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SPECIAL ISSUE: LINKING VA AND NON-VA DATA TO ADDRESS US VETERAN HEALTH SERVICES ISSUES

Linkage of VA and State Prescription Drug Monitoring Program Data to Examine Concurrent Opioid and Sedative-Hypnotic Prescriptions among Veterans

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Objective. To examine the prevalence of concurrent Veterans Health Administration (VA) and non-VA prescriptions for opioids and sedative-hypnotic medications among post-9/11 veterans in Oregon.

Data Sources. VA health care and prescription data were probabilistically linked with Oregon Prescription Drug Monitoring Program (PDMP) data.

Study Design. This retrospective cohort study examined concurrent prescriptions among n = 19,959 post-9/11 veterans, by year (2014–2016) and by patient demographic and clinical characteristics. Veterans were included in the cohort for years in which they received VA outpatient care; those receiving hospice or palliative care were excluded. Concurrent prescriptions were defined as ≥1 days of overlap between outpatient prescriptions for opioids and/or sedative-hypnotics (categorized as benzodiazepines vs. non-benzodiazepines).

Principal Findings. Among 5,882 veterans who filled opioid or sedative-hypnotic prescriptions at VA pharmacies, 1,036 (17.6 percent) filled concurrent prescriptions from non-VA pharmacies. Within drug class, 15.1, 8.8, and 4.6 percent received concurrent VA and non-VA opioids, benzodiazepines, and non-benzodiazepines, respectively. Veteran demographics and clinical diagnoses were associated with the likelihood of concurrent prescriptions, as was enrollment in the Veterans Choice Program.

Conclusions. A considerable proportion of post-9/11 veterans receiving VA care in Oregon filled concurrent prescriptions for opioids and sedative-hypnotics. Fragmentation of care may contribute to prescription drug overdose risk among veterans.

Key Words. Veterans, VA health care system, data linkage, opioid safety, medication safety, dual use

Prescription drug overdose is an epidemic in the United States (US), resulting in 40,995 deaths in 2016 (US Centers for Disease Control and Prevention [CDC] National Center for Health Statistics 2017a). As a class of psychotropic medications that acts on the central nervous system, opioid analgesics are associated with almost half of all prescription drug overdoses, accounting for 17,087 (42 percent) deaths in 2016. In response, opioids have become the focus of large-scale public health initiatives to curb the epidemic (Dowell, Haegerich, and Chou 2016; CDC National Center for Injury Prevention and Control 2017). Despite these efforts, opioid-related overdose deaths have continued to increase. Further complicating the public health response, 58 percent of opioid overdoses in 2016 involved multiple psychotropic drugs (CDC National Center for Health Statistics 2017a). Some of the highest risk combinations involve opioids taken with benzodiazepine and non-benzodiazepine sedative-hypnotics, which can increase overdose risk by potentiating depressant effects on the respiratory system (Jones, Mogali, and Comer 2012; Abrahamsson et al. 2017; Garg, Fulton-Kehoe, and Franklin 2017; Sun et al. 2017). To reduce rates of prescription drug overdose, it is essential to understand trends in overlapping—or concurrent—prescription drug use.

State-run prescription drug monitoring programs (PDMPs) collect data on the dispensation of controlled medications across providers and health care systems (Finklea, Sacco, and Bagalman 2013). PDMPs are used to understand and reduce prescription drug overdose risk at both the patient and systems levels. At the patient level, health care providers may query a state PDMP to identify all controlled substances a patient has received from a licensed pharmacy in a respective state. This may inform prescription decisions in cases where potentially unsafe drug combinations are detected. State legislatures have increasingly been mandating prescriber enrollment and prescriber

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queries of state PDMPs, with evidence suggesting these to be effective policies in reducing overdose risk (Brandeis University 2016). At the systems level, analysts can use PDMP data to monitor trends in controlled substance prescribing within states. Although PDMP data may be used to identify patients with concurrent prescriptions, and thus examine trends in high-risk combinations, little information on patient characteristics is available in most PDMPs (Griggs, Weiner, and Feldman 2015; Becker et al. 2017), thereby limiting our ability to identify risk factors for receiving high-risk prescription combinations from multiple providers.

The Department of Veterans Affairs, Veterans Health Administration (VA), is the largest integrated health care provider in the United States (Kizer and Dudley 2009). The VA provides health care and pharmacy services to over nine million enrolled veterans each year (US Department of Veterans Affairs 2017a). VA health care data contain comprehensive information about veterans and their health conditions, including diagnoses and prescription medications. However, many veterans use VA health care services in combination with private or other public health care providers (Shen et al. 2003; Hynes et al. 2007), and non-VA health care data are not comprehensively available in VA data.

Veterans who use VA health care have a higher rate of fatal drug overdose than the general U.S. population (Bohnert et al. 2011). This may be due to the unique demographic and health conditions among veterans, prescribing practices within the VA, or a combination of both. It could also be due to veterans' receipt of high-risk psychotropic prescriptions from multiple health care providers. In 2014, the VA implemented a multifaceted Opioid Safety Initiative, which has reduced opioid prescribing within the VA, as well as the proportion of veterans receiving concurrent opioid and sedative-hypnotic prescriptions (Westanmo et al. 2015; Gellad, Good, and Shulkin 2017; Lin et al. 2017). However, veterans who use non-VA health care may counter these efforts, knowingly or unknowingly, by receiving psychotropic medications from their non-VA providers. The Veterans Access, Choice, and Accountability Act of 2014—through its Veterans Choice Program—authorized veterans to receive VA-paid treatment from non-VA community providers under certain conditions, a move suggesting the VA will cover the cost of larger proportions of non-VA health care services in the years to come (US Department of Veterans Affairs 2017b,c, 2018a). Indeed, in 2018, Congress passed the VA Maintaining Internal Systems and Strengthening Integrated Outside Networks (MISSION) Act to extend Choice Program funding and consolidate it with other programs under the VA's Community Care Program (US

Department of Veterans Affairs 2018c). Although some safeguards are in place, gaps in information transfer between Veterans Choice Program and other community care providers, and the VA, can result in high-risk medication overlap (US Department of Veterans Affairs. Office of Inspector General 2017c).

Veterans' increasing use of VA and non-VA health care services provides an opportunity to examine and reduce concurrent high-risk prescriptions from VA and non-VA providers. Linking VA health care data to state PDMP data can provide a more complete picture of Veterans' prescriptions and creates an opportunity to analyze patient risk factors for concurrent prescription use. To demonstrate the utility of such a linkage, we linked VA to Oregon PDMP data to examine concurrent VA and non-VA opioid and sedative-hypnotic prescriptions among post-9/11 veterans in Oregon. Oregon law requires eligible pharmacies to submit data to the PDMP but does not mandate provider enrollment or queries (Brandeis University 2018a,b). We focused on post-9/11 veteran VA users because this cohort tends to be in the age groups at highest risk of prescription drug overdose and is likely to receive non-VA health care through employer-based private insurance. High proportions of post-9/11 veterans receive prescription opioids from the VA, with up to one-third of some samples receiving concurrent sedative-hypnotics (Macey et al. 2011; Seal et al. 2012).

The objectives of this project were to: (1) demonstrate the utility of linking VA to state PDMP data to identify concurrent VA and non-VA prescriptions among VA users; (2) examine patterns in concurrent VA and non-VA prescriptions; and (3) identify patient demographic and clinical characteristics that may be associated with concurrent VA and non-VA prescriptions.

METHODS

We designed a retrospective cohort study utilizing administrative data from the VA and the Oregon Health Authority (OHA), Public Health Division. The protocol and use of these databases were approved by the VA Portland Healthcare System and the Oregon Public Health Division Institutional Review Boards. Identifiers for all service members who served in the military after September 11, 2001 were obtained from the VA-Department of Defense Identity Repository (VADIR; US Department of Veterans Affairs 2009). VADIR data were combined with administrative data for all individuals who utilized VA health care during a 6-year period (January 1, 2011 through

December 31, 2016) using the VA Corporate Data Warehouse (US Department of Veterans Affairs 2018b). This resulted in a roster of post-9/11 veteran VA users. We restricted this roster to veterans who had received VA outpatient health care services at any of the three medical centers or 14 community-based outpatient clinics in Oregon between January 1, 2014 and December 31, 2016. The flow of veterans from the source population into the final analytic cohort is depicted in Figure 1.

Cohort

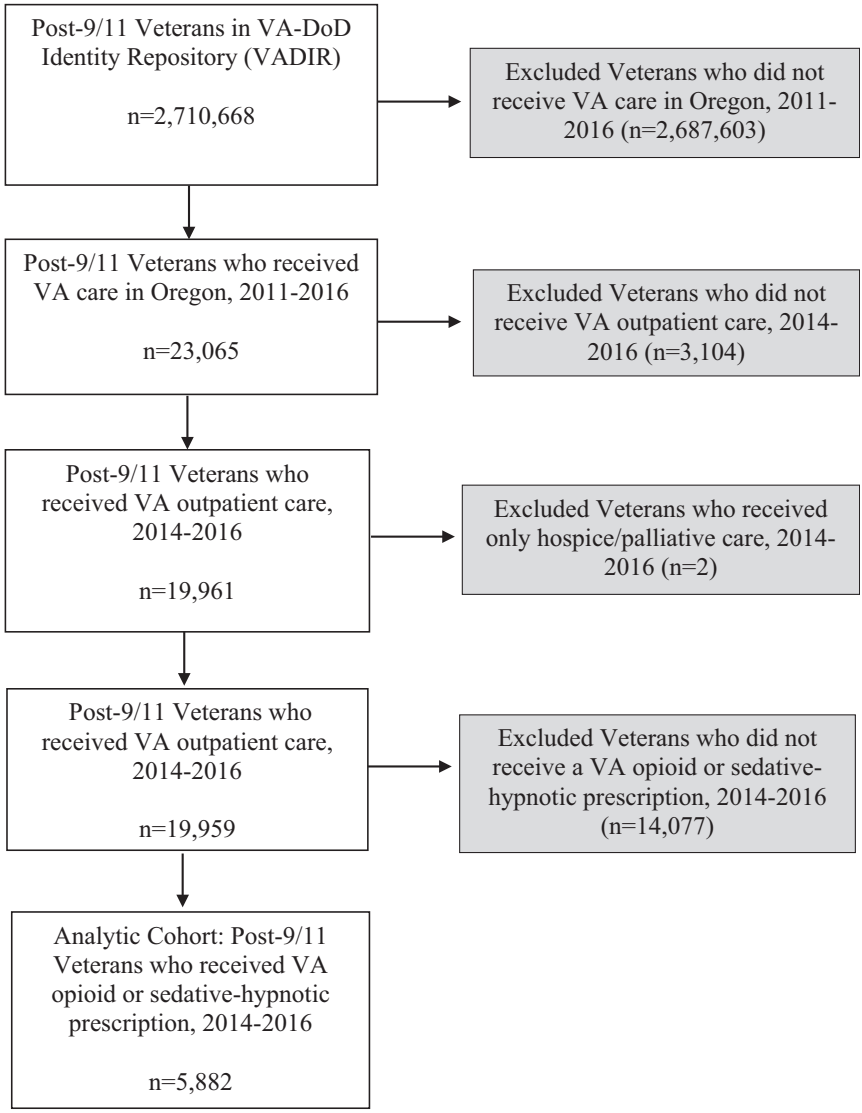
Post-9/11 veterans receiving VA outpatient care during any one of the three study years were eligible for inclusion. Those who received hospice or palliative care (identified using VA treating specialty codes 1F or 96; stop codes 351 or 353; or fee basis codes 37, 38, or 43) were excluded. The resulting database described an overall cohort of 19,959 post-9/11 veterans. For each veteran, up to three recent addresses were included in our data file to aid in the linkage to non-VA data.

Data Linkage

We used the Oregon PDMP database, managed by OHA, to identify controlled prescriptions dispensed to Veterans from non-VA pharmacies (Oregon Health Authority 2018). The Oregon PDMP is mandated by state statute to collect data on Schedule II-IV controlled substances dispensed by Oregon-licensed retail pharmacies (State of Oregon 2009). The program was implemented in 2011 and nearly 100 percent of all mandated Oregon pharmacies contribute prescription data (Oregon Health Authority 2017). Prescriptions must be reported within 72 hours of dispensation. PDMP data are collected at the prescription level; for the years 2014–2016, data elements included limited patient information (name, birthdate, sex, and address), details of the medication dispensed (date, product ID, quantity dispensed, number of days supplied), and a unique pharmacy ID. The length of a prescription, or the number of days of medication supplied, was not collected by the PDMP prior to 2014, thus limiting our ability to identify overlapping prescriptions between 2011 and 2013.

VA cohort data were probabilistically linked to a data extract from the Oregon PDMP. Procedures for linking these databases were governed by a data use agreement negotiated between the VA and OHA. Probabilistic linkage is a method used when a unique identifying key is not available across

Figure 1: Flow of Participants from Source Population to Analytic Cohort



databases; in this case, Social Security Numbers were not available in PDMP data. Probabilistic linkage uses properties of variables common to multiple databases to determine the probability that a pair of records refer to the same person or event and should be linked. Detailed explanations of this method

are published elsewhere (Fellegi and Sunter 1969; Jaro 1995; Cook, Olson, and Dean 2001). Variables used for our linkage included full patient name, date of birth, sex, and address/billing location information (city, county, and zip code). Each database contained a separate row for every combination of person and address at which he or she received VA health care or filled a PDMP prescription. We conducted a many-to-many linkage to account for veterans who may have moved during the study period or filled multiple prescriptions. A pair of records was required to achieve a probability of at least 0.9 to be considered a true match. Following linkage, the database was transformed to person-level records for analysis. Duplicate VA prescription records were identified in the PDMP and removed prior to analysis.

Prescription Fills

We identified veterans' outpatient prescriptions for opioids and sedative-hypnotics in both VA and PDMP data; drug classes and individual drug names are listed in Table 1. Sedative hypnotics were categorized as benzodiazepines versus non-benzodiazepines and are referred to by these separate categories hereafter. VA prescription drugs adhere to the VA national formulary (US Department of Veterans Affairs 2017d) and are therefore a subset of drugs identified in the table. We used VA drug classification system codes CN101, CN302, and CN309 to identify opioid analgesics, benzodiazepine derivative

Table 1: Drug Classifications and Drug Names

Drug Class	*Drug Names*
Opioids	acetaminophen-codeine; belladonna-opium; buprenorphine; buprenorphine-naloxone; butalbital-acetaminophen-caffeine-codeine; butorphanol tartrate; codeine; codeine-guaifenesin; diphenoxylate-atropine; fentanyl; hydrocodone; hydrocodone-acetaminophen; hydrocodone-chlorpheniram; hydrocodone-homatropine; hydrocodone-ibuprofen; hydromorphone; meperidine; methadone; morphine; oxycodone; oxycodone-acetaminophen; oxycodone-ibuprofen; oxymorphone; promethazine-codeine; tapentadol; tramadol; tramadol-acetaminophen
Benzodiazepines	alprazolam; chlordiazepoxide; clonazepam; clorazepate; diazepam; flurazepam; lorazepam; oxazepam; temazepam; triazolam
Non-benzodiazepines	buspirone; butalbital; chloral hydrate; dichloralphenazone; eszopiclone; pentobarbital; phenobarbitol; ramelteon; secobarbital; suvorexant; zaleplon; zolpidem

sedative-hypnotics, and non-benzodiazepine derivative sedative-hypnotics, respectively. PDMP prescriptions are categorized as opioid analgesics, benzodiazepines, and non-benzodiazepine sedative-hypnotics by program administrators using a compilation of drugs and conversion factors from the CDC National Center for Injury Prevention and Control (2016); drugs not classified in this system are categorized using National Drug Codes and technical expertise. As in past research (Becker et al. 2017; Suda et al. 2017; Sun et al. 2017), veterans were defined as having a concurrent prescription if there was one or more days of overlap between filled prescriptions (e.g., at VA and non-VA pharmacies). Due to the potential for high-risk combinations of concurrent prescriptions, we included all opioid medications regardless of therapeutic purpose, including those used in the treatment of opioid use disorders (e.g., buprenorphine and methadone). Opioid antagonists (naloxone and naltrexone) were excluded from this analysis.

Demographic and Clinical Characteristics

Veterans' demographic and clinical characteristics were extracted from VA administrative databases (VADIR or Corporate Data Warehouse). Demographic variables were coded into broad categories for parsimony and, where possible, ease of comparison with past VA or opioid safety research. Age was computed as of January 1, 2014 and categorized as ≤35, 36–45, and ≥46 years. Race was categorized dichotomously as white and other-than-white. Marital status was similarly dichotomized as married versus other-than-married, and education level as high-school-or-less versus more-than-high-school. Veterans' residential location was categorized as urban versus other-than-urban using patients' addresses and the zip code approximation of the 2010 US urban-rural continuum tables (US Department of Agriculture 2016). Veterans' service connection status, an indicator of disability related to veterans' military service, was categorized as none, service-connected <50 percent, and service-connected ≥50 percent. Paid invoices served to identify veterans as participants in the Veterans Choice Program; veterans were coded as Choice Program participants if they had paid program services from the time of its implementation forward.

We used International Classification of Diseases—9th Revision—Clinical Modification (ICD-9-CM) codes to identify mental health and pain-related diagnoses through September 30, 2015 (US Department of Health and Human Services 2009). ICD-10-CM codes were used to identify diagnoses assigned between October 1, 2015 and December 31, 2016 (CDC National

Center for Health Statistics 2017b). To identify equivalent diagnoses between coding schema, we used the Centers for Medicare & Medicaid Services General Equivalency Mapping tables with a forward-backward method (US Centers for Medicare & Medicaid Services 2016); code lists are available in the Appendix SA3. Diagnoses of interest were based on conditions known to be prevalent among post-9/11 veterans and/or associated with psychotropic prescription use (Taylor et al. 2012; Cifu et al. 2013). These included cancer, traumatic brain injury, post-traumatic stress disorder (PTSD), anxiety disorders other than PTSD, pain disorders (any pain; headache; back or neck pain), depression, and substance use disorders (any substance use disorder [excluding nicotine use disorder]; opioid use disorder). We coded veterans with one or more respective codes assigned during an inpatient stay or two or more codes assigned during an outpatient visit as having the diagnosis of interest. Because diagnosis codes do not necessarily represent the onset or end of an episode of disease or injury, we included codes that had been assigned at any point between January 1, 2011 and December 31, 2016.

Data Analyses

We conducted descriptive analyses examining the proportions of veterans receiving opioids, benzodiazepines, or non-benzodiazepines from the VA who filled concurrent prescriptions from non-VA pharmacies for any of these three drug classes. (We also examined differences between concurrent prescriptions received *within* the VA from those received *outside* the VA, and computed the proportions of veterans with concurrent prescriptions from *either* within or outside the VA.) Proportions of veterans with concurrent prescriptions from the same drug class (e.g., VA opioids and non-VA opioids) or from different drug classes (e.g., VA opioids and non-VA benzodiazepines) were examined for the entire study period as well as for each one-year calendar period (2014, 2015, and 2016) to explore potential patterns of change. For the one-year periods, veterans were excluded in any individual year that they did not receive outpatient care or that they received hospice or palliative care from the VA.

Logistic regression models were used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) estimating associations between veterans' demographic and clinical characteristics and their likelihood of any concurrent VA and non-VA prescription fills. Multivariable models were used to estimate each association of interest while controlling for potential confounders. We employed a multivariable model specification strategy based on causal modeling and directed acyclic graphs, as described in Greenland, Pearl, and

Robins (1999) and demonstrated by Hernán et al. (2002). This method of confounder identification is based on a priori knowledge or assumptions about associations between variables of interest and guides specification of parsimonious statistical models through omission of covariates that are not theoretical confounders. In our multivariable analyses, odds of concurrent VA and non-VA prescriptions are calculated in reference to each hypothesized risk factor while controlling for potential confounders identified a priori from the directed acyclic graphs. This procedure was repeated for each separate independent variable, resulting in different sets of covariates being included in different models (covariates included in each model are identified in table footnotes). All analyses were performed using *SAS/STAT* software version 9.4 (Cary, NC).

RESULTS

Concurrent Prescription Fills

Among the 19,959 post-9/11 veterans receiving VA outpatient care in Oregon between 2014 and 2016, 5,882 filled prescriptions for one of the three drug classes at VA pharmacies; 4,385 (22.0 percent) received opioids, 1,649 (8.3 percent) received benzodiazepines, and 1,626 (8.1 percent) received non-benzodiazepines during the study period. Compared to veterans who did not receive these VA prescriptions, greater proportions of those who did had VA service connection ≥50 percent were enrolled in the Veterans Choice Program, and had each diagnosis of interest (comparisons are presented in the Appendix SA2). Among the 5,882 veterans who received VA prescriptions, 2,070 (35.2 percent) had also used non-VA pharmacies to fill prescriptions for one of these three drug classes between 2014 and 2016, though not necessarily at the same time as (concurrent with) their VA prescriptions. A smaller proportion (n = 1,036; 17.6 percent) filled *concurrent* prescriptions for the same or another of these drug classes from non-VA pharmacies.

The proportions of veterans with concurrent outpatient prescription fills are displayed in Table 2. Among the 4,385 veterans receiving opioids from the VA, 661 (15.1 percent) filled concurrent non-VA opioid prescriptions; among those receiving VA benzodiazepines or non-benzodiazepines, 145 (8.8 percent) and 74 (4.6 percent) filled non-VA prescriptions for the same drug class, respectively. Notably, 13.7 percent and 13.4 percent of veterans receiving VA prescriptions for benzodiazepines or non-benzodiazepines filled concurrent non-VA prescriptions for opioids, respectively. Accounting for

Table 2: Concurrent VA and Non-VA Prescription Fills among $n = 5{,}882$ Post-9/11 Veterans Receiving Opioids, Benzodiazepines, or Non-Benzodiazepines from the VA, 2014–2016

	*VA Prescription Drug Class**		
*Concurrent Prescription Drug Class**	*Opioids n = 4,385 n (%)*	*Benzodiazepines n = 1,649 n (%)*	*Non-benzodiazepines n = 1,626 n (%)*
VA			
Opioids	–	580 (35.2%)	478 (29.4%)
Benzodiazepines	580 (13.2%)	–	318 (19.6%)
Non-benzodiazepines	478 (10.9%)	318 (19.3%)	–
Non-VA			
Opioids	661 (15.1%)	236 (13.7%)	218 (13.4%)
Benzodiazepines	126 (2.9%)	145 (8.8%)	53 (3.3%)
Non-benzodiazepines	34 (0.8%)	22 (1.3%)	74 (4.6%)
VA or Non-VA			
Opioids	661 (15.1%)	671 (40.7%)	576 (35.4%)
Benzodiazepines	646 (14.7%)	145 (8.8%)	343 (21.1%)
Non-benzodiazepines	492 (11.2%)	326 (19.8%)	74 (4.6%)

*Categories of drug classes are not mutually exclusive across columns or rows due to receipt of multiple drug classes among some veterans.
PDMP, Prescription drug monitoring program; VA, Veterans Affairs.

concurrent prescriptions from *either* VA *or* non-VA providers highlighted proportions of veterans that received concurrent prescriptions across sources. For example, among veterans receiving benzodiazepines from the VA, the proportion receiving concurrent opioids from *either* VA or non-VA providers was 40.7 percent. The proportions of veterans with concurrent VA and non-VA prescription fills by year are presented in Table 3. Proportions of veterans with concurrent prescription medications stayed relatively consistent over the three-year study period.

Characteristics Associated with Concurrent Prescription Fills

Proportions of veterans with concurrent VA and non-VA prescription fills at any time between 2014 and 2016 are presented in Table 4, organized by veterans' demographic and clinical characteristics. In bivariable models, veterans who were 36–45 years of age, or 46 years and older, were more likely to have concurrent prescription fills than those 35 or younger (OR = 1.4; 95% CI: 1.2, 1.6 and OR=1.4; 95% CI: 1.2, 1.7, respectively). Veterans who were

Table 3: Concurrent VA and Non-VA Prescription Fills among n = 5,882 Post-9/11 Veterans Receiving Opioids, Benzodiazepines, or Non-Benzodiazepines from the VA, 2014–2016, by Year

	*VA Prescription Drug Class**		
*Concurrent Non-VA Prescription Drug Class**	*Opioids*† *n (%)*	*Benzodiazepines*† *n (%)*	*Non-Benzodiazepines*† *n (%)*
2014	**n = 2,386**	**n = 927**	**n = 868**
Opioids	286 (12.0%)	96 (10.4%)	87 (10.0%)
Benzodiazepines	43 (1.8%)	55 (5.9%)	19 (2.2%)
Non-benzodiazepines	14 (0.6%)	9 (1.0%)	31 (3.6%)
2015	**n = 2,395**	**n = 935**	**n = 907**
Opioids	321 (13.4%)	103 (11.0%)	106 (11.7%)
Benzodiazepines	56 (2.3%)	62 (6.6%)	26 (2.9%)
Non-benzodiazepines	17 (0.7%)	6 (0.6%)	33 (3.6%)
2016	**n = 2,306**	**n = 889**	**n = 911**
Opioids	271 (11.8%)	99 (11.1%)	81 (8.9%)
Benzodiazepines	42 (1.8%)	47 (5.3%)	17 (1.9%)
Non-benzodiazepines	11 (0.5%)	10 (1.1%)	26 (2.9%)

*Categories of drug classes are not mutually exclusive across columns or rows due to receipt of multiple drug classes among some veterans.
†Bolded numbers within each column represent the number of veterans receiving VA prescription fills from the respective drug class in the specified year.
PDMP, Prescription drug monitoring program; VA, Veterans Affairs.

married versus other-than-married (OR = 1.2; 95% CI: 1.0, 1.4), or who lived in other-than-urban versus urban locations (OR = 1.5; 95% CI: 1.3, 1.7), were also more likely to have concurrent prescription fills. Similarly, veterans with ≥50 percent VA service connection status, compared to those who did not have service-connected disability status, were more likely to have filled concurrent prescriptions (OR=1.8; 95% CI: 1.4, 2.4, as were veterans enrolled in the Veterans Choice Program (OR=1.6; 95% CI: 1.4, 1.8). Except for marital status, these associations remained significant in multivariable models while controlling for potentially confounding variables.

Veterans' VA clinical diagnoses were also associated with their likelihood of concurrent VA and non-VA prescription fills. In bivariable models, all diagnoses of interest except cancer were associated with concurrent prescription fills; most notably, veterans diagnosed with PTSD had twice the odds as those without to have concurrent prescription fills (OR = 2.1; 95% CI: 1.8, 2.4), as were those with any pain (OR = 1.9; 95% CI: 1.6, 2.4), back or neck pain (OR = 2.0; 95% CI: 1.7, 2.4), or opioid use disorder diagnoses (OR=2.0;

Table 4: Characteristics Associated with Concurrent VA and Non-VA Prescription Fills among $n = 5{,}882$ veterans Receiving Opioids, Benzodiazepines, or Non-benzodiazepines from the VA, 2014–2016

	Any Concurrent VA and Non-VA Prescription Fills		*Logistic Regression*	
Veteran Characteristics Demographics	*Yes (n = 1,036[a]) n (%)*	*No (n = 4,846[a]) n (%)*	*Bivariable Models OR (95% CI)[b]*	*Multivariable Models OR (95% CI)[b]*
Age (years)[c]				
≤35	633 (61.1)	3,336 (68.8)	Referent	Referent
36–45	252 (24.3)	952 (19.7)	**1.4 (1.2, 1.6)**	**1.4 (1.2, 1.7)**
≥46	151 (14.6)	558 (11.5)	**1.4 (1.2, 1.7)**	**1.4 (1.2, 1.8)**
Sex[c]				
Male	909 (87.7)	4,294 (88.6)	0.9 (0.7, 1.1)	0.9 (0.7, 1.1)
Female	127 (12.3)	552 (11.4)	Referent	Referent
Race[c]				
White	862 (83.2)	3,945 (81.4)	1.1 (0.9, 1.4)	1.2 (1.0, 1.4)
Other-than-white	174 (16.8)	901 (18.6)	Referent	Referent
Education Level[d]				
High-school-or-less	846 (82.0)	3,936 (81.2)	1.1 (0.9, 1.3)	**1.2 (1.0, 1.5)**
More-than-high-school	186 (18.0)	905 (18.7)	Referent	Referent
Marital Status[e]				
Married	515 (49.7)	2,212 (45.7)	**1.2 (1.0, 1.4)**	1.1 (1.0, 1.3)
Other-than-Married	521 (50.3)	2,634 (54.4)	Referent	Referent
Residential Location[e]				
Urban	594 (57.7)	3,233 (67.4)	Referent	Referent
Other-than-urban	435 (42.3)	1,562 (32.6)	**1.5 (1.3, 1.7)**	**1.5 (1.3, 1.7)**
VA Service Connection Status[f]				
None	67 (6.5)	506 (10.4)	Referent	Referent
<50%	114 (11.0)	814 (16.8)	1.1 (0.8, 1.5)	1.0 (0.7, 1.4)
≥50%	855 (82.5)	3,526 (72.8)	**1.8 (1.4, 2.4)**	**1.7 (1.3, 2.2)**
Choice Program Participant[g]				
Yes	395 (38.1)	1,367 (28.2)	**1.6 (1.4, 1.8)**	**1.4 (1.2, 1.6)**
No	641 (61.9)	3,479 (71.8)	Referent	Referent
VA Clinical Diagnoses				
Cancer[h]				
Yes	97 (9.4)	387 (8.2)	1.2 (0.9, 1.5)	1.1 (0.9, 1.4)
No	939 (90.6)	4,459 (91.8)	Referent	Referent
Traumatic Brain Injury[i]				
Yes	179 (17.3)	490 (10.1)	**1.9 (1.5, 2.2)**	**1.6 (1.3, 1.9)**
No	857 (82.7)	4,356 (89.9)	Referent	Referent
PTSD[j]				
Yes	777 (75.0)	2,844 (58.7)	**2.1 (1.8, 2.5)**	**1.8 (1.6, 2.2)**
No	259 (25.0)	2,002 (41.3)	Referent	Referent
Anxiety[k]				
Yes	291 (28.1)	1,055 (21.8)	**1.4 (1.2, 1.6)**	**1.3 (1.1, 1.5)**
No	745 (71.9)	3,791 (78.2)	Referent	Referent
Any Pain[l]				
Yes	903 (87.2)	3,730 (77.0)	**2.0 (1.7, 2.5)**	**1.6 (1.3, 1.9)**
No	133 (12.8)	1,116 (23.0)	Referent	Referent

continued

Table 4. *Continued*

Veteran Characteristics Demographics	Any Concurrent VA and Non-VA Prescription Fills: Yes (n = 1,036[a]) n (%)	Any Concurrent VA and Non-VA Prescription Fills: No (n = 4,846[a]) n (%)	Logistic Regression: Bivariable Models OR (95% CI)[b]	Logistic Regression: Multivariable Models OR (95% CI)[b]
Headache[l]				
Yes	238 (23.0)	828 (17.5)	**1.4 (1.2, 1.7)**	1.1 (0.9, 1.3)
No	798 (77.0)	4,018 (82.9)	Referent	Referent
Back or Neck Pain[l]				
Yes	842 (81.3)	3,288 (67.8)	**2.1 (1.7, 2.4)**	**1.6 (1.4, 2.0)**
No	194 (18.7)	1,558 (32.2)	Referent	Referent
Depression[m]				
Yes	562 (54.3)	2,032 (41.9)	**1.6 (1.4, 1.9)**	**1.2 (1.0, 1.4)**
No	474 (45.8)	2,814 (58.1)	Referent	Referent
Any Substance Use Disorder (Excluding Nicotine Use Disorder)[n]				
Yes	319 (30.8)	1,063 (21.9)	**1.6 (1.4, 1.8)**	**1.3 (1.1, 1.5)**
No	717 (69.2)	3,783 (78.1)	Referent	Referent
Opioid Use Disorder[n]				
Yes	94 (9.1)	231 (4.8)	**2.0 (1.6, 2.6)**	**1.6 (1.2, 2.1)**
No	942 (90.9)	4,615 (95.2)	Referent	Referent

[a]Cell counts do not necessarily sum to the total *n* due to small amounts of missing data for some demographic or health care diagnosis variables.
[b]Bolded font represents statistical significance at $p < .05$.
[c]Multivariable model included age, sex, and race.
[d]Multivariable model included age, sex, race, and education level.
[e]Multivariable model included age, sex, race, education level, and respective demographic variable (marital status or residential location).
[f]Multivariable model included age, sex, race, education level, marital status, residential location, and VA service connection status.
[g]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, and Choice program participation.
[h]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, and cancer diagnosis.
[i]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, and TBI diagnosis.
[j]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, cancer diagnosis, TBI diagnosis, and PTSD diagnosis.
[k]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, cancer diagnosis, TBI diagnosis, PTSD diagnosis, and anxiety diagnosis.
[l]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, cancer diagnosis, TBI diagnosis, PTSD diagnosis, anxiety diagnosis, and respective pain diagnosis (any pain, headache, or back/neck pain).
[m]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, cancer diagnosis, TBI diagnosis, PTSD diagnosis, anxiety diagnosis, any pain diagnosis, and depression diagnosis.
[n]Multivariable model included age, sex, race, education level, marital status, residential location, VA service connection status, Choice program participation, cancer diagnosis, TBI diagnosis, PTSD diagnosis, anxiety diagnosis, any pain diagnosis, depression diagnosis, and respective substance use disorder (any substance use disorder or opioid use disorder).
CI, confidence interval; OR, odds ratio; PTSD, post-traumatic stress disorder; VA, Veterans Affairs.

95% CI: 1.5, 2.5). Although slightly attenuated, these diagnoses were still significantly associated with concurrent prescription fills while accounting for potential confounders in multivariable modeling.

DISCUSSION

This study is the first to our knowledge to link VA health care data with state PDMP data to analyze concurrent opioid and sedative-hypnotic prescriptions among veterans receiving VA care. Considerable proportions of post-9/11 veterans receiving VA outpatient care in Oregon filled concurrent VA and non-VA prescriptions for medications from within and across drug classes. Probabilistic linkage of VA to state PDMP data provided a more complete picture of the magnitude of veterans' concurrent prescriptions than just VA or PDMP data alone; it also provided an opportunity to examine upstream demographic and clinical correlates of concurrent prescriptions.

Linkage of data managed by different institutions can be complicated, particularly where protecting patient data and personal health information is of the utmost importance. Both VA and PDMP data systems' privacy rules are governed by state statute, federal statute, and the Health Insurance Portability and Accountability Act, in addition to other privacy laws. Many states' PDMP data are inaccessible for research due in part to privacy concerns (Brandeis University 2017). In our experience, the management of the Oregon PDMP by the Public Health Division, a shared interest in veterans' health, and a history of collaboration and partnership between institutions (e.g., Basham et al. 2011; Kane et al. 2014; Leonhard et al. 2015) supported the development of a data use agreement that met both VA and state PDMP program requirements. This included negotiating the details of where and on what information technology system to bring the data together for linkage.

There were several technical challenges to overcome as well. The success of probabilistic linkage projects is highly dependent on the quality and completeness of the identifiers used to construct the probability model (Cook, Olson, and Dean 2001). The VA databases are populated in near real-time to support decision making around health care quality and safety, and the OHA routinely conducts audits to ensure integrity of the PDMP data (Oregon Health Authority 2017), strengthening confidence in data accuracy. Due to the mobile nature of our relatively young veteran population, having access to previous addresses was important to ensure a veteran had the best opportunity to match to a PDMP record. Finally, post-linkage, creating a person-level

database from the resulting many-to-many matched pairs of prescriptions proved challenging. Having collaborators facile with SQL programming and managing relational databases will be an asset to others embarking on similar interagency linkage projects.

In this study, more than one-third of veterans who received opioids or sedative-hypnotics from the VA had received these prescriptions from non-VA prescribers at some point during the study period. This figure is higher than a similar figure presented from an analysis of Kentucky PDMP data, which identified multiple payers for approximately 18 percent of veterans that received VA-paid prescription opioids (Becker et al. 2017). However, both studies illuminate the large proportion of veterans accessing both VA and non-VA health care, and are indicators of the high number of psychotropic prescriptions that are filled by this patient population. Dual use of VA and non-VA health care among Medicare/Medicaid-eligible veterans is a well-studied phenomenon and has been shown to increase risk of poor health outcomes due to fragmentation of care (Shen et al. 2003; Wolinsky et al. 2006; Hynes et al. 2007). Our work shows this risk also exists in the younger, lesser-studied population of post-9/11 veterans. This finding reinforces the need for coordinated and complementary care—and interoperable electronic health care records—across systems, but also highlights the importance of state PDMP queries, which can be used now for ascertaining veterans' complete prescription histories.

Among veterans who received prescriptions from both VA and non-VA providers, many received prescriptions that were concurrent. These medications were likely identifiable to prescribers through a PDMP query. Recent opioid prescribing guidelines published by the CDC recommend that PDMP queries be conducted by prescribers or their delegates with each new opioid prescription and at least quarterly during ongoing opioid therapy (Dowell, Haegerich, and Chou 2016). Similarly, VA policy requires clinicians to conduct annual PDMP queries for any patient receiving prescriptions for controlled substances (US Department of Veterans Affairs 2016). Across state systems, the number of PDMP queries made by prescribers and their registered delegates has increased dramatically in recent years, including those made by VA providers (Gellad, Good, and Shulkin 2017; Oregon Health Authority 2017). Indeed, research demonstrates that implementation of state PDMP programs—likely in concert with other public health initiatives to curb the overdose epidemic—has reduced opioid prescribing and misuse (Griggs, Weiner, and Feldman 2015; Bao et al. 2016; Patrick et al. 2016; Ali et al. 2017). However, our work suggests a need for improved utilization of state

PDMPs. It is unknown whether concurrent prescriptions occur because PDMP queries are not yet conducted at the mandated frequency, clinicians are not using results from PDMP queries to modify care, or some other factor. This is an area for further research.

The VA's Opioid Safety Initiative, a multifaceted approach to improving prescription safety, has resulted in reduced opioid prescribing at every VA Healthcare System in the US (Westanmo et al. 2015; Gellad, Good, and Shulkin 2017; Lin et al. 2017). Opioid and benzodiazepine coprescribing within the VA has also decreased consistently year over year (Lin et al. 2017). However, when accounting for non-VA prescriptions, we observed proportions of veterans receiving concurrent prescription opioids and benzodiazepines that remained consistent across years, suggesting that some veterans may be making up the difference using non-VA providers to supplement VA prescriptions. Thus, although improvements in safe opioid prescribing have been realized within the VA, there is a need to account for non-VA prescriptions when considering veterans' overall prescription safety.

Our work identified demographic and clinical correlates of potential high-risk concurrent prescribing between VA and non-VA providers that were similar to past opioid research. Younger age, white race, being married, and living in rural areas are known correlates of high-risk opioid use among post-9/11 veterans (Hudson et al. 2017); these factors were also associated with concurrent VA/non-VA prescriptions in our study. Additionally, similar to ours, prior work has found that clinical diagnoses such as PTSD, depression, pain, and substance use disorders were associated with high-risk opioid use and adverse outcomes (Seal et al. 2012; Hudson et al. 2017; Quinn et al. 2017). In addition to these demographic and clinical correlates, we found that veterans with higher percent service connection status (i.e., greater disability) and participants in the Veterans Choice Program were more likely to have concurrent VA/non-VA prescriptions, even while controlling for other important demographic factors. Our findings corroborate the body of research suggesting that patients with the highest risk of adverse outcomes are also the most likely to receive high-risk prescriptions (Quinn et al. 2017). They also support findings published in the VA Office of Inspector General's recent report that identified high-risk prescribing to Veterans Choice Program participants along with gaps in information transfer between Choice Program providers and veterans' VA health care records (US Department of Veterans Affairs. Office of Inspector General 2017c). Together, these efforts highlight a population of

veterans with significant clinical need whose health and safety may benefit from enhanced monitoring using state PDMPs.

Limitations

Limitations of this work include the potential for lack of generalizability of trends observed in Oregon to other states. From 2010 to 2014, Oregon had among the highest rates of nonmedical use of prescription analgesics in the country (US Substance Abuse and Mental Health Services Administration 2017). Additionally, post-9/11 veterans in Oregon may have different health profiles than those living in other states—Oregon has no active duty military bases and its National Guard had one of the highest rates of deployment to post-9/11 wars (National Guard of Oregon 2003). Uncertainty about data accuracy may also be a limitation of this work. The OHA conducts frequent audits of PDMP data, which demonstrate high accuracy (Oregon Health Authority 2017). However, the ICD-9-CM and ICD-10-CM diagnosis codes used to identify veterans' clinical characteristics may not accurately represent veterans' health status, given potential miscoding, and the fact that these codes represent treatment receipt rather than veterans' disease states. Additionally, the translation from ICD-9-CM to ICD-10-CM codes can introduce errors into the diagnosis categories under study. However, recent VA data suggest a high degree of reliability with ICD-10-CM implementation, as evidenced by similar proportions of many chronic disease diagnoses across the transition period (Yoon and Chow 2017). Our approach of coding a veteran with a diagnosis if they had one or more respective inpatient, or two or more outpatient, ICD codes assigned at any time between 2011 and 2016 may make this transition between systems less of a concern. Similarly, other variables that could be important drivers of concurrent prescription medication use may have been excluded from these analyses due to our reliance on administrative data or our particular analytic decisions. For example, our use of outpatient pharmacy data alone may have resulted in an undercount of methadone if veterans were receiving treatment through an opioid substitution program and, similarly, we did not account for Medicaid eligibility, a comorbidity index, or some other potentially important variables in these analyses. Future research should examine effects of these variables on veterans' likelihood of concurrent prescriptions. Finally, our analysis did not take prescription dosages into account. It is possible that veterans receiving concurrent VA and non-VA medications have systematically

higher (or lower) overall doses of opioids and/or sedative-hypnotics than those who do not receive concurrent prescriptions. The overarching objective of this study was to establish the utility of linking VA to state PDMP data to examine proportions and characteristics of veterans who use both VA and non-VA providers for opioid and sedative-hypnotic prescriptions. Our follow-on work will examine the complex interplay of prescription dosing, dual system use, and veterans' risk.

Conclusion

Fragmentation of care between VA and non-VA systems may contribute to risk of prescription drug overdose and other adverse events. Linkage of VA to state PDMP data can help identify areas in need of further quality improvement initiatives. Future efforts to link VA to PDMP data in Oregon, as well as with additional states, will enable surveillance of changes over time as well as more generalizable analyses of veterans' concurrent prescriptions. State PDMPs are useful tools in reducing the prescription drug overdose epidemic (Griggs, Weiner, and Feldman 2015); ultimately, maturation of prescription drug safety programs like the VA's Opioid Safety Initiative, coupled with more consistent use of PDMP queries and—potentially—the development of interoperable electronic health records systems, could decrease veterans' risk of prescription drug overdose.

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References

Abrahamsson, T., J. Berge, A. Öjehagen, and A. Håkansson. 2017. "Benzodiazepine, z-Drug and Pregabalin Prescriptions and Mortality among Patients in Opioid Maintenance Treatment – A Nation-Wide Register-Based Open Cohort Study." *Drug and Alcohol Dependence* 174: 58–64.

Ali, M. M., W. N. Dowd, T. Classen, R. Mutter, and S. P. Novak. 2017. "Prescription Drug Monitoring Programs, Nonmedical use of Prescription Drugs, and Heroin use: Evidence from the National Survey of Drug Use and Health." *Addictive Behaviors* 69: 65–77.

Bao, Y., Y. Pan, A. Taylor, S. Radakrishnan, F. Luo, H. A. Pincus, and B. R. Schackman. 2016. "Prescription Drug Monitoring Programs are Associated with Sustained Reductions in Opioid Prescribing by Physicians." *Health Affairs* 35 (6): 1045–51.

Basham, C., L. M. Denneson, L. Millet, X. Shen, J. Duckart, and S. K. Dobscha. 2011. "Characteristics and VA Health Care Utilization of U.S. Veterans Who Completed Suicide in Oregon between 2000 and 2005." *Suicide and Life Threatening Behavior* 41 (3): 287–96.

Becker, W. C., B. T. Fenton, C. A. Brandt, E. L. Doyle, J. Francis, J. L. Goulet, B. A. Moore, V. Torrise, R. D. Kerns, and P. W. Kreiner. 2017. "Multiple Sources of Prescription Payment and Risky Opioid Therapy among Veterans." *Medical Care* 55: S33–6.

Bohnert, A. S., M. A. Ilgen, S. Galea, J. F. McCarthy, and F. C. Blow. 2011. "Accidental Poisoning Mortality among Patients in the Department of Veterans Affairs Health System." *Medical Care* 49 (4): 393–6.

Brandeis University, Heller School for Social Policy and Management, Prescription Drug Monitoring Program Training and Technical Assistance Center (PMDP TTAC). 2016. "PDMP Prescriber Use Mandates: Characteristics, Current Status, and Outcomes in Selected States" [accessed on April 30, 2018]. Available at http://www.pdmpassist.org/pdf/Resources/Briefing_on_mandates_3rd_revision_A.pdf

Brandeis University, Heller School for Social Policy and Management, Prescription Drug Monitoring Program Training and Technical Assistance Center (PMDP TTAC). 2017. "State Profiles" [accessed on April 30, 2018]. Available at http://www.pdmpassist.org/content/state-profiles

Brandeis University, Heller School for Social Policy and Management, Prescription Drug Monitoring Program Training and Technical Assistance Center (PMDP TTAC). 2018a. "PDMP Mandatory Enrollment of Providers and Dispensers" [accessed on April 30, 2018]. Available at http://www.pdmpassist.org/pdf/Mandatory_Enrollment_20180417a.pdf

Brandeis University, Heller School for Social Policy and Management, Prescription Drug Monitoring Program Training and Technical Assistance Center (PMDP TTAC). 2018b. "PDMP Mandatory Query by Providers and Dispensers" [accessed on April 30, 2018]. Available at http://www.pdmpassist.org/pdf/Mandatory_Query_20180319.pdf

Cifu, D. X., B. C. Taylor, W. F. Carne, F. William, D. Bidelspach, N. A. Sayer, J. Scholten, and E. H. Campbell. 2013. "Traumatic Brain Injury, Posttraumatic Stress

Disorder, and Pain Diagnoses in OIF/OEF/OND Veterans." *Journal of Rehabilitation Research & Development* 50 (9): 1169–76.

Cook, L. J., L. M. Olson, and J. M. Dean. 2001. "Probabilistic Record Linkage: Relationships between File Sizes, Identifiers and Match Weights." *Methods in Inferential Medicine* 40 (3): 196–203.

Dowell, D., T. M. Haegerich, and R. Chou. 2016. "CDC Guideline for Prescribing Opioids for Chronic Pain – United States, 2016." *Morbidity and Mortality Weekly Report* 65 (1): 1–49.

Fellegi, I. P., and A. B. Sunter. 1969. "A Theory for Record Linkage." *Journal of the American Statistical Association* 64 (328): 1183–210.

Finklea, K. M., L. N. Sacco, and E. Bagalman. 2013. "Prescription Drug Monitoring Programs" Congressional Research Service [accessed on April 30, 2018]. Available at https://fas.org/sgp/crs/misc/R42593.pdf

Garg, R. K., D. Fulton-Kehoe, and G. M. Franklin. 2017. "Patterns of Opioid Use and Risk of Opioid Overdose Death among Medicaid Patients." *Medical Care* 55 (7): 661–8.

Gellad, W. F., C. B. Good, and D. J. Shulkin. 2017. "Addressing the Opioid Epidemic in the United States: Lessons from the Department of Veterans Affairs." *Journal of the American Medical Association Internal Medicine* 177 (5): 611–2.

Greenland, S., J. Pearl, and J. M. Robins. 1999. "Causal Diagrams for Epidemiologic Research." *Epidemiology* 10 (1): 37–48.

Griggs, C. A., S. G. Weiner, and J. A. Feldman. 2015. "Prescription Drug Monitoring Programs: Examining Limitations and Future Approaches." *Western Journal of Emergency Medicine* 16 (1): 67–70.

Hernán, M. A., S. Hernández-Díaz, M. M. Werler, and A. A. Mitchell. 2002. "Causal Knowledge as a Prerequisite for Confounding Evaluation: An Application to Birth Defects Epidemiology." *American Journal of Epidemiology* 155 (2): 176–84.

Hudson, T. J., J. T. Painter, B. C. Martin, M. A. Austen, J. S. Williams, J. C. Fortney, M. D. Sullivan, and M. J. Edlund. 2017. "Pharmacoepidemiologic Analyses of Opioid use among OEF/OIF/OND Veterans." *Pain* 158 (6): 1039–45.

Hynes, D. M., K. Koelling, K. Stroupe, A. Noreen, K. Mallin, M. Sohn, F. M. Weaver, L. Manheim, and L. Kok. 2007. "Veterans' Access to and Use of Medicare and Veterans Affairs Health Care." *Medical Care* 45 (3): 214–23.

Jaro, M. A. 1995. "Probabilistic Linkage of Large Public Health Data Files." *Statistics in Medicine* 14 (5–7): 491–8.

Jones, J. D., S. Mogali, and S. D. Comer. 2012. "Polydrug Abuse: A Review of Opioid and Benzodiazepine Combination Use." *Drug and Alcohol Dependence* 125 (1–2): 8–18.

Kane, W. G., D. A. Wright, R. Fu, and K. F. Carlson. 2014. "Racial/Ethnic and Insurance Status Disparities in Discharge to Posthospitalization Care for Patients with Traumatic Brain Injury." *Journal of Head Trauma Rehabilitation* 29 (6): E10–7.

Kizer, K. W., and R. A. Dudley. 2009. "Extreme Makeover: Transformation of the Veterans Health Care System." *Annual Review of Public Health* 30: 313–39.

Leonhard, M. J., D. A. Wright, R. Fu, D. P. Lehrfeld, and K. F. Carlson. 2015. "Urban/Rural Disparities in Oregon Pediatric Traumatic Brain Injury." *Injury Epidemiology* 2 (1): 32.

Lin, L. A., A. S. B. Bohnert, R. D. Kerns, M. A. Clay, D. Ganoczy, and M. A. Ilgen. 2017. "Impact of the Opioid Safety Initiative on Opioid-Related Prescribing in Veterans." *Pain* 158 (5): 833–9.

Macey, T. A., B. J. Morasco, J. P. Duckart, and S. K. Dobscha. 2011. "Patterns and Correlates of Prescription Opioid Use in OEF/OIF Veterans with Chronic Non-Cancer Pain." *Pain Medicine* 12 (10): 1502–9.

National Guard of Oregon. 2003. "Oregon Sentinel: The Official Newsletter of the Oregon National Guard" [accessed April 30, 2018]. Available at http://www.oregon.gov/OMD/AGPA/docs/sentinel/winter03.pdf

Oregon Health Authority, Division of Public Health. 2017. "Oregon Prescription Drug Monitoring Program. 2016 Annual Report to the PDMP Advisory Commission" [accessed on April 30, 2018]. Available at http://www.orpdmp.com/orpdmpfiles/PDF_Files/Reports/PDMP_AC_AnnualReport_2016.pdf

Oregon Heatlh Authority. 2018. "Oregon Prescription Drug Monitoring Program" [accessed April 30, 2018]. Available at http://www.orpdmp.com/

Patrick, S. W., C. E. Fry, T. F. Jones, and M. B. Buntin. 2016. "Implementation of Prescription Drug Monitoring Programs Associated with Reductions in Opioid-Related Death Rates." *Health Affairs* 35 (7): 1324–32.

Quinn, P. D., K. Hur, Z. Chang, E. E. Krebs, M. J. Bair, E. L. Scott, M. E. Rickert, R. D. Gibbons, K. Kroenke, and B. M. D'Onofrio. 2017. "Incident and Long-Term Opioid Therapy among Patients with Psychiatric Conditions and Medications: A National Study of Commercial Health Care Claims." *Pain* 158 (1): 140–8.

Seal, K. H., Y. Shi, G. Cohen, B. E. Cohen, S. Maguen, E. E. Krebs, and T. C. Neylan. 2012. "Association of Mental Health Disorders with Prescription Opioids and High-Risk Opioid Use in US Veterans of Iraq and Afghanistan." *Journal of the American Medical Association* 307 (9): 940–7.

Shen, Y., A. Hendricks, S. Zhang, and L. E. Kazis. 2003. "VHA Enrollees' Health Care Coverage and Use of Care." *Medical Care Research and Review* 60 (2): 253–67.

State of Oregon, 75th Oregon Legislative Assembly. 2009. "Senate Bill 355, an Act Relating to an Electronic Prescription Monitoring Program; Appropriating Money; Limiting Expenditures" [accessed April 30, 2018]. Available at https://olis.leg.state.or.us/liz/2009R1/Downloads/MeasureDocument/SB355/Introduced

Suda, K. J., B. M. Smith, L. Bailey, W. F. Gellad, Z. Huo, M. Burk, F. Cunningham, and K. T. Stroupe. 2017. "Opioid Dispensing and Overlap in Veterans with Non-Cancer Pain Eligible for Medicare Part D." *Journal of the American Pharmacists Association* 57: 333–40.

Sun, E. C., A. Dixit, K. Humphreys, B. D. Darnall, L. C. Baker, and S. Mackey. 2017. "Association Between Concurrent use of Prescription Opioids and Benzodiazepines and Overdose: Retrospective Analysis." *British Medical Journal* 356: j760.

Taylor, B. C., E. M. Hagel, K. F. Carlson, D. X. Cifu, A. Cutting, D. E. Bidelspach, and N. A. Sayer. 2012. "Prevalence and Costs of Co-Occurring Traumatic Brain

Injury with and without Psychiatric Disturbance and Pain among Afghanistan and Iraq War Veteran VA Users." *Medical Care* 50 (4): 342–6.

US Centers for Disease Control and Prevention, National Center for Health Statistics. 2017a. "Multiple Cause of Death 1999–2016." CDC WONDER Online Database, Multiple Cause of Death Files, 1999–2016 [accessed on April 30, 2018]. Available at http://wonder.cdc.gov/mcd-icd10.html

US Centers for Disease Control and Prevention, National Center for Health Statistics. 2017b. "International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)" [accessed April 30, 2018]. Available at https://www.cdc.gov/nchs/icd/icd10cm.htm#FY%202018%20release%20of%20ICD-10-CM

US Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. 2016. "CDC Compilation of Benzodiazepines, Muscle Relaxants, Stimulants, Zolpidem, and Opioid Analgesics with Oral Morphine Milligram Equivalent Conversion Factors, 2016 Version" [accessed on April 30, 2018]. Available at http://www.pdmpassist.org/pdf/Conversion%20Reference%20Table.xlsx

US Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. 2017. "Data-Driven Prevention Initiative (DDPI)" [accessed on April 30, 2018]. Available at https://www.cdc.gov/drugoverdose/foa/ddpi.html

US Centers for Medicaid & Medicare Services. 2016. "2017 ICD-10-CM and GEMS" [accessed on April 30, 2018]. Available at https://www.cms.gov/Medicare/Coding/ICD10/2017-ICD-10-CM-and-GEMs.html

US Department of Agriculture, Economic Research Service. 2016. "Documentation: 2010 Rural-Urban Commuting Area (RUCA) Codes" [accessed on April 30, 2018]. Available at https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/documentation.aspx

US Department of Health and Human Services. 2009. "HIPAA Administrative Simplification: Modifications to Medical Data Code Set Standards to Adopt ICD-10-CM and ICD-10-PCS." *Federal Register* 74 (11): 3328–62.

US Department of Veterans Affairs. 2009. "Privacy Act; Systems of Records." *Federal Register* 74 (142): 37093–6.

US Department of Veterans Affairs. 2017a. "Veterans Health Administration" [accessed on April 30, 2018]. Available at https://www.va.gov/health/

US Department of Veterans Affairs. 2018a. "Budget in Brief – 2019" [accessed on April 30, 2018]. Available at https://www.va.gov/budget/docs/summary/fy2019VAbudgetInBrief.pdf

US Department of Veterans Affairs. 2018b. *172VA10P2: VHA Corporate Data Warehouse – VA. 79 FR 4377.* Updated February 23, 2018.

US Department of Veterans Affairs. 2017b. "Veterans Choice Program" [accessed on April 30, 2018]. Available at https://www.va.gov/opa/choiceact/

US Department of Veterans Affairs. 2018c. "VA MISSION Act and New Veterans Community Care Program" [accessed on July 2, 2018]. Available at https://www.va.gov/COMMUNITYCARE/docs/pubfiles/factsheets/FactSheet_20-13.pdf

US Department of Veterans Affairs. Office of Inspector General. 2017c. "Healthcare Inspection: Opioid Prescribing to High-Risk Veterans Receiving VA Purchased Care" [accessed on April 30, 2018]. Available at https://www.va.gov/oig/pubs/VAOIG-17-01846-316.pdf

US Department of Veterans Affairs, Pharmacy Benefits Management Services. 2017d. "VA National Formulary" [accessed on April 30, 2018]. Available at https://www.pbm.va.gov/nationalformulary.asp

US Department of Veterans Affairs, Veterans Health Administration. 2016. "VA Directive 1306: Querying State Prescription Drug Monitoring Programs" [accessed on April 30, 2018]. Available at https://www.va.gov/vhapublications/ViewPublication.asp?pub_ID=3283

US Substance Abuse and Mental Health Services Administration. 2017. "National Survey on Drug use and Health, the CBHSQ Report: State and Substate Estimates of Nonmedical use of Prescription Pain Relievers" [accessed April 30, 2018]. Available at https://www.samhsa.gov/data/sites/default/files/report_3187/ShortReport-3187.html

Westanmo, A. P., P. Marshall, E. Jones, K. Burns, and E. E. Krebs. 2015. "Opioid Dose Reduction in a VA Health Care System – Implementation of a Primary Care Population-Level Initative." *Pain Medicine* 16 (5): 1019–26.

Wolinsky, F. D., T. R. Miller, H. An, P. R. Brezinski, T. E. Vaughn, and G. E. Rosenthal. 2006. "Dual Use of Medicare and the Veterans Health Administration: Are There Adverse Health Outcomes?" *BMC Health Services Research* 6: 131.

Yoon, J., and A. Chow. 2017. "Comparing Chronic Condition Rates Using ICD-9 and ICD-10 in VA Patients FY2014–2016." *BMC Health Services Research* 17 (1): 572.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix SA1: Author Matrix.

Appendix SA2: Characteristics of n = 19,959 Post-9/11 Veteran VA Outpatient Service Users in Oregon, by Receipt of VA Opioid or Sedative-Hypnotic Prescriptions.

Appendix SA3: International Classification of Diseases—9th Revision—Clinical Modification Codes Used to Identify Veterans' Diagnoses of Interest.