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Health Care Provider Utilization of Prescription Monitoring Programs: A Systematic Review and Meta-Analysis

Alysia Robinson, MSc,* Maria N. Wilson, MSc,* Jill A. Hayden, PhD,* Emily Rhodes, MSc,*
Samuel Campbell, MD,† Peter MacDougall, MD,†,‡ and Mark Asbridge, PhD*,†

*Department of Community Health and Epidemiology, Dalhousie University, Halifax, Nova Scotia, Canada; †Department of Emergency Medicine, Dalhousie University, Halifax, Nova Scotia, Canada; and ‡Department of Anesthesiology, Pain Management and Peri-Operative Medicine, Dalhousie University, Halifax, Nova Scotia, Canada

Correspondence to: Mark Asbridge, PhD, Centre for Clinical Research, 5790 University Ave Rm. 407, Halifax, NS B3H 1V7, Canada. Tel: (1) 902-494-3761; E-mail: mark.asbridge@dal.ca

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Abstract

Objective. To synthesize the literature on the proportion of health care providers who access and use prescription monitoring program data in their practice, as well as associated barriers to the use of such data. **Design**. We performed a systematic review using a standard systematic review method with meta-analysis and qualitative meta-summary. We included full-published peer-reviewed reports of study data, as well as theses and dissertations. **Methods**. We identified relevant quantitative and qualitative studies. We synthesized outcomes related to prescription monitoring program data use (i.e., ever used, frequency of use). We pooled the proportion of health care providers who had ever used prescription monitoring program data by using random effects models, and we used meta-summary methodology to identify prescription monitoring program use barriers. **Results**. Fifty-three studies were included in our review, all from the United States. Of these, 46 reported on prescription monitoring program use and 32 reported on barriers. The pooled proportion of health care providers who had ever used prescription monitoring program data was 0.57 (95% confidence interval: 0.48–0.66). Common barriers to prescription monitoring program data use included time constraints and administrative burdens, low perceived value of prescription monitoring program data, and problems with prescription monitoring program system usability. **Conclusions**. Our study found that health care providers underutilize prescription monitoring program data and that many barriers exist to prescription monitoring program data use.

Key words: Prescription Monitoring Programs; Prescription Drug Monitoring Programs; Opioids; Utilization; Systematic Review

Introduction

North America and Western Europe are amid an opioid crisis. In the United States, opioids were found to account for two thirds of all drug overdose deaths, and in Canada, the rate of opioid-related deaths was found to be 7.8 per 100,000 [1, 2]. In Europe, the role of opioids in mortality is also apparent, with opioids being found in 81% of all fatal overdoses [3].

Although considerable attention has been directed to the use of illicit opioids, the crisis is strongly linked to the emergence of prescription opioids as the primary treatment modality to address acute and chronic pain over the past few decades [4–8]. As many patients with pain turned to opioids for treatment, prescription opioids, such as morphine, hydromorphone, and oxycodone, were revealed to have a high risk for abuse and potential for dependence, which has been since reflected in their classification as Schedule II controlled substances [9]. Many strategies developed to combat this crisis have, therefore, also targeted prescription opioids, with a goal

to promote appropriate use of these medications while reducing dependence and potential for harm.

One such strategy is the implementation of prescription monitoring programs (PMPs). PMPs house prescribing and dispensing data for controlled substances from health care providers such as physicians and pharmacists. Opioids are among these controlled substances, making PMPs an important source of a patient's history of controlled substance use, but more specifically, opioid history. In most jurisdictions, PMPs can be used by health care providers when making prescribing or dispensing decisions, ensuring opioids are prescribed in appropriate quantities and when necessary, following best-practice guidelines [10] and reducing the number of individuals at risk of subsequent dependence and harm [11, 12]. PMPs also aim to regulate opioid exposure in the community by monitoring patient behaviors, such as use of multiple providers, and other potential flags for diversion of supply or misuse. Finally, PMPs monitor health care provider prescribing practices and habits and may use this information to inform and educate providers on appropriate prescribing practices [13, 14]. Variations of PMPs have been implemented in 49 states, the District of Columbia, and two territories across the United States and in nine provinces and territories across Canada [15–17]. Few distinct PMPs exist in Europe, as many jurisdictions instead integrate the functions of PMPs into their broader drug distribution systems [18].

The evidence on whether PMPs are effective in reducing inappropriate prescribing is mixed [19–21]. This may be explained by the varying use of PMPs, where there is often suboptimal use of PMP data by health care providers to inform their prescribing and dispensing decisions [22]. In many jurisdictions, health care providers are not aware that a PMP exists where they practice, or similarly, some are aware of PMPs but do not know how to make use of the data in their practice. For example, in a recent study of physicians in jurisdictions with PMPs from across the United States, approximately 72% of providers knew that a PMP was present in their jurisdiction, but only 53% reported actually using one of the programs [23]. It is important to understand the extent to which these programs are being used, and in the case that they are not being frequently used, it is also important to understand why. Health care professionals often identify the presence of too many barriers as a reason why they may not use PMPs [23–25]. Identifying and acknowledging potential barriers to PMP use is an essential first step to optimize utilization [16, 24, 26–28].

We completed a systematic review to, first, determine what proportion of health care providers access and use PMP data in their practice in jurisdictions where a PMP is available, and second, identify common barriers to accessing PMP data that have been identified by health care providers.

Methods

We used a standard systematic review approach [29], following a predefined protocol, and structured the report according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [30]. This research received ethics approval from the research ethics board at Dalhousie University.

Data Sources and Search Strategy

To retrieve all relevant publications, we developed our search strategy in consultation with a medical librarian and applied this strategy to a range of data sources (see Supplementary Appendix A for the Ovid MEDLINE search strategy). Our search had no restrictions on language, country, or study design and included both quantitative and qualitative findings to provide evidence about factors associated with PMP use; we searched up until January 22, 2018. Only fully published peer-reviewed reports of study data were included, except for theses or dissertations. We searched five electronic databases (Medline, Embase, CINAHL, PsychInfo, and Web of Science), as well as dissertation and theses databases. Additionally, we manually searched the reference lists of all included studies and identified relevant reviews. EndNote X8.1 was used to de-duplicate and manage citations [31]. All identified studies were imported to Covidence, a Web-based software developed by Cochrane to facilitate the systematic review process [32].

Study Selection

All titles and abstracts were screened independently for eligibility by two of four investigators (AR, MW, ER, MA) and were pushed forward to full-text review if consensus was achieved on relevance. Two of the four reviewers (same as above) also independently screened full-text articles to determine eligibility for data extraction. Rates of discordance between reviewers for the title/abstract and full-text review were 8.9% and 9.7%, respectively. At all stages, any discrepancies in eligibility between reviewers were discussed to reach consensus. If no consensus could be reached, a third investigator reviewed and assessed the eligibility. Studies were included for full review if they met the following criteria: 1) The publication was a primary research study in full text (i.e., not a systematic review, editorial, abstract, or commentary), 2) the jurisdiction being studied had an operational PMP (not pending or forthcoming), 3) the study had a measure of PMP use (with a denominator for the measure) and/or had identified barriers to PMP use, and 4) the study population consisted of health care providers. Multiple publications presenting data on the same group of respondents are identified as linked in Supplementary Appendix B. Overlapping outcomes from these publications were included only so as to not overweight the findings.

Data Extraction and Quality Assessment

We used a pre-tested data extraction form developed in Covidence to extract relevant study details (authors, year, jurisdiction, study design, sample size, response rate), population characteristics (provider or dispenser type), data sources (focus group, survey, administrative), information on data use, and any barriers identified (including whether these barriers were identified by <50%, ≥50%, or an unknown percentage of the study population) for included studies. Two reviewers completed the data extraction for each study independently, and discrepancies were discussed. When consensus could not be reached by the two initial reviewers, the assessment of a third reviewer was sought. The quality of studies was assessed with the Appraisal tool for Cross-Sectional Studies (AXIS) critical appraisal tool for quantitative studies [33] and the Critical Appraisal Skills Programme (CASP) tool for qualitative studies [34].

Data Analysis

Prevalence of PMP data use was expressed as the proportion of respondents reporting having ever used or always using PMP data. We used Stata version 15 (the metaprop command) to combine proportions of ever using PMP data under a random effects model due to the heterogeneity between studies, using the Freeman-Tukey Double Transformation to stabilize variances. We present the proportion of providers using PMP as a range and a pooled estimate with 95% confidence interval (CI). We also examined rates of PMP data use by provider type. Finally, we present data on the proportion of providers who reported "always using PMP data while prescribing" in our meta-summary. Always using PMP data was presented as mean and standard deviation. Other measures of frequency of use were not pooled due to significant heterogeneity.

Barriers associated with using PMP data were synthesized with qualitative meta-summary methods [35]. Barriers (and the percentage of respondents reporting them) were first extracted at the study level in the context of each individual study and were then coded, compared, and combined by theme through the use of data maps. For syntheses and ease of interpretation, we categorized barriers, as mentioned above, into: those reported by <50% of the study sample (defined as a less common barrier), those reported by ≥50% of the study population (defined as a more common barrier), and those reported by an unknown percentage (i.e., those identified in a qualitative meta-summary, labeled as a general barrier) of the study population.

Results

Searches

Using the search strategy outlined above, we initially identified 1,490 unique records (Figure 1) and reviewed 192 of these publications in full text. In total, we identified 53 studies (56 publications) that met the inclusion for our review, of which 46 reported on PMP data use and 32 identified barriers to PMP data use (Supplementary Appendix B) [36–38].

Study Characteristics

All included studies were conducted in the United States and covered a range of health care professionals: prescriber populations, including physicians (23 studies), dentists (1 study), nurse practitioners (5 studies); administrative populations (i.e., PMP and health care administrators; 3 studies); and pharmacists (13 studies). Many studies identified the health care professionals included in their study broadly, using terms such as *providers* (7 studies), *clinicians* (2 studies), or *prescribers* (7 studies), and 13 studies looked at more than one specific group of health care professionals. Study participation/response rates varied greatly between studies, from 4% to 100%. Specific characteristics of the PMPs and their implementation were not well described in the studies and were therefore not included in our analysis. However, to add context when discussing specific studies, up-to-date information on the current status of PMPs in different jurisdictions within the United States was collected from "PDMP Assist" and is presented in Supplementary Appendix C.

Methodological Quality

The included studies were of variable methodological quality (Supplementary Appendix D). The highest area of concern for study quality among quantitative studies was poor response rates, which were reported to be as low as 4%. Other areas of concern across studies included whether the data were adequately described, replicability of methods, the use of validated instruments to collect observations, justification of the sample size, and the selection of a representative sample, particularly given the use of convenience sampling approaches in many studies (Table 1).

We identified three main areas of concern for qualitative study results: the appropriateness of the recruitment strategy, whether the relationship between researcher and participants was addressed, and the rigor of data analysis (Table 1). In all, qualitative studies were good with respect to their comprehensive assessment of barriers to PMP. Of the 13, six studies used some sort of framework, approach, or method from the literature to describe barriers, and the rest either thematically coded barriers (four studies) or had predefined groupings for barriers based on the structure of questions (three studies).

Prevalence of PMP Data Use

Among the 46 included studies (131,587 participants) reporting data use, the most common outcome reported was the proportion of prescribers or dispensers who have
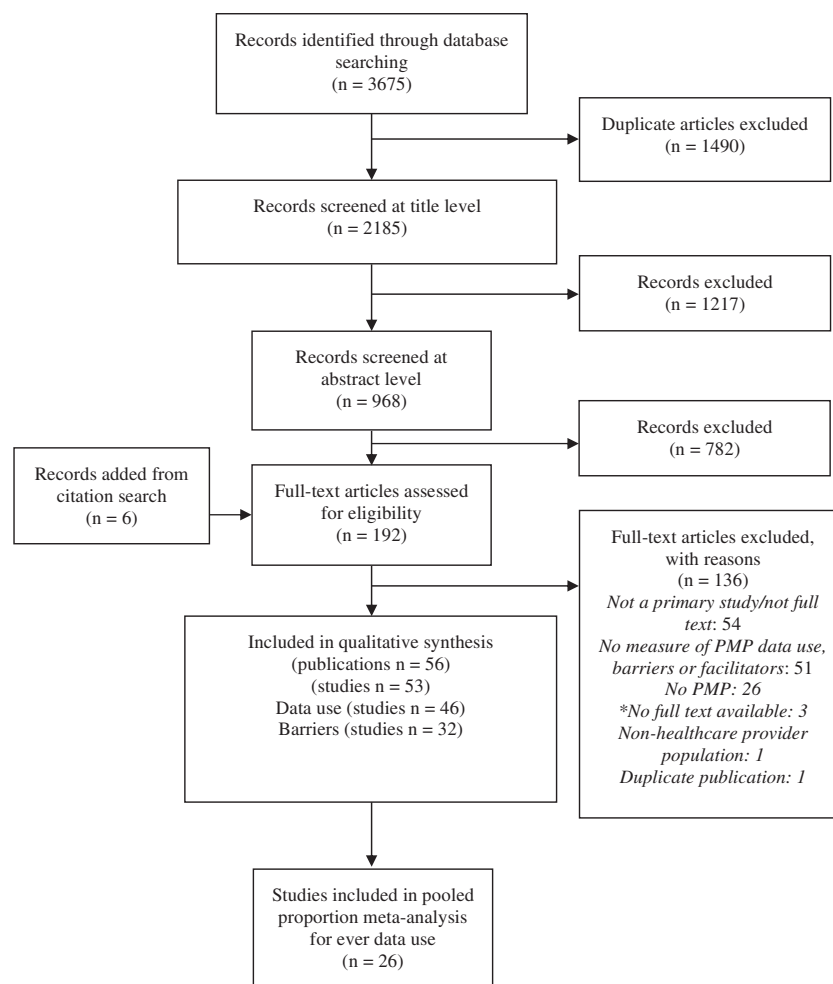
Figure 1. PRISMA diagram for study screening and inclusion process. ES = effect size.

*Reasons for full texts being unavailable to authors: embargoed (1); not yet digitized and informed it would take at least a month (1); not enough information available for authors or library services to find it (1).

"ever" used PMP data. This outcome was reported in 26 studies representing 30 unique prescriber/dispenser groups (107,998 participants), with proportions of "ever use" of PMP data ranging from 0.08 to 1.00 (Figure 2) [23–25, 27, 28, 39–59]. Overall, the pooled proportion of health care providers who have ever used PMP data was 0.57 (95% CI: 0.48–0.66). Among the health care providers included in these studies, physicians and pharmacists were the two specific groups studied most often, in fourteen and seven studies, respectively. The pooled proportions of physicians (0.63; 95% CI: 0.43–0.81) and pharmacists (0.57; 95% CI: 0.41–0.73) ever using PMP data did not differ significantly. There were no observable differences in data use by year of study publication (Supplementary Appendix E).

Another 24 studies (108,327 participants) reported on other measures of frequency of PMP data use [22, 23, 27, 28, 39, 41, 43, 46, 47, 50, 56, 57, 60–71]. Frequency of use was defined either within a specified time frame (i.e., past week, past month, over study period) or in specific scenarios (i.e., when prescribing to a new patient or to

high-risk patients). A common measure of frequency of use was the proportion of health care professionals who "always" checked or used PMP data when making a prescribing or dispensing decision, which was reported by 11 studies (4,919 participants) [23, 24, 43, 46, 52, 56, 60, 61, 65, 67, 71].

Across these 11 studies, there was a low percentage of health care providers who always used PMP data when making prescribing or dispensing decisions, ranging from 0% to 68% (mean [SD]: 18.7% [18.4%]). Three studies reported a percentage of health care providers who always used PMP data that was markedly higher than the mean: Blum (2016), Fleming (2014), and Chaudhary (2017) [56, 60, 61].

Barriers to PMP Data Utilization

From the 32 studies (11,266 participants) that discussed barriers to PMP data use, we identified 18 groups of barriers (Table 2) [23–25, 27, 28, 41–47, 49, 50, 54–56, 58, 59, 64, 66, 67, 71–80].

Table 1. Summary of critical appraisal of studies with quantitative data using AXIS and CASP tool

	Total studies yes, n*	Total studies yes, %
AXIS Item		
1. Were the aims/objectives of the study clear?	41	93.2%
2. Was the study design appropriate for the stated aim(s)?	41	93.2%
3. Was the sample size justified?	8	18.2%
4. Was the target/reference population clearly defined? (Is it clear whom the research was about?)	43	97.7%
5. Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?	36	81.8%
6. Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?	26	59.1%
7. Were measures undertaken to address and categorize nonresponders?	6	15.4%
8. Were the risk factor and outcome variables measured appropriate to the aims of the study?	41	93.2%
9. Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialed, piloted, or published previously?	30	68.2%
10. Is it clear what was used to determine statistical significance and/or precision estimates? (e.g., P values, CIs)	28	80.0%
11. Were the methods (including statistical methods) sufficiently described to enable them to be repeated?	30	68.2%
12. Were the basic data adequately described?	28	63.6%
13. Does the response rate raise concerns about nonresponse bias?[†]	33	86.8%
14. If appropriate, was information about nonresponders described?	5	13.2%
15. Were the results internally consistent?	35	79.5%
16. Were the results for the analyses described in the methods presented?	38	86.4%
17. Were the authors' discussions and conclusions justified by the results?	39	88.6%
18. Were the limitations of the study discussed?	42	95.5%
19. Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?[†]	0	0.0%
20. Was ethics approval or consent of participants attained?	42	95.5%
CASP Item	**Total studies yes, n**	**Total studies yes, %**
1. Was there a clear statement of the aims of the research?	14	100.0%
2. Is a qualitative methodology appropriate?	14	100.0%
3. Was the research design appropriate to address the aims of the research?	12	85.7%
4. Was the recruitment strategy appropriate to the aims of the research?	9	64.3%
5. Were the data collected in a way that addressed the research issue?	14	100.0%
6. Has the relationship between researcher and participants been adequately considered?	8	57.1%
7. Have ethics issues been taken into consideration?	13	92.9%
8. Was the data analysis sufficiently rigorous?	10	71.4%
9. Is there a clear statement of findings?	14	100.0%
10. How valuable is the research?[‡]	12	85.7%

*Because of certain questions being inapplicable for some studies, N is not always 44: Question 7, N = 39; Question 10, N = 35; Question 13, N = 38; and Question 14, N = 38.

[†]Higher rate of responding *yes* can be interpreted as of concern.

[‡]*Yes* answer indicates that value was demonstrated.

Time constraints were the most commonly identified barrier. Time constraints were identified as a less common barrier in eight studies [24, 27, 41, 45, 54–56, 67], a more common barrier in five studies [23, 43, 46, 47, 74], and a general barrier in another five studies [50, 64, 71, 78, 80]. This was represented by reports from health care providers that the process of obtaining information from the PMP to advise prescribing or dispensing situations, specifically in the processes of logging in or retrieving information, was too time consuming.

Issues with system slowness were identified as a less common barrier in five studies [24, 27, 41, 44, 55], a more common barrier in three studies [44, 74, 79], and a general barrier in seven studies [50, 64, 71, 72, 76, 78, 80]. Specific issues included lag times in system updates, as well as infrequent updates, the "timing out" of data

access requests, and the lack of timely receipt of information from the system (including inability to query in real time). These issues impact the utility of PMPs for health care providers in a prescribing or dispensing situation.

Related to system issues are issues with usability and a lack of training or guidance in using the PMP. Issues with usability were identified as a less common barrier in ten studies [23, 28, 41, 43, 45, 47, 55, 56, 67, 75], a more common barrier in two studies [54, 74], and a general barrier in seven studies [49, 64, 72, 73, 77, 78, 80]. The issue of a lack of training or guidance in using the PMP was identified as a less common barrier in one study [79], a more common barrier in one study [74], and a general barrier in three studies [42, 64, 71]. Usability issues, including difficulty accessing or navigating the PMP and interpreting the data, could promote a lack of confidence
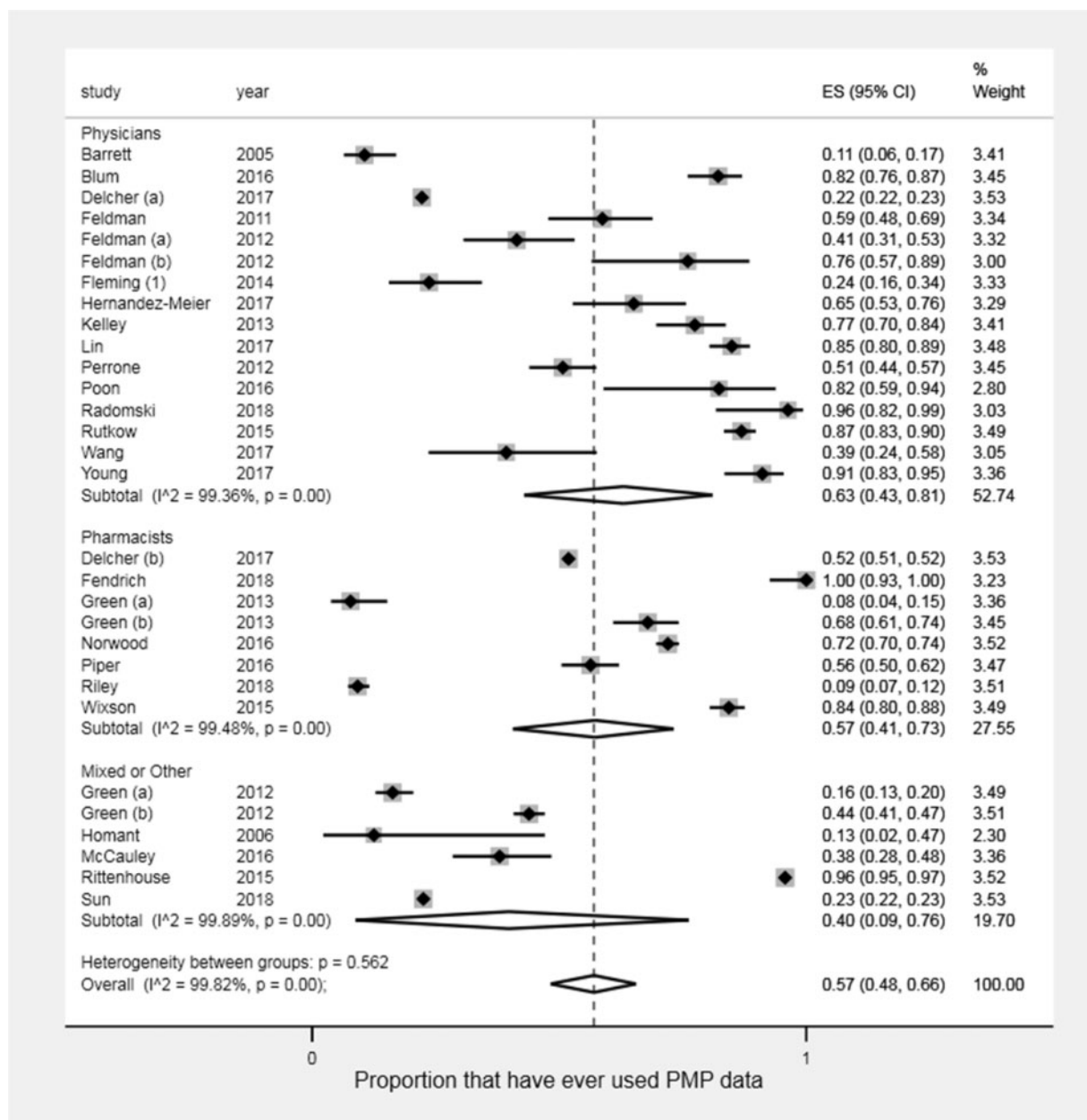
Figure 2. Results of pooled proportion meta-analysis of ever PMP data use by physicians, pharmacists, and mixed or other populations.*

*Feldman (a) represents the subgroup of residents, whereas Feldman (b) represents the subgroup of attending physicians. Green (a) represents pharmacists in Rhode Island, and Green (b) represents pharmacists in Connecticut.

in using the PMP that may prompt health care providers to identify the need for better training or guidance.

Not seeing the value in PMP data was identified as a less common barrier in ten studies [23, 28, 41, 44, 45, 47, 55, 56, 58, 79] and a general barrier in four studies (it was not identified in any study as a more common barrier) [42, 71, 72, 74]. Most often, this was reported as providers feeling that the use of PMPs would not impact their clinical practice. Other reports included not wanting to use PMP data or feeling that they could rely on their instincts in prescribing or dispensing situations.

Along with this, health care professionals expressed that PMPs inhibited their ability to prescribe, impairing their autonomy and raising concerns about patient privacy. This was identified as a less common barrier in six studies [43, 46, 55, 56, 58, 66] and a general barrier in two studies (it was not identified in any study as a more common barrier) [64, 72]. This is linked to a concern that PMPs may result in patients being under-treated (one less common and one general) [56, 72].

Health care providers were also concerned about patient satisfaction ratings and patient flow. This was identified as a less common barrier in two studies [43, 79]

Table 2. Reporting barriers to PMP use identified from included studies

| Barrier Group | Study IDs and Frequency of Barrier Reporting | | | Examples of Barrier Group |
	Minor (Reported by <50% of Study Sample)	Major (Reported by ≥50% of Study Sample)	General (No Frequency Reported)	
Not seeing value in PMP data	Rutkow 2015 (23), Perrone 2012 (47), McCauley 2016 (45), Lin 2017 (44), Feldman 2012 (58), Barrett 2005 (45), Hernandez-Meier 2017 (41), Blum 2016 (56), Green 2012 (28), Ulbrich 2010 (79)	NA	Warren 2016 (71), Carnes 2017 (72), Homant 2006 (42), Deyo 2015 (74)	Feel it would not impact or change clinical practice, did not want to use PMP, feel they can rely on their own instinct.
Availability of technology	Perrone 2012 (47), Hernandez-Meier 2017 (41), Green 2012 (28), Green 2013 (27), Wixson 2015 (25)	Ulbrich 2010 (79)	Pugliese 2018 (77), Hildebran 2014 (64)	Limited access to phone, internet, or computers at work, not having access to PMP during all hours of the dazy.
Usability issues	Rutkow 2015 (23), Blum 2016 (56), Perrone 2012 (47), McAllister 2015 (67), Fazio 2017 (75), Hernandez-Meier 2017 (41), Green 2012 (28), McCauley 2016 (45), Kelley 2013 (43), Barrett 2005 (55)	Deyo 2015 (74), Wang 2017 (54)	Pugliese 2018 (77), Poon 2016 (49), Worley 2015 (80), Click 2017 (73), Carnes 2017 (72), Smith 2015 (78), Hildebran 2014 (64)	Difficulty interpreting PMP data, difficulty accessing and navigating the PMP, format of information is not easy to use, lack of confidence in performing PMP tasks.
Time constraints to using PMP data	McCauley 2016 (45), McAllister 2015 (67), Hernandez-Meier 2017 (41), Blum 2016 (56), Green 2013 (27), Young 2017 (24), Wang 2017 (54), Barrett 2005 (55)	Rutkow 2015 (23), Perrone 2012 (47), Norwood 2016 (46), Kelley 2013 (43), Deyo 2015 (74)	Radomski 2018 (50), Hildebran 2014 (64), Worley 2015 (80), Warren 2016 (71), Smith 2015 (78)	Time consuming to log in, to retrieve information, increase in burden or workload.
Lack of awareness of PMP	Perrone 2012 (47), Feldman 2011 (59), Ulbrich 2010 (79), Lin 2017 (44)	McCauley 2016 (45), Green 2012 (28), Green 2013 (27)	NA	Unaware of PMP or availability of PMP data among nonusers.
System slowness	Young 2017 (24), Barrett 2005 (55), Green 2013 (27), Lin 2017* (44), Hernandez-Meier 2017 (41)	Ulbrich 2010 (79), Lin 2017* (44), Deyo 2015 (74)	Radomski 2018 (50), Carnes 2017 (72), Naiman 2013 (76), Hildebran 2014 (64), Worley 2015 (80), Warren 2016 (71), Smith 2015 (78)	Delay in receiving requested reports, lag time in system updates from when a prescription is dispensed to when it shows up in the PMP, delays in reporting to the system, inability to directly query the system in real time, requests not processing or timing out, system slowness.
Concerns with privacy, monitoring, and autonomy	LeMire 2012 (66), Kelley 2013 (43), Blum 2016 (56), Feldman 2012 (58), Barrett 2005 (55), Norwood 2016 (46)	NA	Hildebran 2014 (64), Carnes 2017 (72)	Concerns with patient privacy, feel they are being policed, feel they are being inhibited in prescribing, fear of legal ramifications.
Lack of training/education or policies/ guidelines	Ulbrich 2010 (79)	Deyo 2015 (74)	Hildebran 2014 (64), Homant 2006 (42), Warren 2016 (71)	Lack of training on how to use PMP or interpret findings, no guidance on how to integrate PMP into workflow, lack of knowledge on PMP policies or laws.
Inability to delegate access	Green 2012 (28), Green 2013 (27), Deyo 2015 (74)	NA	Carnes 2017 (72), Smith 2015 (78), Click 2017 (73)	Lack of staff available to access the system, inability of residents to query the system, unable to share account or delegate access.

Barrier Group	Study IDs and Frequency of Barrier Reporting			Examples of Barrier Group
	Minor (Reported by <50% of Study Sample)	Major (Reported by ≥50% of Study Sample)	General (No Frequency Reported)	
Lack of integration and data sharing (between systems and jurisdictions)	Blum 2016 (56), Deyo 2015 (74)	NA	Radomski 2018 (50), Naiman 2013 (76), Worley 2015 (80), Carnes 2017 (72), Click 2017 (73)	No interstate data sharing, no integration with electronic health/medical record, inability to search outside of one's jurisdiction.
Patient satisfaction concerns	Kelley 2013 (43), Ulbrich 2010 (79)	NA	Hildebran 2014 (64), Smith 2015 (78)	Worried about patient satisfaction rating (which may impact salary), concern with confronting patients, detracting from patient flow.
PMP does not meet provider data needs	Blum 2016 (56), Barrett 2005 (55)	NA	Radomski 2018, (50) Carnes 2017 (72), Homant 2006 (42)	Does not cover certain populations such as Veteran's Affairs or homeless, does not monitor drugs of interest, inability to access information on ones own prescribing history.
Problems with log-in credentials	Perrone 2012 (47), Hernandez-Meier 2017 (41), Blum 2016 (56), Young 2017 (24)	NA	Poon 2016 (49), Naiman 2013 (76), Hildebran 2014 (64), Click 2017 (73)	Difficulty remembering login credentials, frequent password changes required.
Problems with registration process	Perrone 2012 (47), Norwood 2016 (46), McAllister 2015 (67), Lin 2017 (44), Hernandez-Meier 2017 (41), Green 2012, Blum 2016 (56), Green 2013 (27)	Ulbrich 2010 (79)	Hildebran 2014 (64), Smith 2015 (78)	Too time consuming to register, do not know how to register, having to register on each new computer.
No incentive to use PMP	Perrone 2012 (47)	NA	Hildebran 2014 (64), Smith 2015 (78)	No reimbursement for task or incentive (financial or otherwise) to use PMP data.
Data not reliable	Lin 2017* (44), Blum 2016 (44)	Lin 2017 * (44)	Hildebran 2014 (64), Click 2017 (73)	Patient reports filed under more than one ID, missing data, inaccurate data or errors in the system, not all clinicians use the system so patient history may not be comprehensive..
Lack of support from administration	Green 2012 (28), Green 2013 (27), Kelley 2013 (43)	NA	NA	PMP not required or promoted by administration, or PMP use is discouraged by administration.
Potential for under-treatment	Blum 2016 (56)	NA	Carnes 2017 (72)	Restrictions in providing opioids to patients who patients feel really need them (i.e. cancer, palliative care, surgery, etc.).

*Identifies studies that have reported barriers within the barrier group for more than one category of frequency of reporting.

and a general barrier in two studies (it was not identified in any study as a more common barrier) [64, 78].

Less frequently acknowledged barriers included the lack of incentives to use the PMP (one less common [47] and two general [64, 78]), the perception that the data collected for PMPs were not reliable (two less common [44, 56], one more common [44], and two general [64, 73]), and a lack of support from PMP administrators (three less common) [27, 28, 43]. Others included an inability to delegate access to staff (three less common [27, 28, 74] and three general [72, 73, 78]), a feeling that the PMP did not

provide the type of data a health care provider needed to make dispensing decisions (two less common [55, 56] and three general [42, 50, 72]), and a lack of integration and data sharing across PMP systems in different jurisdictions (two more common [56, 74] and five general [50, 72, 73, 76, 80]). Further barriers related to usability included the availability of the technology required to use the PMP (five less common [25, 27, 28, 41, 47], one more common [79], and two general [64, 77]) and problems with log-in credentials (four more common [24, 41, 47, 56] and four general [49, 64, 73, 76]). Finally, there was an identified lack

of awareness of the PMP system (four more common [44, 47, 59, 79] and three less common [27, 28, 45]), as well as problems in registering for the PMP (eight more common [27, 28, 41, 44, 46, 47, 56, 67], one less common [79], and two general [64, 78]).

Discussion

This systematic review identified a significant body of literature on PMP data use and barriers, with 46 identified studies examining PMP data use and 32 identified studies looking at barriers to PMP data use.

Only half of health care providers have ever used PMP data, and on average only about 20% check the system with each prescribing or dispensing decision. Some studies lacked detail that would allow us to distinguish whether "always use" was measured only within the context that the PMP should be used, or simply for every visit. Therefore, we are unable to distinguish "always use" from "always use in the appropriate scenario," where the appropriate scenario is use of the PMP in cases in which opioids or other controlled substances are being prescribed or filled. The wide range in health care professionals who had ever used a PMP could be influenced by the unique characteristics of the PMP itself (i.e., mandatory PMP use or training) or the study design.

We were unable to study the unique characteristics of the PMPs because of the insufficiency of information on the PMP itself in the studies; however, we were able to summarize information from "PDMP Assist" (Supplementary Appendix C) to add context and hypothesize about our results below. One characteristic we discuss below is mandatory use. There are many complex factors of mandatory PMP use, particularly with regard to the degree to which mandatory use is expected (i.e., only for certain substances, or certain providers, or under suspicious circumstances) and how it would be enforced. As such, we were unable to fully explore the impact of mandatory PMP use laws/declarations on actual PMP use by health care providers, nor have we included this information in Supplementary Appendix C (characteristics of PMPs). However, some information on mandatory use can be obtained from the "PDMP Assist" website [81]. How information on use was gathered would also affect reported estimates, including whether data was collected from surveys or in a cohort study, while the response rate and those who agree to participate may capture different levels of PMP users. The year of the study did not seem to have an impact on use as per our sensitivity analysis. This may be due to the different timelines for PMP implementation and uptake in each jurisdiction.

When comparing the characteristics of PMPs (see Supplementary Appendix C) in studies in the top 15% of PMP ever use [23, 24, 39, 50, 52] against those in the bottom 15% of PMP ever use [27, 28, 42, 51, 55], the only difference of note is the inclusion of mandatory training. None of the jurisdictions in the studies in the

bottom 15% of PMP ever use currently have mandatory training, whereas jurisdictions in three of the five studies in the top 15% of PMP ever use currently have mandatory training, which suggests that it may play a role in facilitating greater PMP use. We also compared whether either solicited, or solicited and unsolicited, reports to prescribers and dispensers had any impact on ever use of PMPs. We determined whether reports were solicited, or solicited and unsolicited, by the jurisdiction in which the study took place, using information in Supplementary Appendix C, for those studies that reported ever use and were conducted in just one jurisdiction (19 out of the 26 studies reporting ever use). For reports to prescribers, there were only slight differences in the percentage of ever use according to whether reports were solicited or solicited and unsolicited (59% vs. 52%, respectively). However, for reports to dispensers, there was a greater difference in the percentage of ever use depending on whether reports were solicited or solicited and unsolicited (53% vs. 69%, respectively); however, the latter figure is based on only four studies.

Three studies reported notably higher frequencies of health care providers always using PMP data. Features of these studies that may have accounted for those high frequencies are mandatory use [82], timeliness of data availability [83], law enforcement connection [84], and provider groups [85]. Mandating the use of PMPs may generate greater use, though it does not generate perfect compliance [56]. Targeting the timeliness and ease of accessing data might increase PMP use by addressing numerous identified barriers (Table 2) [61]. More immediate data availability, as well as law enforcement involvement, may stress the importance of checking PMP data. Finally, though many health care professional groups were assessed, a study of nurse practitioners showed higher levels of always using the PMP [60]. Specific provider groups might be more engaged with using the PMP, and understanding why that is the case could be important in developing interventions to increase PMP data use overall.

Barriers that contribute to the low overall utilization of PMPs are important targets for policy and system planning. Many of the barriers identified by health care providers were strongly interrelated and point largely to system-level changes. The largest of these were related to time and usability. To increase use, PMP administrators must look at ways to simplify and speed up the process of accessing PMP data, to increase confidence and ease of using the system among health care providers. Because health care providers already have such a brief time to interact with patients, any improvements to system speed and usability may alleviate the burden of limited time. An intervention to improve PMP literacy may further support this aim and may reassure health care providers by helping them understand the information that the PMP provides, why it is necessary for public health

safety, and how patient privacy/confidentiality is protected.

Although these are not the only barriers identified, finding resolutions to these common perceived barriers might be expected to facilitate an increase in PMP data use. Health care professionals have themselves stated that the removal of barriers would increase their day-to-day use of their PMP [24]. Administrators and policy makers have incentive and justification, and now information, to allocate resources toward removing barriers to PMP use.

Better-controlled prescribing (including the use of PMP data) may help to reduce harms directly, through controlling inappropriate prescribing, and indirectly, by reducing the number of problem users. Our finding that PMP data use is low and that many barriers exist to using PMP data demonstrates that this tool is not being used to its fullest potential and could potentially have a larger positive impact on the opioid crisis in reducing misuse and potential harms.

The data collected on PMP data use may be biased in several ways and should be interpreted with caution. The main concerns identified in our critical appraisal of the literature included sampling methods, low response rates, and whether nonresponders may have been systematically different from responders in terms of the outcome of interest. This low response rate and lack of information on nonresponders is problematic, as it not possible to assess whether responders and nonresponders were systematically different from one another. It is likely that those who responded were more actively engaged in the use of PMPs and hold stronger opinions about PMPs. This could have caused an overestimation of the proportion of health care providers who use PMPs and could have inflated the reporting of barriers. Furthermore, there is the potential for biases to emerge in self-reported studies, including social desirability and recall bias. This should not detract from the large number of studies that were identified and pooled for this analysis, which is a study strength.

It is also important to note that we were unable to distinguish between "PMP use" and "appropriate use of a PMP" because of the lack of detail in the included studies. This is a limitation, as we know all use is not created equal. Nevertheless, through this review, we were still able to synthesize information on patterns of use, which has been a gap in the literature.

Another important consideration is that all studies included in this review are from the United States. Although the identified barriers in U.S. studies may be applicable to similar PMP systems in Canada, they may not be applicable to more integrated prescription systems, as are found in many parts of Europe. As such, primary studies are required in both Europe and Canada, as they are both embedded in different health care systems. Additionally, whether or not a jurisdiction has mandatory PMP checking is likely an important characteristic

of the PMP that may have contributed to the varying rates of use reported above. Lastly, it should be acknowledged that the mere existence of a PMP may produce a benefit, regardless of its barriers or usage, as it serves as a reminder to prescribe opioids with careful consideration.

The findings from this review may have implications for other studies and reviews examining aspects of PMP utilization or effectiveness, as we know there are barriers that would directly impact use and indirectly impact effectiveness. Two recent systematic reviews of the impact of PMP status on prescribing and overdose outcomes found unclear and mixed results [86, 87]. In both cases, the barriers and low usage levels of PMPs identified in our review may help explain the uncertainty in relationships between PMPs and outcomes. In terms of future studies, we note that among the studies in this review, PMPs (their implementation and features) were not well described. Rather than assessing simply the presence or absence of a PMP, future research should assess the impact of different features or different modes of implementation of PMPs on use and effectiveness.

Conclusion

This review has described the current use of PMP data among health care providers and has highlighted several key barriers experienced by health care providers in their daily use of PMP data. PMPs remain a vital tool to help combat the potential harms associated with prescription opioid misuse. Although these tools are present in most jurisdictions in North America, PMPs remain sorely underutilized, and many barriers to use have been identified. For PMPs to reach their fullest potential for health care providers, patients, and the public, these barriers must be removed or reduced. This review represents a first step in cataloging PMP use barriers for PMP administrators so that meaningful changes can be implemented.

Acknowledgments

Supplementary Data

Supplementary Data may be found online at http://painmedicine.oxfordjournals.org.

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