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Publication Date

2020-07-01

DOI

10.1016/j.drugalcdep.2020.107983

Peer reviewed

Recent incarceration and risk of first-time injection initiation assistance: a prospective cohort study of persons who inject drugs

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Abstract

Background: Given the prevalence and harms of incarceration among persons who inject drugs (PWID) and their role in injection drug use initiation, we aimed to investigate whether recent incarceration influences the likelihood PWID assist others in their first-ever injection.

Methods: Prospective cohort study of PWID in Vancouver, Canada who had their *PReventing Injecting by Modifying Existing Responses* (PRIMER) baseline visit between December 2014 and

May 2017, reported never providing injection initiation assistance previously, and had   1 follow-up visit. The primary outcome, provision of injection initiation assistance, was defined via self-report as helping anybody inject for the first time in the past six months. The primary exposure was recent incarceration, i.e., self-report of being jailed, imprisoned or detained in the past six months. Participants were assessed biannually until November 2017, drop-out, or their first report of the primary outcome.

Results: 1,199 PWID (62.1% male; mean (SD) age, 44.4 (12.3) years) were included in our study. Across 4,171 follow-up visits, 67 participants (5.6%) reported providing injection initiation assistance. The proportion of participants reporting recent incarceration varied between 2.4% to 5.1% per follow-up visit. Based on a multivariable discrete-time proportional hazards regression analysis, recent incarceration was associated with an increased risk of providing injection initiation assistance during the same six-month period (adjusted hazard ratio, 2.64; 95% CI, 1.19 to 5.86).

Conclusions: The observed association between recent incarceration and risk of providing injection initiation assistance suggests that incarceration could be contributing to the expansion of injection drug use practices within vulnerable populations over time.

Keywords

Injection initiation; Jail; prison; detainment

1. INTRODUCTION

The United States and Canada are presently in the throes of an opioid overdose crisis, with fatal drug overdose emerging as a leading cause of preventable death in both countries (Public Health Agency of Canada (PHAC), 2019; Kerr, 2019; Rudd et al., 2016). While a concurrent crisis of opioid misuse in both nations may have originated from opioid overprescribing, the majority of overdose deaths in recent years have been attributed to synthetic, often illicitly-produced opioids such as fentanyl and related analogues (Ahmad et al., 2019; PHAC, 2019; Kerr, 2019; Vashishtha et al., 2017). Thus, the increasing frequency of overdose deaths despite declining opioid prescribing rates may be partially explained by the transition of individuals from prescription opioid misuse to injecting illicit opioids (Canadian Institute for Health Information (CIHI), 2017; Cepeda et al., 2019; Centers for Disease Control and Prevention (CDC), 2018). Correspondingly, experts have recommended that overdose prevention efforts should focus on upstream prevention of injection drug use initiation, in addition to reducing harms among persons who inject drugs (PWID) (Vlahov et al., 2004; Werb et al., 2018). Evidence suggests that between 73% to 89% of first-time injections are assisted directly or indirectly – via education on, or exposure to, injecting practices – by PWID (Jauffret-Roustide et al., 2009; Morris et al., 2012). As such, efforts to prevent the expansion of injection drug use among vulnerable populations must prioritize the identification of modifiable factors that influence the likelihood PWID assist with first-time injections (Werb et al., 2018).

Incarceration is highly prevalent among PWID compared to the general population, with an estimated 1.8 million or 72.2% (95% CI 61.8% to 82.6%) of PWID in the US and Canada

having ever been incarcerated (Degenhardt et al., 2017). Evidence from multiple settings suggests that many PWID initiate injection drug use (Allwright et al., 2000; Boys et al., 2002; Calzavara et al., 2003; Sarang et al., 2006) or continue injecting while incarcerated (Pollini et al., 2016; Kolind and Wake, 2016). This could be explained by insufficient access to addictions treatment (e.g., opioid agonist treatment for opioid use disorder) within carceral environments (Pragnell et al., 2016) and the close proximity between inmates who are not injecting (ever or currently) with inmates who are actively injecting, leading to exposure to, and normalization of, injection drug use practices (Small et al., 2005). Injecting within prisons is associated with heightened risk of blood-borne disease (e.g., HIV, Hepatitis C) acquisition and transmission due to the high prevalence of related infections among inmates and insufficient access to sterile syringes and other injecting equipment (Dolan et al., 2016; Pollini et al., 2016; Sarang et al., 2006; Small et al., 2005). It has been well-documented that many of the harms associated with incarceration for PWID persist through the months immediately following their release. During this post-release period, PWID often experience challenges in accessing adequate medical treatment for addiction (and other co-morbidities) (Koehn et al., 2015), social supports, and economic resources, which may compel their return to community spaces where drug use is commonplace (Binswanger et al., 2012). In turn, recently incarcerated PWID are more likely to continue (or relapse to) injection drug use (DeBeck et al., 2009; Genberg et al., 2015) and inject in public settings (McKnight et al., 2007; Scheim et al., 2017). Furthermore, this post-release period is characterized by increased risk of blood-borne disease (tied to risky injecting equipment sharing practices) (Wood et al., 2005; Milloy et al., 2009; Pollini et al., 2016) and fatal overdose (Merrall et al., 2010).

In addition to the apparent individual-level harms associated with incarceration among PWID, there is mounting evidence to suggest that their incarceration may contribute to the population-level expansion of injection drug use. Specifically, recent studies have found that not being enrolled in opioid agonist treatment, frequently injecting drugs, and injecting in the presence of others – all potential consequences of incarceration (both during imprisonment and immediately following release) – may elevate the risk that PWID assist injection-naïve persons into injection drug use (Bluthenthal et al., 2015 a,b; Ben Hamida et al., 2018; Melo et al., 2018; Marks et al., 2019; Mittal et al., 2019; Rafful et al., 2018), by increasing the frequency and visibility of their injecting practices to others vulnerable to initiation. Therefore, PWID with recent incarceration experiences may be at increased risk of assisting others in initiating injection drug use. To evaluate this hypothesized association, we conducted a longitudinal study of PWID living in Vancouver, Canada.

2. METHODS

2.1. Study design, setting, and data collection

PReventing Injecting by Modifying Existing Responses (PRIMER) is an ongoing, longitudinal consortium of cohorts of persons who use drugs across multiple cities in North America (Vancouver, Canada; San Diego, USA; Tijuana, Mexico) and France (Bordeaux, Marseille, Paris, and Strasbourg). The full study protocol has been published previously (Werb et al., 2016). A chief aim of PRIMER is to identify socio-structural factors that might

influence the risk that PWID provide injection assistance to individuals who have previously never injected (Werb et al., 2016). All PRIMER participants complete interviewer-administered questionnaires that contain common survey items soliciting data on participants' experiences with providing injection initiation assistance, other drug-related behaviors (e.g., frequency and mode of consumption by drug type), experiences with law enforcement (e.g., police interactions, incarceration history), and sociodemographic characteristics (Werb et al., 2016).

For the current study, we included data from three linked, PRIMER-affiliated prospective cohort studies in Vancouver, Canada: the *Vancouver Injection Drug Users Study* (VIDUS), the *At-Risk Youth Study* (ARYS), and the *AIDS Care Cohort to Evaluate exposure to Survival Services Study* (ACCESS) (Werb et al., 2016). Recruitment into each cohort required self-reported illicit drug use other than or in addition to cannabis (which was illegal during the study period) in the past month, residence within the greater Vancouver area, and written informed consent; however, only VIDUS required injection drug use in the month prior to enrollment (Werb et al., 2016). The common PRIMER questionnaire was first integrated into interviews for these Vancouver-based cohorts in December 2014; therefore, this study includes data collected for VIDUS/ARYS/ACCESS members between December 2014 and November 2017 at biannual follow-up visits (Werb et al., 2016).

2.2. Participants

Members of VIDUS/ARYS/ACCESS were included in the following study if they met all of the following criteria: (1) completed their first interview with the PRIMER questionnaire between December 2014 and May 2017 (hereafter referred to as baseline); (2) had at least one follow-up visit by November 2017; (3) reported ever injecting drugs at baseline; and (4) reported never assisting another in initiating injection drug use at baseline.

This study was approved by the University of California San Diego Human Research Protection Program and the University of British Columbia/Providence Health Care Research Ethics Board.

2.3. Outcome

The primary outcome was the provision of injection initiation assistance, defined via self-report as a response of "yes" to the question: "In the past six months, have you helped anybody inject who had never injected before?" (Melo et al., 2018; Mittal et al., 2019; Rafful et al., 2018). All participants were observed up to the first visit at which they reported the outcome or, in the absence of ever reporting the outcome, until they were lost to follow-up (e.g., died) or the conclusion of the observation window (whichever came first). Participants who did not report the outcome were censored following their last observed visit and did not contribute to the risk set for any subsequent periods during follow-up (Singer and Willett, 2003). Since all participants reported no history of helping others initiate injection drug use at baseline, this study explicitly concerns participants' first reported instance(s) of injection initiation assistance provision.

2.4. Exposure

The primary exposure was recent incarceration, defined as a confirmatory response to the question "Have you been in detention, jail or prison (overnight or longer) in the past six months?". Given prior evidence emphasizing that PWID are at increased risk of injection drug use and adverse drug-related outcomes both during and immediately following incarceration, we opted to model contemporaneous exposure and outcome responses in our primary analysis (see subsection 2.6) (DeBeck et al., 2009; Genberg et al., 2015; Merrall et al., 2010; Milloy et al., 2008; Rafful et al., 2018).

2.5. Covariates

A set of covariates consisting of variables that might confound the relationship between recent incarceration and provision of injection initiation assistance was selected *a priori* based on prior literature. Specifically, in accordance with disjunctive cause criterion for confounder selection, we captured, and subsequently controlled for (see subsection 2.6), any measured covariates that might cause the exposure and/or outcome (VanderWeele and Shpitser, 2011; VanderWeele, 2019). The full set of covariates (i.e., potential confounders) included: age; sex; recent homelessness (i.e., "have you been homeless in the last six months?"); recent frequency of injection drug use (defined as   daily, <daily, none); recent public injection; recent methamphetamine injection drug use; recent non-injection drug use; recent opioid agonist treatment enrollment (i.e., methadone maintenance program or buprenorphine/naloxone); recent frequency of law enforcement interactions (defined as 0, 1 or >1 interaction(s)); and history of prior incarceration (Ben Hamida et al., 2018; Melo et al., 2018; Mittal et al., 2019; Omura et al., 2014; Rafful et al., 2018). All participant characteristics qualified as 'recent' reflect experiences over the prior six months.

While age, sex, and history of prior incarceration were fixed at baseline, all other variables (including exposure) were allowed to vary by visit to minimize misclassification (Singer and Willett, 2003). All time-varying covariates were recoded so that their value at a given visit reflected their value at the preceding visit (i.e., lagged) to ensure covariate measurement always preceded both exposure and outcome measurement (Singer and Willett, 2003).

2.6. Statistical analysis

The conditional probability of providing injection initiation assistance per six-month follow-up interval (i.e., the discrete-time hazard) was summarized using a life table (Singer and Willett, 2003). After stratifying by recent incarceration status, hazard probabilities were plotted over time to visually assess periods of increased risk within exposure-based groups and the relative difference in their group-specific hazards (Singer and Willett, 2003).

The association between recent incarceration (exposure) and provision of injection initiation assistance (outcome) was estimated as a hazard ratio (HR) with corresponding 95% confidence interval (CI) via multivariable discrete-time proportional hazards regression using a binomial distribution with complementary log-log (clog-log) link (Singer and Willett, 2003). Fixed effects for time (i.e., follow-up visit) and all covariates listed in subsection 2.5 were included in the regression model. The additivity assumption was assessed via independent Wald χ^2 tests for statistical interactions between recent

incarceration with visit (equivalent to testing the proportional hazards assumption) and age respectively (Singer and Willett, 2003). Non-linear relationships between continuous covariates (age and time) and the clog-log hazard were alternatively specified with model fit compared using AIC values. Final model fit was visually assessed by plotting deviance residuals (Singer and Willett, 2003). Regression analysis was restricted to complete and uncensored person-period observations.

Multiple sensitivity analyses were performed. First, to investigate potential bias due to complete case analysis, we imputed missing exposure and covariate information via multiple imputation using fully conditional specification (Sterne et al., 2009). The corresponding imputation model for each imputed variable was made conditional on all other variables within the primary analytic model (Sterne et al., 2009). A regression model identical to the primary analysis specifications was fit to each of the 20 imputed data sets (Bodner, 2008; Graham et al., 2007). Estimated coefficients and standard errors were pooled using Rubin's rules to obtain the final HR and 95% CI (Rubin, 1987). Second, we conducted an E-value analysis to determine how strongly a potential binary unmeasured confounder – such as an indicator of bipolar disorder (a known correlate of incarceration) (Fovet et al., 2015) – would have to be associated with both the primary exposure and outcome to completely negate their observed association, after accounting for all other covariates controlled for in the primary regression analysis (VanderWeele and Ding, 2017). Lastly, by modelling contemporaneous exposure and outcome values in the primary analysis, it is possible that some participants' exposure values at a given visit were influenced by their outcome responses at those same visits (Singer and Willett, 2003). Thus, to overcome potential reverse causality, the primary regression analysis was repeated after substituting contemporaneous exposure values with lagged values from the prior visit (i.e., incarceration in the past seven to twelve months) (Singer and Willett, 2003).

Among participants who reported the outcome while under observation, we used χ^2 tests of independence (or Fisher's exact test where appropriate) to independently determine whether recently incarcerated participants were more (or less) likely to provide injection initiation assistance to a friend/acquaintance, sibling, stranger, sex partner (casual or intimate), or an inmate.

Analyses were performed using SAS Version 9.4 with two-tailed P values .05 deemed statistically significant.

3. RESULTS

3.1. Baseline characteristics

In total, 1,199 PWID were identified as eligible and selected into the study sample (Figure 1). At baseline, the mean age of participants was 44.4 years (standard deviation, 12.3) with most participants being male (744, 62.1%) and reporting a history of prior incarceration (1,012, 84.4%). In the six months prior to baseline, 278 participants had experienced homelessness (21.2%), 703 (58.6%) used non-injected drugs, and 369 injected drugs daily (30.8%).

3.2.   Hazard of providing injection initiation assistance

Overall, 5.6% (67/1,199) of participants provided injection initiation assistance during follow-up. Cumulatively, 4,171 follow-up visits were observed, with over half of participants having 4 follow-up visits (interquartile range, 2 to 5). Table 1 summarizes the probability of providing injection initiation assistance by six-month follow-up interval, conditional on having not provided such assistance previously. The probability of first providing injection initiation assistance was highest between participants' baseline and first follow-up visits; however, the hazard was relatively low in each interval.

Missing information for recent incarceration status was observed for 9.5% of visits (395/4,171), only one of which resulted in the outcome of interest (0.3% or 1/395) (Figure 1). Among 3,776 visits by 1,198 participants with non-missing recent incarceration status, the proportion of participants who were recently incarcerated ranged from 2.4% to 5.1% per follow-up visit. Figure 2 suggests that the hazard of providing injection initiation assistance, while low throughout and trending downward, was consistently greater at each visit among participants who were recently incarcerated compared to those that were not.

3.3.   Recent incarceration and hazard of providing injection initiation assistance

Altogether, 3,449 visits by 1,113 participants were eligible for our primary discrete-time proportional hazards regression sample (Figure 1). Nearly all of the 327 person-period observations excluded from regression analysis for missing covariate information had a missing values for 5 of the covariates (308 or 94.2%) (Figure 1). At baseline, the median age of the 1,113 participants in the regression sample was higher (47 years) when compared to the 86 participants excluded due to missing exposure (n=1) or covariate information (n=85) (39 years; P value<.01) (Supplemental Table 1)[1]; however, the proportion of participants who were male, ever incarcerated at baseline, and provided injection initiation assistance during follow-up did not differ between included and excluded participants.

Table 2 summarizes the primary discrete-time proportional hazards regression analysis. At each follow-up interval, the estimated probability of providing injection initiation assistance for the first time in the past six months was 164% greater among PWID who were recently incarcerated versus those who were not (HR, 2.64; 95% CI, 1.19 to 5.86), after adjusting for all listed covariates. This statistically significant association did not vary over time (statistical interaction with visit, $\chi^2(1)=0.35$; P=.56) or by age (statistical interaction with age, $\chi^2(1)=2.30$; P=.13). While the hazard decreased by 10% with each successive visit, this decline was not statistically significant.

3.3.1.   Sensitivity analyses—Multiple imputation did not meaningfully alter the association between recent incarceration and providing injection initiation assistance (HR 2.61; 95% CI, 1.13 to 6.05) (Supplemental Table 2)[1]. An E-value analysis indicated that an unmeasured binary confounder would have to be associated with a 4.73-fold increase (or greater) in the risk of both recent incarceration and first-time provision of injection initiation assistance – after adjustment for measured covariates – to nullify their observed association

in the primary regression analysis (i.e., reduce HR from 2.64 to 1.00). The HR for recent incarceration would become statistically insignificant (i.e., lower limit of corresponding 95% CI reduced from 1.19 to 1.00) if an unmeasured binary confounder was minimally associated with a 1.67-fold increase in the risk of both exposure and outcome. After lagging the primary exposure, PWID were 69% more likely to report first-time injection initiation assistance provision in the past six months provided they were incarcerated between seven to twelve months prior versus those who were not incarcerated in that same period; however, the association was not statistically significant (95% CI, 0.68 to 4.23) (Supplemental Table 3)[2].

3.4. PWID-initiate relationships

Among participants with the outcome and non-missing exposure information (66/1,198 or 5.5%), most reported assisting an acquaintance or friend in initiating injection drug use, irrespective of recent incarceration status (77.3% overall) (Supplemental Table 4)[2]. No PWID reported assisting an inmate in their first injection.

4. DISCUSSION

In this longitudinal cohort study of over 1,000 PWID in Vancouver, Canada – most of whom had a prior history of incarceration (84.4%) – we found that recent incarceration (i.e., being detained, jailed or imprisoned in the past six months) was associated with a 164% increase in the risk of assisting another person in their first injection during the same period, after controlling for potential confounders using multivariable discrete-time proportional hazards regression. Notably, this association did not vary significantly over time or by age. Over half of all participants attended at least four (out of a maximum of five) follow-up visits, with observation for only 5.6% (67/1,199) of participants concluding with their first report of providing injection initiation assistance. No participants reported assisting an inmate in their first injection event.

To our knowledge, this is the first finding of an association between recent incarceration and increased risk of providing injection initiation assistance. This finding suggests that in addition to numerous individual-level harms associated with incarceration among PWID, their incarceration may contribute to population-level expansion of injection drug use. While the relationship between recent incarceration and injection initiation assistance by PWID has not been studied previously, our primary finding is consistent with prior literature that has associated incarceration of PWID with several drug-related harms and, separately, associated these same harms with increased risk that PWID facilitate others' entry into injection drug use. Specifically, it is well-known that PWID often experience difficulty accessing adequate addictions treatment (e.g., opioid agonist treatment for opioid use disorder) while incarcerated (Pragnell et al., 2016) and in the months immediately following their release (Koehn et al., 2015). Consequently, recently incarcerated PWID may continue or return to injecting drugs (Kolind and Duke, 2016; DeBeck et al., 2009; Genberg et al., 2015) and, in doing so, routinely inject in front of others (McKnight et al., 2007; Scheim et al., 2017).

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[2]Supplementary material can be found by accessing the online version of this paper at http://dx.doi.org and by entering doi: …

Relatedly, not being enrolled in opioid agonist treatment, frequent injection drug use, and public injecting have been independently identified as factors associated with PWID assisting others in their first-ever injection (Mittal et al., 2019; Marks et al., 2019; Bluthenthal et al., 2015 a,b; Ben Hamida et al., 2018; Melo et al., 2018; Rafful et al., 2018). It is therefore possible that our primary association may be explained by recent incarceration experiences increasing the vulnerability of PWID to engaging in frequent and highly visible injection drug use practices within both carceral environments and their communities post-release, thereby increasing their exposure to, and interaction with, persons vulnerable to initiation in these settings (Binswanger et al., 2012; Guise et al., 2018).

After lagging the primary exposure by six months, we found that incarceration in the past seven to twelve months was associated with a 69% increase in the likelihood that PWID provided injection initiation in the past six months; however, the association was not statistically significant (95% CI, 0.68 to 4.23). One possible explanation is that, if there is an effect of recent incarceration on subsequent risk of providing injection initiation assistance, it may be strongest over the short-term (i.e., while in custody or in the months immediately following release) given how lagging the exposure attenuated the focal association. In considering both our contemporaneous (primary) and lagged (secondary) exposure-outcome associations, our subanalysis finding – that no participants reported assisting a fellow inmate during follow-up – might further suggest that, if an effect truly exists, recent incarceration may specifically elevate the risk that PWID provide injection initiation assistance in the community within the first months after their release. Prior research has consistently characterized the period immediately following incarceration (often defined as the first six months) as one of insufficient medical, social, and economic resources for PWID (Binswanger, et al., 2012). In experiencing an increased burden of untreated substance use disorders and other medical comorbities, unstable housing, and unemployment, PWID made vulnerable by their recent incarceration experiences may be more likely to return to environments where both drug use and requests to provide injection initiation assistance are ubiquitous (Werb et al., 2008; Binswanger et al., 2012; Guise et al., 2018).

Despite the strength of the observed association between recent incarceration (exposure) and provision of injection initiation assistance (outcome) in the primary analysis and its apparent consistency with prior literature, it is important to acknowledge potential sources of bias including (1) outcome misclassification, (2) unmeasured confounding, (3) informative censoring, and (4) contemporaneous exposure and outcome measurement. The low observed frequency of injection initiation assistance (5.6% overall) could reflect both the nature of our sample (all participants reported no history of this outcome at baseline) and known stigma around this behavior resulting in outcome underreporting (Guise et al., 2018); however, outcome underreporting in discrete-time survival analysis typically biases exposure estimates towards the null and to a lesser degree relative to outcome overreporting (Meier et al., 2003). Estimated E-values suggest it is unlikely that an unmeasured binary confounder exists with a strong enough relation to both exposure and outcome (HR 4.73) – after adjusting for measured covariates – to nullify the primary association, particularly when considering the largest observed covariate-outcome association (recent methamphetamine injection drug use, HR 2.09) (VanderWeele and Ding, 2017). While our findings were robust to alternative assumptions of exposure and covariate missing data mechanisms, the

assumption of non-informative censoring underlying our discrete-time survival analyses is questionable. As some participants may have been lost-to-follow-up (and thus censored) due to continued incarceration and inmate initiation assistance is unlikely according to our subanalysis, our primary association likely overestimates the true relationship for these censored participants who remained at-risk for the outcome despite being lost-to-follow-up (Singer and Willett, 2003). Lastly, as we modelled contemporaneous exposure and outcome measures (i.e., both reflect behaviors over the past six months) in the primary analysis, it is possible that reverse causality is an alternative explanation for the primary association. Specifically, provision of injection initiation assistance in the community, which might serve as a proxy measure for risk-taking behaviors, could influence subsequent risk of incarceration. This alternative interpretation potentially explains both the subanalysis findings and secondary (i.e., lagged) exposure-outcome associations we observed, which were equally equivocal with respect to the true direction of the relationship. However, given the known drug-related risks experienced by PWID in the period immediately post-release, as well as the fact that IDU initiation provision is often motivated as a result of structural vulnerability, it is likely that the association we identified between the exposure and outcome is at least partially explained by PWID assisting in IDU initiation events post-release. Future longitudinal studies to confirm or refute the findings reported herein should seek to clarify the direction of the focal relationship by assessing recent incarceration status both prior and proximal (i.e. within months) to outcome measurement to circumvent the afforementioned issues of reverse causality. Additionally, it will be important to investigate the pathways underlying the observed association and consider how both setting and duration might modify the relationship between recent incarceration and injection initiation assistance among PWID.

5. CONCLUSION

Our primary finding of an association between recent incarceration and provision of injection initiation assistance among PWID suggests that incarceration may contribute to the expansion of injection drug use within vulnerable populations. Secondary findings further suggest that carceral experiences may specifically increase the risk that PWID recently released from prison facilitate others' entry into injection drug use within the community. This study therefore provides further evidence of potential individual-level harms arising from the incarceration of PWID. Alternative approaches to reducing problematic substance use and related behaviors – including the provision of injection initiation assistance – should be considered by policymakers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

ABBREVIATIONS AND ACRONYMS

US	United States
PWID	person who injects drugs (s.); people (or persons) who inject drugs (pl.)
PRIMER	PReventing Injecting by Modifying Existing Responses
VIDUS	Vancouver Injection Drug Users Study
ARYS	At-Risk Youth Study
ACCESS	AIDS Care Cohort to Evaluate exposure to Survival Services Study

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Highlights

- Injection drug use initiation often facilitated by persons who inject drugs (PWID)

- Recently incarcerated PWID more likely to provide injection initiation assistance

- Incarceration may be contributing to population expansion of injection drug use
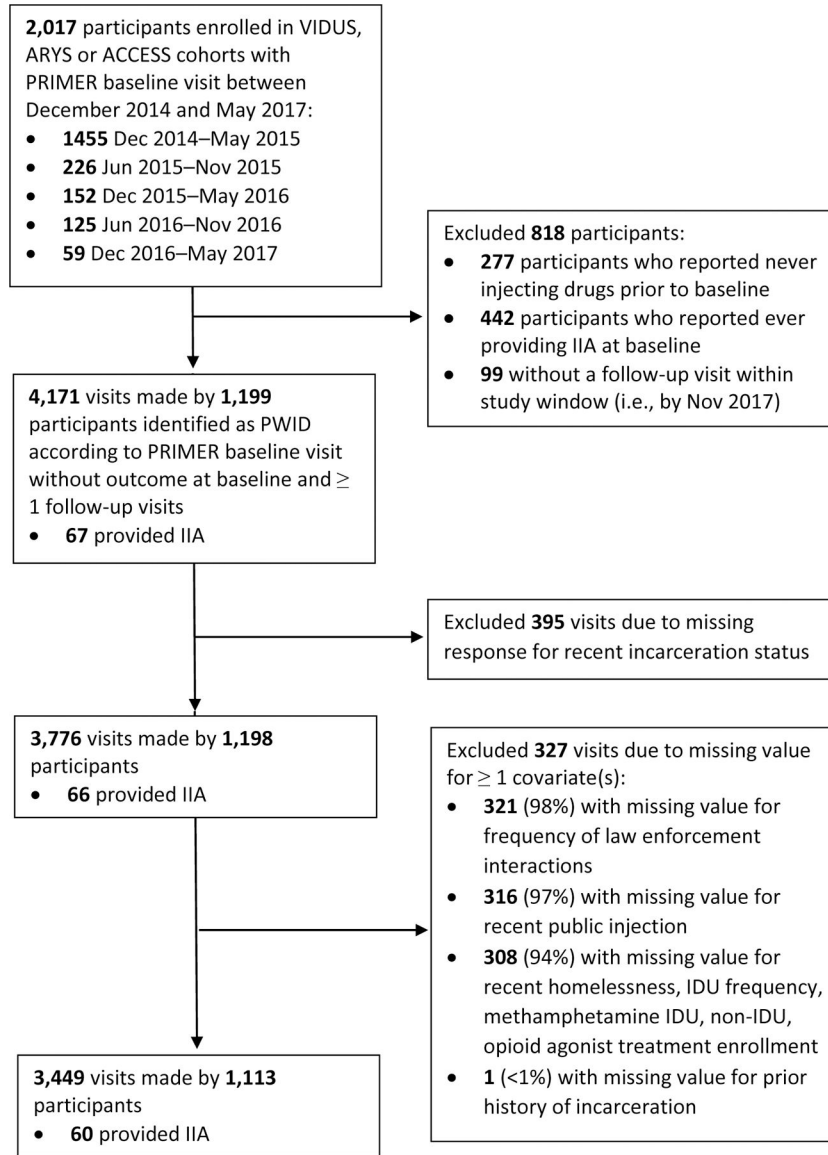
Figure 1. Flow of participants into study and regression samples.

Notes: VIDUS = *Vancouver Injection Drug User Study*; ARYS = *At-Risk Youth Survey*; ACCESS = *AIDS Care Cohort to Evaluate exposure to Survival Services Study;* IIA = injection initiation assistance.
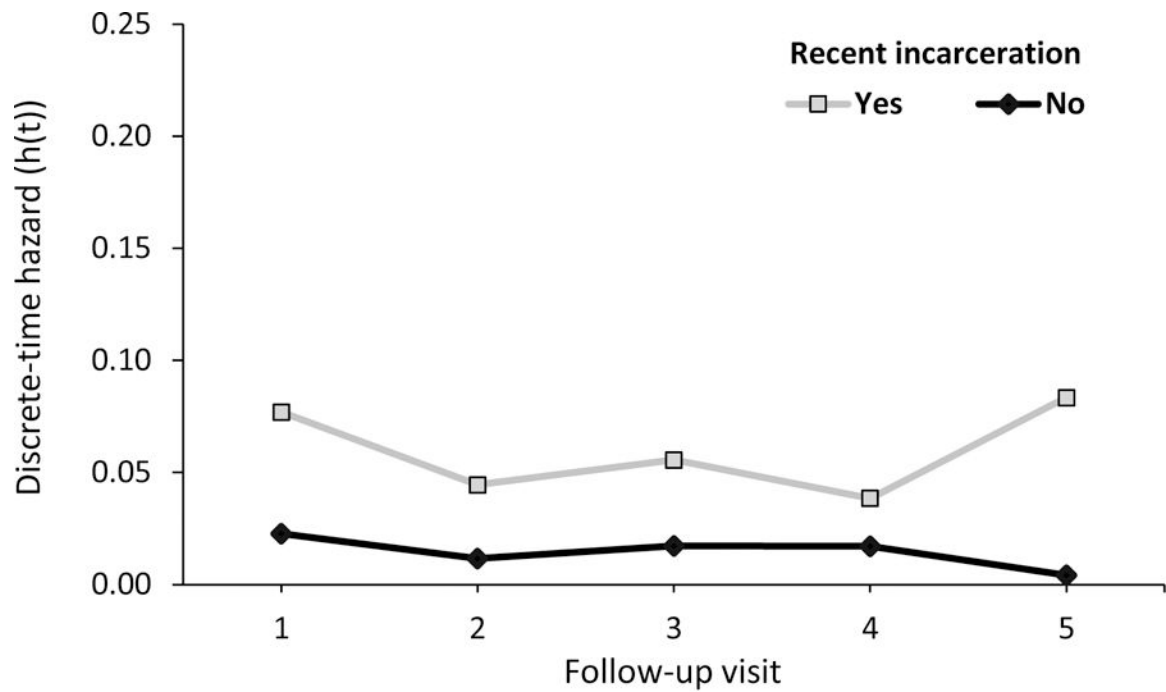
Figure 2. Discrete-time hazard of first providing injection initiation assistance over six-month follow-up visits by recent incarceration status among persons who inject drugs in Vancouver, Canada, December 2014 to November 2017 (N_{visits}=3,776; $N_{participants}$=1,198; N_{events}=66).

Note: IIA = injection initiation assistance.

Table 1.

Probability of providing injection initiation assistance per six-months of follow-up among persons who inject drugs in Vancouver, Canada, December 2014 to November 2017 (N_{visits}=4,171; $N_{participants}$=1,199; N_{events}=67).

Follow-up visit	Interval[a] (months)	Number of participants			Probability of	
		At-risk at start of interval	With 1st provision of IIA during interval	Censored[b] at the end of interval	1st provision of IIA within interval (%)	No provision of IIA through end of interval (%)
1	(0,6]	1199	27	176	2.3	97.8
2	(7,12]	996	12	171	1.2	96.6
3	(13,18]	813	14	137	1.7	94.9
4	(19, 24]	662	11	150	1.7	93.3
5	(25, 30]	501	3	498	0.6	92.8

Notes: IIA = injection initiation assistance.

[a] At each follow-up visit, the interval reflects the preceding six months over which the outcome was assessed.

[b] Participants who were censored at the end of an interval were not observed beyond that interval (i.e., did not attend a subsequent follow-up visit) either due to the end of observation window or being lost to follow-up (including death).

Table 2.

Association between recent incarceration and hazard of providing injection initiation assistance among persons who inject drugs in Vancouver, Canada, December 2014 to November 2017 (N_{visits}=3,449; $N_{participants}$=1,113; N_{events}=60).

Characteristic	aHR	95% CI
Recent incarceration, yes vs no	2.64	1.19, 5.86[*]
Follow-up visit, per additional six-month interval	0.90	0.74, 1.09
Age[a], per 1-year increase	0.96	0.93, 0.98
Sex[a], male vs female	1.15	0.66, 1.97
Prior history of incarceration[a], yes vs no	0.56	0.31, 1.04
Homelessness[b], yes vs no	0.81	0.42, 1.56
Frequency of law enforcement encounters[b]		
1 vs 0	0.88	0.39, 1.99
>1 vs 0	0.56	0.28, 1.15
Non-IDU[b], yes vs no	1.40	0.81, 2.42
Frequency of IDU[b]		
Daily versus none	2.33	0.96, 5.70
Less than daily versus none	1.59	0.65, 3.88
Recent public injection[b], yes vs no	1.24	0.70, 2.19
Methamphetamine IDU[b], yes vs no	2.09	1.10, 3.96[*]
OAT enrollment[b], yes vs no	1.18	0.70, 2.00

[*] *Notes*: Statistically significant at *P* value .05. aHR = adjusted hazard ratio; CI = confidence interval; IDU = injection drug use; OAT = opioid agonist treatment. Results are from a multivariable binomial regression model with clog-log link. All aHR are adjusted for full list of characteristics in the table.

[a] Fixed at baseline value.

[b] Responses lagged to prior visit, i.e. variable refers to behaviors between seven to twelve months prior.