may be explained partly by “regression to the mean”; when rates become very low, it becomes incrementally harder to lower them further. In addition, the COVID-19 pandemic led to decreased ED volumes in 2020. Nonetheless, observed patterns cannot be completely explained. Thus, long-term studies with more granular data and enhanced design are warranted in future.

5. Conclusion

Understanding the impact of institutional interventions in the context of national attention, legislative, policy, and educational initiatives on clinical practice change is important in refining future efforts to curb overprescribing of opioids. In 2012-2020, we found that opioid prescriptions decreased significantly for discharged ED patients with heightened effects from the two specific opioid prescribing interventions. Rather than focusing on specific institutional interventions, the concerted policy efforts on changing prescribing behaviors are likely to be responsible for long-term success in reducing prescribing.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

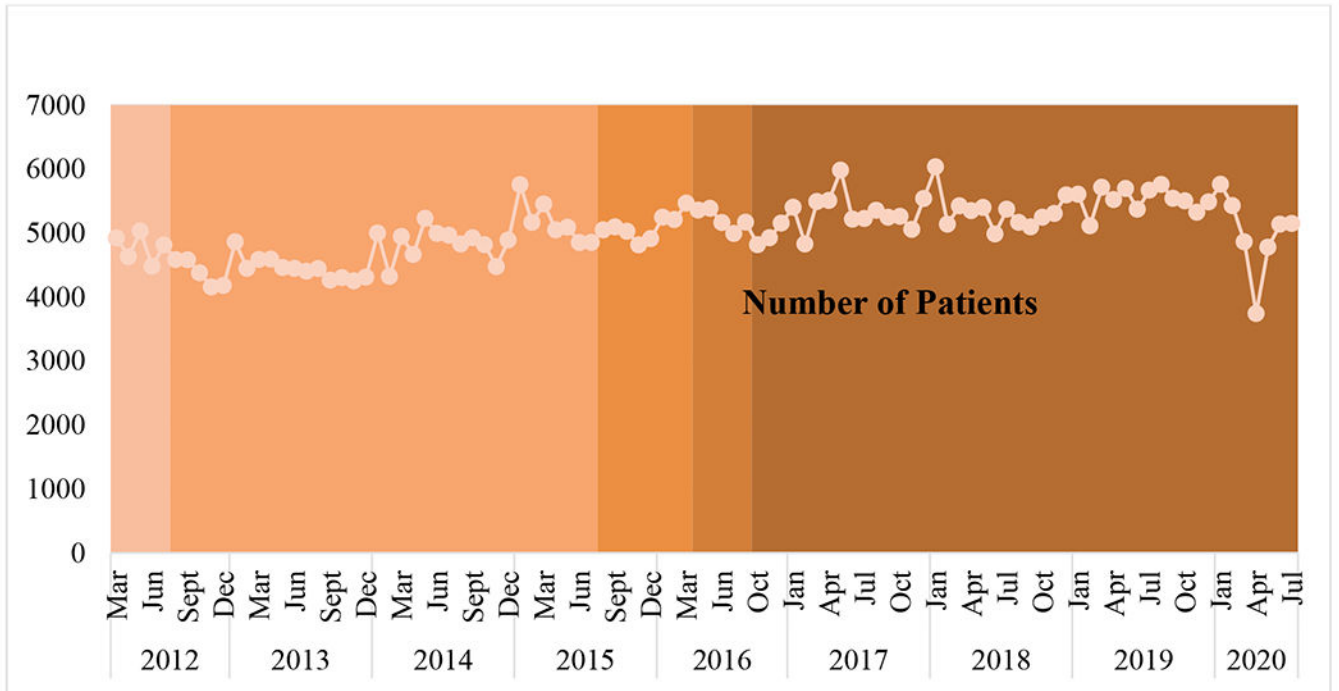
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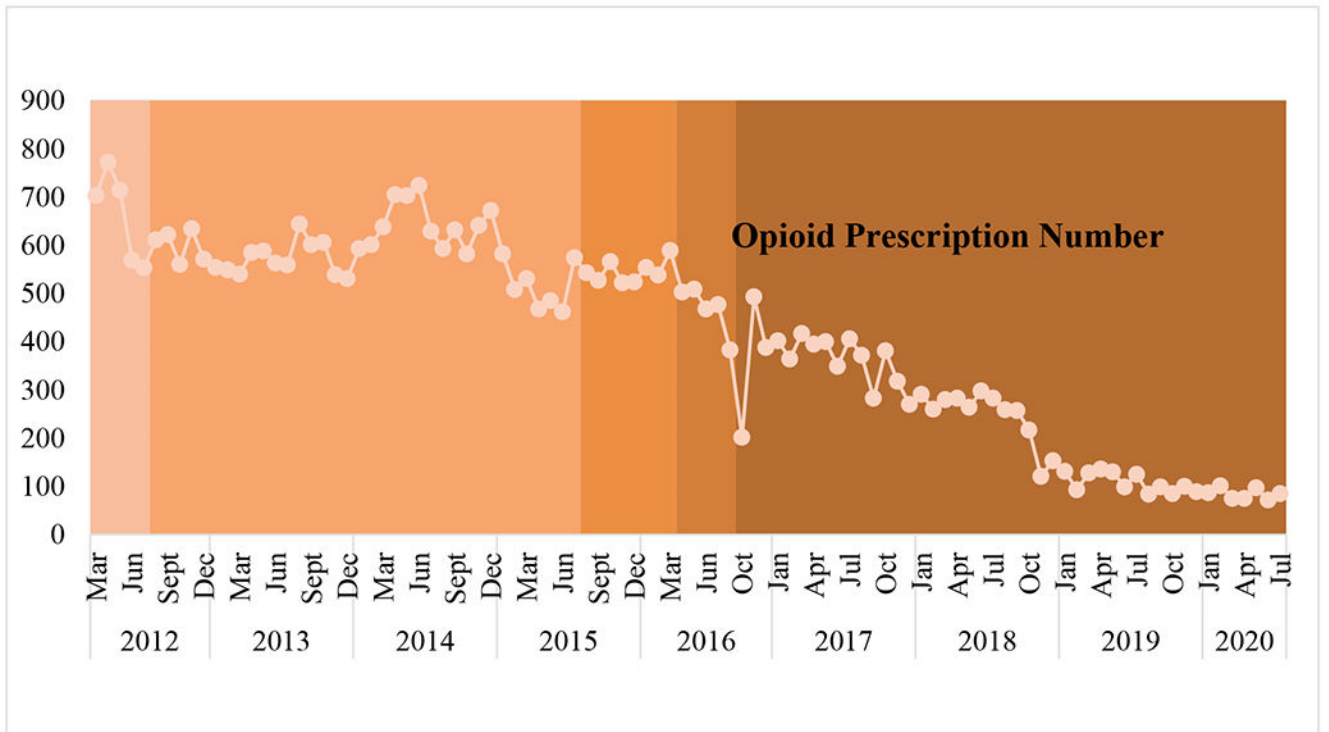
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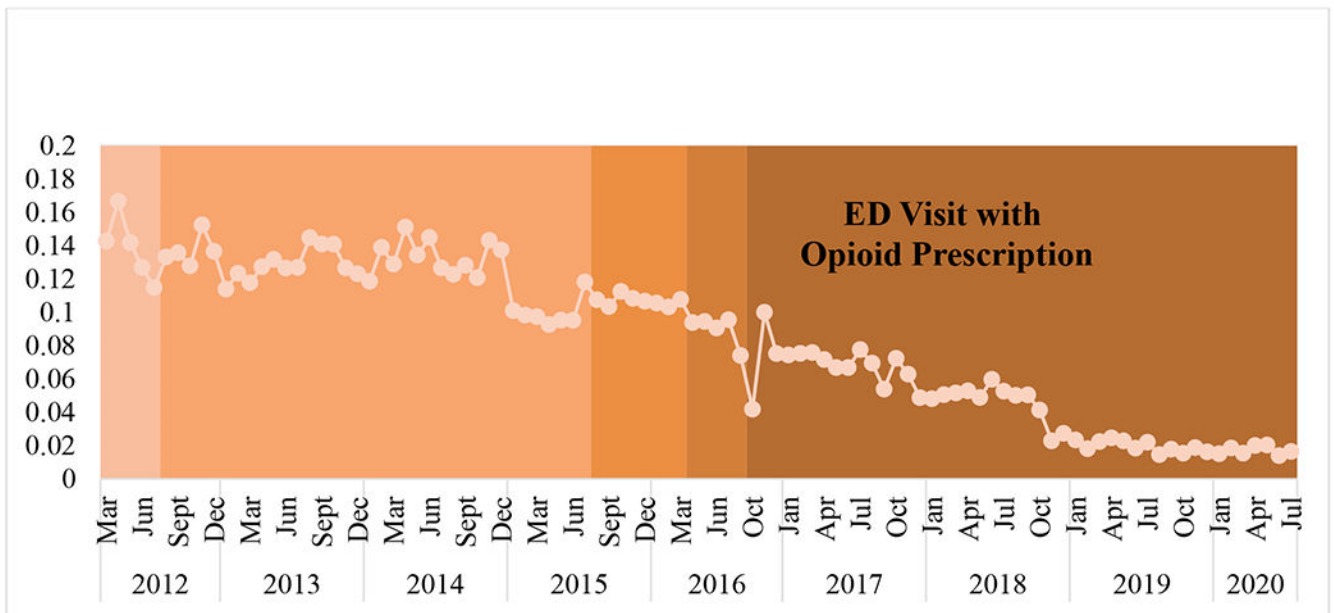
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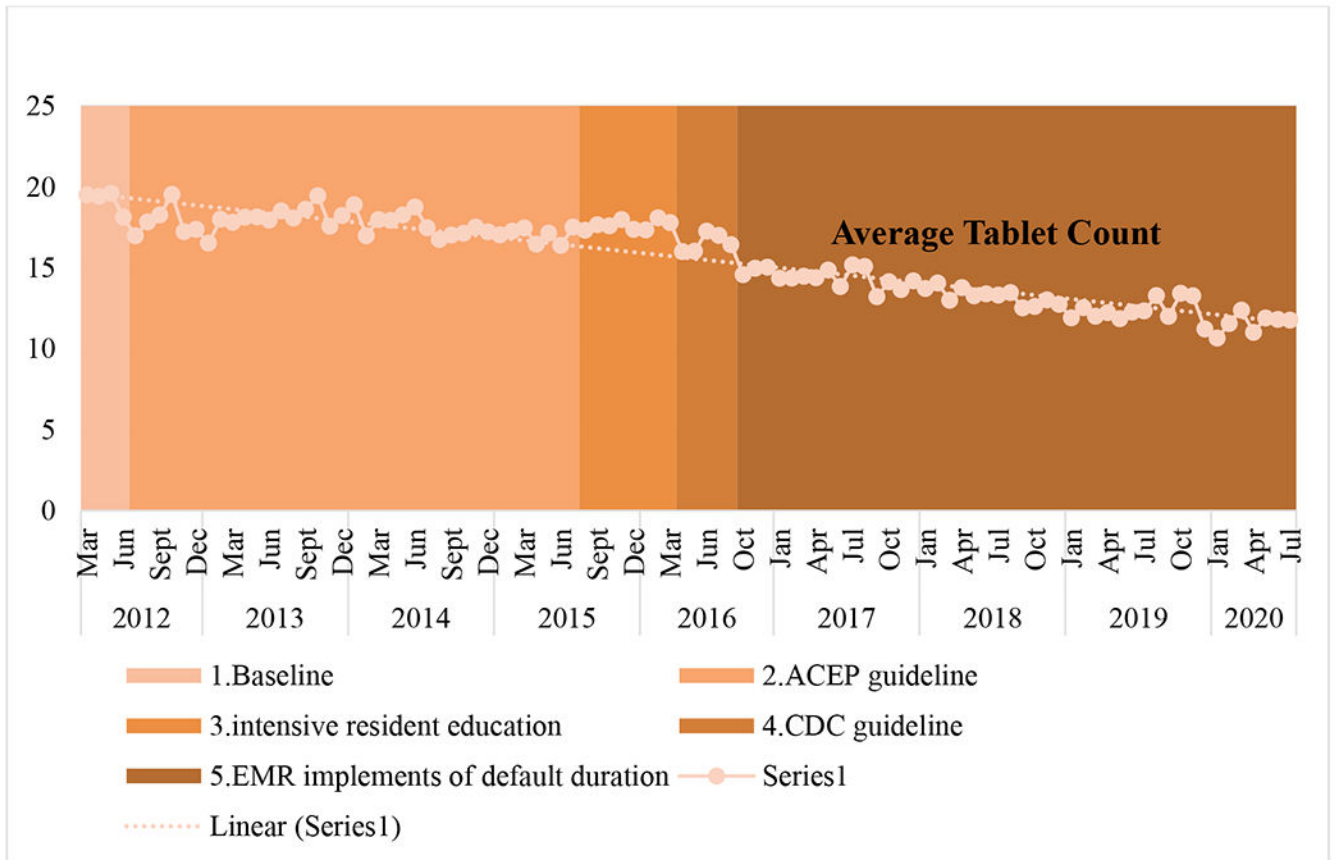
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(b)



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(d)

Figure 1. Trends on (a) Number of patients; (b) Opioid prescription number; (c) ED visit with opioid prescription; and (d) Average table count

Table 1.

Demographics and opioid prescription variables in 2012-3 and 2019-20

	Opioid prescription, First 12 months (N=7412) ¹	Opioid prescription, Last 12 months (N=1049) ¹
Age, mean (\pm SD)	42.1 (\pm 15.1)	46.5 (\pm 15.7)
Female, N (%)	3770 (50.9%)	555 (52.9%)
Monthly total ED visits	4589	5206
ED length of stay in hours, mean (\pm SD)	6.5 (\pm 4.8)	6.8 (\pm 9.2)
Total opioid prescription/total ED visits	13.5%	1.7%
Tablet count per visit, mean (\pm SD)	18.3 (\pm 9.3) (N=7197) ²	12.0 (\pm 5.2) (N=985) ²
Monthly opioid prescription number, mean (\pm SD)	618 (\pm 75)	87 (\pm 10)
Monthly opioid prescription (mg), mean (\pm SD)	88930 (15949)	7118 (1391)

N: sample size, SD: standard deviation, ED: emergency department.

¹Patients discharged with an opioid prescription.

²Tablet count excluded patients receiving patches, solutions, capsules, and bottles.

Table 2.

Segmental regression models with interrupted time series

a. Total opioid prescription number over time (year)			
Parameter	Estimate	Standard Error	P-value
Intercept	618.7	27.5	
Baseline trend	-7.4	12.7	0.56
At changepoint 1	40.6	46.6	0.39
Trend after changepoint 1	-289.2	61.3	<0.0001
At changepoint 2	197.9	43.8	<0.0001
Trend after changepoint 2	171.7	60.9	0.006
b. Opioid prescription per total emergency department visit over time			
Parameter	Estimate	Standard Error	P-value
Intercept	0.14	0.005	
Baseline trend	-0.007	0.003	0.007
At changepoint 1	0.01	0.01	0.24
Trend after changepoint 1	-0.06	0.01	<0.0001
At changepoint 2	0.04	0.01	0.0002
Trend after changepoint 2	0.04	0.01	0.003
c. Total tablet number over time			
Parameter	Estimate	Standard Error	P-value
Intercept	18.8	0.23	
Baseline trend	-0.48	0.11	<0.0001
At changepoint 1	1.11	0.43	0.01
Trend after changepoint 1	-1.34	0.54	0.01
At changepoint 2	-1.03	0.41	0.01
Trend after changepoint 2	0.88	0.54	0.10

Explanatory variable (or regressor) is coded as time (year) since January 2012. Thus, intercept can be interpreted as the mean value of an outcome variable at year 0.

Value at changepoint and trend after changepoint can be interpreted as the level of change at the changepoint and additional increment in outcome variable (i.e., incremental slope) per 1 year increase after the changepoint, respectively.

P-value tests the null hypothesis: change in outcome value/level at a given changepoint or incremental slope after each changepoint is 0.

Changepoint 1: Intensive educational intervention, July 2015 and 2: EHR implementation at ED, Sep 2016.

A sample regression equation is derived as follows:

Mean of opioid prescriptions = $618.7 - 7.4 * X + 40.6 * I(X > 3.6) - 289.2 * (X - 3.6)^+ + 197.9 * I(X > 4.8) + 171.7 * (X - 4.8)^+$, where X = year since 2012 January, and (a)⁺ is a if a > 0, or 0 if a ≤ 0, i.e., the positive part of a function, and I(.) is an indicator function; 1 if condition in (.) met, or 0 otherwise.