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Workers' Compensation and the Opioid Epidemic

State of the Field in Opioid Prescription Management

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Yonatan Ben-Shalom, Megan McIntyre, Jia Pu, Marisa Shenk, and Wenjia Zhu (Mathematica); William Shaw (University of Connecticut Health Center)

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U.S. Department of Labor
Chief Evaluation Office
200 Constitution Avenue, NW
Washington, DC 20210
Project Officer: Kuangchi Chang

Submitted by:

Mathematica
1100 1st Street, NE, 12th Floor
Washington, DC 20002-4221
(202) 484-9220
(202) 863-1763

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Executive summary

The problem of prescription opioid misuse and addiction is of concern to the U.S. Department of Labor (DOL) and other stakeholders interested in the health of American workers. Injured workers are often prescribed opioids to ease pain, and people in their prime working-age years have relatively high rates of drug overdose deaths and other adverse events related to prescription opioids (Centers for Disease Control and Prevention 2018).

The opioid epidemic has important implications for the civilian labor force. Therefore, DOL's Chief Evaluation Office, in partnership with DOL's Office of Worker's Compensation Programs, contracted with Mathematica and the University of Connecticut Health Center to help build knowledge about opioid prescription management strategies. As part of this effort, the project team conducted an environmental scan to identify existing policies, strategies, and practices for opioid prescription management and evidence on their effectiveness. The environmental scan covered approaches implemented in workers' compensation and other health care settings, such as health insurance programs and health care systems.

In our review, we sought to determine which approaches are the most promising for further consideration by relevant stakeholders, how and where they were implemented, and the strength of the evidence about their effectiveness. We focused on studies published from 2014 to 2019 and ultimately identified 134 studies of initiatives and strategies across a variety of intervention categories, settings, and research designs. The many studies published in recent years reflect the growing interest in the United States among policymakers and researchers to evaluate the effects of new policy-level programs designed to improve opioid prescribing practices and reduce opioid misuse and overdose deaths (see, for example, National Science and Technology Council 2019).

Overall, most studies reported positive effects on reducing opioid prescribing rates, dosages, and refill rates and improving physicians' attitudes and practices, and these patterns held even when researchers made strenuous efforts to rule out competing explanations for these effects. Positive effects of policy change have generally exceeded secular trends in reduced opioid prescribing rates or shown a sudden shift after a policy is implemented. We conclude from this evidence that new opioid policy changes in the past six years have shown a measurable influence on opioid prescribing practices. The size of the effect varies depending on the chosen outcome measure, follow-up period, and setting, but the reported changes in outcomes were nontrivial. Because of a lack of comparable outcomes across studies, we could not quantitatively synthesize and compare effect sizes between policy categories, but no one policy appeared to far exceed the benefits of other strategies. For policymakers, choices between specific policy actions may relate more to context, level of regulatory influence or authority, ease of administration, and the ability to enforce or reinforce the policies.

Our environmental scan led to several overarching qualitative observations. First, multi-pronged approaches that reach a larger number of stakeholders and address numerous prescribing factors simultaneously may be more effective than narrow approaches that target very specific stakeholders and prescribing factors. For example, state-level policies that involve prescribers, pharmacists, health insurers, and patients may result in larger cumulative effects than narrower policies that only target one of those groups. Second, leveraging the use of data and technology to track and manage opioid prescribing has clear advantages and may improve policy implementation. For example, state prescription drug monitoring programs (PDMPs) may be more effective when they are linked to electronic medical record systems and integrated with PDMPs of neighboring states. Third, many effective policies combined education and training with methods for tracking and reinforcing the desired prescribing methods. For

example, prescriber education and training methods were commonly paired with peer-based feedback and reinforcement. In addition to these overall observations, our environmental scan showed effective policies in several areas, which we describe below.

Policies with substantial evidence

- **Prescription guidelines.** New prescribing guidelines issued by federal and state authorities and by professional medical associations have contributed to reductions in opioid prescribing rates. Adoption and enforcement of these guidelines within health care and insurance systems have shown further benefits.
- **PDMPs.** PDMPs are electronic database systems implemented by nearly all states that allow or require providers to check that patients are not receiving opioids from multiple sources. PDMPs have reduced opioid prescribing rates, and efforts are being made to improve their integration between states and within electronic medical record systems.
- **Dispensing limits.** Adopting drug formularies, requiring prior authorizations, or otherwise limiting the quantity of opioid medications and circumstances in which providers can prescribe them are effective policies to reduce opioid prescribing rates. Twelve state workers' compensation regulatory systems have adopted drug formularies.
- **Multifaceted interventions.** Some states and health care systems have adopted a multifaceted approach to alter opioid prescribing practices that includes guideline adoption, provider education, patient and consumer outreach, and data-driven solutions. Combining multiple system-level strategies has reduced opioid prescribing.
- **Provider education.** Training providers to follow more effective opioid prescribing practices has been implemented widely, and these training programs have reduced opioid prescribing rates, especially when the education is paired with peer feedback and advice.

Policies with emerging evidence

- **Laws and policies**. Enacting laws or regulations at the state or federal level pertaining to opioid prescribing limits, cannabis, and treatment options for opioid use disorder is associated with measurable improvements in opioid-related outcomes. Reclassifying the risk level of some opioid medications has shown a dramatic effect.
- **Automated alerts**. Computerized alerts within electronic medical record systems can inform providers about patients at risk of opioid overuse or misuse. This automated strategy has been shown to reduce opioid prescribing within emergency departments and the Veterans Health Administration system.
- **Predictive modeling**. Large administrative data sources within health care systems can be mined to develop computational models that synthesize various factors that predict problematic patterns of opioid use.
- **Pharmacist interventions**. Engaging pharmacists to review and consult with health care providers can improve adherence with opioid prescribing guidelines. An automatic pharmacist consult can be triggered when opioids exceed recommended dosages or when co-prescribing with other medications represents contraindications.
- **Opioid tapering**. Establishing opioid tapering programs with or without medication substitution has been shown to reduce opioid use for those at high opioid doses, but these programs also require the availability of psychological therapy or support for patients.

- **NSAID substitution**. Offering nonsteroidal anti-inflammatory drugs (NSAIDs) as an alternative pain management strategy after surgery reduces opioid prescribing, but these programs usually include counseling on behavioral pain self-management strategies.
- **Patient education**. Providing information about opioid risks to patients before and after surgery has been shown to decrease opioid prescribing rates and increase patient awareness of opioid-related risks.
- **Information sharing**. Sharing patient data and provider prescribing patterns across provider groups and health care systems has been shown to reduce opioid prescribing.

For policymakers, there is a clear indication that efforts to create new policies or revise existing policies to reduce opioid prescribing practices have been largely effective, though these changes can occur gradually over several years, and long-term evaluations of prescribing trends provide the best method to assess the effects of policy change. Overlapping or simultaneous policy changes can make it difficult to accurately assess the effects of a specific policy change, but researchers have employed a variety of methods to distinguish policy effects from secular changes in prescribing policies.

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I. Introduction

From 1999 to 2016, the rate of deaths from drug overdoses involving prescription opioids, adjusted for differences in the age distribution over time, more than quadrupled. In 2016, an estimated 17,087 people died from drug overdoses involving prescription opioids. The number of deaths from drug overdoses involving any opioids was even larger—an estimated 42,329 in 2016 (Centers for Disease Control and Prevention [CDC] 2018).

The problem of prescription opioid misuse and addiction is of particular concern to the U.S. Department of Labor (DOL) and other stakeholders interested in the health of workers in the United States. Injured workers are often prescribed opioids to ease pain, and people in their prime working-age years have relatively high rates of drug overdose deaths involving prescription opioids; in 2016, rates were highest among those ages 45 to 54 (10.1 per 100,000) and 35 to 44 (9.2 per 100,000). These deaths represent just a fraction of adverse events related to opioid use and misuse among working-age people. In 2015, according to the CDC, people ages 20 to 64 accounted for more than 43,000 nonfatal hospitalizations related to opioid poisoning (excluding heroin and methadone poisonings) and a similar number of nonfatal emergency department visits related to opioid poisoning.

The opioid epidemic has important implications for the civilian labor force. DOL's Chief Evaluation Office therefore seeks to build knowledge about opioid prescription management strategies and to identify promising approaches to help address opioid use and misuse among U.S. workers. The federal government also has a specific interest in the topic because of its role as provider of workers' compensation insurance to more than 2.5 million federal and postal workers though the Federal Employees' Compensation Act program. This program is administered by the Division of Federal Employees' Compensation within DOL's Office of Workers' Compensation (OWCP).

The Chief Evaluation Office, in partnership with OWCP, contracted with Mathematica and the University of Connecticut Health Center to contribute to this effort. Mathematica and the University of Connecticut Health Center conducted an environmental scan to identify approaches to opioid prescription management as well as existing evidence on the approaches' effectiveness in reducing opioid prescriptions and improving patient outcomes. The objective for the environmental scan was to develop a thorough understanding of existing policies, strategies, and practices implemented in workers' compensation and other health care settings (such as health insurance programs and health care systems) to reduce opioid prescriptions and opioid dependence. Specifically, we sought to determine which approaches are the most promising for further consideration by relevant stakeholders, how and where they were implemented, and the strength of the evidence about their effectiveness

A. Federal, state, and private initiatives to address the opioid crisis

Stakeholders interested in improving the health of workers in the United States have a strong interest in policies, programs, and interventions to help address the ongoing health crisis stemming from widespread abuse of, and addiction to, opioid painkillers and illicit opioids. The Trump administration has made addressing the opioid crisis a high priority. In March 2017, the president issued an executive order establishing a commission on combatting drug addiction and the opioid crisis. In its final report, the commission made 56 specific recommendations to combat the opioid addiction crisis, addressing federal funding and programs; opioid addiction prevention; opioid addiction treatment, overdose reversal, and recovery; and research and development by federal agencies (Christie et al. 2017).

DOL, like other federal agencies, has taken action to address the economic and workforce-related impacts of the opioid epidemic. This includes a new grant pilot program that will help states train and provide other supports to new, incumbent, and dislocated workers who have been impacted by the opioid crisis (DOL 2018). Grants from this program will also help states build the skilled workforce required to treat such workers.

DOL's efforts complement other federal agencies' significant actions to support treatment and recovery services, target availability of overdose reversal drugs, and train first responders, among other initiatives. For example, (1) CDC developed and published the CDC Guideline for Prescribing Opioids for Chronic Pain, which provides recommendations for prescribing opioid pain medication for patients 18 and older in primary care settings; (2) the U.S. Department of Health and Human Services (HHS) has granted hundreds of millions of dollars in Opioid State Targeted Response grants to fund state efforts to provide prevention, treatment, and recovery support services to people with opioid use disorder; and (3) the U.S. Food and Drug Administration (FDA) has issued new and more stringent requirements for makers of immediate-release opioids (Dowell et al. 2016; HHS 2018; FDA 2018).

State governments, private health insurers, and workers' compensation insurers have also taken steps to address the opioid crisis. Prescription opioid misuse and addiction are of particular concern to stakeholders in workers' compensation because injured workers are often prescribed opioids to ease pain. These approaches include using prescription drug monitoring programs (PDMPs), introducing rules that limit dispensing of prescriptions, and implementing treatment guidelines and protocols. Research on the effectiveness of these approaches has been inconclusive (Haegerich et al. 2014, Healthcare Fraud Prevention Partnership 2017).

B. This report

This report presents a review and synthesis of approaches to opioid prescription management and existing evidence on their effectiveness in reducing opioid prescriptions and improving patient outcomes. Our review includes studies of initiatives and strategies across a variety of intervention categories, settings, and research designs. We first describe the methods and sources we used for the environmental scan (Chapter II). We then provide a high-level synthesis of the 134 studies we identified in our environmental scan (Chapter III) and a more in-depth synthesis for each of the 13 intervention categories that emerged from our environmental scan (Chapters IV to XVI). Finally, we summarize the implications of the existing evidence for new initiatives and further research (Chapter XVII).

II. Methods for the environmental scan

To identify promising approaches to opioid prescription management, we reviewed recent studies of programs that aimed to curb opioid prescriptions and opioid dependence, documenting key program features, the research methods by which they were evaluated, and the main study findings. Below, we summarize our approach to identifying the studies we reviewed and then explain the information we extracted from each study and how we did so.

A. Identifying programs and research studies

We first reviewed reports published in 2014 or later that DOL and project team members were already familiar with.[1] These reports cited numerous studies that examined the effectiveness of various policies and interventions that aimed to curb opioid prescriptions and opioid dependence. We then searched for relevant studies in websites of professional associations and research institutions that focus on the health of workers in the United States.[2] Finally, we conducted a targeted literature search of relevant studies published from 2014 to 2019, using four major databases: MEDLINE, PsycINFO, CINAHL, and Academic Search Premier. We designed the search to identify studies of programs intended to curb opioid prescriptions that also included results from some type of impact evaluation.[3] We augmented this search with studies recommended by members of a technical working group we convened on April 24, 2019.[4] Our final list of studies for the environmental scan included 134 studies.[5]

For this environmental scan, DOL was particularly interested in approaches that had a direct goal of reducing opioid prescriptions and would be potentially applicable in a workers' compensation setting, so we focused our scan on such approaches. For example, we did not review nonpharmacological approaches to pain management—even though such approaches could ultimately lead to reduced opioid prescriptions and this is an important area that the National Academies of Sciences, Engineering, and Medicine (NASEM) has been looking into, among others (NASEM 2019). Potentially promising nonpharmacological approaches include cognitive behavioral therapy, physical therapy, and massage

[1] These reports included American College of Occupational and Environmental Medicine (2016); Haegerich et al. (2014); Healthcare Fraud Prevention Partnership (2017); International Association of Industrial Accident Boards and Commissions (2018); National Council on Compensation Insurance (2018a, 2018b); Rothkin (2018); Shaw et al. (2017a, 2017b); Thumula et al. (2017); and Thumula and Liu (2014).

[2] Specifically, we searched the websites of the International Association of Industrial Accident Boards and Commissions (IAIABC), the Workers Compensation Research Institute (WCRI), the American College of Occupational and Environmental Medicine (ACOEM), the National Council on Compensation Insurance (NCCI), and the California Workers' Compensation Institute.

[3] The exact search terms, which allowed for flexibility in the exact wording and in the proximity of keywords to each other, were: "((opioid* n/2 prescri*) OR "opioid management") AND ("evidence-based" OR program* OR implement* OR Initiative OR intervention OR evaluation OR demonstration OR pilot OR strateg* OR practice OR model OR guideline OR "worker* compensation") AND (Impact* OR effect* OR efficac* OR benefit* OR improv* OR progress OR growth OR increas* OR decreas* OR reduc* OR gain OR declin* OR success* Or assess* Or evaluat*)."

[4] Members of the technical working group had expertise in workers' compensation, occupational medicine, prescription management, private insurance practices, and research and evaluation. The group included Marianne Cloeren (University of Maryland School of Medicine), Jaymie Mai (Washington State Department of Labor & Industries), Adam Seidner (The Hartford), Vennela Thumula (WCRI), and Amy Lee (Texas Department of Insurance).

[5] Three of the 134 studies are from before 2014; we included Fox et al. (2013) because a correspondence in response to that study was published in the same journal in 2014, and we included Franklin et al. (2012) and Garg et al. (2013) based on recommendations from the technical working group.

nonpharmacological approaches include cognitive behavioral therapy, physical therapy, and massage therapy (for example, Hofmann et al. 2012; Sun et al. 2018; and Buckenmaier et al. 2016).

B. Extracting study information and classifying by research design

We used RefWorks, a web-based bibliography manager, as the database for our environmental scan and we recorded the information we extracted for each of the final studies in a matrix. Table II.1 describes the components we extracted from each study. The completed matrix with the information extracted from all 134 final studies is in Appendix A.

To determine the effectiveness of policy interventions, it is important to know how carefully each study was conducted and whether each evaluation was relatively free from bias. For example, some studies may report changes in opioid prescribing at the time that a policy intervention was enacted without considering other competing explanations (that is, other changes that were occurring at the same time or important differences between the groups being compared). Using analytic strategies that account for other trends and factors and reduce the risk of bias and alternate explanations provides the most credible evidence. Studies with the strongest designs are less likely to lead to bias and are more likely to support causal links between policy interventions and resulting changes in opioid prescribing practices.

To assess the strength of the research design in each study, we largely followed the classification implemented in DOL's Clearinghouse for Labor Evaluation and Research (CLEAR). CLEAR rates labor-related studies high, moderate, or low based on the strength of causal evidence they contain (DOL 2019). However, given the large number of studies in this environmental scan, it was beyond the scope of this effort to fully implement CLEAR's rigorous method for determining evidence ratings. Instead, we classified the eight different research designs we identified across the 134 studies as stronger or weaker designs based on the highest possible causal evidence rating they could achieve in CLEAR, as shown in Table II.2.[6]

[6] We classified predictive analytic models as stronger designs because studies implementing predictive analytics assessed the accuracy of predictive models but did not make causal claims. We classified quasi-experimental designs (QEDs) with nonequivalent comparison groups as weaker designs to differentiate them from QEDs with equivalent comparison groups.

Table II.1. Study components extracted in the environmental scan

Component	Description
Intervention category	Options include prescription guidelines, PDMPs, provider education, dispensing limits, multifaceted interventions, patient education, automated alerts, laws and policies, predictive modeling, pharmacist interventions, opioid tapering, nonsteroidal anti-inflammatory drug substitution, information sharing (see also Table III.1)
Intervention setting or geography	Information about the setting (for example, hospital, health system, or insurance program) and geography (for example, nationwide, state, or city) in which the intervention was implemented
Problem statement or research question	The problem the study sought to solve or the research question it sought to answer
Intervention overview	A brief description of the program implemented or studied
Level of intervention	Whether the intervention was targeted at providers, patients, both providers and patients, or a health system
Treatment stage	Whether the intervention targeted opioid use at the acute or chronic stage of pain, or both
Research design	The research design used to evaluate the intervention's impact (see Table II.3 for details)
Treatment group sample size and characteristics	Size, demographic characteristics, and diagnostic characteristics of the treatment group
Comparison group, if applicable	Size, demographic characteristics, and diagnostic characteristics of the comparison group, if applicable
Data source(s)	The data source(s) used to evaluation the intervention's impact
Follow-up period	Months or years in which outcomes are captured
Measurement approach	The measurement approach used to track outcomes (for example, annual totals, annual percentages, quarterly averages).
Results	The program's estimated impacts on, or associations with, the outcomes tracked (all results are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated)
Key takeaway	Short nontechnical summary of the main finding for the study

Table II.2. Classification of research designs for the environmental scan

Research design	Study method	Highest possible causal evidence rating in CLEAR	Classification for environmental scan
Randomized controlled trial (RCT)	Compare outcomes between people randomly assigned to treatment and control groups; only treatment group members receive the intervention	High	Stronger design
Interrupted time series (ITS)	Compare outcomes for the treatment group before and after an intervention was implemented, accounting for pre-intervention trends	High	Stronger design
QED with equivalent comparison group/s (QED equivalent)	Compare outcomes between a treatment group and a comparison group with similar baseline characteristics	Moderate	Stronger design
Predictive analytics	Assess the accuracy of models designed to predict certain outcomes	n.a.	Stronger design
QED with nonequivalent comparison group/s (QED nonequivalent)	Compare outcomes between a treatment group and a comparison group with different baseline characteristics, sometimes controlling for differences between the two groups	Moderate	Weaker design
Pre-post	Compare outcomes for a treatment group before and after an intervention was implemented, without accounting for pre-intervention trends	Low	Weaker design
Cross-sectional	Examine cross-sectional associations between the intervention and outcomes	Low	Weaker design
Program description only	Only describe the features of a relevant program or intervention but do not formally evaluate its outcomes	n.a.	Weaker design

CLEAR = Clearinghouse for Labor Evaluation and Research; QED = quasi-experimental design; n.a. = not applicable.

III. Overview of intervention categories and research designs

This chapter describes the intervention categories that emerged from our environmental scan and the distribution of research designs across all 134 studies and within each intervention category.[7] If a study spanned more than one category but primarily focused on intervention elements from one category, we assigned the study to that category. Otherwise, we classified that study as a "multifaceted" intervention. Table III.1 summarizes the intervention categories that emerged from our environmental scan and also shows how the 134 studies are distributed across those categories. More than half of the studies (72 of 134) fell into one of three intervention categories: prescription guidelines (25), PDMPs (24), and dispensing limits (23). We also identified a relatively large number of studies in the multifaceted interventions (17) and provider education (15) intervention categories. We found relatively small numbers of studies (2 to 6) in the remainder of intervention categories.

We classified about one-third of the 134 studies as having stronger designs (mostly interrupted time series [ITS]) and two-thirds as having weaker designs (mostly pre-post designs) (Table III.2). The 13 intervention categories varied with respect to strength of research design (Figure III.1). Five categories included 15 or more studies. Of these, the level of evidence was strongest for prescription guidelines and PDMPs, in which 44 and 50 percent of studies had stronger research designs, respectively. The level of evidence was relatively weak for the remaining eight categories, each of which included six or fewer studies. In the conclusions (Chapter XVIII), we refer to the first five categories with 15 or more studies as policies with "substantial evidence," and we refer to the remaining eight categories with 6 or fewer studies as policies with "emerging evidence."

In the following chapters, we provide a more in-depth synthesis for each of the 13 intervention categories that emerged from our environmental scan. Beside the variation across studies in the type and strength of research design, we found considerable variation in intervention settings, target populations, and outcome measures, among other study components.

[7] In late 2019, after completing the analysis we report here, Haegerich and colleagues published an update of their 2014 systematic review of "the impact of state policy and systems-level interventions on prescription drug overdose" (Haegerich et al. 2014). Naturally, there is considerable overlap between the studies included in the updated review, which focused on "state, community and systems-level prevention strategies to address the opioid crisis" (Haegerich et al. 2019) and in this report. Key differences between our review and the new review by Haegerich and colleagues include how each team classified studies into intervention categories and the nature of detail provided on each study and its findings. Notably, our review does not include studies of interventions focused on naloxone education and distribution, the largest category of studies in Haegerich et al. (2019), and Haegerich and colleagues did not review predictive models.

Table III.1. Categories of interventions identified in the environmental scan

Category	Description	Number of Studies
Prescription guidelines	Guidelines or guideline-based care to help providers manage opioid prescriptions	25
PDMPs	Statewide prescription drug-monitoring databases that providers can (and are sometimes required to) use	24
Dispensing limits	Programs or policies that restrict provider prescribing options	23
Multifaceted interventions	Multiple simultaneous strategies to help providers manage opioid prescriptions	17
Provider education	Education programs designed to help providers manage opioid prescriptions	15
Laws and policies	Local, state, or national policy or law changes designed to help providers manage opioid prescriptions	6
Automated alerts	Automated alerts to providers about high-risk patients	5
Predictive modeling	Predictive models designed to identify problematic opioid use	4
Pharmacist interventions	Programs in which a pharmacist intervenes to help providers manage opioid prescriptions	4
Opioid tapering	Programs designed to safely taper chronic pain patients' use of opioids	4
NSAID substitution	Interventions that offer NSAID alternatives to opioid prescriptions for pain	3
Patient education	Patient education programs aimed at increasing awareness of opioid-related risks	2
Information sharing	Programs that share information on opioids prescriptions across providers or databases	2

PDMPs = prescription drug monitoring programs; NSAID = nonsteroidal anti-inflammatory drug.

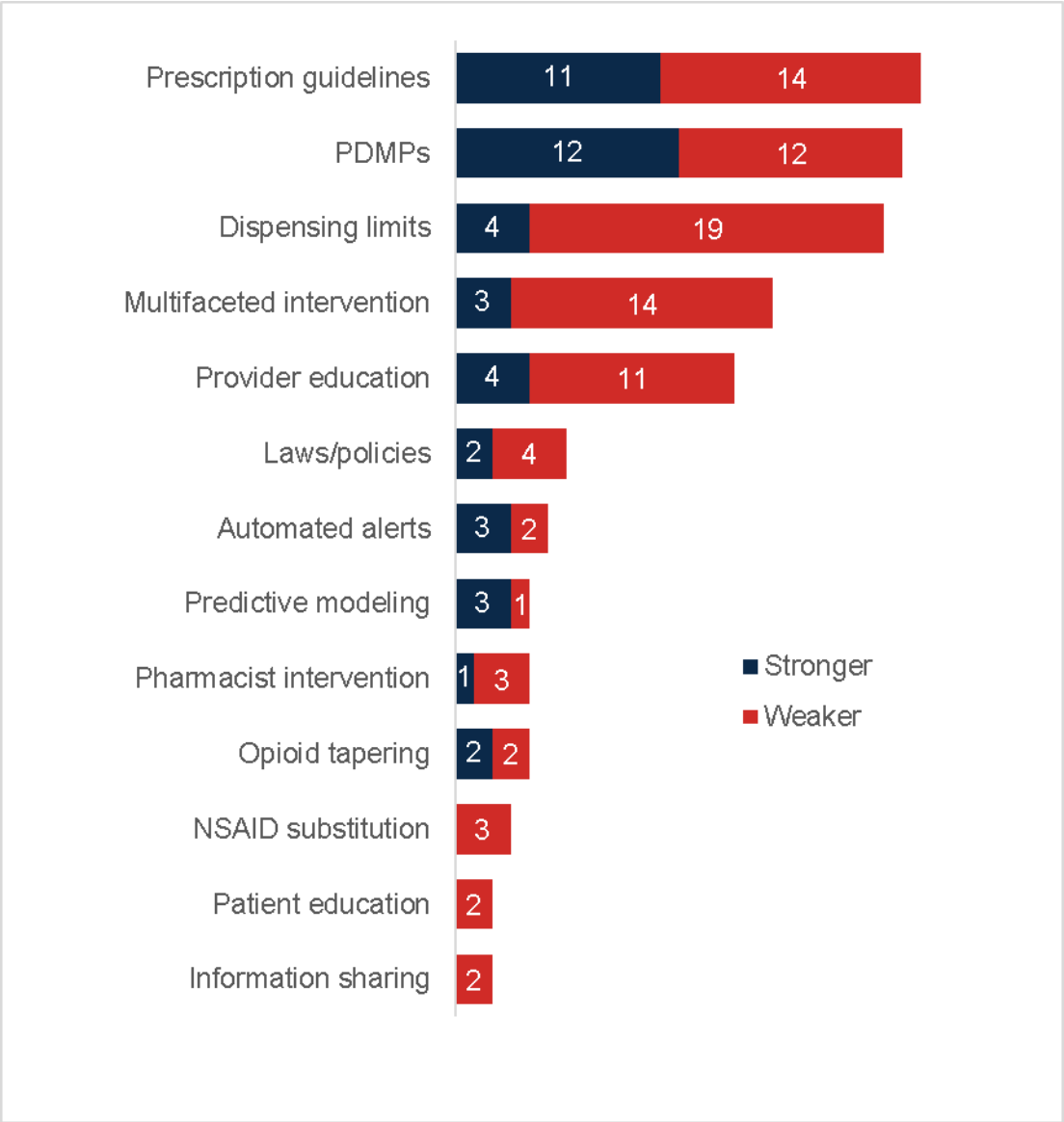
Table III.2. Strength of research design

Stronger designs		Weaker designs	
Research design	**Number**	**Research design**	**Number**
RCT	7	QED nonequivalent	14
ITS	26	Pre-post	65
QED equivalent	9	Cross-sectional	7
Predictive analytics	3	Program description only	3
Total	**45**	**Total**	**89**

Note: See Table II.2 for the description of each research design.

RCT = randomized control trial; ITS = interrupted time series; QED = quasi-experimental design.

Figure III.1. Strength of research designs, by intervention category



Notes: N = 134. Stronger designs include randomized controlled trial, interrupted time series, equivalent comparison group, and predictive analytics. Weaker designs include nonequivalent comparison group, pre-post, cross-sectional, and program description only. See Table II.1 for the description of each research design.

PDMPs = prescription drug monitoring programs; NSAID = nonsteroidal anti-inflammatory drug.

IV. Prescription guidelines

A. Overview

The environmental scan produced 25 studies related to releasing, adopting, implementing, or monitoring compliance of prescription guidelines focusing on the opioid prescribing practices of health care providers. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table IV.1).

Key observations

- Medical guidelines to encourage more effective opioid prescribing practices have been issued by federal and state governments and professional medical associations.
- Adopting or enforcing these prescription guidelines within health care and insurance systems can reduce opioid prescribing rates, dosages, and duration.
- Achieving compliance with prescription guidelines may require tracking individual providers and telling them how their adherence compares with peers.
- Peer-based education, monitoring, and feedback can facilitate adoption.
- Prescription guidelines show benefits when they are released nationally and when health care systems formally adopt them as best practice.

Table IV.1. Category overview: prescription guidelines

Study features	Summary
Primary foci	Improve guideline-adherent opioid prescribing practices; reduce combined opioid and benzodiazepine prescribing, reduce opioid refill rates; reduce average daily morphine milligram equivalent (MME) dose, improve adherence to specific guideline provisions; reduce number of patients receiving opioid prescriptions; increase non-opioid pain prescriptions; urine drug testing; periodic patient reassessments
Treatment stages	Acute (8); chronic (7); all (10)
Levels of intervention	Provider (15); provider and patient (3); primary care provider (3); emergency department provider (3); physician and nurse practitioner teams (1)
Settings/geographies	Veterans Health Administration (VHA) systems in Connecticut, Texas, and nationwide; primary care clinics in California, Minnesota, New York, Texas, and Wisconsin ; emergency departments in California, Maine, Ohio, and Washington; a community health center in Connecticut; a surgical department in Michigan; workers' compensation systems for Colorado and for a private insurance company; an orthopedic practice in Massachusetts; an urgent care practice in Rhode Island; a community provider sample in Oregon; statewide pharmacy data in North Carolina; nationwide pharmacy data; a private health system in Massachusetts
Intervention subtypes	Adopting or publishing opioid-related pain management guidelines; implementing guidelines in health systems and specialty clinics; improving guideline adherence through provider outreach and education; monitoring, case review, and feedback of prescribing practices; peer advice and consultation

Eight studies focused on guidelines related to the acute stage of pain (for example, post-surgery, emergency departments, and urgent care); 7 studies focused on chronic pain (for example, primary care and patients with long-term opioid use); and 10 studies addressed all stages of pain management. Most studies (15) aimed to change individual provider education and behavior across all provider types in a health care system, but 10 studies focused on specific medical specialties or health systems (for example, emergency medicine, primary care, surgery, or other specialty care teams).

Participating entities or data sources for the 25 studies included Veterans Health Administration (VHA) systems, networks of primary care clinics, hospital emergency or surgical departments, private payers, orthopedic practices, urgent care centers, and national or statewide pharmacy data. Local or state efforts were geographically diverse and included guideline initiatives in California, Connecticut, Maine, Massachusetts, Minnesota, New York, North Carolina, Ohio, Oregon, Texas, and Wisconsin.

The 25 studies varied in terms of the types of programs intended to implement guideline recommendations. The largest-scale evaluation used data from about 50,000 pharmacies nationwide to assess pharmacy outcomes in response to adopting the CDC guidelines for prescribing opioids for chronic pain (Bohnert et al. 2018). The smallest evaluations evaluated outcomes of small groups of providers participating in individual training programs designed to improve guideline adherence (for example, Gaiennie and Dols 2018). Besides the evaluation of newly adopted guideline documents, other studies evaluated different guideline implementation and training methods, system case monitoring and feedback, and peer advice and consultation.

B. Findings

Table IV.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Nearly half (11 of 25) of the studies for evaluating the impact of prescription guidelines on opioid prescribing practices used stronger research designs that were relatively free from bias. Nine of these rigorous studies used interrupted time series (ITS) designs, one used a quasi-experimental design (QED) with an equivalent comparison group, and one used a randomized controlled trial (RCT) (Table IV.2). The period of pre- and post-implementation varied substantially. Among studies with stronger designs, the period of follow-up assessment varied from five months to 6.5 years, and data were composed of monthly or annual totals or averages. For ITS designs, a comparison of trends (linear slopes) before and after implementing the guidelines was the primary means of evaluation.

Most studies with stronger and weaker designs reported positive findings on most outcomes. Nine out of 11 studies with stronger designs reported on various measures of opioid prescribing. These studies generally showed a measurable benefit of implementing the guidelines even after controlling for an observed secular decline in opioid prescribing across all providers. Four studies that specifically examined changes in opioid prescribing rates reported 0.9 to 39.6 percent reductions in opioid prescribing attributed to the new guidelines. One study, however, showed a 9.4 percent increase in opioid prescription fills (Buttorff et al. 2017). Two studies with stronger designs evaluated the effect of guideline implementation on guideline adherence (Liebschutz et al. 2017; Barber et al. 2017). The percentage improvement in guideline-adherent cases showed a wide variation, from 2.2 to 74.3 percent, as studies applied very different criteria to define adherence.

Table IV.2. Key takeaways: prescription guidelines

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Liebschutz et al. 2017	RCT	12 months (within the period from January 2014 to March 2016)	Annual totals and percentages	• **Share receiving guideline-concordant care: ↑ 28.1 pp (74.3 percent)** • Share with signed agreement: ↑ 47.8 pp (796.7 percent) • Share with urine drug test in past 12 months: ↑ 16.7 pp (28.8 percent)	Over the 12-month follow-up period, patients in the intervention group were 28.1 pp more likely to have received guideline-concordant care (74.3 percent change compared with control group).
Barber et al. 2017	ITS	• Directive 1: July 2003 to December 2009 (78 months) • Directive 2: July 2005 to December 2009 (54 months) • Directive 3: July 2008 to December 2009 (18 months) • Directive 4: October 2006 to December 2009 (39 months)	Monthly compliance with directive	• **Directive 1 (oxycodone CR prescriptions): ↑ 2.2 percent at point of introduction** • **Directive 4 (new propoxyphene prescriptions): ↑ 0.09 percent at point of introduction**	In the month immediately after each directive was implemented, compliance increased by 2.2 percent (directive 1) and 0.09 percent (directive 2).
Bohnert et al. 2018	ITS	March 2016 to December 2017 (22 months)	Rate of monthly decline	• **Opioid prescriptions dispensed per 100,000 persons: ↑ 33.267 (141.7 percent)** • Opioid prescriptions written for 90 MED or more per day per 100,000 persons: ↑ 4.444 (125.0 percent) • Percentage of patients with concurrent opioid and benzodiazepine prescriptions: ↑ 0.056 (266.7 percent)	Over the 22-month follow-up period, the monthly rate of opioid prescriptions fell by 33.3 pp faster per month (142 percent change compared with baseline).
Garcia et al. 2016	ITS	July 2012 to June 2015 (3 years)	Rate of annual decline	• **Patients receiving opioid prescriptions: ↑ 6.319 pp (703.7 percent)** • Opioid prescriptions per 1,000 persons: ↑ 6.322 pp (355 percent)	Over the 3-year follow-up period, the annual probability of opioid prescriptions fell by 6.319 pp faster (703.7 percent change compared with baseline).
Garg et al. 2013	ITS	April 2007 to December 2010 (45 months)	Monthly percentages	• **Workers' compensation claimants receiving opioid prescriptions: ↓ 3.7 pp (25.6 percent)** • Incident users receiving doses greater than 120 mg MED per day: ↓ 35 percent	Over the 45-month follow-up period, the monthly probability of opioid prescriptions fell by 3.7 pp (25.6 percent change compared with baseline).
Ghobadi et al. 2018	ITS	January to December 2014 (12 months)	Annual percentage	• **Parenteral opioid use: ↓ 3.6 pp (16.4 percent)** • Opioids prescribed at discharge: ↓ 1.5 pp (9.1 percent)	Over the 12-month follow-up period, the annual probability of parenteral opioid use fell by 3.6 pp (16.4 percent change compared with baseline).

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Howard et al. 2018a	ITS	November 2016 to March 2017 (5 months)	Median OME and pill count	• **Prescription size: ↓ 175 (70 percent)** • **Pill count: ↓ 25 (62.5 percent)**	Over the 5-month follow-up period, the median prescription size fell by 175 OME (70 percent change compared with baseline) and the median pill count fell by 25 (62.5 percent change compared with baseline).
Howard et al. 2018b	ITS	November 2016 to August 2017 (10 months)	Average OMEs	• **Laparoscopic sleeve gastrectomy: ↓ 155.7 (34.8 percent)** • **Laparoscopic appendectomy: ↓ 87.9 (50.6 percent)** • **Laparoscopic inguinal hernia repair: ↓ 77.1 (41.7 percent)** • **Thyroidectomy/parathyroidectomy: ↓ 38.9 (47.7 percent)**	Over the 10-month follow-up period, average OMEs fell by between 38.9 and 155.7 (34.8 to 50.6 percent changes compared with baseline).
Osborn et al. 2017	ITS	January 2012 to June 2014 (2.5 years)	Percentage and average	• **Patients receiving opioid prescriptions: ↓ 10.2 pp (39.6 percent)** • Pills prescribed: ↓ 2.9 pp (14.8 percent)	Over the 2.5-year follow-up period, the percentage of patient visits with opioids prescribed fell by 10.2 pp (39.6 percent change compared with baseline).
Weiner et al. 2017	ITS	May 2012 to December 2014 (32 months)	Monthly totals	• Opioids prescribed: ↓ 309.7 (0.9 percent) • MMEs prescribed: ↓ 1,904.8 (0.9 percent)	Over the 32-month follow-up period, the total number of opioids prescribed fell by 309.7 per month, and the total number of MMEs prescribed fell by 1,904.8 (each 0.9 percent change compared with baseline).
Buttorff et al. 2017	QED equivalent	n.d. (6 months)	6-month totals	• **Opioid fills: ↑ 0.582 (9.4 percent)** • Pain fills: ↑ 0.254 (5.3 percent) • Mental health fills: ↑ 0.152 (10.9 percent) • Total fills: ↑ 1.633 (8.2 percent) • Drug spending: ↑ $515 (13.7 percent) • Opioid spending ↑ $444 (25.1 percent)	Over the 6-month follow-up period, the total number of opioid fills increased by 0.582 (9.4 percent change compared with baseline).
Weaker designs					
Edmond et al. 2018	QED non-equivalent	July 2008 to June 2013 (5 years)	Annual percentage	• **Long-term opioid therapy use (more than 90 days of opioids): ↓ 0.9 pp (21.4 percent)** • Referrals to physical therapy: ↑ 11.0 pp (74.3 percent) • Referrals to occupational therapy: ↑ 5.5 pp (105.8 percent)	Over the 5-year follow-up period, the probability of long-term opioid use fell by 0.9 pp (21.4 percent change compared with baseline).

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Rhon et al. 2019	QED non-equivalent	n.d. (12 months)	Annual average	• **Outpatient visits: ↓ 25 (43 percent)** • Outpatient costs: ↓ $5088 (48.5 percent)	Over the 12-month follow-up period, the average number of outpatient visits in the year following an initial consultation were 25 (43 percent) lower and average costs were $5,088 (48.5 percent) lower than the comparison group.
Anderson et al. 2015	Pre-post study	April 2012 to March 2013 (12 months)	Annual percentage	• **Chronic opioid therapy patients with opioid treatment agreements: ↑ 14.2 pp (28.8 percent)** • Chronic opioid therapy patients with urine drug tests: ↑ 20.2 pp (30.5 percent) • Chronic opioid therapy patients with behavioral health visits: ↑ 3.7 pp (15.3 percent)	Over the 12-month follow-up period, the annual probability of chronic opioid therapy patients with opioid treatment agreements increased by 14.2 pp (28.8 percent change compared with baseline).
Chen et al. 2016	Pre-post study	November 2013 to June 2014 (8 months)	8-month percentage	• **Patients receiving opioid prescriptions: ↓ 0.5 pp (14.2 percent)** • Patients receiving 3 or more opioid prescriptions): ↓ 0.4 pp (19.1 percent) • Urine drug screens ordered for chronic opioid patients: ↑ 8.1 pp (87.2 percent)	Over the 8-month follow-up period, the percentage of patients prescribed 1 or more opioids fell by 0.5 pp (14.2 percent change compared with baseline).
Earp et al. 2018	Pre-post study	October to December 2016 (3 months)	Average total MMEs	• **Tier 1 (37.5 MME): ↓ 74.4 (65.5 percent)** • **Tier 2 (75 MME): ↓ 109.7 (64.1 percent)** • **Tier 3 (150 MME): ↓ 98.4 (42.9 percent)** • **Tier 4 (225 MME): ↓ 56.7 (21.4 percent)** • **Tier 5 (300 MME): ↓ 123.0 (33.3 percent)**	Over the 3-month follow-up period, the average total MMEs prescribed per patient fell by between 57 and 123 MMEs compared with a 3-month baseline period.
Fox et al. 2013	Pre-post study	March to August 2011 (5 months)	5-month percentage	• **Dental patients receiving opioid prescriptions: ↓ 17 pp (28.8 percent)**	Over the 5-month follow-up period, opioid prescriptions fell by 17 pp (28.8 percent change compared with baseline).
Franklin et al. 2012	Pre-post study	* 2008–2010 (3 years) * 2007–2010 (4 years)	Annual totals and quarterly averages and percentages	• **Annual total prescriptions, Schedule II: ↓ 26 percent in 2008–2010** • **Share of time-loss claimants receiving 120 mg per day MED or more: ↓ 35 percent from quarter 1 2007 to quarter 4 2010** • Annual total prescriptions, Schedule III: ↓ 34 percent in 2008–2010 • Share of time-loss claimants with opioid prescriptions: ↓ 37 percent from quarter 1 2007 to quarter 4 2010	Following the implementation of the Washington State Opioid Guideline, annual total Schedule II prescriptions fell by 26 percent from 2008 to 2010, and the share of time-loss claimants receiving 120 mg per day MED or more fell by 35 percent from quarter 1 2007 to quarter 4 2010.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Gaiennie and Dols 2018	Pre-post study	January 2017 to March 2017 (10 weeks)	10-week percentages and totals	• **Number of opioid prescriptions written: ↓ 10 percent** • Proportion of patients referred to pain management: ↑ 7 percent	Over the 10-week follow-up period, the number of opioid prescriptions written to chronic non-cancer pain patients fell by 10 percent.
Gillette et al. 2018	Pre-post study	January to December 2015 (12 months)	Annual totals	• **Opioid claims: ↓ 2.15 percent**	Over the 12-month follow-up period, the annual number of opioid claims fell by 2.15 percent compared with the previous year.
Lee et al. 2019	Pre-post study	November 2016 (1 months)	Monthly average	• **OMEs for simple mastectomy or wide local excision for melanoma prescribed following procedures recommending 20 tablets: ↓ 37 percent** • **OMEs for lumpectomy or breast biopsy prescribed following procedures recommending 20 tablets: ↓ 42 percent**	Over the 1-month follow-up period, monthly average OMEs fell by between 37 and 42 percent changes compared with the previous month.
Tenney et al. 2019	Pre-post study	2010–2012 (3 years)	Annual averages and ratios	• **Ratio of long-acting to short-acting opioids: ↑ 0.12 (192 percent)** • **Mean MED per claim: ↑ 5 (71 percent)**	From 2010 to 2012, the ratio of long-acting to short-acting opioids almost doubled, and mean MED per claim increased by 71 percent.
Witt et al. 2018	Pre-post study	November 2016 to April 2017 (6 months)	6-month percentage	• **Patients discontinued chronic opioid therapy or had doses below 5 MMEs per day: 22.1 percent**	Over the 6-month follow-up period, 22.1 percent of patients had discontinued chronic opioid therapy or had doses lower than 5 MMEs per day.
Young et al. 2018	Pre-post study	n.d. (4 weeks)	Weekly average over two 4-week periods	• **Opioid prescriptions: ↓ 2.43 (31.8 percent)**	Over the second 4-week follow-up period, opioid prescriptions fell by 2.43 (31.8 percent change compared with baseline).
McCalmont et al. 2018	Cross-sectional study	January to April 2017 (4 months)	Sample percentage	• **Providers read and applied the 2016 CDC Guideline for Prescribing Opioids for Chronic Pain: 56.6 percent**	Over a 4-month sample period, 56.6 percent of providers read and applied the 2016 CDC guideline.

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

CDC = Centers for Disease Control; CR = controlled release; ITS = interrupted time series; OME = oral morphine equivalent; MED = morphine equivalent dosing; MME = morphine milligram equivalent; n.d. = no date; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial.

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V. Prescription drug monitoring programs

A. Overview

Key observations

- PDMPs are statewide electronic databases that allow or require providers to check that patients are not getting opioids from multiple sources.
- 49 states and the District of Columbia have operational PDMPs; Missouri is the only state without one.
- PDMPs have largely worked as intended to reduce opioid prescriptions.
- Efforts are being made to improve PDMP usability, integration across health information systems, and data sharing across states.

The environmental scan produced 24 studies evaluating the impact of states implementing PDMPs or interventions involving new requirements for how providers should make use of PDMPs. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table V.1).

Three studies focused on outcomes related to the acute stage of pain (for example, post-surgery, emergency departments, and urgent care); 3 studies focused on chronic pain (for example, primary care, patients with long-term opioid use); and 18 studies addressed all stages of pain management. Most studies (19) examined changes in individual provider behavior across all provider types in a specific health care system, state, group of states, or nationwide; 2 studies focused on providers in emergency department settings (Suffoletto et al. 2018; Sun et al. 2018).

Most of the studies examined outcomes in one state (10), across a group of states (6), or across all states or counties in the nation (5). Two studies were performed in specific medical systems, and one study used data from three private insurance plans (Bao et al. 2018).

The 24 studies varied in terms of the types of PDMP-related changes they evaluated. State-specific studies typically focused on the impact of instituting a PDMP in that state or strengthening an existing PDMP. However, 2 state studies examined the impact of sending unsolicited PDMP-based opioid prescription records to providers (Young et al. 2017; McDonald et al. 2019). Studies of groups of states or nationwide data often focused on how impacts associated with PDMPs varied by how states implemented PDMPs.

Table V.1. Category overview: PDMPs

Study features	Summary
Primary foci	Cross-state variation in PDMP implementation (for example, comprehensive use mandates, delegation laws, and interstate data sharing); PDMP implementation and regulation of pain management clinics in a single state; automated alerts to providers
Treatment stages	Acute (3); chronic (3); all (18)
Levels of intervention	County level (1); provider (21); provider and patient (1); state level (1)
Settings/geographies	Nationwide; states (numerous); academic medical center (New Hampshire); emergency departments (Pennsylvania and Washington); private insurance plans
Intervention subtypes	Emergency prescribing rules requiring review of patients PDMP history; PDMP implementation; PDMP mandate and delegation policies; interstate PDMP data sharing; PDMP voluntary registration; unsolicited reporting of PDMP data to providers

B. Findings

Table V.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Half (12 of 24) of the studies used stronger designs that were relatively free from bias. These rigorous studies primarily used ITS designs (Table V.2). One study involved an RCT of unsolicited PDMP-based opioid prescription records to providers (McDonald et al. 2019), and two studies used QED equivalent analyses in which either prescribers (Deyo et al. 2018) or patients (Young et al. 2017) were matched to similar comparison group members. The period of pre- and post-implementation of PDMP-related interventions varied substantially across studies. Among studies with stronger designs, the period of follow-up assessment varied from seven months to five years, and data were composed of daily, monthly, quarterly, or annual totals, averages, and rates. For ITS designs, studies often reported both immediate changes and changes in trends (linear slopes) before and after implementing a PDMP.

All studies with stronger designs and most studies with weaker designs reported positive findings on most outcomes; four studies with weaker designs found no statistically significant impacts (Lin et al. 2018, Nam et al. 2017; Stucke et al. 2018; Sun et al. 2018). The studies reported numerous types of outcomes with little consistency in outcome variables across studies. Studies that examined opioid prescribing volumes all had stronger designs and found a significant drop in opioid prescribing volumes following PDMP implementation. Three ITS studies reported reductions in monthly opioid prescribing volumes, each using quite different measurement approaches: Chang et al. (2018) found a monthly reduction of 3.88 kg per high-risk prescriber; Moyo et al. (2017) found a monthly 2.36 kg reduction among 310,105 Medicare enrollees; and Rutkow et al. (2015) found that over a 12-month follow-up period, the monthly opioid volume in Florida fell by 2.46 kilograms faster per month than before the implementation of a PDMP and pill mill law.

One RCT and three ITS studies reported reductions in opioid prescription rates, again with each using different measurement approaches. For example, McDonald et al. (2018), in an RCT, found that over a 400-day follow-up period, providers in the treatment group were 13 percent less likely to continue prescribing opioids to patients than were control group members. In another study, Ranapurwala et al. (2019) found that one year after implementation of a PDMP, opioid prescriptions fell by 34 per 1,000 people, and continued to fall at a rate of 6 per 1,000 faster than before the change.

Eight studies evaluated the effect of PDMP implementation on morphine milligram equivalent (MME) dose. These studies provided impact estimates for initial and/or refill prescriptions or for morphine equivalent dosing (MED) over 24 hours. Studies with both stronger and weaker designs estimated measurable reductions in opioid dose. Here too, variation in how studies reported estimates make it difficult to compare across studies. For example, Al Achkar et al. (2018) found that immediately after PDMP implementation, daily MED per patient fell by 3.17 mg, and after that it continued to fall 110 percent faster than before the change. In comparison, Chang et al. (2018) found that, over 12-month follow-up period, daily MED among patients of high-risk prescribers fell by 0.88 mg per month.

Table V.2. Key takeaways: PDMPs

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
McDonald et al. 2019	RCT	n.d. (400-day period following date of assignment of treatment and control groups)	400-day hazard	• **Continued prescription: ↓ 13 percent**	Over the 400-day follow-up period, providers were 13 percent less likely to continue prescribing to patients.
Al Achkar et al. 2018	ITS	December 15, 2013 to November 6, 2014 (325 days)	Daily MED per patient	• **All opioids: ↓ 3.17 mg at point of implementation; 110% change in daily slope**	Immediately after implementation, daily MED per patient fell by 3.17; it continued to fall 110% faster than before the change.
Chang et al. 2018	ITS	October 2011 to September 2012 (12 months)	Monthly count and average among high-risk prescribers	• **Opioid patients: ↓ 536** • Opioid prescriptions: ↓ 847 • Average daily MED: ↓ 0.88 mg • Total opioid volume: ↓ 3.88 kg	Over the 12-month follow-up period, number of opioid patients among high-risk prescribers fell by 536 per month.
Haffajee et al. 2018	ITS	January 2010 to December 2014 (5 years)	Quarterly average	• **MED per person: ↓5.57 - 77.13 mg**	Over the states' varying follow-up periods, the quarterly average MED per enrollee fell by between 5.57 and 77.13 mg.
Moyo et al. 2017	ITS	12 months (within 2007 to 2012)	Monthly opioid volume totals	• **All: ↓ 2.36 kg (6.21 percent)** • Beneficiaries on disability: ↓ 1.67 kg • Age 65+: ↓ 0.75 kg • PDP beneficiaries: ↓ 1.17 kg • MAPD beneficiaries: ↓ 1.16 kg Dispensed prescriptions: • Beneficiaries on disability: ↑ 259 per month • MAPD beneficiaries: ↓ 610 per month	Over the 12-month follow-up period, opioid volume fell by 2.36 kg per month (6.21 percent change compared with baseline).
Patrick et al. 2016	ITS	1 year (within 1999-2013)	Annual rates per 100,000 population	• Opioid-related overdose deaths per 100,000 • **PDMP implementation: ↓ 1.12** • PDMP with 4 or more drug schedules monitored: ↓ 0.55 • PDMP with weekly or more data updates: ↓ 0.82	Over the 1-year follow-up period, opioid-related overdose deaths fell by 1.12 per 100,000.
Ranapurwala et al. 2019	ITS	January 2003 to December 2014 (12 years; outcomes assessed over 1- to 2-year delays after PDMP implementation)	Quarterly averages and rate per 1,000 insured	• **Opioid prescription per 1,000: ↓ 34 after one year, ↓ 6 change in slope** • Daily MME: ↓ 2.9 mg after two years, no change in slope • MME per refill: ↓ 42 mg after two years, ↓ 2.2 change in quarterly slope	One year after implementation, opioid prescriptions fell by 34 per 1,000; they continued to fall at a rate of 6 per 1,000 faster than before the change.
Rutkow et al. 2015	ITS	October 2011 to September 2012 (12 months)	Rate of monthly decline	• **Opioid volume: ↓ 2.46 kg (357 percent)** • MMEs per transaction: ↓ 0.45 mg (281 percent)	Over the 12-month follow-up period, opioid volume fell by 2.46 kg faster per month (357 percent change compared with baseline).

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Suffoletto et al. 2018	ITS	September 2016 to March 2017 (7 months)	Monthly percentage	• **Patients discharged with opioid prescriptions: ↓ 0.0156 at point of implementation, ↓ 0.0011 change in slope**	One month after implementation, share of patients discharged with opioid prescriptions fell by 0.0156; it continued to fall at a rate of 0.0011 faster than before the change.
Winstanley et al. 2018	ITS	April 2015 to March 2017 (24 months)	Monthly count	• **Opioids dispensed: ↓ 579,000**	Over the 24-month follow-up period, the monthly number of opioids dispensed fell by 579,000.
Deyo et al. 2018	QED equivalent	October 2011 to September 2014 (36 months)	Quarterly averages per capita	• **Opioid pills: ↓ 1.9 (11.2 percent)** • Daily MME: ↓ 0.39 mg (13.9 percent)	Over the 36-month follow-up period, the quarterly number of opioid pills per capita fell by 1.9 pills (11.2 percent change compared with baseline).
Young et al. 2017	QED equivalent	August 2011 to July 2012 (12 months)	Annual counts and averages	• **Number of opioid prescriptions: ↓ 21.8 percent** • Number of prescribers: ↓ 22.1 percent • Number of pharmacies: ↓ 23.5 percent • Dosage units: ↓ 20.4 percent • Total days' supply: ↓ 21.8 percent • Total MMEs: ↓ 17.1 percent • Average daily MMEs: ↓ 10.7 percent	Over the 12-month follow-up period, opioid prescription fell by 21.8 percent.
Weaker designs					
Ayres and Jalal 2018	QED non-equivalent	2006 to 2015 (10 years)	Annual prescriptions per 100 persons	• **Effect of must-access PDMP in high-prescribing counties: ↓ 5.64 per 100** • Medicaid expansion laws: ↓ 2.06 per 100 • Good Samaritan laws: ↓ 2.53 per 100	Between 2006 and 2015, must-access PDMPS were associated with a reduction of 5.64 prescriptions per 100 persons in high-prescribing counties.
Bao et al. 2018	QED non-equivalent	2011 to 2015 (5 years)	Annual percentage	• **Overlapping opioid prescriptions: ↓ 9.17 percent** • 3 or more opioid prescribers: ↓ 6.55 percent	Over the 5-year follow-up period, the annual probability of overlapping opioid prescriptions fell by 9.17 percent.
Buchmueller and Carey 2018	QED non-equivalent	18 months (within 2007 to 2013)	Half-year percentages	Effect of PDMP "must access" laws • **Opioid users: ↓ 2.4 percent** • Five or more prescribers: ↓ 8 percent • Four or more new patient visits: ↓ 14 percent	Over the 18-month follow-up period, PDMP "must access" laws were associated with a 2.4 percent decrease in the share of opioid users.
Dowell et al. 2016	QED non-equivalent	2006 to 2013 (8 years)	Annual average and count per 100,000 people	• **Opioid MMEs: ↓ 80.1 mg** • Prescription opioid overdose deaths per 100,000 people: ↓ 1.2	Over the 8-year follow-up period, the average number of MMEs prescribed per resident fell by 80.1 mg.
Nam et al. 2017	QED non-equivalent	n.d. 1999 to 2014 (16 years)	Annual rates per 100,000 population	• **Overdose mortality rates: no change**	Over the 16-year follow-up period, overdose mortality rates showed no statistically significant change.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Pauly et al. 2018	QED non-equivalent	January 2004 to December 2014 (11 years)	Average rate of annual increase	• **Prescription opioid-related poisonings: ↓ 6.3 pp (67 percent)**	Over the 11-year follow-up period, the average annual increase in the rate of prescription opioid-related poisonings was 6.3 pp slower in PDMP states (67 percent relative change).
Wen et al. 2017	QED non-equivalent	2011 to 2014 (4 years)	Quarterly averages per 100 enrollees	• **Schedule II opioid prescriptions: ↓ 1.4 per 100 enrollees (9 percent)** • Medicaid spending on Schedule II opioid prescriptions: ↓ $59.7 (11 percent)	Over the 4-year follow-up period, Schedule II opioid prescriptions per 100 Medicaid enrollees were 1.4 lower in states with a mandate (9 percent difference).
Yarbrough 2018	QED non-equivalent	2010 to 2013 (4 years)	Annual days' supply prescribed per physician	• **Oxycodone: ↓ 5.2 percent** • Schedule IV opioids: ↑ 1.4 percent • Hydrocodone: ↓ 2.8 percent • Overall opioids: ↓ 2.0 percent	From 2010 to 2013, PDMPs were associated with a 5.2 percent decrease in annual total days' supply of oxycodone prescribed per physician.
Stucke et al. 2018	Pre-post study	January to June 2017 (6 months)	6-month percentage	• **Patients prescribed opioids after surgery: no change**	Over the 6-month follow-up period, there were no statistically significant changes in the percentage of patients prescribed opioids after surgery.
Sun et al. 2018	Pre-post study	November 2014 to September 2015 (11 months)	11-month rate	• **Opioid prescriptions per 1,000 encounters: no change**	Over the 11-month follow-up period, there was no statistically significant change in the rate of opioid prescriptions per 1,000 encounters.
Surratt et al. 2014	Pre-post study	January 2009 to September 2012 (45 months)	Diversions per 100,000 population	• **Oxycodone: ↓ 18.34 per 100,000 (65.99 percent)** • Morphine: ↓ 1.82 per 100,000 (58.71 percent) • Methadone diversion rate: ↓ 3.22 per 100,000 (78.55 percent)	During the 15-quarter follow-up period, the average diversion rates for oxycodone decreased by 18.34 per 100,000 (65.99 percent relative change).
Lin et al. 2018	Cross-sectional study	2012 (1 year)	Annual odds	• **Physician opioid prescribing for chronic non-cancer pain: no change**	Over the 1-year follow-up period, there were no statistically significant changes in the odds of opioid prescribing for non-cancer pain.

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

ITS = interrupted time series; MAPD = Medicare Advantage and Prescription Drug Plan; MED = morphine equivalent dosing; MME = morphine milligram equivalent; n.d. = no date; PDMP = prescription drug monitoring program; PDP = Prescription Drug Plan; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial.

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VI. Dispensing limits

A. Overview

Key observations

- Some policies implemented by health insurers, workers' compensation programs, and health systems have sought to limit the quantity of opioids and circumstances under which a provider can prescribe them.
- Many public and private health insurance systems require prior authorization for opioid prescriptions, and 12 states have adopted drug formularies in their workers' compensation systems.
- Dispensing limits can substantially reduce opioid prescriptions.

The environmental scan produced 23 studies related to programs or policies that restrict providers' prescribing options. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table VI.1).

One study focused on dispensing limits related to the acute stage of pain (for example, post-surgery, emergency departments, and urgent care) and 4 studies focused on chronic pain (for example, primary care and patients with long-term opioid use). Most studies (18) addressed all stages of pain management. The majority of studies (15) aimed to change individual provider behavior, 6 studies examined both provider and patients' behavior, and 2 studies focused on patients.

The 23 studies included a wide variety of settings: a health system in New Haven, Connecticut; a hospital in Boston, Massachusetts; community health centers in Omaha, Nebraska; state Medicaid plans in Massachusetts, North Carolina, Oklahoma, and Oregon; Medicaid managed care plans in Colorado and Michigan; an academic dentistry school; a comprehensive cancer center; an internal medicine clinic, emergency departments; Washington's worker's compensation program; and the Veterans Affairs workers' compensation program.

The studies varied in terms of the types of programs intended to limit dispensing of opioids. This included studies of prior authorization requirements (sometimes combined with other rules), default pill counts set in electronic health record (EHR) systems, protocols setting MED limits for prescribers, refill limits, lock-in programs restricting patients to receive prescriptions from a single provider, drug formularies restricting the types of drugs available to patients, and pill mill laws aimed at curbing opioid prescribing by pain management clinics.

Table VI.1. Category overview: dispensing limits

Study features	Summary
Primary foci	Reduce opioid prescriptions after acute pain, improve adherence to chronic pain protocols, reduce doctor shopping, eliminate post-surgery opioid use, reduce extended release or long-acting opioid therapy
Treatment stages	Acute (1); chronic (4); all (18)
Levels of intervention	Patient (2); provider (15); provider and patient (6)
Settings/ geographies	Health system in New Haven, Connecticut; hospital in Boston, Massachusetts; community health centers in Omaha, Nebraska; state Medicaid plans in Massachusetts, North Carolina, Oklahoma, and Oregon; Medicaid managed care plans in Colorado and Michigan; an academic dentistry school; a comprehensive cancer center; an internal medicine clinic, emergency departments; Washington worker's compensation; Veterans Affairs workers' compensation
Intervention subtypes	Prior authorization; EHR default pill counts; MED limits; refill limits; lock-in programs; drug formularies; pill mill laws

B. Findings

Table VI.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Only 4 of 23 studies used stronger designs that were relatively free from bias. Two studies used ITS designs and 2 others used QED equivalent analyses. The period of pre- and post-implementation of guidelines varied substantially across studies. Among studies with stronger designs, the period of follow-up assessment varied from three months to 18 months. Two of the 4 studies with stronger designs examined monthly measures, 1 examined quarterly measures, and another examined annual measures. Studies with weaker designs varied widely in their measurement approach.

Studies with both stronger and weaker designs reported positive findings on most outcomes. Most studies showed a significant drop in opioid prescribing rates coincident with implementing dispensing limits, but only one of the four studies with stronger research designs tracked opioid prescription rates. That study, Keast et al. (2018), found that over the 12-months follow-up period, the annual probability of opioid-naive extended-release and long-acting (ER/LA) use fell by 0.7 percentage points (a 70 percent reduction compared to baseline). Three of the four studies with stronger designs tracked opioid dose as their primary outcome. Garcia et al. (2019) found that in the quarter immediately after the implementation of each of three increasingly strict prior-authorization rules, the median average daily MED fell by about 3 percent compared to the previous quarter. Lyapustina et al. (2016) found that, over the 12-months follow-up period, the monthly average MED per transaction fell by 0.57 mg (an 8 percent change compared to the baseline trend). Hartung et al. (2017) found that over the 18-months follow-up period, the monthly probability of an opioid fill over 120 mg MED fell by 1.7 percentage points (a 53 percent change compared to baseline).

Table VI.2. Key takeaways: dispensing limits

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Garcia et al. 2019	ITS	October to December 2004 (3 months) April to June 2014 (3 months) January to March 2016 (3 months)	Median average daily MED	• **Intervention 1b (PA for more than 360 mg): ↓2.96 percent** • **Intervention 2 (PA for more than 240 mg): ↓2.66 percent** • **Intervention 3 (PA for more than 120 mg): ↓3.05 percent**	In the quarter immediately after each intervention, the median average daily MED fell by about 3 percent compared with the previous quarter.
Lyapustina et al. 2016	ITS	September 2010 to August 2011 (12 months)	Monthly averages and totals	• **Average MED per transaction: ↓0.57 mg (↓8.06 percent)** • Opioid volume: ↓9.99 kg (24.3 percent) • Opioid prescriptions: ↓12,200 (22.8 percent) • Opioid pills dispensed: ↓714,000 (19.5 percent)	Over the 12-months follow-up period, the monthly average MED per transaction fell by 0.57 mg (8 percent change compared with baseline).
Hartung et al. 2017	QED equivalent	July 2012 to December 2013 (18 months)	Monthly percentage	• **Opioid fill more than 120 mg MED: ↓ 1.7 pp (53.0 percent)** • Opioid fill less than 61 mg MED: ↑1.0 pp (4.9 percent) • Fill of medications for neuropathic pain: ↑1.2 pp (9.0 percent) • Multiple pharmacy use: ↓0.1 pp (62.5 percent)	Over the 18-months follow-up period, the monthly probability of an opioid fill over 120 mg MED fell by 1.7 pp (53 percent change compared with baseline).
Keast et al. 2018	QED equivalent	July 2008 to June 2009 (12 months)	Annual percentage	• **Opioid-naive ER/LA opioid use: ↓0.7 pp (70 percent)** • Any new opioid ER/LA use ↓1.4 pp (33 percent)	Over the 12-months follow-up period, the annual probability of opioid-naive ER/LA use fell by 0.7 pp (70 percent compared with baseline).
Weaker designs					
Barnett et al. 2018	QED non-equivalent	July 2015 to December 2016 (18 months)	Monthly rate per 10,000 people	• **Extended release opioid initiation: ↓0.97 (36 percent)** • Short-acting opioid fills: ↑7.0 (1.4 percent)	Over the 12-months follow-up period, the monthly rate of extended release opioid initiation fell by 0.97 per 10,000 people (36 percent change compared with baseline).
Texas Department of Insurance 2017	Pre-post study with additional comparison group	September 2011 to August 2012 (12 months)	Annual counts and costs	• **Injured employees receiving N-drugs: ↓20,105 (67 percent)** • Injured employees receiving other drugs: ↓556 (1 percent) • N-drug costs: ↓$7M (78 percent) • Other drug costs: ↑$438K (1 percent)	Over the 12 months follow-up period, the number of injured employees receiving N-drugs fell by 20,105 (67 percent change compared with baseline).

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Chiu et al. 2018	Pre-post study	n.d. (18 months)	3-month averages	• **Number of pills prescribed per prescription: ↓ 5.22 (19.5 percent)** • MME per prescription: ↓ 34.41 (19.6 percent)	Over the 3-month follow-up period, the average number of pills prescribed per prescription fell by 19.5 percent compared with baseline.
Downes et al. 2018	Pre-post study	July 2015 to July 2016 (12 months)	Annual total and percentages	• **Number of patients receiving long-term opioid therapy: ↓ 97 (44 percent)** • Percentage of patients on opioids with above the MED limit: ↓ 1 pp (17 percent) • Percentage of patients on opioids with pain contracts: ↑ 23 pp (41 percent) • Percentage of patients on opioids receiving urine drug screening: ↑ 18 pp (42 percent)	Over the 12-month follow-up period, the annual number of patients receiving opioid therapy fell by 97 (44 percent compared with baseline).
Dreyer et al. 2015	Pre-post study	March 2008 to August 2013 (Outcomes were assessed up to 36 months after date of enrollment)	Percentages in the 6-, 12-, 24-, and 36-month periods	• **Opioid use: no change**	Because of the small sample size, the results did not allow for statistical testing of the sample.
Franklin et al. 2019	Pre-post study	January 2013 to December 2017 (5 years)	Quarterly percentage	• **Persistent opioid use: ↓ 4 pp (80 percent)**	Over the 5-year follow-up period, the quarterly percentage of persistent opioid use fell by 4 pp (80 percent change compared with baseline).
Hayes and Swedlow 2019	Pre-post study	January to June 2018 (6 months)	6-month percentages	• **Exempt drug prescriptions: ↑ 5.3 pp (16 percent) compared with 2016, ↑ 3.3 pp (9 percent) compared with 2017** • Non-exempt drug prescriptions: ↓ 9.2 pp (17 percent) compared with 2016, ↓ 7.8 pp (15 percent) compared with 2017	Over the 6-month follow-up period, the percentage of exempt drug prescriptions rose by 5.3 pp (16 percent change) compared with 2016 and rose by 3.3 percentage points (9 percent change) compared with 2017.
Holland et al. 2019	Pre-post study	May to July 2018 (3 months)	3-month percentages	• **Patients who used opioids in-hospital postoperatively: ↓ 23 pp (34 percent)** • Patients discharged with opioids: ↓ 51 pp (56 percent)	Over the 3-month follow-up period, the percentage of women who used any opioid postoperatively in the hospital fell by 23 pp (34 percent change compared with baseline).
Mark et al. 2018	Pre-post study	June 2017 to June 2018 (1 year)	Annual averages	• **Opioid pills prescribed for laparotomy surgery: ↓ 32 (72 percent)** • **Opioid pills prescribed for laparoscopic or robotic surgery: ↓ 37 (97 percent)** • **Opioid pills prescribed for ambulatory surgery: ↓ 14 (99 percent)**	Over the 1-year follow-up period, the average number of opioid pills prescribed at discharge fell by 72 to 99 percent compared with baseline.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Nadeau et al. 2018	Pre-post study	February 2016 to May 2017 (15 months)	Pre- and post- 5-quarter totals and averages	• **Opioid prescriptions: ↓ 2,487 (47.1 percent)** • **Tablets prescribed per opioid prescription: ↓ 3.2 (19.0 percent)** • No significant increase in untreated pain attributable to the intervention	Over the 5-quarter follow-up period, the number of opioid prescriptions decreased by 2,487 and the number of tablets prescribed per opioid prescription decreased by 3.2 (47.1 and 19.0 percent change, compared with prior 5 quarters).
Naumann et al. 2018	Pre-post study	Up to 12 months after program release, or until June 30, 2013, for those enrolled from October 2010 to September 2012.	Monthly and daily averages	**During lock-in:** • **Dispensed controlled substances: ↓ 0.05 per person-month (2.2 percent)** • **Daily MME: ↑ 18.7 (28.2 percent)** **Post-release:** • **Dispensed controlled substances: ↓ 0.23 per person-month (10 percent)** • **Daily MME: ↑ 11.1 (16.8 percent)**	Over the 12-month max follow-up period, the monthly average number of dispensed controlled substances decreased by 0.05 during lock-in and by 0.23 during the year following release, compared with the average before intervention. But the average daily MME of dispensed opioid prescriptions increased by 18.7 during lock-in and increased by 11.1 during post-release.
Reid et al. 2018	Pre-post study	June to December 2017 (7 months)	7-month averages	• **Number of pills prescribed in first postoperative opioid prescription: ↓ 28 pills (54 percent)** • **MMEs prescribed in first postoperative opioid prescription: ↓ 306 MMEs (58 percent)** • MMEs prescribed in first 30 days: ↓ 262.63 MMEs (29.5 percent) • Number of opioid scripts filled in first 30 days: ↑ 0.29 (16.6 percent)	Over the 7-month follow-up period, average number of pills provided in the first postoperative opioid prescription fell by 28 pills (54 percent change compared with baseline). Average total MMEs in the first postoperative opioid prescription fell by 306 MME (58 percent change compared with baseline).
Riggs et al. 2017	Pre-post study	August to October 2014 (3 months)	3-month median and percentage	• **TDD in OME: ↓ 0.2 mg (3 percent)** • More than 120mg OME per day and long acting opioids: no significant change	Over the 3-month follow-up period, median TDD of opioid measured in OME fell by 0.2 mg (3 percent change compared with baseline).
Santistevan et al. 2018	Pre-post study	January 2014 to October 2014 (10 months)	10-month median and percentage	• **Median number of tablets per prescription: ↓ 5 (25 percent)** • Patients receiving 20 tablets: ↓ 0.27 pp (54 percent)	Over the 10-month follow-up period, the median number of opioid tablets per prescription fell by 5 tablets (25 percent change compared with baseline).
Skinner et al. 2016	Pre-post study	October 2010 to June 2013 (33 months)	Monthly averages	• **Opioid prescriptions: ↓ 48 percent** • Pharmacies used: ↓ 49 percent • Total days' supply: ↓ 17 percent	Over the 33-month follow-up period, the monthly average number of opioid prescriptions fell by 48 percent compared with baseline.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Slovis et al. 2018	Pre-post study	February to April 2018 (3 months)	Monthly medians and percentage	• **Median number of opioid prescriptions: ↓ 9 (16 percent)** • **Opioid prescriptions more than 3 days: ↓ 61 pp (76 percent)** • **Median number of opioid pills dispensed: ↓ 4 (33 percent)**	Over the 3-month follow-up period, the monthly median number of opioid prescriptions fell by 9 (16 percent change compared with baseline). The monthly share of opioid prescriptions lasting more than 3 days fell by 61 pp (76 percent change compared with baseline). The monthly median number of opioid pills dispensed fell by 4 (33 percent change compared with baseline).
Vu and Childress 2017	Pre-post study	• Opioid usage: August to November 2017 (4 months) • MED: October 2017 to September 2018 (12 months)	• Opioid use: averages across claimants during first 60 days after date of injury; average across claimants 61 to 120 days after date of injury; • MED: Averages by quarter and by month	• **Total morphine equivalents per claimant: ↓ 410 (41.2 percent)** • Opioid spend per claimant: ↓ $22.67 (46.7 percent) • Opioid scripts per claimant: ↑ 0.4 (30.8 percent)	After the opioid rule change in August 2017, the average total morphine equivalents per claimant decreased by 410 (41.2 percent change compared with baseline).
Weimer et al. 2016	Pre-post study	January to August 2013 (8 months)	8-month averages	• **Average daily MED: ↓ 64 mg MED (24 percent)** • Average daily MED among Tapered to Safer Dose patients: ↓ 122 mg MED (59 percent)	Over the 8-month follow-up period, the average daily dose of opioids fell by 64 mg MED (24 percent change compared with baseline).
Zivin et al. 2019	Pre-post study	May to July 2016 (3 months)	3-month percentage	• **WVU site - 15-pill opioid prescriptions: ↑ 21 pp (134 percent)**	Over the 3-month follow-up period, the percent of 15-pill opioid prescriptions rose by 21 pp (134 percent change compared with baseline).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless “no change” is indicated.

BCN = Blue Care Network; ER/LA = extended-release and long-acting; ITS = interrupted time series; MED = morphine equivalent dosing; MME = morphine milligram equivalent/mean morphine equivalent; N-drugs = not recommended drugs; OME = oral morphine equivalent; PA = prior authorization; pp = percentage points; QED = quasi-experimental design; TDD = total daily dose; WVU = West Virginia University.

VII. Multifaceted interventions

A. Overview

The environmental scan produced 17 studies that combined various aspects of provider training, dispensing limits, risk detection, guideline adoption, public information campaigns, care coordination, and other system-level improvements, all with the intention of altering the opioid prescribing practices of health care providers. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table VII.1).

Key observations

- Some states and health care systems have applied a multifaceted approach to improving opioid prescribing by combining multiple intervention strategies.
- Multifaceted interventions have combined guideline implementation, provider education, patient outreach, and technological solutions to track prescribing behavior and provide feedback.
- Combining multiple system-level strategies has been shown to be effective in modifying opioid prescribing practices within health care systems.
- Implementing multifaceted intervention strategies can help to reach providers, patients, payers, and the public.

Eight studies focused on all stages of pain management, another eight focused on chronic pain and opioid use, and one focused on acute pain. Five studies aimed to change individual provider education and behavior across all provider types in a health care system, 4 studies focused on both providers and patients, 1 study specifically targeted primary care providers and two studies targeted physician and nurse teams. Another study intervened just on patients, while 4 other studies implemented changes in entire health care systems.

Participating entities or data sources for the 17 studies included VHA systems, private clinic networks, a rural hospital, private health care systems, statewide programs, and nationwide pharmacy data. Multifaceted interventions were reported for national health systems or in programs instituted in Colorado, New York, Ohio, Oregon, Washington, and the northwest U.S. region.

The studies varied in terms of the types of system-level efforts that were evaluated, but most included at least two major elements from the categories identified in the environmental scan (for example, combining provider education with adopting guidelines or combining risk identification with pharmacy interventions). The most consistent components of multifaceted interventions included elements of guideline implementation, provider training, patient outreach, and technological solutions to support monitoring, feedback, and communication.

Table VII.1. Category overview: multifaceted interventions

Study features	Summary
Primary foci	Reduce opioid prescribing; improve adherence to treatment guidelines and evidence-based care; increase knowledge of nonpharmacological approaches to pain management; improve knowledge of patient screening and monitoring; provide feedback on provider behavior versus normative practices.
Treatment stages	Acute (1); chronic (8); all (8)
Levels of intervention	All provider types (5); providers and patients (4); primary care providers (1); physician and nurse teams (2); patients (1); entire health care systems (4)
Settings/geographies	VHA (Ohio and nationwide); primary care clinics (New York); emergency departments (Washington); health care systems (Colorado, Washington, and northwestern United States); statewide program (Oregon), nationwide poison center data; nationwide pharmacy data
Intervention subtypes	EHR risk detection; improved treatment options and care coordination; provider training; public information and resources; other system-level efforts

B. Findings

Table VII.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Only 3 of the 17 studies used stronger designs that were potentially free from bias. These studies included an RCT and two ITS designs. The period of pre- and post-implementation of multilevel interventions varied substantially across studies. Among the three studies with stronger designs, the period of follow-up assessment varied from 1.0 to 8.5 years.

The three studies with stronger designs reported positive findings for their outcomes. The odds of patients receiving opioid prescriptions from an emergency department were reduced by 80 percent (Neven et al. 2016). The number of patients receiving more than a 100 and 200 MME daily dose fell by 331 and 164 per month faster than prior to implementation, respectively (Lin et al. 2017). The number of patients receiving more than a 120 MME daily dose declined by 62.5 percent and the number of patients receiving more than 109 days' supply of opioids declined by 56.7 percent (Von Korff et al. 2016). Studies with weaker designs generally reported positive findings.

Table VII.2. Key takeaways: multifaceted interventions

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Neven et al. 2016	RCT	August 2012 to Jul 2013 (12 months)	Annual percentage	• **Odds of receiving opioid prescription from the ED relative to control group: ↓ 80 percent**	Over the 12-month follow-up period, the odds of receiving an opioid prescription from the ED fell by 80 percent compared with the control group.
Lin et al. 2017	ITS	October 2013 to September 2014 (12 months)	Change in monthly totals	• **Patients receiving more than 100 MME per day: ↓ 331** • Patients receiving more than 200 MME per day: ↓ 164 • Patients receiving concurrent opioids and benzodiazepines: ↓ 781	Over the 12-month follow-up period, the number of patients receiving 100 MME per day fell by 331 per month faster than prior to implementation.
Von Korff et al. 2016	ITS	January 2006 to June 2014 (8.5 years)	Rates of reduction in 3-month percentage and 90-day average daily MED	• **Patients receiving 120 MME or more per day: ↓ 10.5 pp (62.5 percent) in treatment group and ↓ 7 pp (34.0 percent) in comparison group** • Average MMEs per day: ↓ 35.8 mg (47 percent) in treatment group and ↓ 27.5 mg (30 percent) in comparison group • Patients receiving 109 days' supply or more: ↓ 13.6 pp (56.7 percent) in treatment group and ↓ 5.4 pp (26.9 percent) in comparison group • "Reductions in prescribing of high opioid dose and excess opioid days supplied ... were substantially greater in the group practice setting that implemented additional initiatives to alter shared physician expectations regarding appropriate COT prescribing, compared with the contracted physicians' patients."	Over the 8.5 year follow-up period, the probability of receiving 120 MME or more per day fell by 10.5 pp (63 percent change compared with baseline).
Weaker designs					
Bucher et al. 2017	QED non-equivalent	July 2013 to December 2014 (18 months)	• Percentage change in quarterly rates per 100,000 people • Percentage change in quarterly rates per 1,000 prescriptions	**Intentional ER/LA opioid abuse per 100,000 people:** • **↓ 13.1 pp compared with immediate release opioids** • ↓ 30.6 pp compared with prescription stimulants **Intentional ER/LA opioid abuse per 1,000 prescriptions:** • **↓ 19.4 pp compared with immediate release opioids** • ↓ 18.1 pp compared with prescription stimulants	Over the 18-month period following the introduction of ER/LA REMS, rates of intentional ER/LA opioid abuse fell by 13.1 and 19.4 pp more, respectively, than they fell for immediate-release opioids.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Brose et al. 2018	Pre-post study	January 2012 to July 2016 (4.5 years)	Quarterly percentage and average	• **Outpatients receiving opioids: ↓ 23 pp (59.0 percent)** • Opioid prescriptions through outpatient service: ↓ 1 (40 percent)	Over the 4.5-year follow-up period, the quarterly percentage of outpatients receiving opioids fell by 23 pp (59 percent change compared with baseline).
Divino et al. 2017	Pre-post study	July 2013 to December 2014 (18 months)	Quarterly average	• **ER/LA opioid prescriptions: ↓ 239,700 (4.3 percent)**	Over the 18-month follow-up period, the quarterly average number of ER/LA opioid prescriptions fell by 239,700 (4.3 percent change compared with baseline).
Dorflinger et al. 2014	Pre-post study	July 2011 to June 2012 (12 months)	Annual percentage	• **Chronic opioid patients with doses 120 MME or more per day: ↓ 3 pp (10.8 percent)** • Patients with opioid agreements: ↑ 53.2 pp (190.7 percent) • Patients received urine toxicology tests: ↑ 27.1 pp (51.6 percent)	Over the latest 12-month follow-up period, the annual share of chronic opioid patients with doses 120 MME or more per day fell by 3 pp (10.8 percent change compared with the first project year).
Hedberg et al. 2018	Pre-post study	January 2016 to December 2017 (24 months)	Quarterly percentage	• **Population receiving 90 MME or more per day: ↓ 0.41 pp (36.9 percent)** • Prescription opioid overdose deaths: ↓ 0.0009 pp (20 percent)	Over the 24-month follow-up period, the quarterly percentage of the population receiving 90 MME or more per day fell by 0.41 pp (36.9 percent change compared with baseline).
Motov et al. 2018	Pre-post study	September 2015 to December 2017 (28 months)	Pre- and post-percentages	• **Patients receiving opioids in the ED: ↓ 12.73 pp (29.8 percent)** • **Opioids prescribed at discharge: ↓ 25.49 pp (37.2 percent)**	Over the 28-month follow-up period, the probability of receiving opioids in the ED fell by 12.73 pp (29.8 percent change compared with baseline) and of being prescribed opioids at discharge fell by 25.49 pp (37.2 percent change compared with baseline).
Rivich et al. 2018	Pre-post study	January 2015 to March 2016 (12 months)	Median average daily MED	• **Opioid dose: ↓ 37 mg (11.7 percent)**	Over the 12-month follow-up period, the median average daily MED opioid dose fell by 37 mg (11.7 percent change compared with baseline).
Weiner et al. 2019	Pre-post study	July 2015 to April 2018 (34 months)	Monthly total	• **Schedule II prescriptions: ↓ 2,793 (31.2 percent)** • Patients receiving opioid prescriptions: ↓ 1,969 (28.7 percent)	Over the 34-month follow-up period, the monthly number of Schedule II prescriptions fell by 2,793 (31.2 percent change compared with baseline).
Whiteside et al. 2018	Pre-post study	2015 (6 months)	6-month percentage	• **Prescription opioid misuse: no change**	Over the 6-month follow-up period, there were no statistically significant changes in prescription opioid misuse.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Wong et al. 2018	Pre-post study	2015–2016 academic year; 2016–2017 academic year	Annual percentage and average	**2015–2016:** • **Toxicology: ↑ 28 pp (52.8 percent)** • **Average daily MME: ↓ 29.0 mg (30.0 percent)**	Over the 2015–2016 academic year follow-up period, percentage of annual toxicology screening increased by 28 pp (52.8 percent change compared with baseline) and average daily MME decreased by 29 mg (30 percent change compared with baseline). There were no statistically significant incremental changes for the 2016–2017 academic year.
Workers Compensation Research Institute 2017	Pre-post study	n.d. (12 months following date of injury between January 1, 2011, and December 31, 2013)	Annual percentage and average	• **Injured workers receiving opioid prescriptions: ↓ 10 pp (18.5 percent)** • MMEs per claim: ↓ 225 mg (15.3 percent)	Over the 12-month follow-up period, the annual probability of receiving an opioid prescription fell by 10 pp (18.5 percent change compared with baseline).
McCann et al. 2018	Cross-sectional study	March 2014 to September 2015 (18 months)	• Percentage of patients throughout the intervention period • Averages per visit at the beginning and end of the intervention period	• **Share weaned off opioids: 41 percent** • No differences in MME per day or pain scores after 18 months for those who remained on opioid medications	Upon conclusion of the 18-month intervention, 41 percent of patients were weaned off of opioids. There were no differences in MME per day or pain scores after 18 months for those who remained on opioid medications.
Crawford & Company 2014	Program description only	n.a.	n.a.	n.a.	As this was a program description only, there are no study findings to report.
Kaiser Permanente 2018	Program description only	n.a.	n.a.	n.a.	As this was a program description only, there are no impact or association findings to report.

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

ED = emergency department; ER/LA = extended-release and long-acting; ITS = interrupted time series; MED = morphine equivalent dosing; MME = morphine milligram equivalent; n.a. = not applicable; n.d. = no date; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial; REMS = Risk Evaluation and Mitigation Strategy.

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VIII. Provider education

A. Overview

Key observations

- Training providers to use more effective opioid prescribing practices has shown promise.
- Peer-based consultation, feedback, and advice using established guidelines may help to reinforce the information in provider training materials.
- Most provider education efforts have focused on health care settings where opioids are first prescribed, such as emergency medicine, post-surgical recovery, trauma centers, internal medicine, and pain management.

The environmental scan produced 15 studies evaluating whether educational programs for health care providers can alter their opioid prescribing practices. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table VIII.1).

Most studies (12) focused on all stages of pain management, but 3 focused on chronic pain only. Five studies aimed to change individual provider education and behavior across all provider types in a health care system, and 7 focused on specific medical specialties or health systems (for example, surgical interns and medical residents, chronic pain specialists, trauma center physicians, military physicians, and internal medicine supervising physicians). Three studies included elements of education for both providers and patients jointly.

Participating entities or data sources for the 15 studies included a VHA system, a medical residency program, academic medical centers, military provider networks, state provider registries, local health care systems, and trauma centers. Local or state efforts were geographically diverse and included provider training programs at both the local and national levels. Connecticut, the District of Columbia, Kentucky, Massachusetts, Maryland, Minnesota, New York, Pennsylvania, and South Carolina reported provider training results.

The 15 studies varied in terms of the types of programs offered to health care providers. Some studies used mailed information only, whereas others combined peer-based advice, review of established treatment guidelines, summary of best practices, access to specific tools and resources, small-group face-to-face training sessions, continuous monitoring and feedback, online training, one-on-one training, and information on nonpharmacological treatments for pain and pain management.

Table VIII.1. Category overview: provider education

Study features	Summary
Primary foci	Reduce opioid prescribing; improve adherence to treatment guidelines and evidence-based care; increase knowledge of nonpharmacological approaches to pain management; improve knowledge of patient screening and monitoring; provide feedback on provider behavior versus normative practices.
Treatment stages	Chronic (3); all (12)
Levels of intervention	All provider types (5); provider and patient (3); chronic pain specialists (1), surgical residents and interns (2); medical residents (1); military physicians (1); trauma physicians (1); internal medicine supervisors (1)
Settings/geographies	Medical resident or intern training programs (Connecticut, Massachusetts, and Washington, DC), community physicians (New York, South Carolina, and Washington); U.S. military providers (national); emergency trauma physicians (Kentucky and Pennsylvania); health system providers (Maryland, national); internal medicine faculty (Massachusetts); hand surgeons (midwestern U.S.), and VHA (Minnesota)
Intervention subtypes	Mailed educational materials; online training programs; group training, one-on-one peer advice and training; individual monitoring and feedback; comparison of prescribing behavior with peer-based norms

B. Findings

Table VIII.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Only 4 of the 15 studies used stronger designs that were relatively free from bias. These rigorous studies included an RCT, an ITS design, and two QED equivalent studies. Some studies evaluated actual opioid prescribing practices before and after training, whereas others assessed only changes in provider or patient knowledge, attitudes, and beliefs. The period of pre- and post-implementation of guidelines varied substantially across studies. Among studies with stronger designs, the period of follow-up assessment varied from 2 to 16 months, and data were composed of self-report surveys (for example, ratings of confidence to prescribe opioids in accordance with training recommendations) or actual prescribing practices (for example, MME per prescription) in the months before and after participation in training programs.

The RCT study (Pasquale et al. 2017) reported no change in outcomes for the treatment group versus the control group. However, the three other studies with strong designs generally reported positive findings. Decreases in the daily MME dose of opioid prescriptions varied from 34 to 39 percent. Confidence ratings improved from 18.2 to 34.6 percent in one study of medical residents (Alford et al. 2016a) and from 184 to 380 percent in another study of surgical interns (Chiu et al. 2019). Studies with weaker designs generally reported positive findings.

Table VIII.2. Key takeaways: provider education

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Pasquale et al. 2017	RCT	November 7, 2014, to August 4, 2015 (9 months)	9-month averages	• **Opioid or pain medications filled: no change**	Over the 9-month follow-up period, the average number of opioids or pain medications filled showed no significant changes compared with the comparison group.
Meisenberg et al. 2018	ITS	January 2017 to April 2018 (16 months)	Monthly average and percentage	• **MME per prescription: ↓ 34 percent** • Opioid prescription rate: ↓ 38 percent	Over the 16-month follow-up period, the monthly average MME per prescription fell by 34 percent compared with the average of the 6-month baseline.
Alford et al. 2016a	QED equivalent	n.d. (8 months)	Post-intervention assessment scores	**For immediate OSCE exam treatment group:** • **Combined safe opioid prescribing confidence summary score: ↑ 0.52 (18.2 percent)** • **Combined safe opioid prescribing self-reported practices summary score: ↑ 0.85 (34.6 percent)**	Over the 8-month follow-up period, provider assessment combined summary scores for safe opioid prescribing confidence and self-reported practices improved by 0.52 and 0.85 percent, respectively, in the treatment group with immediate OSCE exam compared with the control group (18.2 percent and 34.6 percent larger change, respectively, compared with control group).
Chiu et al. 2019	QED equivalent	First 2 months of residency in academic year 2017–2018	2-month percentages and average	• **MME per prescription: ↓ 80.7 MME (39 percent)** • Interns comfortable prescribing opioids: ↑ 76 pp (380 percent) • Interns comfortable prescribing non-opioid analgesia: ↑ 59 pp (184 percent)	Over the 2-month follow-up period, the average percentage of MME per prescription fell by 80.7 MME (39 percent change compared with baseline).
Weaker designs					
Kattan et al. 2016	QED non-equivalent	Period 1 – September to November 2013 (3 months) Period 2 – December 2013 to February 2014 (3 months)	Rate of 3-month decline	• **High dose opioid analgesic prescriptions (more than 100MME): ↑ 5.1 pp (70 percent)**	Over the second 3-month follow-up period, the rate of decline in the percentage of high-dose opioid analgesic prescription rates was faster by 5.1 pp in the intervention group (70 percent change relative to the nonequivalent comparison group).
Katzman et al. 2018	QED non-equivalent	2013–2016 (4 years)	Percentage change in annual averages and percentages	• **Annual average opioid prescriptions: ↓ 16.1 pp relative to comparison** • Average MME prescribed: ↓ 16.9 pp relative to comparison • Share of opioid users: ↓ 12.1 pp relative to comparison	Over the 4-year follow-up period, opioid prescriptions per patient decreased by 16.1 pp more for the treatment group than the comparison group.

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Alford et al. 2016b	Pre-post study	June to July 2014 (2 months)	Percentages at 2 months post-intervention	• **Correct responses to knowledge items: ↑ 9 pp (15 percent)** • Confidence in applying safe opioid prescribing care: 67 percent • Implementation of practice changes: 86 percent	At 2 months post-intervention, the percentage of correct responses to knowledge items rose by 9 pp (15 percent change compared with baseline).
Arnautovic et al. 2018	Pre-post study	August to September 2017 (2 months)	2-month totals and percentage	• **Number of opioid pills prescribed: ↓ 10 (27 percent)** • Laparoscopic cholecystectomy number of opioid pills prescribed: ↓ 15 (41 percent) • Patients reporting prescribed fewer narcotics post-intervention: 71 percent	Over the 2-month follow-up period, the total number of opioid pills prescribed fell by 10 pills (27 percent change compared with baseline).
Larson et al. 2018	Pre-post study	n.d. (3 months)	3-month percentages	• **PDMP use adopted among previous nonusers: 83 percent** • Used a standardized scale to monitor pain intensity and interference with daily functioning: ↑ 13 pp (30 percent)	Over the 3-month follow-up period, 83 percent of physicians who had not previously used the PDMP adopted PDMP.
Martello et al. 2018	Pre-post study	April to May 2017 (2 months following the formal education program)	2-month rate	• **Opioid prescribing rate (the share of total prescriptions that were for opioid medications): ↓ 5.4 pp (25 percent)**	Over the 2-month follow-up period, the opioid prescribing rate fell by 5.4 percentage points (25 percent change compared with baseline).
Oyler et al. 2018	Pre-post study	January to December 2015 (1 year)	Annual median	• **Median daily discharge MME: ↓ 45 (50 percent)**	Over the 1-year follow-up period, the overall median daily discharge MME fell by 45 MME (50 percent compared with baseline).
Roy et al. 2019	Pre-post study	n.d. (3 months)	Percentages at 3 months post-intervention	• **Correct responses to knowledge questions: ↑ 11 pp (16 percent)** • "High-level" confidence in safer opioid prescribing practice scores: ↑ 39 pp (90 percent)	At three months post-intervention, correct responses to knowledge questions rose by 11 pp (16 percent change compared with baseline).
Stanek et al. 2015	Pre-post study	n.d. 2012 (3 months)	3-month averages	• **Number of opioid tablets per prescription for the wrist ganglion surgery: ↓ 48 percent** • **Number of opioid tablets per prescription for the metacarpal fracture surgery: ↓ 20 percent**	Over the 3-month follow-up period, for 2 of the 4 surgeries, the average number of opioid tablets per prescription fell by 20 to 48 percent compared with baseline.
Westanmo et al. 2015	Pre-post study	July to September 2014 (3 months)	3-month percentages	• **High-dose (more than 200 MED daily) opioid prescriptions: ↓ 0.53 pp (82 percent)** • Unique pharmacy patients prescribed at least 1 opioid: ↓ 2.7 pp (20 percent)	Over the 3-month follow-up period, the overall percent of high-dose (more than 200 MED daily) opioid prescriptions fell by 0.53 pp (82 percent change compared with baseline).

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Langford et al. 2019	Cross-sectional study	n.d. (6 months)	Post-intervention survey scores	• **Self-reported knowledge and confidence in opioid prescribing for acute pain: improved** • Learning to construct a safe opioid taper plan for acute pain: associated with increased self-reported likelihood of incorporating the Washington State PMP • Learning to construct a safe opioid taper plan for acute pain: associated with increased perceived competence • Learning to distinguish between short- and long-acting opioids: associated with using multimodal analgesia • Learning to safely initiate opioids for acute pain: significantly associated with reducing the duration of opioid prescriptions	In the survey following the intervention, respondents reported an improvement in knowledge and confidence in opioid prescribing for acute pain.

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

ITS = interrupted time series; MED = morphine equivalent daily; MME = morphine milligram equivalent; n.d. = no date; OSCE = Objective Structured Clinical Examination; PCP = primary care physician; PDMP = prescription drug monitoring program; PMP = prescription monitoring program; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial.

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IX. Laws and policies

A. Overview

The environmental scan produced six studies that evaluated the effects of adopting new laws or regulatory policies intended to alter the opioid prescribing practices of health care providers (Table IX.1). These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype.

Key observations

- Some states have enacted laws or regulations pertaining to opioid prescribing limits, cannabis, and treatment options for opioid use disorder.
- Reclassifying the risk level of some opioid medications has reduced opioid prescribing rates overall.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

Two of the studies focused on laws and regulations that pertained to the chronic stage of pain, two on the acute stage of pain, and two on all stages of pain. Four studies involved laws and regulatory policies targeting health care providers, one study (Bradford et al. 2018) compared the effect of medical cannabis laws on opioid prescribing, and another (Holton et al. 2018) evaluated a new, multilevel state law designed to engage businesses, churches, health care, law enforcement, state and local public health offices, individuals in recovery, and family and friends of those with opioid use disorders.

Studies evaluated the effects of both state laws (three studies) and federal regulatory changes (three studies). Four studies extracted data for analysis from national pharmacy data and two studies extracted data from the EHRs of single health care systems (two studies). Three studies used nationwide sources of data, and three used state-level or local data (Missouri, Oregon, and Vermont).

The six studies varied in terms of the types of laws evaluated. Three studies (Jones et al. 2016; Raji et al. 2018; Tan et al. 2018) evaluated changes in opioid prescribing in response to the Drug Enforcement Agency's rescheduling of opioid medications to Schedule II drugs. One study (Bradford et al. 2018) compared opioid prescribing between states with and without medical cannabis laws, and the other two studies (MacLean et al. 2018; Holton et al. 2018) evaluated the effectiveness of state-level policy making.

Table IX.1. Category overview: laws and policies

Study features	Summary
Primary foci	Reduce patient eligibility criteria for opioid prescribing; reduce pill count and dose for opioid prescribing; substitute medical cannabis for opioids; increase safety precautions and oversight for prescribing opioids
Treatment stages	Chronic (2); acute (2); all (2)
Levels of intervention	Provider (4); states (1); multi-level (1)
Settings/geographies	Federal regulations; comparison of state laws; new laws and policies enacted in Oregon, Vermont, and a medical center in Missouri.
Intervention subtypes	Rescheduling of opioid medications by the Drug Enforcement Agency; effect of medical cannabis laws on opioid prescribing; state law enabling multilevel education and dissemination effort; state law with multiple restrictions on opioid prescribing patterns and patient eligibility.

B. Findings

Table IV.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Only two of the six studies used stronger designs that were relatively free from bias. Both used an ITS design. The period of pre- and post-implementation of guidelines varied substantially across studies, with results typically segmented by monthly or annual periods.

The two studies with stronger designs reported positive findings on most outcomes. Jones et al. (2016) found that over the 12-month follow-up period, the number of hydrocodone combination product prescriptions fell by 26 million (a 22 percent change compared to baseline). Tan et al. (2018) found that over the 27-month follow-up period, average doses prescribed fell by 0.19 MME per day faster after the rule change compared to before. Studies with weaker designs generally reported positive findings.

Table IX.2. Key takeaways: laws and policies

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Jones et al. 2016	ITS	October 2014 to Sep 2015 (12 months)	Annual totals	• **Hydrocodone combination product prescriptions: ↓ 26,335,319 (22 percent)** • Hydrocodone combination product tablets dispensed: ↓ 1,122,415,048 (16.4 percent)	Over the 12-month follow-up period, the number of hydrocodone combination product prescriptions fell by 26 million (22 percent change compared with baseline).
Tan et al. 2018	ITS	October 2014 to December 2016 (27 months)	Daily change in mean MME	• **All prescriptions: ↓ 0.19 MME per day** • Laparoscopic procedures: ↓ 0.17 MME per day	Over the 27-month follow-up period, average doses prescribed fell by 0.19 MME per day after the rule change compared with before.
Weaker designs					
Raji et al. 2018	Pre-post study with additional comparison group	June 2013 to June 2015 (2 years)	Monthly percentage	• **Opioid prescriptions: ↓ 0.54 pp (11.4 percent)** • Hydrocodone combination product prescriptions: ↓ 0.71 pp (25.9 percent)	Over the 2-year follow-up period, the monthly probability of opioid prescriptions fell by 0.54 pp (11.4 percent change compared with baseline).
Holton et al. 2018	Pre-post study	2014 to 2017 (4 years) 2011 to 2016 (6 years)	Annual rates (per 1,000 residents for opioid prescriptions and per 100,000 residents for opioid overdose deaths)	• **Opioid prescriptions: ↓ 62.2 per 1,000 (23.8 percent) in 2014–2017** • **Opioid overdose deaths: ↓ 2.6 per 100,000 (30.2 percent) in 2011–2016** • Opioid prescriptions greater than 90 MME: ↓ 5.7 per 1,000 (44.5 percent) from 2014 to 2017	Oregon's multiple interventions addressing opioid misuse and abuse are associated with a decline of 62.2 in opioid prescriptions per 1,000 residents from 2014 to 2017 and a decline of 2.6 in opioid overdose deaths per 100,000 from 2011 to 2016 (23.8 percent and 30.2 percent declines compared with baseline, respectively).
MacLean et al. 2018	Pre-post study	July to December 2017 (6 months)	6-month median	• **MME prescribed after discharge: ↓ 45 (39.8 percent)**	Over the 6-month follow-up period, the median MMEs prescribed after discharge fell by 45 (39.8 percent change compared with baseline).
Bradford et al. 2018	Cross-sectional study	2010 to 2015 (6 years)	Annual total million daily doses	Medical cannabis dispensaries: • **All opioids: ↓ 3.742 (14.4 percent)** • Hydrocodone: ↓ 2.320 (17.4 percent) • Morphine: ↓ 0.361 (20.7 percent) Medical cannabis home cultivation only: • **All opioids: ↓ 1.792 (6.9 percent)** • Hydrocodone: ↓ 1.256 (9.4 percent)	Over the 5-year follow-up period, MCLs were associated with 3.742 and 1.792 million fewer daily doses in states with medical cannabis dispensaries and in states with medical cannabis home cultivation only, respectively (14.4 percent and 6.9 percent change compared with states without MCLs, respectively).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

ITS = interrupted time series; MCL = medical cannabis law; MME = morphine milligram equivalent; pp = percentage points.

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X. Automated alerts

A. Overview

The environmental scan produced five studies related to implementing automated alerts to help manage opioid prescriptions, treat chronic pain, and reduce overdose risk. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table X.1).Three studies focused on chronic pain (for example, patients with long-term opioid use), one on acute pain management (for example, headache pain), and one study addressed all stages of pain management. Most of the studies (4) focused on changing individual provider behavior, and one study focused on changing both patient and provider behavior. Participating entities or data sources for the studies included emergency departments (in Indiana, Ohio, and North Carolina) and the VHA.

Key observations

- Electronic tools can alert providers about patients with high risk of opioid overuse or misuse based on data in electronic medical records.
- Automated alerts have been tested in emergency departments and in the Veterans Health Administration.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

The studies varied in terms of the types of programs intended to implement automated alerts. Two large studies in the VHA assessed automated alerts designed to identify patients receiving chronic opioid therapy or who had a high risk of substance use disorder or other risk factors and were co-prescribed benzodiazepines. The three smaller studies focused on emergency departments with automated alerts in place to implement screening questions or refer patients to tapering or pain management programs.

Table X.1. Category overview: automated alerts

Study features	Summary
Primary foci	Automated alerts to help with opioid management for acute headache, opioid-seeking behavior, benzodiazepine co-prescribing, overdose risk, and chronic pain
Treatment stages	Chronic (3); acute (1); all (1)
Levels of intervention	Provider (4); provider and patient (1)
Settings/geographies	EDs (Indiana; Charlotte, North Carolina; and Ohio); VHA
Intervention subtypes	Algorithms to identify opioid seekers or high-risk patients and refer to other services, reminders to assess pain for chronic opioid therapy patients

B. Findings

Table X.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results. Three of the studies used stronger designs that were potentially free from bias. These rigorous studies included one RCT, one ITS design, and one QED equivalent analysis. The follow-up period of assessment for studies with stronger designs was either one year or six months. Data were composed of annual averages and percentages, or percentages over the total follow-up period.

The studies with stronger designs generally reported positive findings. Ringwalt et al. (2015) showed a 38 percent decline in the percentage of patients prescribed opioids over a one-year follow-up period—relative to a randomly assigned control group. The other two studies with stronger designs showed decreases in co-prescriptions with benzodiazepines (26 percent) and in average MEMD per month (11.6). The two studies with weaker designs also reported generally positive findings.

Table X.2. Key takeaways: automated alerts

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger design					
Ringwalt et al. 2015	RCT	n.d. (12 months in the period from May 2012 to June 2013 depending on cohort)	Annual percentage and average	• **Patients prescribed opioids during visits: ↓ 10 pp (38 percent)** • Number of return visits to the ED: ↓ 4.69 (28 percent)	Over the 12-month follow-up period, the probability of patients prescribed opioids during their visits fell by 10 pp (38 percent change compared with baseline).
Malte et al. 2018	ITS	July 2014 to July 2015 (12 months)	Annual and 6-month percentages	• **Co-prescribing opioids and benzodiazepines: ↓ 6.5 pp (26 percent) over 12 months** • Long-term (90 days or more) concurrent opioid and benzodiazepine fills: ↓ 28 pp (29 percent) over 6 months • Short-term (less than 90 days) concurrent opioid and benzodiazepine fills: ↓ 42 pp (66 percent) over 6 months	Over the 12-month follow-up period, annual co-prescribing of opioids and benzodiazepines fell by 6.5 pp (26 percent change compared with baseline).
Patel et al. 2018	QED equivalent	January to June 2015 (6 months)	Changes in average MEMD and the RIOSORD index score	• **Change in MEMD: ↓ 11.6** • **Change in RIOSORD: ↓ 0.53**	Over the 6-month follow-up period, patients with a complete COT-CR had a greater reduction in MEMD and RIOSORD by 11.6 and 0.53, respectively, than patients with an incomplete COT-CR.
Weaker design					
Ahmed et al. 2017	Pre-post study	January to April 2013 (3 months) January to August 2014 (8 months)	Post-intervention percentages	• **Group 1 - patients treated with opioids and barbiturates: ↓ 59 pp (89 percent)** • Group 1 - scheduled follow-up appointments: ↑ 44 pp (81 percent) • Group 1 - patients discharged with opioids: ↓ 25 pp (68 percent) • **Group 2 - patients treated with opioids and barbiturates: ↓ 38 pp (58 percent)** • Group 2 - neurology consults: ↑ 28 pp (467 percent) • Group 2 - patients discharged with opioids: ↓ 31 pp (84 percent)	Over the 3-month follow-up period, the percentage of patients treated with opioids and barbiturates in Group 1 fell by 59 pp (89 percent change compared with baseline) and the percentage of patients in Group 2 fell by 38 pp (58 percent change compared with baseline).
Kahler et al. 2017	Pre-post study	n.d. (12 months)	Annual medians	• **ED visits: ↓ 71 percent** • Statewide opioid prescriptions: ↓ 38 percent • Statewide prescribers: ↓ 36 percent	Over the 12-month follow-up period, annual median ED visits fell by 71 percent compared with baseline.

[a] We ordered the studies based on declining strength of research design (see Table II.2).
[b] The follow-up period indicates the time period over which researchers measured impacts.
[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.
COT-CR = chronic opioid therapy - clinical reminder; ED = emergency department; ITS = interrupted time series; MEMD = morphine equivalent monthly dose; n.d. = no date; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial; RIOSORD = Risk Index for Overdose and Serious Opioid-Induced Respiratory Depression.

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XI. Predictive modeling

A. Overview

Key observations

- Predictive modeling uses large administrative data sources to help identify problematic patterns of opioid use and guide provider treatment plans.
- Examples include models applied in an integrated managed care organization, the Veterans Health Administration, and by workers' compensation insurers.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

The environmental scan produced four studies that related to predictive models designed to identify problematic opioid use. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table XI.1). One study focused on chronic pain (that is, patients with long-term opioid use), one study focused on acute pain management (that is, new opioid users), and two studies addressed all stages of pain management. Three of the studies focused on assessing predictive models designed to identify problematic patterns of opioid use, and one study described how a predictive model can help inform provider treatment plans. Participating entities or data sources for the studies included an integrated managed care organization in Washington, the VHA, prescription data from Medicaid and private insurance claims, and a large workers' compensation insurer.

Table XI.1. Category overview: predictive modeling

Study features	Summary
Primary foci	Models to identify problematic opioid use, risk of chronic pain
Treatment stages	Acute (1); chronic (1); all (2)
Levels of intervention	Predictive model (3); provider (1)
Settings/geographies	Integrated managed care organization in Washington, VHA, Medicaid and private insurance claims data, large WC insurer
Intervention subtypes	Risk stratification using natural language processing of EHR notes or analysis of opioid prescriptions in EHR and insurance claims data; targeting resources and care to injured workers at risk of developing chronic pain

EHR = electronic health records; VHA = Veterans Health Administration; WC = workers' compensation

B. Findings

Table XI.2 summarizes the methods, results, and key takeaway for each study in the category. We organized the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analyses, and a key takeaway or takeaways based on the primary results.

Three of the studies focused on assessing predictive models designed to identify problematic patterns of opioid use. One of these studies (Carrel et al. 2015) evaluated the effectiveness of identifying patients with problem opioid use through natural language processing in review of clinical notes. The authors found that natural language processing–assisted manual review identified 32.5 percent additional patients with clinically diagnosed problem opioid use compared with traditional diagnostic codes. Another study (Oliva et al. 2017) assessed the predictive performance of VHA's Stratification Tool for Opioid Risk Mitigation (STORM) and found that STORM performed well in predicting any overdose or suicide-

related event in FY2011 based on EHR data from FY2010. A third study (Rough et al. 2019) examined five different algorithms to predict aberrant opioid prescription behavior and found varying degrees of accuracy across the five algorithms and two data sets they used. The fourth study (The Travelers Indemnity Company 2019) contained a program description but no formal analysis.

Table XI.2. Key takeaways: predictive modeling

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Carrell et al. 2015	Predictive analytics	n.a. (data from 2006–2012)	Additional patients with clinically diagnosed problem opioid use	• **Additional patients with clinically diagnosed problem opioid use: ↑728 (32.5 percent)**	NLP-assisted manual review identified 728 additional patients with clinically diagnosed problem opioid use compared with traditional diagnostic codes (32.5 percent increase compared with baseline).
Oliva et al. 2017	Predictive analytics	FY2010 to FY2011 (12 months, on average)	Area under the ROC curve (a measure of model fit)	• **Area under the curve for model predicting any overdose or suicide-related event: 0.83**	The STORM tool performed well in predicting any overdose or suicide-related event in FY2011 based on EHR data from FY2010 (83 percent probability that a person with overdose or suicide-related event in FY2011 had higher predicted probability than person who did not).
Rough et al. 2019	Predictive analytics	12 months (within the periods 2000–2006 for MAX data and 2004–2014 for CDM data)	Difference in risk of aberrant behavior	**Risk of aberrant behavior, MAX data** • **CMS Overutilization Monitoring System: ↑14.04 percent** • **Opioid Misuse Score: ↑5.64 percent** • **Modified CS-PURE: ↑3.64 percent** • **Katz et al.: ↑0.96 percent** • **Capeda et al.: ↑ 5.10 percent** Risk of aberrant behavior, CDM data • CMS Overutilization Monitoring System: ↑13.35 percent • Opioid Misuse Score: ↑7.84 percent • Modified CS-PURE: ↑2.98 percent • Katz et al.: ↑0.47 percent • Capeda et al.: ↑ 4.41 percent	Five algorithms had varying accuracy in identifying increased risk of adverse opioid-related events in prescription data.
Weaker designs					
The Travelers Indemnity Company 2019	Program description only	n.a.	n.a.	n.a.	As this was a program description only, there are no study findings to report.

[a] We organized the studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless “no change” is indicated.

CDM = Clinformatics Data Mart; CMS = Centers for Medicare and Medicaid Services; EHR = electronic health record; FY = fiscal year; MAX = Medicaid Analytic eXtract; n.a. = not applicable; NLP = natural language processing; ROC = receiver operating characteristics.

XII. Pharmacist interventions

A. Overview

The environmental scan produced four studies related to policy changes that used pharmacists to manage, control, or consult on the opioid-prescribing practices of health care providers. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table XII.1).

Key observations

- Engaging pharmacists to review and consult with health care providers can improve adherence with opioid guidelines.
- Pharmacist interventions can be automatically triggered when opioid prescriptions exceed recommended dosages.
- Pharmacist interventions can reduce co-prescribing of opioids with benzodiazepines or highlight other contraindications.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

Two of the studies focused on pharmacists' involvement for the chronic stage of pain, and the other two focused on all stages of pain. Three studies aimed to increase collaboration and cooperation between health care providers and pharmacists, whereas the fourth focused on pharmacists' informational materials sent to patients. Two studies evaluated policies to change patient and provider behavior across all provider types in a health care system, and two studies focused on specific medical specialties (primary care and surgery).

Participating entities for the four studies included a VHA system, a large health maintenance organization, a state-wide health information network, and a single primary care residency clinic. The studies extracted data for analysis from EHRs, PDMPs, and pharmacy dispensing records. Pharmacist interventions were evaluated in California, Kansas, Oregon, Utah, and Washington.

The four studies varied in terms of the types of programs intended to integrate pharmacists into opioid-prescribing practices. Two studies (Pardo et al. 2017; Luchen et al. 2018) evaluated changes to EHR systems that triggered automatic pharmacist evaluations whenever an opioid and benzodiazepine medication was requested for a single patient. Other programs sought to trigger a pharmacist consultation when a 50 MME dose was exceeded (Cox et al. 2018) or to educate pre-surgical patients scheduled for total hip arthroplasty (THA) or total knee arthoplasty (TKA) about the dangers of long-term opioid use after surgery (Smith et al. 2018).

Table XII.1. Category overview: pharmacist interventions

Study features	Summary
Primary foci	Reducing co-prescribing of opioid and benzodiazepine medications; reducing the number of patients receiving opioid prescriptions exceeding a 50 MME dose; altering patients' and providers' expectations of the need for long-term post-surgical opioids
Treatment stages	Chronic (2); all (2)
Levels of intervention	Provider (3); patient (1)
Settings/geographies	VHA system in California; a family medicine residency clinic in Utah; a health information network in Kansas; and a health maintenance organization spanning the states of Oregon and Washington
Intervention subtypes	Reprogramming of EHR systems to prompt automatic pharmacist consultations; educational materials from pharmacists to pre-surgical patients; pharmacist educational materials and consultation opportunities to health care providers with prescriptions exceeding recommended opioid dosages

B. Findings

Table XII.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Only one of the four studies (Smith et al. 2018) used a stronger design (RCT) that was potentially free from bias. In that study, the authors analyzed 90-day totals for opioid prescribing before and after the intervention and reported that post-surgery dispensed morphine equivalents was 46 percent lower in the treatment group compared with the control group. The three studies with weaker study designs generally reported positive findings.

Table XII.2. Key takeaways: pharmacist interventions

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Smith et al. 2018	RCT	May to July 2016 (3 months)	90-day totals	• **Dispensed morphine equivalents among patients who underwent THA: ↓ 46 percent**	Over the 90-day follow-up period, post-surgery DME was 46 percent lower in the treatment group compared with the control group.
Weaker designs					
Cox et al. 2018	Pre-post study	November 2016 to February 2017 (4 months)	Averages at the end of 4 months (Feb 2017)	• **MME per day based on number of pills prescribed per month: ↓ 19 (14 percent)** • MME per day based on prescription directions: ↓ 26 (17 percent)	At the end of the 4-month intervention period, the average MME per day based on the number of pills prescribed per month fell by 19 MME per day (14 percent change compared with baseline).
Luchen et al. 2018	Pre-post study	October to December 2017 (3 months)	3-month totals	• **Number of opioids, BZD agent tapers, or discontinuation: ↑ 22 (63 percent)** • Number of opioid or BZD dose increases: ↑ 14 (26 percent) • Number of Naloxone prescriptions: ↑ 2 (6 percent)	Over the 3-month follow-up period, the total number of opioids, BZD agent tapers, or discontinuation rose by 22 (63 percent compared with baseline).
Pardo et al. 2017	Pre-post study	March 7, 2014, to September 8, 2015 (18 months)	Quarterly percentage and pre-post total	• **Patients co-prescribed BZDs and opioids: ↓ 4.56 pp (35 percent) in quarter 4 fiscal year 2015 compared with quarter 1 fiscal year 2014** • Total number of overdose-related events: ↓ 3 (18 percent) in post-intervention period compared with pre-intervention period	Over the 18-month follow-up period, the percentage of co-prescribed BZDs and opioids fell by 4.56 pp (35 percent change compared with baseline).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

BZD = benzodiazepines; MME = morphine milligram equivalent; pp = percentage points; RCT = randomized controlled trial; THA = total hip arthroplasty.

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XIII. Opioid tapering

A. Overview

The environmental scan produced four studies related to opioid tapering. These studies varied in their primary foci, treatment stages, levels of intervention, the setting and geography in which they were implemented, and the intervention subtype (Table XIII.1).

Key observations

- Opioid tapering programs for chronic pain patients may include tapering with or without substitution to other drugs, such as buprenorphine, which reduces withdrawal symptoms.
- These programs often include some form of psychological therapy or support.
- An example is an opioid tapering program in the Veterans Health Administration that showed a significant reduction in opioid prescription doses.

Three studies focused on chronic pain (for example, patients with long-term opioid use and veterans) and one study addressed all stages of pain management. The studies were split in terms of levels of intervention, with two studies focused on changing individual provider behavior and two on changing individual patient behavior. Participating entities or data sources for the four studies varied and included a VHA primary care clinic, a VHA regional health system, the Medicaid program in Massachusetts, and a pain relief center in Seattle, Washington.

The studies varied in terms of the types of program intended to implement opioid tapering. One large study assessed statewide Medicaid pharmacy claims for long-acting opioids in response to prior authorization requirements. The other evaluations were smaller, evaluating outcomes of specific institutions that implemented referrals to an opioid reassessment clinic, chart review, and taper support.

Table XIII.1. Category overview: opioid tapering

Study features	Summary
Primary foci	Opioid tapering; rotation to buprenorphine or methadone; improved safety for patients co-prescribed opioids and benzodiazepines
Treatment stages	Chronic (3); all (1)
Levels of intervention	Provider (2); patient (2)
Settings/geographies	Multidisciplinary primary care clinic (VHA); regional health care system (VHA); center for pain relief (Washington); state Medicaid program (Massachusetts)
Intervention subtypes	Prior authorization requirements; opioid reassessment clinic; chart review and recommendations from pharmacist and psychiatrist; taper support

B. Findings

Table XIII.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results.

Two of the studies used stronger designs that were relatively free from bias. One of these rigorous studies (Sullivan et al. 2017) was an RCT with a 34-week follow-up period, the other (Oldfield et al. 2018) was a QED equivalent with a 22-month follow-up period. The former reported no statistically significant change in daily opioid doses, and the latter reported a decline in daily MME of 30 mg relative to the comparison group. The studies with weaker designs generally reported positive findings.

Table XIII.2. Key takeaways: opioid tapering

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Stronger designs					
Sullivan et al. 2017	RCT	n.d. (34 weeks)	Averages at 22 weeks and 34 weeks	• **Daily MME: no change**	Over the 34-week follow-up period, there was no statistically significant difference in average daily MME in the past week at either 22 or 34 weeks following the intervention between the treatment group and the control group.
Oldfield et al. 2018	QED equivalent	March 2016 to January 2018 (22 months)	• Process measures: total number and percentage of patients • Outcome measures: changes between the referral visit and the final visit	• **Change in daily MME: ↓ 30 mg relative to comparison** • **Percentage trialing buprenorphine: ↑ 60 pp relative to comparison** • BZD prescribing and marijuana use: no significant change	Over the 22-month follow-up period, daily MME decreased by 30 mg more in the treatment group compared with the comparison group, and patients in the treatment group were 60 pp more likely to trial a partial agonist drug than the comparison group.
Weaker designs					
Garcia et al. 2014	Pre-post study	January to December 2005 (12 months)	Annual totals	• **Number of unique utilizers: ↓ 18 percent** • Number of claims: ↓ 4.1 percent	Over the 12-month follow-up period, the total number of unique utilizer claims fell by 18 percent compared with baseline.
Zaman et al. 2018	Pre-post study	n.d. (6 months)	6-month percentages and averages	• **Co-prescribed BZDs and opioids: ↓ 33 pp (33 percent)** • Opioid doses: ↓ 19 mg (22 percent) • BZD doses: ↓ 2.7 mg (17 percent) • Patients prescribed 100mg MEDD or more: ↓ 8 pp (30 percent)	Over the 6-month follow-up period, the percent of patients co-prescribed BZDs and opioids fell by 33 pp (33 percent change compared with baseline).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

BZD = benzodiazepines; MME = morphine milligram equivalent; n.d. = no date; pp = percentage points; QED = quasi-experimental design; RCT = randomized controlled trial.

XIV. NSAID substitution

A. Overview

Key observations

- Nonsteroidal anti-inflammatory drugs (NSAIDs) can serve as alternatives to opioids for treating pain following surgery.
- Programs offering NSAID substitution often include some form of counseling on pain management strategies.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

The environmental scan produced three studies related to using nonsteroidal anti-inflammatory drug (NSAID) substitution or multimodal analgesia to manage pain and reduce opioid prescribing (Table XIV.1). All three studies focused on the acute stage of pain (for example, post-surgery). Two studies focused on changing individual provider behavior, and one focused on providers and patients, both in hospital settings. Two studies focused on single institutions (one in Nebraska, the other unnamed) and one study examined outcomes for about 25 percent of hospitals nationwide (Cozowicz et al. 2019).

The studies differed in terms of the types of program implemented. The study focused on hospitals nationwide did not examine a specific intervention but compared outcomes for patients who received multimodal analgesia with those receiving opioids only. One study consisted of pain counseling and shared decision making on nonopioid multimodal analgesia plans (Miltisakh et al. 2018). Another study examined outcomes following scheduled dosing of NSAIDs and other multimodal analgesics (Walker et al. 2018).

Table XIV.1. Category overview: NSAID substitution

Study features	Summary
Primary foci	Substituting NSAIDs or other nonopioid analgesics for pain management
Treatment stages	Acute (3)
Levels of intervention	Provider (2); Patient and provider (1)
Settings/geographies	Hospitals nationwide; head and neck surgery department (Nebraska); surgical departments at a single institution
Intervention subtypes	Counseling; shared decision making; scheduled dosing

B. Findings

Table XIV.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results. All three studies used weaker research designs that might have been influenced by bias, and each of the studies reported positive findings.

Table XIV.2. Key takeaways: NSAID substitution

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Weaker designs					
Cozowicz et al. 2019	QED non-equivalent	January 2006 to December 2016 (10 years)	• For opioid prescriptions, length of stay, cost: totals during the hospital stay (day of surgery, day 1 after surgery, and inpatient days after that) • For post-operative complications: odds during the postoperative period (day 1 after surgery and inpatient days after that)	For patients who received more than two modes of non-opioid analgesia versus those who received only opioids: • **Total opioid use during hospital stay: ↓ 7.2 percent** • Gastrointestinal complications: 0.65 odds ratio • Postoperative mechanical ventilation: 0.23 odds ratio • Postoperative critical care admission: 0.60 odds ratio	Among patients undergoing hip and knee replacements who have OSA, those who received more than two non-opioid analgesia modes during their inpatient stays had 7.2 percent lower opioid use compared with patients who received opioids only.
Walker et al. 2018	Pre-post study	January to June 2017 (6 months)	Average MMEs over 72-hour period	• **Opioid consumption: ↓ 31 MME (24.2 percent)**	Over the 6-month follow-up period, average MMEs of opioids consumed over a 72-hour period following surgery fell by 31 (24.2 percent change compared with baseline).
Militsakh et al. 2018	Cross-sectional study	January to June 2017 (6 months)	6-month percentage	• **Postoperative opioid prescriptions: ↓ 11.2 pp (85.5 percent)**	Over the 6-month follow-up period, the percentage of postoperative opioid prescriptions fell by 11.2 pp (85.5 percent change compared with baseline).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

MME = morphine milligram equivalent; NSAID = nonsteroidal anti-inflammatory drug; OSA = obstructive sleep apnea; pp = percentage points; QED = quasi-experimental design.

XV. Patient education

A. Overview

Key observations

- Providing information to patients who are preparing to undergo surgery can increase their awareness of opioid-related risks.
- Patient education strategies may include providing informational handouts to patients as well as counseling by a physician at discharge.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

The environmental scan produced two studies related to providing education to patients on opioid prescribing, use, and disposal (Table XV.1). Both studies focused on educating patients in the acute stage of pain (for example, post-surgery). Both studies aimed to change individual patient and provider behavior. One study took place in an orthopedic surgery department at a hospital in Massachusetts and focused on providing information about safe opioid use to patients experiencing carpal tunnel release and distal radius volar locked plating procedures (Dwyer et al. 2018). The other study took place in an obstetrics and gynecology department at a different hospital in Massachusetts and focused on educating patients on pain management after cesarean delivery (Prabhu et al. 2018).

The two studies differed in terms of the types of education provided or program implemented. In the orthopedic surgery study, patients received handouts on safe opioid use and disposal. In the cesarean delivery study, patients were counseled using handouts and decided with their provider how many tablets of opioids they would be prescribed.

Table XV.1. Category overview: patient education

Study features	Summary
Primary foci	Providing education to patients on safe opioid use following procedures
Treatment stages	Acute (2)
Levels of intervention	Patient and provider (2)
Settings/geographies	Orthopedic surgery department (hospital in Massachusetts); obstetrics and gynecology department (hospital in Massachusetts)
Intervention subtypes	Handouts on safe opioid use and disposal; handouts; counseling; and shared decision making

B. Findings

Table XV.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results. Both studies used weaker research designs that might be influenced by bias, and each of the studies reported positive findings.

Table XV.2. Key takeaways: patient education

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Weaker designs					
Dwyer et al. 2018	Pre-post study	April to September 2016 (6 months)	6-month average	• **Pills prescribed for CTR procedures: ↓ 12 (54.5 percent)** • **Pills prescribed for VLP procedures: ↓ 14 (35.9 percent)**	Over the 6-month follow-up period, the average number of pills prescribed for CTR procedures fell by 12 (54.5 percent change compared with baseline), and the average number of pills prescribed for VLP procedures fell by 14 (35.9 percent change compared with baseline).
Prabhu et al. 2018	Pre-post study	November 7, 2016, to January 10, 2017 (2 months) June 10 to August 14, 2017 (2 months)	2-month average	• **Opioid tablets prescribed (phase 1): ↓ 6 (18.2 percent)** • **Opioid tablets prescribed (phase 2): ↓ 3 (12 percent)**	Over the 2-month follow-up period after Phase 1, the average number of opioid tablets prescribed fell by 6 (18.2 percent change compared with baseline), and over the 2-month follow-up period after Phase 2, the average number of opioid tablets prescribed fell by 3 (12 percent change compared with the previous period).

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless “no change” is indicated.

CTR = carpal tunnel release; VLP = distal radius volar locked plating.

XVI. Information sharing

A. Overview

The environmental scan produced two studies related to sharing information on opioid prescribing across health care providers (Table XVI.1). Both studies addressed all stages of pain management, and both aimed to change individual provider behavior, though one focused on the emergency department of a single hospital in Massachusetts (Boyle et al. 2019) and the other on information sharing across state borders (Lin et al. 2019).

Key observations

- Sharing information on opioid prescriptions across providers or databases can alter opioid prescribing patterns.
- Examples include sharing information on prescribing patterns among providers in an emergency department and making PDMP data available across state borders.
- Preliminary evidence from a small number of studies is positive, but more research is needed.

Table XVI.1. Category overview: information sharing

Study features	Summary
Primary foci	Sharing prescribing data information with clinicians
Treatment stages	All (2)
Levels of intervention	Provider (2)
Settings/geographies	Suburban hospital (Massachusetts); multiple states
Intervention subtypes	Sharing individual and comparison prescribing data with clinicians; PDMP data-sharing agreements with no, partial, or all bordering states on whether patients receive opioid prescriptions

B. Findings

Table XVI.2 summarizes the methods, results, and key takeaway for each study in the category. We ordered the studies based on declining strength of research design (Table II.2) and recorded the time period over which researchers measured impacts, primary and secondary results from their analysis, and a key takeaway or takeaways based on the primary results. Both studies used weaker research designs that might be influenced by bias. One study reported positive findings and the other found no change.

Table XVI.2. Key takeaways: information sharing

Citation	Research design[a]	Follow-up period[b]	Measurement approach	Results[c]	Key takeaway
Weaker designs					
Boyle et al. 2019	Pre-post study	October 2015 to March 2016 (6 months)	Monthly rate per 100 patients discharged	• **Opioid prescriptions: ↓ 3.5 per 100 patients (28 percent)**	Over the 6-month follow-up period, the rate of opioid prescriptions fell by 3.5 per 100 patients discharged (28 percent change compared with baseline).
Lin et al. 2019	Cross-sectional study	Survey conducted in 2014	Annual number	• **Patients receiving opioid prescriptions for non-cancer pain: no change**	Over the 1-year follow-up period, there were no statistically significant changes in the number of patients receiving opioid prescriptions for non-cancer pain.

[a] We ordered studies based on declining strength of research design (see Table II.2).

[b] The follow-up period indicates the time period over which researchers measured impacts.

[c] Percentages represent estimated change relative to baseline. Bold text indicates the primary outcome. Non-bold indicates secondary outcomes. All results in this column are either statistically significant at the 5 percent level or based on changes observed in data for the entire relevant population, unless "no change" is indicated.

ITS = interrupted time series.

XVII. Conclusions

The goal of this study was to review and synthesize recent policy approaches to opioid prescription management and to review their effectiveness in reducing opioid prescriptions and improving other related patient outcomes. Escalating opioid prescribing rates from 2000 to 2015 have been blamed for higher rates of opioid misuse, addiction, and overdose deaths in recent years across the United States (Christie et al. 2017; CDC 2018). Understanding how policy changes can influence the prescribing practices of health care providers is critical for decision makers within state and federal government; for health insurance systems, hospitals, providers, and pharmacy networks; and for public and community-based health systems (National Science and Technology Council 2019). These systems are rapidly undergoing many opioid-related policy changes, but there is a need to evaluate the effectiveness of these operational and regulatory changes.

To summarize findings, consolidate knowledge, and recommend future research, we conducted an environmental scan of the published literature using combinations of keywords representing opioids, programs, and impact evaluation from 2014 to 2019, and this process produced 134 studies. These studies included a variety of initiatives, policy changes, and interventions in various settings and policy levels that applied a variety of research evaluation designs. The large number of published studies over six years reflects the growing interest in the United States among policymakers and researchers to evaluate the effects of new policy-level programs (for example, National Science and Technology Council 2019).

For policymakers, there is a clear indication that efforts to create new policies or revise existing policies to reduce opioid prescribing practices have been largely effective, though these changes can occur gradually over several years, and long-term evaluations of prescribing trends provide the best method to assess the effects of policy change. Overlapping or simultaneous policy changes can make it difficult to accurately assess the effects of a specific policy change, but researchers have employed a variety of methods to distinguish policy effects from secular changes in prescribing policies.

Overall, most studies reported positive effects on reducing opioid prescribing rates, opioid dosages, and refill rates and improving physicians' attitudes and practices, and these patterns held even when researchers made strenuous efforts to rule out competing explanations for these effects. Positive effects of policy change have generally exceeded secular trends in reduced opioid prescribing rates or shown a sudden shift after a policy was implemented. We conclude from this evidence that new opioid policy changes in the past six years have shown a measurable influence on opioid prescribing practices. The size of this effect varies depending on the chosen outcome measure, follow-up period, and setting, but the reported changes in outcomes were nontrivial. Because of a lack of comparable outcomes across studies, we were not able to quantitatively synthesize and compare effect sizes between policy categories, but no one policy appeared to far exceed the benefits of other strategies. For policymakers, choices between specific policy actions may relate more to the context, level of regulatory influence or authority, ease of administration, and the ability to enforce or reinforce these policies.

Our environmental scan led to several overarching qualitative observations. First, multi-pronged approaches that reach a larger number of stakeholders and address numerous prescribing factors simultaneously may be more effective than narrow approaches that target very specific stakeholders and prescribing factors. For example, state-level policies that involve prescribers, pharmacists, health insurers, and patients may result in larger cumulative effects than narrower policies that target only one of those groups. Second, leveraging the use of data and technology to track and manage opioid prescribing has

clear advantages and may improve policy implementation. For example, state PDMPs may be more effective when linked to electronic medical record systems and when integrated with PDMPs of neighboring states. Third, many effective policies combined education and training with methods for tracking and reinforcing the desired prescribing methods. For example, prescriber education and training methods were commonly paired with peer-based feedback and reinforcement.

In addition to these overall observations, our environmental scan showed effective policies in the areas described below.

Policies with substantial evidence

- **Prescription guidelines**. New prescribing guidelines issued by federal and state authorities and by professional medical associations have contributed to reductions in opioid prescribing rates. Adoption and enforcement of these guidelines within health care and insurance systems have shown further benefits.
- **Prescription Drug Monitoring Programs (PDMPs)**. PDMPs are electronic database systems implemented by nearly all states that allow or require providers to check that patients are not receiving opioids from multiple sources. PDMPs have reduced opioid prescribing rates, and efforts are being made to improve their integration between states and within electronic medical record systems.
- **Dispensing limits**. Adopting drug formularies, requiring prior authorizations, or otherwise limiting the quantity of opioid medications and circumstances in which providers can prescribe them are effective policies to reduce opioid prescribing rates. Twelve state workers' compensation regulatory systems have adopted drug formularies.
- **Multifaceted interventions**. Some states and health care systems have adopted a multifaceted approach to alter opioid prescribing practices that includes guideline adoption, provider education, patient and consumer outreach, and data-driven solutions. Combining multiple system-level strategies has reduced opioid prescribing.
- **Provider education**. Training providers to follow more effective opioid prescribing practices has been implemented widely, and these training programs have reduced opioid prescribing rates, especially when the education is paired with peer feedback and advice.

Policies with emerging evidence

- **Laws and policies**. Enacting laws or regulations at the state or federal level pertaining to opioid prescribing limits, cannabis, and treatment options for opioid use disorder has shown measurable improvements in opioid-related outcomes. Reclassifying the risk level of some opioid medications has shown a dramatic effect.
- **Automated alerts**. Computerized alerts within electronic medical record systems can inform providers about patients at risk of opioid overuse or misuse. This automated strategy has been shown to reduce opioid prescribing within emergency departments and the Veterans Health Administration system.
- **Predictive modeling**. Large administrative data sources within health care systems can be mined to develop computational models that synthesize various factors predicting problematic patterns of opioid use.

- **Pharmacist interventions**. Engaging pharmacists to review and consult with health care providers can improve adherence with opioid prescribing guidelines. An automatic pharmacist consult can be triggered when opioids exceed recommended dosages or when co-prescribing with other medications presents contraindications.
- **Opioid tapering**. Establishing opioid tapering programs with or without medication substitution has been shown to reduce opioid use for patients receiving high opioid doses, but these programs also require the availability of psychological therapy or support for patients.
- **NSAID substitution**. Offering nonsteroidal anti-inflammatory drugs (NSAIDs) as an alternative pain management strategy after surgery reduces opioid prescribing, but these programs usually include counseling on behavioral pain self-management strategies.
- **Patient education**. Providing information about opioid risks to patients before and after surgery has been shown to decrease opioid prescribing rates and increase patients' awareness of opioid-related risks.
- **Information sharing**. Sharing patient data and provider prescribing patterns among provider groups and health care systems has been shown to reduce opioid prescribing.

Our review approach had some important limitations. First, differences between study designs and choices of outcome measures precluded using a meta-analytic strategy to quantitatively synthesize results across studies evaluating similar policy changes and to make head-to-head comparisons on the effects of different policies. Second, our scan of the published literature focused on opioid prescribing policies only; the scan did not include policy evidence related to non-pharmacological pain management alternatives or treatment for opioid use disorder. Finally, because of the large number of studies, we did not apply a detailed rating system to assess and score multiple aspects of methodological rigor systematically for each study. Instead, we used a relatively gross measure of methodological quality to classify the strength of the overall study design (for example, we deemed ITS analysis to be superior to a simple pre-post design).

Results of the environmental scan suggest several implications for future research and for publishing results of program evaluations. First, a greater uniformity of outcome measures across studies would provide more opportunities for meta-analytic methods to synthesize findings and to compare effects between different types of policy interventions. The most common metrics for program evaluation were opioid prescribing rates and MMEs, but the unit of analysis varied by patient, provider, or location. In some cases, only percentage changes were reported with no specific dose or rate information. Second, using more rigorous evaluation methods would enable researchers to better account for secular trends in opioid prescriptions and other policy changes that confound many of the results in the studies we reviewed. Finally, most of the studies in our review focused on immediate, direct effects on opioid prescriptions. Although such findings point to potential approaches for successfully curbing opioid prescriptions, the implications for long-term outcomes for workers and others in need of pain relief are less clear. Studies that track other important outcomes (such as measures of employment, well-being, and mortality) and for longer follow-up periods would greatly improve our understanding of the true benefits (and sometimes unintended consequences) of various approaches.

In conclusion, there is a large and growing evidence base to support the benefits of policy changes designed to reduce opioid prescribing rates in the United States. Policy changes have occurred at the federal, state, and various organizational levels within the U.S. health care system. Though more accumulated evidence exists for some policy changes than for others, most scientific policy evaluations in the peer-reviewed literature have shown mild to moderate effects of policy changes on opioid prescribing.

the peer-reviewed literature have shown mild to moderate effects of policy changes on opioid prescribing. While more research is needed to provide more exact comparisons between policies, we encourage policymakers to consider any of the policy interventions described in this report with respect to their own context, needs, and resources. The existing evidence base suggests that effective policy changes could include elements of education and training, data tracking and automation, regulatory measures, peer-based support and feedback, and alternative treatment options.

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