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The impact of community-level prevention strategies on high-dose opioid dispensing rates: 2014–2019

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Abstract

Background: Prescription opioids played a major role in the current opioid overdose epidemic. High rates of opioid prescribing and dispensing exposed many people to opioids, and high-dose opioid prescriptions (e.g., 90 morphine milligram equivalents [MME] per day) contributed to increases in opioid overdoses. The Centers for Disease Control and Prevention (CDC) Prevention for States (PfS) program provided funding to jurisdictions ("PfS recipients") with a high burden of opioid-involved overdoses. This paper examines associations between strategies addressing high-dose opioid prescribing and changes in high-dose opioid dispensing.

Methods: Monthly opioid dispensing data (2014–2019) from IQVIA Xponent were analyzed using longitudinal growth models (LGM) to compare high-dose opioid dispensing rates in the 29 jurisdictions that participated in PfS with rates in non-PfS jurisdictions. Additional models examined associations between specific PfS activities and changes in high-dose dispensing among PfS recipients.

Results: High-dose dispensing rates decreased significantly in both PfS and non-PfS jurisdictions from 2014 to 2019. Rates of high-dose opioid dispensing rates in PfS jurisdictions were not significantly different than those in non-PfS jurisdictions ($p = 0.07$). Among PfS recipients, multiple activities were associated with decreases in high-dose dispensing rates over time, including moving towards real-time prescription drug monitoring program (PDMP) reporting ($p < 0.001$) and implementation of opioid dispensing interventions for insurers/ health systems ($p < 0.05$).

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Authorship contributions

All authors contributed to the conceptualization and writing of this manuscript. All authors were involved in the review and edition of this manuscript. Dr. Guy additionally assisted with acquiring the data used for analysis.

Disclaimer

Findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Declaration of Competing Interest

The authors report no declarations of interest.

Conclusions: High-dose opioid dispensing rates decreased throughout the United States from 2014–2019. As the drug epidemic continues to evolve, implementation of prevention activities by state and local partners is important. These findings highlight two potential prevention strategies and activities that jurisdictions can utilize.

Keywords

Drug overdose; Opioid; Prevention; Interventions

1. Introduction

From 1999 to the 2010s, the United States has seen increases in prescription opioid dispensing and overdose deaths (Compton and Volkow, 2006; Han et al., 2015). In 2018, there were nearly 47,000 opioid involved overdose deaths in the United States, and almost 15,000 of these deaths involved prescription opioids (Wilson et al., 2020). This represents a 2% decrease in all opioid-involved overdose deaths and a 13.5 % decrease in prescription opioid involved overdose deaths from 2017 to 2018 (Wilson et al., 2020). A strong risk factor for drug overdose is high-dose opioid dispensing, which is defined as daily doses ≥90 morphine milligram equivalents (MMEs) (Bohnert et al., 2018; Dowell et al., 2016). Thus, there is the need for prevention efforts to address this risk factor.

Several efforts for clinicians to address the risks associated with high-dose opioid dispensing include uptake of opioid prescribing guidelines, increased use of prescription drug monitoring programs (PDMPs) and other health system interventions. Release of prescription opioid guidelines such as the Centers for Disease Control and Prevention Guideline for Prescribing Opioids for Chronic Pain and the VA/DoD Clinical Practice Guideline for Opioid Therapy for Chronic Pain cautioned clinicians to avoid high dose opioid dispensing (Department of Veterans Affair, 2017; Dowell et al., 2016). Although opioid prescribing practices such as high-dose dispensing were decreasing prior to the release of the CDC guidelines, findings from Bohnert et al. found that the release of the CDC guidelines was associated with a greater decline in high-dose dispensing (Bohnert et al., 2018). These guidelines remain one avenue to improve patient safety and chronic pain management to decrease risks associated with high-dose opioid dispensing.

Other clinician tools such as PDMPs showed effectiveness in reducing opioid dispensing risk factors; however, effectiveness varied by PDMP attributes (Finley et al., 2017; Lin et al., 2018). Health system interventions such as alerts in electronic health records have been used to decrease risks associated with high-dose opioid dispensing. Lowenstein et al. found that electronic medical record (EMR) alerts and prescribing limits resulted in a greater decrease in opioid dose per new prescription compared to a state without alerts and limits (Lowenstein et al., 2020). A study by Meisenberg et al. noted reductions in opioid prescribing after implementing several health system interventions, such as academic detailing, and EMR-based education tools (Meisenberg et al., 2018). Building on this evidence, CDC funded states to implement evidence-based interventions with an aim to reduce high-dose dispensing and other high-risk opioid dispensing practices as part of an overall strategy to reduce opioid overdose deaths.

Previously described research documented the effectiveness of some clinician and health-system focused interventions; however, the quality of the evidence has generally been low or geographically limited. Better research to understand the impact of these interventions on opioid dispensing is needed in order to inform future prevention efforts; thus, the aim of this analysis is 1) assess differences in high-dose opioid dispensing between Prevention for States (PfS) funded and non-funded jurisdictions (all 50 states and Washington, DC) and 2) assess the association between PfS-funded prevention activities and changes in high-dose dispensing rates among PfS recipients.

2. Methods

2.1. Description of intervention

The Prevention for States (PfS) program funded 16 state health departments (recipients) in 2015 and an additional 13 recipients in 2016 with goals of decreasing rates of prescription opioid misuse and opioid use disorder and decreasing prescription opioid overdose death rates (Centers for Disease Control and Prevention, 2017). PfS recipients were selected based on burden of opioid overdose morbidity and mortality through a competitive application process, and the program is described in detail elsewhere (Robinson et al., 2019). Briefly, PfS required funded recipients to implement two prevention strategies: 1) enhance and maximize prescription drug monitoring programs (PDMPs) and 2) implement community or insurer/health system interventions. Within Strategy 1 (enhance and maximize PDMPs), recipients could identify one or more activities to implement: (1) move toward universal registration and use of PDMPs, (2) make PDMPs easier to use and access, (3) move toward real-time PDMP reporting, (4) expand and improve proactive reporting, and (5) conduct public health surveillance with PDMP data and publicly disseminate reports. For Strategy 2 (implement community or insurer/health system interventions), recipients could identify one or more activities to implement: (1) provide technical assistance to high-burden communities, (2) implement prescription opioid dispensing interventions for insurers and/or health systems, and (3) enhance the uptake of evidence-based opioid prescribing guidelines. The RTI International Institutional Review Board determined this project was in support of program evaluation and designated the work as not research with human subjects.

2.2. Measures

2.2.1. PfS strategies and major activities—Implementation of PfS strategies and associated activities was assessed using annual progress reports (APRs), which each recipient was required to submit to the CDC. Each APR included lists and descriptions of activities implemented as part of each of the two required strategies. APRs that described overdose prevention activities implemented from 2015 to 2019 were available for this analysis. Under each activity, recipients reported the status (planned, in progress, completed, or discontinued) and associated time period (month/year) for each individual subactivity implemented. An activity was classified as being implemented based on the month and year of implementation start of the first subactivity. While recipients did report discontinuing subactivities, it was extremely rare for a recipient to discontinue all subactivities within a broader activity category. This occurred in three instances across the cooperative agreement,

representing less than 1% of activities. Therefore, once an activity was recorded as implemented in the APR it was coded as implemented for the remainder of the timespan.

2.2.2. Monthly high-dose opioid dispensing rates—Dispensing data for all 50 states and the District of Columbia (referred to as jurisdictions below) from IQVIA Xponent were used to examine the association between PfS funding and implementation of specific PfS activities and high-dose opioid dispensing rates. High-dose opioids dispensing rate was chosen as the outcome since studies show the risk of opioid-related overdose and death increase as prescription opioids are taken in higher dosages and this was also a goal of the PfS program (Centers for Disease Control and Prevention, 2017; Dowell et al., 2016; Park et al., 2016). IQVIA Xponent is based on a sample of 49, 900 retail pharmacies, which dispense approximately 92 % of all retail pharmacy prescriptions in the United States. Data from 2014 to 2019 were used in analyses and were chosen to examine opioid dispensing before and through the entirety of PfS funding. High-dose opioid dispensing rates per 100 people were calculated as the total number of prescriptions per month for daily dosages ≥90 MME, divided by the annual jurisdiction-level census population and multiplied by 100. We calculated MME using published conversion factors from the CDC (Center for Disease Control, 2020). These data from all 50 states (plus DC) were used to compare changes among jurisdictions (i.e., recipients) that received PfS funding relative to all non-funded jurisdictions. A second set of analysis used data only from PfS recipients and examined the impact of specific activities on high-dose opioid prescribing.

2.3. Statistical analyses

High-dose opioid dispensing rate data were aggregated by month at the state (or District of Columbia) level to reflect the state health department PfS jurisdiction. State-level data from states that did not receive PfS funding were used as the comparisons. A total of 72 observations (12 months X 6 years) were nested within each of the PfS funded (n = 29) and comparison (n = 22) jurisdictions (i.e., jurisdictions that did not receive funding).

Longitudinal growth modelling (LGM) was used to assess the differences in change over time in monthly high-dose opioid dispensing rates attributable to PfS funding and PfS activities. LGM is a “person-centered” approach to longitudinal data where each jurisdiction (PfS and non-PfS) has their own trajectory (intercept and slopes), as compared to “variable-centered” approaches such as regression modelling. Jurisdiction was the unit of analysis for all models and random effects were included for intercepts and each slope, which allowed each jurisdiction to have its own initial value and rates of change that varied around the overall estimates (Curran and Hussong, 2003; Muthén, 2004). The LGM approach is a “difference in differences” model, in which the normative or secular trend was incorporated and the impact of PfS was estimated as a deviation from that trajectory.

The random effects account for some of the variability in jurisdiction-level outcomes and rates of change and reduces some of the error or non-model variance, in a manner similar to the inclusion of jurisdiction-level covariates. This method of dealing with the multitude of potential policy and programmatic confounders is more parsimonious and less subject

to model misspecification through the inclusion of irrelevant covariates and omission of important or missing covariates.

With this analytic technique it was possible to assess whether the overall rate of change in high-dose dispensing across jurisdictions increased after the month when each PfS recipient began implementation of an activity, independent of other PfS recipients; this was an important consideration given that some activities were nearly ubiquitous by the end of the funding period The overall estimates of rates of change reflect the estimated grand mean rates across the jurisdictions, with variability (standard errors for testing significance) determined by how well the individual jurisdictions conform to the overall estimates.

A piecewise LGM was used to model two distinct slopes or periods of change over time. The first corresponded to the pre-funding timeframe and included the months from January 2014 to when PfS funding began (July 2015 for cohort 1 and April 2016 for cohort 2). For non-PfS jurisdictions this initial change included January 2014 to the midpoint between funding initiations of cohorts 1 and 2. The pre-funding rate of change was constrained to be equivalent for both PfS jurisdictions and non-PfS jurisdictions. A second slope was estimated to reflect changes after funding was initiated. This slope was allowed to vary across PfS jurisdictions vs non-PfS jurisdictions to address the research question of whether PfS funding was associated with greater declines in high-dose opioid dispensing rates.

A sensitivity analysis was conducted to assess whether the release of the CDC *Guideline for Prescribing Opioids for Chronic Pain* in 2016 may have had a confounding effect on the findings (Dowell et al., 2016). A separate piecewise LGM was run with an additional inflection point for all jurisdictions set to the release of the Guideline. The difference between PfS and non-PfS jurisdictions was estimated to examine if there was a further decrease in high-dose dispensing not associated with the release of the Guideline. Results of this model were essentially identical, so results are based on the models without this additional inflection point to be more parsimonious.

Associations between PfS-funded activities and monthly high-dose opioid dispensing rates were estimated within PfS jurisdictions using the LGM. Monthly high-dose opioid dispensing rates were examined post-PfS funding for differences between jurisdictions that did and did not implement each activity. An activity was classified as having been implemented based on the month indicated in the APR. Once an activity was implemented, it was coded as an effect for the remainder of the timespan to assess its ongoing impact on high-dose opioid dispensing. The estimated difference in slope with and without the activity in effect was the measure of the activity's impact on the high-dose opioid dispensing rate. Separate models were estimated for each activity. All analyses were conducted using SAS version 9 using 2-tailed tests with significance threshold of $p < 0.05$.

3. Results

3.1. Preliminary analyses

Table 1 shows the number of PfS recipients that implemented an activity for at least one month during each year from 2015–2019. Strategy 1, Activities 2 and 5 ("Make PDMPs

easier to use and access" and "Conduct public health surveillance with PDMP data and publicly disseminate reports," respectively) and Strategy 2, Activity 1 ("Identify and provide technical assistance to high-burden communities and counties, especially efforts to address high-risk prescribing") all showed rapid uptake and were nearly ubiquitous by 2017.

3.2. Comparative changes in monthly high-dose opioid dispensing rates between PfS-funded and Non-PfS funded jurisdictions

Monthly high-dose opioid dispensing decreased consistently in all jurisdictions from 2014 to 2019 (Table 2 and Fig. 1). In January of 2014, rates of high-dose opioid dispensing rates in PfS jurisdictions (0.79 high-dose opioid prescriptions per 100 residents) were not significantly different than those in non-PfS jurisdictions (0.65 high-dose opioid prescriptions per 100 residents; 0.133, $p = 0.07$). Within PfS jurisdictions, the decrease in high-dose dispensing rates was statistically significant after receiving PfS funding (−0.011, $p < 0.001$). High-dose dispensing rates also decreased significantly in non-PfS jurisdictions (−0.009, $p < 0.001$). The decrease in high-dose dispensing rates during the post-funding period did not differ significantly between PfS and non-PfS funded jurisdictions ($p = 0.10$).

Additional exploratory analyses were conducted with a variant of the LGM used above. This model separated the post-funding slope into a segment from funding to 2018 and separate segment from 2018 to 2019 based on the flattening of the curve during that time. These analyses found that between 2014 and 2018, the rate of change in high-dose dispensing rates was significantly greater within PfS jurisdictions compared with non-PfS jurisdictions ($p < 0.05$), but between 2018 and 2019 the rate of change in high-dose dispensing slowed for all jurisdictions. Analysis of monthly high-dose dispensing rates across 2019 indicated that while the rate of change for both PfS and non-PfS jurisdictions was still significant (−0.004 for both groups), it was less than half the rate of change estimated for non-PfS jurisdictions in the post-funding period and approximately one third the overall rate of decrease observed in PfS jurisdictions post-funding.

3.3. Changes in monthly high-dose opioid dispensing rates after implementation of PfS activities among PfS recipients

Among PfS recipients, four of the five possible activities under Strategy 1 were associated with decreases in monthly high-dose opioid dispensing rates (Table 3). Activity 1: Move toward universal registration and use of PDMPs (−0.003, $p < 0.001$), Activity 2: Make PDMPs easier to use and access (−0.001, $p < 0.001$), Activity 3: Move toward real-time PDMP reporting (−0.003, $p < 0.001$), and Activity 4: Expand and improve proactive reporting (−0.001, $p = 0.006$) were all associated with decreases in high-dose dispensing rates, such that the rates of change increased after the PfS recipient implemented the activity. Activity 5: Conduct public health surveillance with PDMP data and publicly disseminate reports was not significantly associated with the rate of change in high-dose dispensing rates; PfS recipients did not experience a faster or slower change in high-dose dispensing rates after implementing this activity. All three activities under Strategy 2 were significantly associated with decreases in monthly high-dose opioid dispensing rates (Table 3); high-dose opioid dispensing rates declined faster when PfS recipients implemented these activities.

4. Discussion

The goal of the PfS program was to fund jurisdictions to implement opioid overdose prevention strategies to achieve reductions in dispensing behaviors, such as high-dose opioid dispensing, and ultimately deaths associated with opioid overdose. The purpose of this study was to describe differences in high-dose opioid dispensing rates between jurisdictions with and without PfS funding. Additionally, we explored the association between implementation of specific targeted opioid overdose prevention activities and changes in high-dose opioid dispensing among jurisdictions that received PfS funding. This is the first study showing an association between the implementation of specific PfS prevention activities and changes in high-dose opioid dispensing rates across multiple states.

Overall, opioid prescribing has been decreasing since 2011, which is prior to the implementation of PfS. Consistent with overall secular trends, we found that monthly high-dose opioid dispensing declined across all jurisdictions, regardless of PfS funding. Selection criteria for PfS funding included a demonstrated need based on opioid overdose rates, so it is not surprising that in 2014, PfS jurisdictions had slightly higher, although not statistically significant, monthly high-dose dispensing rates compared with non-PfS jurisdictions. Results indicated that declines in high-dose dispensing slowed nationwide in 2019, and it is possible that, on average, over the past few years, the nation is reaching a stable point for high-dose opioid dispensing. However, existing variability of opioid prescribing within jurisdictions (e.g., counties within states) that is not explained by differences in underlying pain conditions as well as variability in opioid prescribing by different pain conditions indicates a need to continue to monitor and implement strategies to improve practices related to high-dose opioid dispensing and evidence-based pain care. (Mikosz et al., 2020; Schieber et al., 2019)

PfS recipients were required to implement activities within two broader strategies: Enhance and maximize prescription drug monitoring programs (Strategy 1) and Implement community or insurer/health system interventions (Strategy 2). Literature on the use of PDMPs to address the opioid overdose epidemic is widely available and demonstrates that proactive use is associated with decreases in opioid dispensing (Cerdá et al., 2020; Haegerich et al., 2019; Strickler et al., 2019; Wen et al., 2019) (Bao et al., 2016; Winstanley et al., 2018).

Findings in this analysis show that providing technical assistance to high-burden communities was one of the PfS activities significantly associated with reductions in high-dose opioid dispensing. State health departments routinely provide technical assistance to communities as part of their ongoing work with local coalitions and community-based organizations to address public health issues. Research indicates that coalitions of community partners are essential for successful public health initiatives (Albert et al., 2011; Mirigian et al., 2018). Often funded by state and/or federal funds, communities are instrumental to developing comprehensive overdose prevention plans (Leece et al., 2019). Increased duration and reach of providing technical assistance allows state health departments to help local community groups expand local coalitions, facilitate strategic partnerships, and increase capacity to implement programs and reach populations in need.

Implementing opioid prescribing interventions for insurers/ health systems was another PfS activity significantly associated with reductions in high-dose opioid dispensing. Academic detailing, which is one-on-one educational outreach and education to physicians, has been implemented with insurers and health systems (Davis et al., 2017; Dieujuste et al., 2020; Kattan et al., 2016). PfS funding provided jurisdictions the ability to implement academic detailing programs systematically by working with large healthcare and/or insurer systems rather than piecemeal implementation. Academic detailing has been shown to impact prescriber behavior, such as checking the PDMP prior to prescribing and improved opioid dispensing practices (Centers for Disease Control and Prevention, 2018; Kattan et al., 2016; Larson et al., 2018). Academic detailing is an opportunity for state health departments to increase safer opioid prescribing. As state health departments receive funds for overdose prevention interventions, additional resources can be directed to increasing capacity and saturation of academic detailing.

The Prevention for States program funded 29 state health departments compared to Overdose Data to Action (OD2A), which provides funding to 66 state, local and select jurisdictions throughout the United States. This analysis demonstrates the association between specific prevention activities and decreases in high-dose opioid dispensing in PfS recipients. These prevention activities are critical in reducing deaths associated with drug overdoses. However, the nation’s drug overdose epidemic is rapidly evolving and is now driven by increases in illicit synthetic opioids and stimulants, thus it is important that a comprehensive approach that focuses on prescription and illicit drugs is implemented. Building on the success of PfS, the CDC launched Overdose Data to Action (OD2A). OD2A represents a continuation and expansion of prevention interventions to allow innovative interventions to emerge in an effort to decrease deaths associated with drug overdoses (Centers for Disease Control and Prevention, 2019).

There are several limitations to this study. First, PfS recipients were selected, in part, based on burden of opioid overdose morbidity and mortality through a competitive application process. It is possible that recipients, and the populations within the recipient states, differed on unmeasured factors that could have contributed to differential rates of changes in opioid prescribing and dispensing behaviors. Additionally, there were two cohorts of PfS funded recipients- the first cohort with 16 recipients started in 2015 and the second cohort with 13 recipients started in 2016. The time period between the funding of the two PfS cohorts includes the release of the CDC Guideline, which may introduce additional confounding with respect to high-dose opioid prescribing. The LGM approach accommodated many of these data and design features such as different trajectories for PfS vs non-PfS jurisdictions (normative change) and variability in cohort funding dates (PfS cohort 1 funded in 2015 and PfS cohort 2 funded in 2016). However, the model restricted the differences from the comparison (non-PfS jurisdiction) slope to be equivalent. While this constraint facilitates a common estimate of PfS, it ignores differences across the cohorts that may affect overall levels of high-dose opioid dispensing as well as rates of change. Further analyses that independently examine PfS cohorts may yield additional insights. Another model-related limitation may be the placement of the inflection point for non-PfS jurisdictions. This point was chosen as the midpoint between the two cohort’s funding dates to increase clarity of the differences in slopes across the groups but this point may not be an accurate representative

of the point of maximal change in the non-funded jurisdictions. Additionally, the models cannot account for potential causes of underlying differences that were not measured. For example, the overall decreasing normative slope in in high dose prescribing is likely a function of multiple factors that may be common or variable across PfS and non-PfS jurisdictions.

We also made analytic decisions that could have impacted the results. The models were run separately, such that each activity was considered independently. While we reduced the likelihood of error by using LGM with monthly data, which considers the rate of change before and after implementation of the activity, it is possible that an additive effect could have occurred within jurisdictions that implemented activities within a short period of time of one another. We were unable to take into account the duration of implementation within a given activity nor the fidelity of implementation. Also, activities were coded and entered into the models in a manner such that once they were initiated, they were continuous through the timespan examined. This method was used to capture the fact that some activities, once completed, would have lasting effects that persisted. For example, decreasing the time required for entering dispensing data into the PDMP is an activity with a set goal and recipients would not need to continue efforts after the goal was achieved. We conducted a sensitivity analysis that used an alternate coding that allowed activities to "turn off" if they were indicated as not being used in the APRs. Conclusions were consistent across the models with a single exception. For the models in which the activities did not persist once on, there was a significant effect of Strategy 1, Activity 5 (Conduct public health surveillance and publicly disseminate reports) in which the rate of high-dose opioid prescribing decreased faster only during the time this activity was in effect.

Finally, during the period that PfS was implemented there were multiple federal, state, and local efforts occurring in different jurisdictions to address the opioid overdose epidemic. Programs such as CDC's Data Driven Prevention Initiative (DDPI) and Enhanced State Opioid Overdose Surveillance (ESOOS) and the Substance Abuse and Mental Health Services Administration (SAMHSA) State Targeted Response to the Opioid Crisis (STR) and State Opioid Response (SOR) grants occurred simultaneously. The distribution of funding from these mechanisms was not consistent across jurisdictions, so it is not possible to know how this funding may have differentially impacted jurisdictions. Thus, PfS activities may have contributed to changes, but causal conclusions cannot be reached.

5. Conclusion

Our results provide insight into the relationship between state or other jurisdiction led opioid overdose prevention activities on opioid dispensing. Continuation and expansion of such prevention efforts have the potential to reduce deaths associated with the evolving overdose crisis. Prevention efforts that facilitate universal registration and use of PDMPs and implementation of select community or insurer/health system interventions that aim to prevent opioid use disorder and drug overdoses involving prescription opioids have the potential to reduce the dispensing of high-dose opioid prescriptions. Continuing these activities and increasing their reach show promise to address high-risk dispensing behaviors. These activities should be pursued in tandem with broader efforts to address the evolving

overdose crisis. Importantly, routine evaluation of these overdose prevention efforts is also needed to continue to improve program delivery for this critical health issue. State health departments, their local partners and communities remain central to addressing the opioid overdose epidemic.

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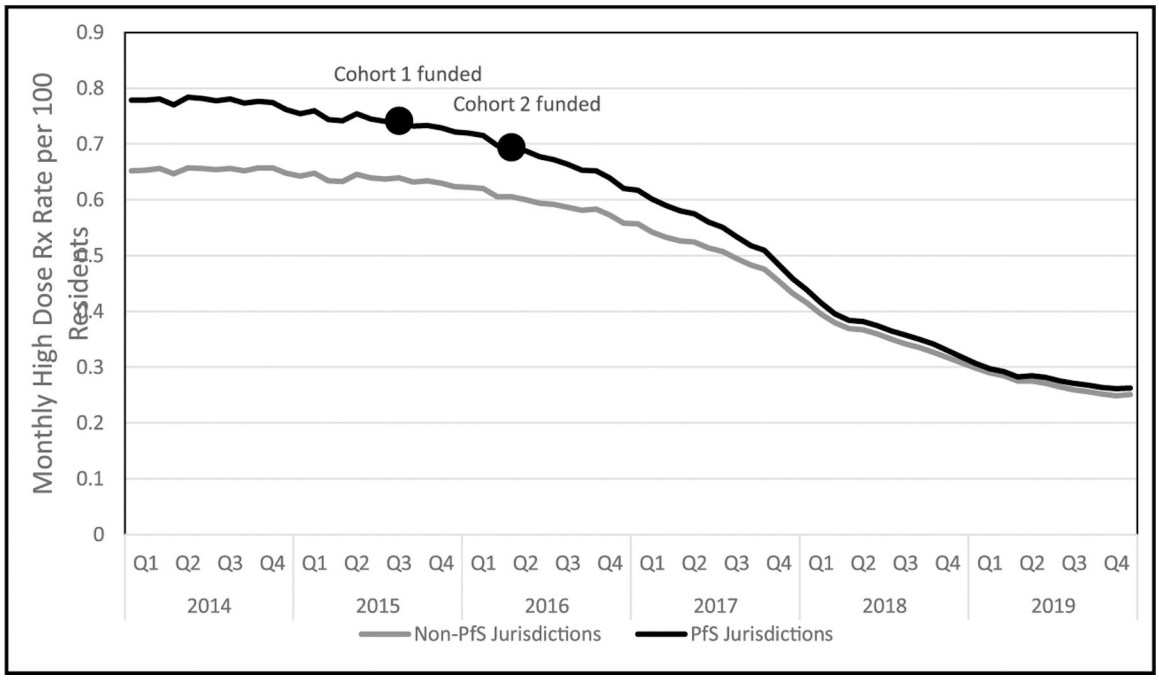

Fig. 1.

Monthly High-Dose Opioid Dispensing Rate per 100 Residents in PfS Recipient Jurisdictions (n = 29) and Non-PfS Jurisdictions (n = 22), 2014–2019. Source IQVIA Xponent state-level data for 2014–2019; Q1 = January to March, Q2 = April to June, Q3 = July to September, Q4 = October to December. High-dose opioid dispensing rate is defined as the total number of opioid prescriptions with a daily dose equal or higher to 90 morphine milligram equivalents.

Table 1

Number of PfS recipients that implemented each overdose prevention activity.

	2015	2016	2017	2018	2019
Number of PfS Recipients Funded	**16**	**29**	**29**	**29**	**29**
Strategy 1: Enhance and maximize a state Prescription Drug Monitoring Program (PDMP)					
Activity 1: Move toward universal registration and use	7	16	18	18	18
Activity 2: Make PDMPs easier to use and access	10	23	26	27	27
Activity 3: Move toward a real-time PDMP	3	10	15	15	15
Activity 4: Expand and improve proactive reporting	6	17	21	21	21
Activity 5: Conduct public health surveillance and publicly disseminate Reports	6	26	28	28	28
Strategy 2: Implement community or insurer/health system interventions to prevent prescription opioid overdose and opioid use disorder					
Activity 1: Identify and provide technical assistance to high-burden communities and counties, especially to address high-risk prescribing	9	19	28	28	28
Activity 2: Implement or improve opioid prescribing interventions for insurers, health systems, or pharmacy benefit managers	4	12	16	16	16
Activity 3: Enhance uptake of evidence-based prescribing guidelines	11	15	16	16	16

Prevention for States (PfS) recipients are jurisdictions that received funding from the CDC to address prescription opioid misuse and opioid use disorder. 16 state health departments received funding in 2015 and an additional 13 recipients received funding in 2016.

Table 2

Changes in Monthly High-Dose Opioid Dispensing Rate per 100 Residents in PfS-Funded (n = 29) and Non-PfS Jurisdictions (n = 22), 2014–2019.

Parameter	Monthly High-Dose Opioid Dispensing Rate per 100 Residents (Standard Error)
PfS-funded Jurisdictions baseline	0.787 (0.047)***
Non-PfS Jurisdictions baseline	0.654 (0.054)***
Difference in baseline	0.133 (0.072)+
Pre-PfS Funding Slope	−0.001 (0.001)*
Post-PfS Funding Slope for PfS Recipient Jurisdictions	−0.011 (0.001)***
Post-PfS Funding Slope for Non-PfS Jurisdictions	−0.009 (0.001)***
Difference in Post-PfS Funding Slopes	−0.002 (0.001)

Note:

+: p < .10

*: p < .05

**: p < .01

***: p<.001.

Estimates (and standard errors) of longitudinal growth models for changes in monthly high-dose opioid dispensing rate per 100 residents. High-dose opioid dispensing rate is defined as the total number of prescriptions with a daily dose equal or higher to 90 morphine milligram equivalents. High-dose opioid dispensing was collected from the IQVIA Xponent database. Prevention for States (PfS) recipients are state health departments that received funding from the CDC to address prescription opioid misuse and opioid use disorder. The pre-funding slopes for PfS and non-PfS recipients are constrained to be equivalent. PfS recipients include two cohorts, one of which funded 16 recipients in 2015 and the other 13 recipients in 2016. The dates of modeled inflections reflect the date of PfS funding, not activity implementation and so vary by PfS cohort. They are the third quarter of 2015 for Cohort 1 and the second quarter 2 in 2016 for Cohort 2. The midpoint between initiation of funding for the two PfS funded cohorts (fourth quarter of 2015) is used as the inflection point for non-PfS recipients.

Table 3

Association between Changes in Monthly High-Dose Dispensing per 100 Residents and Implementation of PfS Activities among PfS Recipients (n = 29), 2014–2019.

	Change in Monthly High-Dose Dispensing Rate after PfS Activity Implemented (Standard Error)
Strategy 1, Activity 1. Move toward universal registration and use of the PDMP	−0.003 (0.0005)***
Strategy 1, Activity 2. Make PDMPs easier to use and access	−0.001 (0.0004)***
Strategy 1, Activity 3. Move toward real-time PDMP reporting	−0.003 (0.0003)***
Strategy 1, Activity 4. Expand and improve proactive reporting	−0.001 (0.0004)**
Strategy 1, Activity 5. Conduct public health surveillance with PDMP data and publicly disseminate reports	−0.001 (0.001)+
Strategy 2, Activity 1. Identify and provide technical assistance to high-burden communities and counties, especially efforts to address high-risk prescribing	−0.002 (0.0003)***
Strategy 2, Activity 2. Implement opioid dispensing interventions for insurers and/or health systems	−0.001 (0.001)*
Strategy 2, Activity 3. Enhance uptake of evidence-based opioid prescribing guidelines	−0.002 (0.0005)***

Note:

+: p < .10

*: p < .05

**: p < .01

***: p<.001.

PDMP = Prescription Drug Monitoring Program. Results represent separate models, such that the impact of each activity was assessed independently of other activities. Estimates (and standard errors) of changes in monthly high-dose dispensing per 100 residents in the time period after PfS recipients implemented the activity. Estimates shown are the average across all PfS recipient states who implemented the activity, regardless of the month the activity was implemented. High-dose opioid dispensing rate is defined as the total number of prescriptions with a daily dose equal or higher to 90 morphine milligram equivalents. Prevention for States (PfS) recipients are jurisdictions that received funding from the CDC to address prescription opioid misuse and opioid use disorder.