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Connections between opioids and road injury: linkage of prescription monitoring and crash databases

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INTRODUCTION

Road traffic injuries and drug overdoses are the two leading causes of injury death in the U.S.[1] In 2017, these two mechanisms were responsible for more than 100,000 deaths. Perhaps more importantly, these two leading causes of injury are closely interconnected. Opioids and other drugs affect driving abilities (e.g., reaction time, alertness, concentration) and crash-related injuries often result in opioid prescribing,[2,3] creating a potential feedback loop from crash to injury to pain to opioid use and back to crash. At any given time, about 20% of drivers have a potentially impairing drug in their system.[4]

Despite the magnitude of these public health problems, very little is known about the interactions between transportation and opioid use. Research has generally relied on isolated trend and risk factor analyses.[5,6] As a result, our picture of connections between these two public health problems is incomplete. Studies to date have largely used fatal crash data to estimate relationships between opioids and other drugs and crash culpability. This work has been limited by toxicological data quality, little contextual information on road users' health, and a narrow focus on fatal crashes only. Likewise, studies that have examined drug-involved crashes in traditional health care databases generally include little information

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about crash circumstances.[7,8] These isolated or "siloed" perspectives limit an understanding of the connections between opioid and traffic crashes and limit abilities to develop solutions. This article examines the linkage potential of two rich population-based data systems, prescription drug monitoring programs (PDMP) and police-reported crash databases, and identifies knowledge gaps amenable to data linkage studies.

POPULATION-BASED SURVEILLANCE ON DRUG DISPENSING AND CRASHES

We first provide an overview of PDMP and crash data system attributes across the U.S. We then follow with a discussion of PDMP-crash data linkage feasibility, potentially transferable lessons from other linkage efforts, and knowledge gaps that could be addressed using PDMP-crash linked data.

Prescription Drug Monitoring Programs

PDMPs are state-level databases designed to facilitate the collection, monitoring, and analysis of data on dispensed controlled substances. By aggregating patient, pharmacy, prescriber, and prescription data entered by pharmacies, PDMPs are primarily used to enhance patient care and support development of prevention and treatment strategies for drug misuse. PDMPs currently exist in all 50 states and the District of Columbia (Missouri has a partial, not statewide, PDMP), among which 65% (n=33) were operational prior to 2010 (Table 1). Controlled substances tracked by PDMPs are classified by the Drug Enforcement Agency into "schedules" according to their potential harm, ranging from Schedule II (high misuse and addiction potential, e.g., methadone) to Schedule V (low misuse and addiction potential, e.g., cough medications with low codeine levels). Controlled substances classified as Schedules II-V are monitored by 76% (n=39) of PDMPs, while the remaining 24% (n=12) monitor Schedules II-IV. Several PDMPs also monitor other, non-scheduled drugs of concern (e.g., butalbital, pseudoephedrine). Schedule I controlled substances include illegal substances with no accepted medical use and are not tracked in PDMPs.

All state PDMPs require detailed dispensing records, including prescription and fill dates, quantity dispensed, days supply, and dosage. Also required in all PDMP databases is the collection of personally identifiable information (PII), including first and last name, address, and date of birth, with some capturing other forms of identification (i.e., driver's license number, social security number). Nearly all PDMPs (94%, n=48) are authorized to release data for research purposes, and law enforcement are often able to gain PDMP access either during an active investigation (71%, n=36) or during court proceedings (29%, n=15). In addition, Utah mandates that substance-related driving convictions (e.g., driving while impaired) be entered in the PDMP. State-level details regarding attributes and specific data elements collected by PDMPs are provided in Appendix Table 1.

Road traffic crash reports

Crash reports provide the primary data source for road safety research. Crash reports are completed by law enforcement officers at the crash scene and include individual, roadway, and vehicle information. Data generally follow a standard format, based on the Model Minimum Uniform Crash Criteria (MMUCC). PII often include first and last name, address, date of birth, and driver's license number.

While many crash report data elements are consistent across states, including detailed information on vehicle characteristics, roadway design, environmental characteristics, and persons' actions at the time of the crash (e.g., ran a red light) and injury status, specific documentation regarding drug involvement varies considerably by state. Sixty-two percent (n=30) of state crash report forms include a field for law enforcement to document whether they suspect a driver to be under the influence of drugs at the time of the crash (Table 2). Most state crash report forms (84%; n=43) provide an opportunity for the officer to document the type of drug test administrated (e.g., blood, urine, drug recognition expert evaluation). Results are most often captured as a positive or negative indication for drug involvement (55%, n=28 states). Additionally, 65% (n=33) of crash report forms provide a field for officers to indicate whether drugs involved were prescriptions or illicit drugs. Completion rates for these fields vary by state and time, and importantly, are germane only to the post-crash population. Scientific inference is severely limited in the absence of population-based based data on drug dispensing and use in the general population of all drivers (crash and non-crash). State-level details regarding specific drug-related data elements captured in crash reports is provided in Appendix Table 2.

Crash and drug-related surveillance data linkage

Prior examples—Several states have initiated or established data systems linking PDMP data to other sources of public health information, providing rich perspectives and information on the opioid epidemic.[9,10] Notable examples include comprehensive data systems in Massachusetts and Tennessee. Massachusetts passed legislation in 2015 to facilitate data sharing across five government agencies and ten data sources related to the opioid crisis, providing an unprecedented look at opioid prescribing, addiction, treatment, and overdose impacts across the state.[10] Similarly, legislation in Tennessee facilitated the development of a data warehouse that stores and links multiple sources of health and prescription data to improve understanding of drug-related issues.[11] In addition to these comprehensive and ongoing data systems, other states have conducted one-time linkages between state PDMPs and emergency department data, hospital admissions, criminal justice data, health insurance claims data, vital statistics records, medical examiner data, or Veteran's Health Administration data to answer novel questions and guide policy. (select examples:12–14)

From a road safety perspective, there have been efforts to take a more comprehensive look at contributors to and burden of crashes. In New Jersey, a comprehensive crash outcomes database was established and includes licensing, crash report, and citation data.[15] The system is also currently expanding to include sources of health data (hospital discharge data, vital records), providing a unique view of causes and consequences of crashes.[16] Multiple states have used probabilistic methods to link crash and injury outcome data (e.g., the Crash Outcome Data Evaluation System) to gain a more complete understanding of crash impacts and to support transportation policy.[17] Finally, numerous one-time linkage efforts have combined crash data with other state databases to explore individual risk factors, subpopulations, or trends in road traffic crashes.[select examples: 18,19]

Potential for PDMP-crash data linkage and transferable linkage lessons—Our assessment of state PDMP and crash database attributes (Tables 1 and 2) indicates that linkage of these two sources is likely feasible in many states with respect to statutory requirements and identifiers available for potential linkage. Additionally, linkage efforts underway in states highlight both the readiness in many states, as well as transferable lessons to potential crash-PDMP data linkage, including: 1) many states have either a comprehensive data system to build from or technical or political experiences to draw from; 2) political will and legislation serve a critical role in fostering linkage processes and creating sustainable data system structures;[10,11] and 3) coalitions of data owners and users can ensure accurate and highly useful research and continued linkage support.[20] We discuss each of these aspects below.

First, linkage requires high-quality matching variables, thorough knowledge about sources to be linked (e.g., data quality considerations), and best practice linkage approaches. In addition to these technical issues, ongoing linkage necessitates trusted relationships between agencies involved. We found many states had a successful history of linkage with PDMP or crash records, suggesting potential foundations to leverage from both technical and political perspectives. Second, many sustainable linked data systems are backed by political will and/or policy, which can help ensure stable funding streams for linkage activities and active use of the data.[10,11] While such opportunities can be difficult to create and foster, there is currently considerable political attention on PDMP data systems, including refining information collected, mandating their use, and bringing in other data sources to increase overall utility. Public health and road safety partners should explore these efforts as potential windows of opportunity to elevate calls for crash data linkage.

Sustainability of linked data systems often includes the establishment of an active coalition that includes data owners and other key stakeholders, providing a forum to regularly demonstrate the tangible benefits of linkage and discuss future analytic directions.[20] In some states, a promising approach could involve integrating crash records experts and PDMP data owners into existing, active opioid or road safety coalitions. In other states, stakeholder integration may be more straightforward, e.g., in four states, law enforcement manages both PDMP and crash records (Table 1).

INSIGHTS TO INFORM PUBLIC HEALTH AND SAFETY PRACTICE

PDMP-crash data linkage provides an opportunity to address several research gaps and ultimately improve clinical, public health, and road safety practice (e.g., informing Drug Recognition Expert training and practice) (Figure 1). Linkage can increase understanding of risk factors and context surrounding crashes as well as provide insights regarding consequences of these events. For example, through a comprehensive understanding of drivers' opioid and other controlled substance regimens prior to crash events, researchers can gain a sense of which substances are most often implicated in crashes and which individual drugs or drug combinations warrant further risk analyses to ultimately inform the evidence base on impairment. Historically, our understanding of substance-impaired driving has been hampered by availability and quality of data. While PDMP-crash data linkage does not solve all impaired driving research limitations (e.g., lack of personal exposure/miles traveled data), it provides a valuable opportunity to illuminate, at a population level, specific substances, combinations of substances, and dose and duration factors deserving more detailed consideration.

In addition to understanding drug-related trajectories leading up to crash events, PDMP-crash data linkage can provide a critical perspective on crash effects, with implications for tertiary prevention following a crash. For example, one could examine how often individuals experiencing crash-related injuries are dispensed opioids and other substances and the crash and substance-related risk factors for long-term drug utilization trajectories that progress from those injuries, as well as the impacts these trajectories might then have on future crash risk. Exploring prescription drug trajectories post-crash and provision of addiction treatment-related medications (e.g., buprenorphine for opioid addiction) can advance understanding of the extent and ways in which crashes alter drug use and connection to treatment (e.g., through drug courts or other channels). While preventing crashes (primary prevention) is of foremost importance, understanding how post-crash pathways might be beneficially altered and repeated injury minimized is critical (tertiary prevention). Ultimately, isolating the impacts of specific prescription drug regimens on crash risk can directly inform patient drug counseling and interventions, including consideration of alternate travel modes.

CONCLUSIONS

Crash and PDMP population-based data systems contain rich information on prescription drug histories and detailed crash circumstances, providing a valuable opportunity to advance understanding of prescription drug trajectories leading to crash events and effects of crashes on subsequent prescription drug patterns. Unfortunately, routine, on-going linkage of these data sources is lacking. However, many states have strong linkage foundations in opioid or road safety arenas, providing technical and political proficiencies to leverage. A complete and unbiased exploration of opioid-impaired driving and its consequences will require comprehensive health, substance, and travel exposure data. PDMP-crash data linkage can help fill one important piece of this puzzle and yield insights regarding the complex interplay between opioids and driving.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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APPENDIX

Details on PDMP-related data abstraction, crash record-related data abstraction, and Appendix Tables 1 and 2 can be found in the attached Appendix files.

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- What are the prescription opioid and controlled substance histories and trajectories of those involved in crashes (of all severity levels) compared to those who do not crash?
- How do crash rates for those on chronic opioid and other controlled substance regimens compare to those on short-term regimens or non-users?
- Which specific opioid or other controlled substance types, dosages, and combinations are associated with increased rates of road traffic crashes?
- How often are persons of different crash-related injury severities dispensed opioids following a crash and at what level (e.g., dose, days' supply)?
- How often do crashes or other traffic convictions trigger entry into opioid (or other substance) use disorder treatment (e.g., initiation of buprenorphine treatment)?
- Do different crash and injury typologies result in different levels of opioid prescribing?

FIGURE 1.
Pressing research questions best answered using linked crash reports and prescription drug monitoring program data

Table 1.

Select attributes of prescription drug monitoring programs[a] pertinent to crash report linkage, investigation, and analyses (n=51)[b]

Attribute	N (%)
Year Prescription Drug Monitoring Program (PDMP) first operational	
<1990	9 (18)
1990-1999	7 (14)
2000-2009	17 (33)
2010-2017	18 (35)
Agency responsible for PDMP administration	
Pharmacy Board	20 (39)
Department of Health	17 (33)
Professional Licensing Agency	6 (12)
Law Enforcement Agency	4 (8)
Substance Abuse Agency	3 (6)
Consumer Protection Agency	1 (2)
Authority to release PDMP data for research	
No authority to release	3 (6)
Authorized to release	48 (94)
Law enforcement access to data	
Access if active investigation	36 (71)
Access if court process (e.g., court order, subpoena, search warrant)	15 (29)
Types of data available to law enforcement	
Patient, prescriber, dispenser histories	42 (82)
Patient and prescriber histories	6 (12)
Patient history	1 (2)
Unknown	2 (4)
Controlled substances monitored [c]	
Schedules II-IV	12 (24)
Schedules II-V	39 (76)
Requirement that substance-related driving convictions be included in PDMP	
Yes	1 (2)
No	50 (98)

[a]Missouri’s PDMP does not span the entire state.

[b]Includes 50 U.S. states and the District of Columbia

[c]Several PDMPs also monitor other specific drugs of concern that might fall outside of these classes (e.g., pseudoephedrine); see Appendix for specific information by state.

Table 2.

Select attributes of crash report forms pertinent to linked analyses with prescription drug monitoring program data (n=51)[a]

Attribute	N (%)
Year of last crash report form update	
2005-2009	16 (31)
2010-2014	23 (45)
2015-2018	12 (24)
Field to document whether drugs were suspected [b]	
Yes	30 (59)
Unknown or not mentioned	21 (41)
Field to document type of drug test administered [b]	
Yes	43 (84)
Unknown or not mentioned	8 (16)
Detail of drug test result documentation [b,c]	
Positive or negative indication for drug involvement	28 (55)
Drugs selected from a pre-defined list	11 (22)
Narrative, supplemental document, or drug recognition expert report	4 (8)
Unknown or not mentioned	8 (16)
Field for whether prescription or illicit drugs involved [b]	
Yes	33 (65)
Unknown or not mentioned	18 (35)

[a]Includes 50 U.S. states and the District of Columbia

[b]Documents whether a field is available on crash report form to capture these elements; completeness varies by state.

[c]Generally captured in terms of broad categories; see Appendix for specific information by state.

Note: State laws and practices may vary with respect to release of data for linkage and research purposes and is an important state-specific consideration.