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Title: Prescription Drug Monitoring Program Integration in the Electronic Health Record

Principal Investigator: Daniel Hartung, PharmD, MPH

Team Members: Steven Kassakian, MD; Sanae Ibrahimi, PhD; Michelle Hendricks, PhD

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Project Officer: Mario Teran

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## **Structured Abstract (200 words)**

**Purpose:** Prescription drug monitoring programs (PDMPs) are a foundation in the US response to the opioid epidemic, but their adoption has been uneven. Integration of PDMP in the electronic health record (EHR) is a promising approach to enhance PDMP use and effectiveness.

**Scope:** We sought to evaluate the integration of PDMP in the EHR in twelve ambulatory primary care clinics at one academic medical center in Portland Oregon.

**Methods:** Using linked data from the EHR and state PDMP program, we evaluated changes in PDMP query rates and controlled substance prescribing using a stepped-wedge observational design where integration was implemented in three waves (four clinics per wave) over a five-month period (May, July, September 2019).

**Results:** After EHR integration, the average number of queries per provider per month increased significantly from 1.43 to 3.94, a 2.74-fold increase ( $p < .0001$ ). PDMP use increased the most in providers who used the PDMP the least before integration.

There was no association between integration of PDMP and overall opioids prescribing, high dose opioid prescribing, and opioids prescribed with benzodiazepines or other opioids. Opioid polypharmacy ( $\geq 4$  opioids from  $\geq 4$  different prescribers) decreased significantly by -1.47 prescriptions per providers ( $p=0.02$ )

**Key Words:** opioids, prescription drug monitoring programs, electronic health records

## **Purpose (Objectives of the study)**

Prescription drug monitoring programs (PDMPs) have been a key component in the US response to the opioid epidemic, but their adoption has been slow because of logistic and administrative barriers to use. Integration of PDMP in the electronic health record (EHR) is a promising approach to enhance PDMP use and effectiveness.

The overall objective of this study was to evaluate the impact of integration of PDMP in the EHR on PDMP use (Aim 1) and opioid prescribing (Aim 2) in 12 primary care clinics located within one academic medical center.

## **Scope**

**Background:** The adoption of prescription drug monitoring programs (PDMPs) has been a central pillar in the United States' (US) response to the evolving opioid epidemic. PDMPs are state-administered centralized electronic database that collect and report controlled substance prescriptions. These data systems are used by a variety of stakeholders including clinicians, who can log into an online portal to review prescribing histories for their patients. Reports on the effectiveness

of PDMP and policies governing their use have been mixed. This likely reflects heterogeneity of programs, their evolution over time, and methodologic differences in study designs evaluating these programs. A common barrier cited by clinicians to using PDMP data in practice involves the time and effort required to register, log in to website portals, and navigate and interpret PDMP reports. A promising approach to enhance PDMP use and effectiveness is integration within the electronic health record (EHR) or other health information technology platforms. As such, state and federal health authorities have made integration of PDMPs a focus of infrastructure funding. Studies from several of these early integrations have shown that EHR integration can significantly improve how often clinicians query the PDMP.

*Context:* In 2019, Oregon Health & Science University (OHSU), the state's only academic medical center, underwent PDMP integration within its EHR platform in primary care clinics over a 6-month period. We sought to evaluate the impact of this integration on clinician query rates of the PDMP and controlled substance prescribing behavior.

*Setting:* The study was conducted in all twelve ambulatory primary care clinics affiliated with the OHSU academic medical center located in the Portland, Oregon metropolitan region. Study clinics were located on OHSU's main Portland campus (n = 3), other locations in Portland (n = 2), Portland suburbs (n = 5), and in the Columbia River Gorge region 60 miles east of Portland (n = 2). Providers assigned to each clinic typically see patients at their designated clinic and only rarely serve patients in other clinics.

*Participants:* This was an observational study examining the impact of PDMP integration in the EHR on PDMP use (PDMP queries) and controlled substance prescribing. For both Aims, the unit of analysis was the prescribing provider. Across the 12 study clinics, 206 providers had at least one query of the PDMP during the study period.

## **Methods**

*Study Design:* We use a stepped-wedge observational design to evaluate the effect of the PDMP EHR integration on PDMP query requests (Aim 1) and prescribing outcomes (Aim 2). The study period was May 2018 through September 2020. Integration within study clinics occurred in three waves on May 13, 2019, July 15, 2019, and September 16, 2019, with 4 clinics implementing the integration in each wave. Thus, each wave had at least 12 months of time before and after their clinic's integration.

*Data Sources/Collection:* Both Aims from this study were constructed using Oregon PDMP controlled substance dispensing data (PDMP dispensing data) obtained from the Oregon Health Authority (OHA) Injury and Violence Prevention Program.

*Aim 1:* The primary outcome was monthly PDMP queries by clinicians (including physicians, nurse practitioners [NPs], physician assistants [PA]) practicing within study clinics. PDMP query data were obtained from Oregon's PDMP program which is administered by the Injury and Violence Prevention Program of the Oregon Health Authority. While PDMP query data are grouped by their source, either the traditional web portal or through the PMP Gateway, the state provided query data combined into one common dataset, without the ability to disaggregate. To identify affected clinicians, we extracted

clinic provider data from OHSU's EHR including DEA number (linking variable), clinic location (urban vs suburban or rural), provider type (i.e. MD/DO, NP, PA), age, and sex.

Aim 2: Outcomes for Aim 2 were constructed using Oregon PDMP controlled substance dispensing data (PDMP dispensing data). To create the study dataset, we first extracted clinic provider data from OHSU's EHR which included provider DEA number. DEA number was used to identify PDMP dispensing data used for this analysis. The study period was the same as Aim 1.

*Interventions:* OHSU, the state's only academic medical center, operates a hospital and multitude of ambulatory care clinics all using a common EHR platform (Epic™; Epic Systems Corporation). The main PDMP vendor in the US (Bamboo Health; previously Appriss Health) provides a single-point access product (PMP Gateway) of PDMP information within healthcare systems EHR workflows in 43 states, including Oregon. The connection between OHSU's EHR and PDMP is through Bamboo Health's PMP Gateway which allows one-click PDMP accessibility, without the requirement to enter additional credentials after initial EHR login. No additional alerts, notifications, or decision support tools were incorporated as part of the integration.

#### *Measures:*

Aim 1: PDMP query rates

Aim 2: Although the focus of our analyses is opioids prescribed by providers at affected clinics, we also sought to estimate other measures of high-risk prescribing (e.g. multiple provider prescribing) that could potentially involve both affected OHSU providers and providers who were not practicing at a study clinic. Thus, several outcomes could include prescriptions written by a mix of both study providers and non-study providers. We developed five opioid-related utilization outcomes to assess the effect of integration on prescribing: opioid prescriptions dispensed per month, opioid prescriptions exceeding 90 morphine milligram equivalents (MME) per day per month, opioid prescriptions dispensed concurrent with another opioid, opioid prescriptions dispensed concurrent with a benzodiazepine prescription, and percent of patients with  $\geq 4$  opioid prescriptions issued by  $\geq 4$  different prescribers in a 180-day period (e.g. opioid polypharmacy). We defined concurrent use as at least one day of overlap using date dispensed and days' supply fields (end date = date dispense + days supply). MME conversions were based on established conversion factors and calculated for each prescription using units dispensed and days' supply fields.

*Limitations:* First, data reported only reflect PDMP use among primary care providers in one academic medical center in one state using one specific vendor developed integration package (Bamboo Health PMP Gateway). While similar positive effects have been reported in health systems in other states, effect sizes varied, and it is unclear how these state and regional factors affected use. In particular, our findings may have limited application to lower resourced healthcare settings (e.g. community health centers, critical access hospitals), which already lag in their informatics capabilities.

Although the intervention was evaluated using staggered, step-wedge design, clinic clusters were not randomly assigned and therefore changes in use may have been affected selection biases. Clinics were clustered and integration sequence assigned to provide relative balance across known characteristics, but unknown factors may have affected our findings.

Additionally, our study did not measure the effect of integration on provider time savings, which has been shown to be a major deterrent of adoption. Finally, we did not evaluate the impact of the integration on patient outcomes.

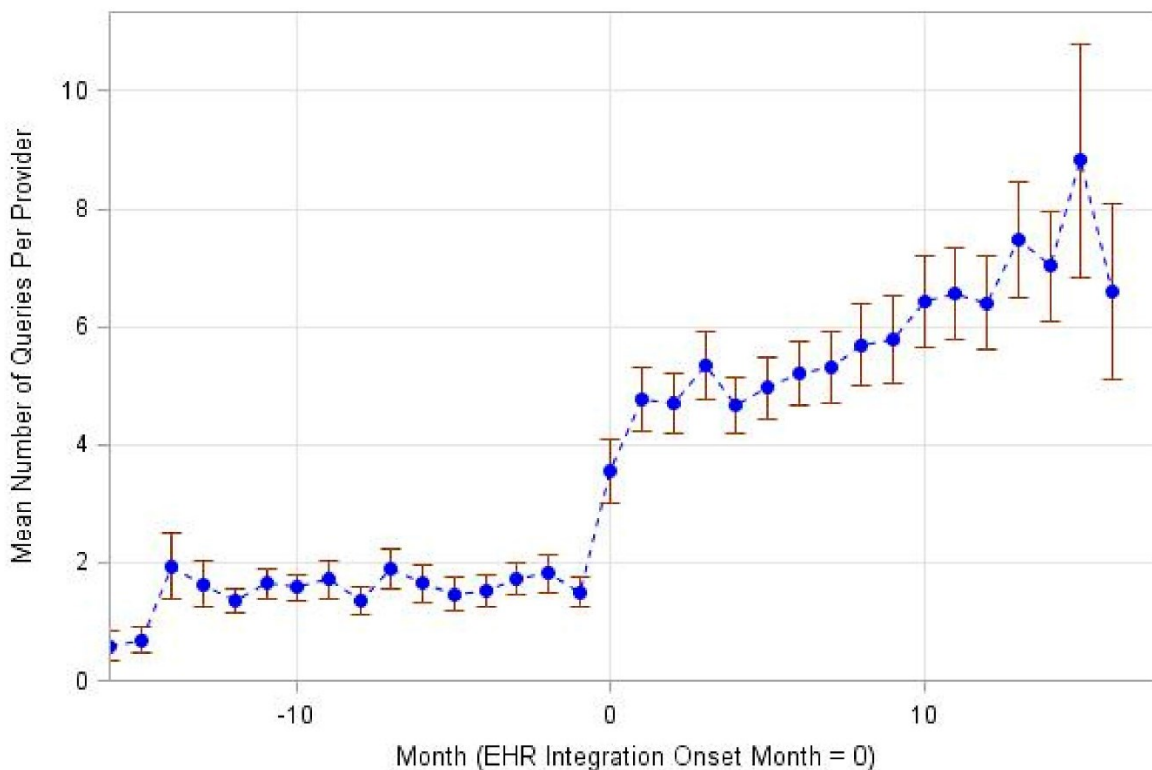
Further research is needed to enhance our understanding of the full impact of integration on controlled substance prescribing, utilization, provider workflow, and patient outcomes.

## Results

### *Principal Findings:*

Aim 1: After integration the model-estimated mean number of queries per provider per month increased significantly after PDMP integration from 1.43 (95% CI 1.07 to 1.91) to 3.94 (95% CI 2.96 to 5.24); a 2.75-fold increase (95% CI 2.11 to 3.59;  $p < .0001$ ).

Figure 1: Changes in mean number of PDMP queries before and after PDMP integration.



The only significant subgroup effect was across pre-integration PDMP use where providers in the lowest quartile of PDMP use before integration increased use from 0.07 (95% CI 0.03 to 0.20) to 2.55 (95% CI 1.45 to 4.50) queries per month, a 36.78 fold (95% CI 16.91 to 79.95;  $p < .0001$ ) increase. This was significantly more than other PDMP users before integration (interaction  $p$ -value  $< 0.0001$ ).

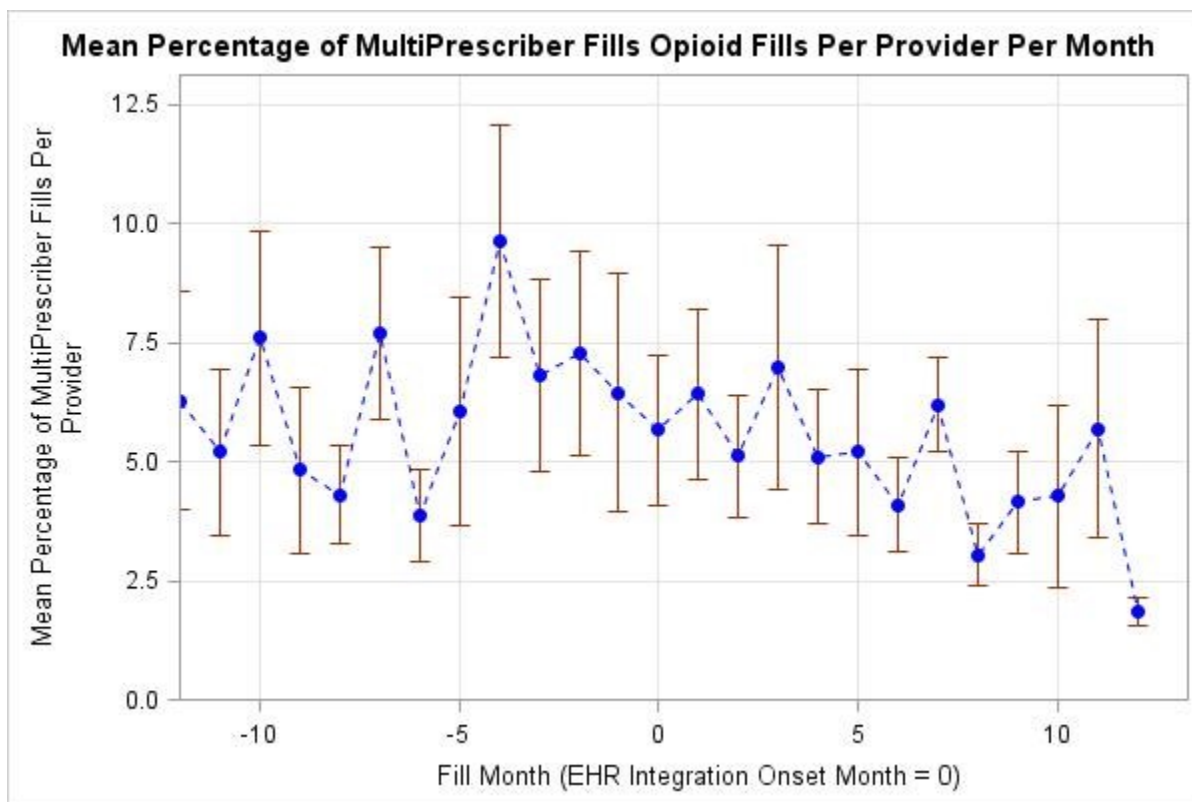
Aim 2: Among included providers, most were female (62%), practiced in urban clinics (77%), and were physicians (72%), and prescribed 16.9 opioid prescriptions per month. Findings from prescribing analyses are summarized in Table 1 and Figure 2. After PDMP integration, there was no significant

change in opioid prescriptions (-0.05; 95% CI -0.11 to 0.01), high-dose opioid prescriptions (0.23; 95% CI -0.99 to 1.46), concurrent opioids prescriptions (0.55; 95% CI 0.68 to 1.78), or opioid-benzodiazepine co-prescriptions (-2.45; 95% CI -5.38 to 0.48) dispensed per provider per month. As shown in Figure 2, opioid polypharmacy decreased significantly by -1.47 prescriptions per provider (95% CI -2.73 to -0.20).

Table 1: Regression coefficients for prescribing outcomes

| Variable   | Estimate** | 95% Confidence Interval | P-value |
|--|------------|-------------------------|---------|
| Opioid prescriptions per month                           | -0.05      | -0.11 to 0.01           | 0.12    |
| Opioid prescriptions >90 MME per day per month           | 0.23       | -0.99 to 1.46           | 0.71    |
| Concurrent opioid benzodiazepine prescriptions per month | 0.55       | -0.68 to 1.78           | 0.38    |
| Concurrent opioid prescriptions per month                | -2.45      | -5.38 to 0.48           | 0.10    |
| Opioid polypharmacy                                      | -1.47      | -2.73 to -0.20          | 0.02    |

Figure 2: percent of patients with >=4 opioid prescriptions issued by >=4 different prescribers in a 180-day period (e.g. opioid polypharmacy).



### *Discussion:*

Aim 1: In this study of primary care providers at one academic medical center, we found that integration of the PDMP in the EHR was associated with nearly a 3-fold increase in the number of PDMP queries requested. While the increase occurred rapidly following integration in all three waves, there was no change in the overall trend following integration. Non-physician providers (NPs/PAs) used the PDMP to a greater extent than physician providers. Providers who used the PDMP the least before integration saw the largest increase in queries after integration.

Improving the accessibility and functionality of state PDMP data is an important step in the evolution of PDMP utility. Although OHSU's integration was among the first healthcare systems to integrate in the state, PDMP integrations have now been completed in more than 1200 facilities across Oregon.

Results from this study align with a state report, which indicates that almost three-quarters of prescribers in Oregon accessed the PDMP through the EHR with every controlled substance prescription they issued. Our findings are also consistent with the growing number of studies that have assessed the effect of EHR integration on PDMP use. In national survey of office-based physicians, those who accessed the PDMP through the EHR were more likely to use it and indicate its use was very easy relative to those who accessed the PDMP through an outside system. Another relatively small survey of providers (physicians, pharmacists) working in one academic medical center in Iowa, found that 58% of respondents indicated that PDMP integration increased the likelihood of reviewing PDMP profiles and 75% indicated that integration reduced the time required to evaluate the PDMP patient history.

Aim 2: We found no significant effect on overall opioid prescribing and several other high risk opioid prescribing patterns. However, we did observe that rates of opioid polypharmacy ( $\geq 4$  opioid prescriptions from  $\geq 4$  or more providers) did decline significantly (-1.47; 95% CI -2.73 to -0.20;  $p=0.02$ ), which suggests integration may have improved uncoordinated opioid prescribing across providers. Very few other studies have examined prescribing changes following PDMP integration in the EHR. In one study from Massachusetts, found integration had no effect on overall opioid prescribing and MMEs dispensed but did not examine other indicators of high risk prescribing.

### *Conclusions:*

Aim 1: Consistent with other recent studies, we find that integration of the PDMP in the EHR was associated with a significant increase in use in primary care clinicians in one academic medical center. The largest increases in queries were among those with the most infrequent PDMP use before integration.

Aim 2: While we did not observe significant changes in opioid prescribing overall after PDMP integration, we did see a significant declines in patterns of opioid polypharmacy. This suggests that PDMP integration may have a role for improving coordination of opioid prescribing across providers.

### *Significance:*

We found the results of our study aligned with the growing body of evidence that indicates that PDMP integration clearly increases PDMP use. While our study did not observe declines in several measures of opioid prescribing, we did note a significant decline in a possible indicator of

uncoordinated opioid prescribing. This also aligns with the emerging literature describing the impact of PDMP integration on opioid prescribing.

*Implications:*

Despite the promise PDMP integration holds for increased use and improved outcomes, less than a quarter of office-based physicians and 10%-15% of hospitals report PDMP integration within their EHR. While nearly all states have enacted laws that permit PDMP integration into EHR and other health informatic platforms, barriers to integration including cost, EHR system interoperability, and information security remain. Our results, coupled with other emerging data suggest that PDMP integration has positive impacts on prescribing quality. Further investment in EHR integration may be required to optimize PDMP use nationally.

**List of Publications and Products (Bibliography of Outputs) from the study.**

1. Hartung DM, Kassakian, SZ, Hendricks MA. Effect of integration of prescription drug monitoring program data in the electronic health record on queries by primary care providers. *Health Informatics J.* 2024 Apr-Jun;30(2):14604582241259337
2. Aim 2 prescribing paper forthcoming.