



Criminal Justice System Involvement as a Risk Factor for Detectable Plasma HIV Viral Load in People Who Use Illicit Drugs: A Longitudinal Cohort Study

Sarah Ickowicz¹ · N. A. Mohd Salleh^{1,2} · Nadia Fairbairn^{1,3} · Lindsey Richardson^{1,4} · Will Small^{1,5} · M.-J. Milloy^{1,3} 

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Abstract

Among HIV-positive people who use illicit drugs (PWUD) in our setting, repeated periods of incarceration adversely affect ART adherence in a dose-dependent manner. However, the impact of non-custodial criminal justice involvement on HIV-related outcomes has not been previously investigated. Data were obtained from a longitudinal cohort of HIV-positive PWUD in a setting of universal no-cost ART and complete dispensation records. Multivariate generalized estimating equations were used to calculate the longitudinal odds of having a detectable HIV VL (VL) associated with custodial and non-custodial CJS exposure. Between 2005 and 2014, 716 HIV-positive ART-exposed PWUD were recruited. In multivariate analysis, both custodial [Adjusted odds ratio (AOR) 0.61, 95% CI 0.45–0.82] and noncustodial (AOR 0.78, 95% CI 0.62–0.99) involvement in the criminal justice system was associated with detectable HIV VL. Among HIV-positive PWUD, both custodial and non-custodial criminal justice involvement is associated with worse HIV treatment outcomes. Our findings highlight the need for increased ART adherence support across the full spectrum of the criminal justice system.

Keywords HIV infections · Anti-HIV agents · Antiretroviral therapy · Prisons · Substance abuse

Introduction

Reduced ART adherence is an important barrier to optimal HIV treatment outcomes among people who use drugs (PWUD) [1]. Previous studies of ART uptake and utilization among PWUD have highlighted important risk factors for reduced ART adherence and higher HIV viral load (VL), including ongoing illicit drug injection, higher intensity drug scene involvement, inadequate housing, poor management of

comorbid conditions, and poor relationships with care providers [2–4]. It has become increasingly clear that criminal justice system (CJS) involvement poses a significant structural barrier to ART adherence among PWUD, with negative effects on HIV treatment outcomes [5, 6].

Incarceration events negatively affect ART adherence in a dose-dependent manner [7, 8], and have been associated with viral rebound in PWUD with previously undetectable HIV VLs [9, 10]. Interruptions in ART are common in custody due to inability to access medications and concerns regarding HIV discrimination and lack of confidentiality [11]. Though programs to initiate ART while in custody have been successful [12], prison release is associated with viral rebound [13]. Community re-entry is associated with high rates of ART discontinuation due in part to lack of continuity in substance use treatment and support services in this time of transition [14]. Those who cycle rapidly through prison release and reincarceration are particularly vulnerable to interruptions in HIV treatment [15].

CJS involvement can be characterized along a spectrum involving both custodial (e.g., youth detention, municipal jail, provincial prison or federal penitentiary) and non-custodial involvement (e.g., being on probation, parole, bail,

✉ M.-J. Milloy
mj.milloy@bccsu.ubc.ca

¹ British Columbia Centre on Substance Use, Vancouver, BC, Canada

² Interdisciplinary Studies Graduate Program, University of British Columbia, Vancouver, BC, Canada

³ Department of Medicine, St. Paul's Hospital, University of British Columbia, Vancouver, BC, Canada

⁴ Department of Sociology, University of British Columbia, Vancouver, BC, Canada

⁵ Faculty of Health Sciences, Simon Fraser University, Vancouver, BC, Canada

conditional sentencing, or diversion). The effect of non-custodial CJS involvement on HIV treatment outcomes has not been fully evaluated. The objective of this study is to elucidate whether CJS involvement across a spectrum of custodial and non-custodial CJS settings is associated with lower rates of optimal HIV treatment outcomes among a cohort of community-recruited HIV-positive PWUD in Vancouver's Downtown East Side (DTES), a setting where universal access to ART for HIV-positive PWUD in the context of treatment-as-prevention (TasP) initiatives and no-cost access to healthcare has been associated with improved HIV virologic control, including increases in the prevalence of non-detectable HIV VL and reduced rates of secondary HIV drug resistance [16].

Methods

Data were obtained from the AIDS Care Cohort to evaluate Exposure to Survival Services (ACCESS), an observational prospective cohort of HIV-seropositive drug users. The study has been described in detail previously [17, 18]. Community-based recruitment strategies were used to enroll HIV-seropositive drug users in Vancouver's DTES neighbourhood. Inclusion criteria were HIV-seropositivity demonstrated by serology, age 18 years or older, and use of illicit drugs other than or in addition to cannabis in the 30 days prior to the baseline interview. The ACCESS study has been approved by the University of British Columbia/Providence Healthcare Research Ethics Board. All participants provide written informed consent.

Following study recruitment and semiannually thereafter, all ACCESS participants complete an interviewer-administered survey that elicits information including socio-demographic characteristics, drug-use patterns and criminal justice-related exposures. They also complete an examination by a study nurse, and a blood sample is drawn for analysis. At recruitment, individuals provide their personal health number (PHN), a unique personal identifier issued to all residents of British Columbia. Using this identifier, study staff establish a confidential linkage with the British Columbia Centre for Excellence in HIV/AIDS (BC-CfE) Drug Treatment Programme (DTP). Through the DTP, the BC-CfE provides HIV/AIDS treatment and care including medications and clinical monitoring to those living with HIV in BC, funded by British Columbia's universal medical system that includes no-cost HIV treatment and care. A complete retrospective and prospective clinical profile is available for all ACCESS participants through the DTP, including all plasma HIV VL observations and CD4+ cell counts conducted as part of the study or ongoing clinical care. This includes any lab investigations drawn while in custody. The clinical profile is linked to the DTP's pharmacy, British Columbia's

sole source of ART. Complete records of antiretroviral agents used, as well as dose and date dispensed for all ART-exposed participants are available via the DTP pharmacy for all ART-exposed participants in British Columbia.

In this study, we included all individuals recruited to the ACCESS study between December 1, 2005 and December 1, 2014, who had at least 1 plasma VL (copies/mL) observation and at least 1 CD4 cell count (per 100 cells/mL) observation within ± 180 days of their baseline interview and had at least 1 day of ART dispensed prior to the final date of the study period.

For these analyses, the primary outcome of interest was detectable plasma HIV VL, defined as ≥ 50 copies/mL, in the previous 180-day period using data from the confidential linkage to comprehensive clinical data. If more than one HIV VL observation was available in any 180-day period, the mean of all observations in that period was used and dichotomized at 50 copies/mL. If no observations in the previous 180 days were available, we used the most recent observation. If no VL observation was available in any 180-day period and there was no record of ART dispensation, the period was defined as detectable. The primary explanatory variable of interest was self-reported exposure to the criminal justice system, defined as noncustodial involvement (e.g., being on probation, parole, bail, conditional sentencing, or diversion) or custodial involvement (e.g., being held in youth detention, municipal jail, provincial prison or federal penitentiary) within the preceding 180 days.

Secondary explanatory variables of interest included: gender (male vs. non-male); age (per year older); self-reported ethnicity (Caucasian vs. non-Caucasian); homelessness (yes vs. no); DTES residence (yes vs. no); level of education (\geq high school diploma vs. $<$ high school diploma); employment (yes vs. no); heavy alcohol use, defined as self-reported consumption of five or more alcoholic drinks per day for men, or four or more drinks per day for women (yes vs. no); heroin injection (\geq daily vs. $<$ daily); cocaine injection (\geq daily vs. $<$ daily); crack-cocaine use (\geq daily vs. $<$ daily); currently being engaged in methadone maintenance therapy (MMT; yes vs. no). The gender variable was defined as male vs. non-male based on self-reported gender during baseline interview. Transgender individuals who did not self-identify as male were included in the non-male category. With respect to substance use variables, the $<$ daily category included participants who reported not using the substance as well as those who reported less than daily use. Using the confidential linkage, we also included CD4 cell count (per 100 cells/mL). We used the mean of all measures in the previous 180 days or, if none, the most recent observation. All variable definitions were consistent with previously published studies [19, 20]. All behavioural variables were treated as time-updated covariates and referred to the six-month period prior to each interview.

We estimated univariate statistics for the relationships between detectable HIV VL and all explanatory variables over the study period with generalized linear mixed-effects modeling. This analytic approach takes account of correlated observations, i.e., repeated measures from cohort participants. To account for potential confounding, we used a multivariate model using an a priori modeling strategy suggested by Greenland et al. [21]. First, we fit a full model, including the primary explanatory and all secondary explanatory variables. Using a manual stepwise approach, we constructed reduced models, each with one variable removed from the full set of secondary explanatory variables. Comparing the value of the coefficient for the primary explanatory in the full model and each of the reduced models, we removed the secondary explanatory corresponding to the smallest relative change. We continued this process until the minimum change from the full model exceeded 5%. This technique has been used successfully by several authors to estimate the independent relationship between an outcome of interest and a selected explanatory variable [22–24] by retaining secondary covariates with greater relative influence on the relationship between the outcome and the primary explanatory variable.

Using the confidential linkage, we also included CD4 cell count (per 100 cells/mL) as well as information on ART dispensation. Specifically, we accessed data on the date and duration of all dispensed antiretroviral medications to calculate a measure of adherence to treatment. In each 180 day observation period, we calculated the quotient of dividing the number of days for which ART was dispensed divided by the number of days since the first dispensation of ART to a maximum of 180 days. We dichotomized this variable at 0.95. In previous analyses, we have validated this measure as a reliable predictor of virologic suppression and survival.

As a subanalysis, we tested if the association between exposure to the criminal justice system and virologic non-suppression was mediated by adherence to ART, as demonstrated in previous analyses of social/structural exposures and HIV virologic outcomes (i.e., homelessness and socioeconomic marginalization). Specifically, we followed the approach suggested by Baron and Kenney and fit three longitudinal GEE models: path a, between the independent variable (criminal justice system exposure, recategorized as any vs. none in the last 6 months) and the proposed mediator (adherence to ART, dichotomized as ≤ 95 vs. $> 95\%$); path b, between the mediator (ART adherence) and the dependent variable (HIV viral load suppression); and path c, between the independent and dependent variables. Using the values for the coefficient and the standard error, we calculated the Sobel test statistic and its significance.

Results

Between December 1, 2005 and December 1, 2014, 874 HIV-seropositive illicit drug users were recruited. Of these, 158 (18%) were excluded as they were ART-naïve or lacked baseline VL/CD4 information. Of the 716 HIV-seropositive illicit drug users included in the analysis, 144 (20%) reported custodial or noncustodial CJS involvement 180 days prior to the baseline interview. The current study included 4768 interviews, and 2384 person-years of observation. A median of 6 follow-up interviews were conducted per participant (IQR 3–10). Three hundred and thirteen individuals (44%) reported any CJS involvement during the study period. Among individuals who reported any CJS involvement, a total of two follow-up interviews were conducted (IQR 1–4).

Table 1 presents the baseline characteristics of the sample population stratified by detectable HIV VL (≥ 50 copies/mL vs. < 50 copies/mL). Younger age (Odds Ratio (OR) 0.4, 95% CI 0.31–0.59), unstable housing (OR 0.5, 95% CI 0.37–0.7), daily heroin injection (OR 0.3, 95% CI 0.19–0.60), and daily use of crack cocaine (OR 0.6, 95% CI 0.45–0.87) were negatively associated with having an undetectable viral load.

Table 2 shows the multivariable analyses of factors associated with an undetectable HIV VL. Both custodial (OR 0.48, 95% CI 0.38–0.61) and noncustodial (OR 0.76, 95% CI 0.62–0.93) CJS involvement were significantly and negatively associated with undetectable HIV VL in unadjusted models. Following adjustment, both custodial (Adjusted Odds Ratio (AOR) 0.61, 95% CI 0.45–0.82) and noncustodial (AOR 0.78, 95% CI 0.62–0.99) CJS involvement retained a significant negative association with having an undetectable HIV VL.

In the subanalysis testing if the association between criminal justice exposure and HIV viral suppression was mediated by adherence to ART, we found a significant negative association between criminal justice exposure and ART adherence; and a significant positive association between ART adherence and viral suppression. A Sobel test supported the hypothesis that ART adherence mediated the relationship between exposure to the criminal justice system and viral suppression ($p < 0.001$).

Discussion

In the present study, we observed an association between both custodial and non-custodial CJS involvement and detectable HIV VL. Custodial involvement exerted a stronger effect on virologic outcomes than non-custodial

Table 1 Baseline characteristics of 716 ART-exposed HIV-positive people who use illicit drugs stratified by plasma HIV-1 RNA viral load, Vancouver, Canada (2005–2014)

Characteristic	HIV VL \geq 50 cop-	HIV VL \leq 50 cop-	Odds ratio (95% CI)	<i>p</i> value
	ies (mL) n (%)	ies (mL) n (%)		
Total	459 (64.11)	257 (35.89)		
Non-custodial CJS	50 (6.98)	12 (1.68)	0.38 (0.20–0.74)	0.003
Custodial CJS	57 (7.96)	25 (3.49)	0.70 (0.43–1.16)	0.163
Age (median, IQR)	137 (19.13)	132 (18.44)	0.43 (0.31–0.59)	0.000
Non-male gender	174 (24.30)	71 (9.92)	0.63 (0.45–0.87)	0.005
Caucasian ethnicity	249 (34.78)	152 (21.23)	1.22 (0.90–1.66)	0.206
Unstable housing ^a	340 (47.49)	153 (21.37)	0.51 (0.37–0.71)	0.000
\geq HS diploma	219 (30.59)	134 (18.72)	1.19 (0.88–1.62)	0.256
DTES residence ^a	316 (44.13)	154 (21.51)	0.68 (0.49–0.93)	0.016
Heavy alcohol use ^a	114 (15.92)	78 (10.89)	1.32 (0.94–1.85)	0.110
\geq Daily crack smoking ^a	174 (24.30)	71 (9.92)	0.63 (0.45–0.87)	0.005
\geq Daily heroin injection ^a	71 (9.92)	15 (2.09)	0.34 (0.19–0.60)	0.000
\geq Daily cocaine injection ^a	40 (5.59)	18 (2.51)	0.79 (0.44–1.41)	0.421
MMT ^a	213 (29.75)	122 (17.04)	1.04 (0.77–1.42)	0.784
CD4 < 200 cells/mL	152 (21.23)	35 (4.89)	0.32 (0.21–0.48)	0.000

^aDenotes activities in the previous 6 months*CI* Confidence interval, *MMT* methadone maintenance treatment, *HS* high school**Table 2** Behavioural, social and clinical factors associated with exhibiting a non-detectable plasma HIV-1 RNA viral load, Vancouver, Canada (2005–2014)

Characteristic	Odds ratio (OR)	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Noncustodial CJS	0.76 (0.62–0.93)	0.78 (0.62–0.99)
Custodial CJS	0.48 (0.38–0.61)	0.61 (0.45–0.82)
Age (per year older)	0.57 (0.51–0.64)	0.58 (0.46–0.72)
Non-male	0.70 (0.62–0.79)	
Caucasian	1.23 (1.10–1.38)	
\geq HS diploma	0.97 (0.87–1.09)	
Unstable housing ^a	0.78 (0.69–0.88)	
DTES residence ^a	0.76 (0.67–0.85)	
Heavy alcohol	0.87 (0.76–1.00)	
\geq Daily crack cocaine smoking ^a	0.58 (0.51–0.66)	0.60 (0.49–0.75)
\geq Daily cocaine injection ^a	0.74 (0.59–0.92)	
\geq Daily heroin injection ^a	0.42 (0.34–0.52)	
MMT ^a	1.41 (1.25–1.58)	1.62 (1.29–2.04)
CD4 < 200 cells/mL	1.36 (1.32–1.41)	

^aDenotes activities in the previous 6 months*CI* Confidence interval, *MMT* methadone maintenance treatment, *HS* high school

involvement. To our knowledge, no previous study has estimated the longitudinal effects of non-custodial CJS involvement on HIV treatment outcomes among PWUD. Previous studies within this setting have similarly shown

that a history of incarceration is associated with ART discontinuation and failure to suppress HIV VL [25, 26]. Given previous evidence demonstrating that ART adherence improves during periods of incarceration, the association between CJS involvement and HIV VL may be driven by issues related to community re-entry.

While stability in care arrangements supports ART adherence, changes in care arrangements during times of transition between criminal justice settings have the potential to lead to treatment discontinuation and reduced ART adherence [11]. A previous systematic review revealed that although ART uptake improves in custodial settings, HIV treatment outcomes are worse following release than pre-incarceration [27]. Previous studies within the Connecticut Department of Corrections have shown that although 70% of prisoners with HIV are able to achieve viral suppression while incarcerated, only 51% of those with viral suppression on release remained suppressed at the time of reincarceration [12, 15]. In addition, periods of community re-entry between incarceration events are high risk for HIV risk-taking behaviours including unprotected sexual intercourse and needle sharing [14, 28]. Though data regarding HIV treatment outcomes for those with non-custodial CJS involvement are limited, a recent study from Baltimore, Maryland revealed that 39% of individuals under community supervision had a detectable HIV VL [29], suggesting that issues in care that arise during times of transition likely have important ongoing effects for those in non-custodial settings.

Despite universal ART access within our setting, ongoing socio-structural barriers to ART uptake including unstable

housing are likely to play a continued role [6, 17, 30, 31]. Among marginalized PWUD with HIV, homelessness is a common concern on community re-entry, and has been linked with re-incarceration, HIV risk behaviour, injection drug use, and worse HIV treatment outcomes [4, 14, 32, 33]. Structural interventions that address housing instability may play an important role in continuity of care for those with non-custodial CJS involvement, and during community re-entry for those with recent incarceration [17, 30, 34–36].

Strategies to improve ART uptake and utilization among high-risk and difficult to reach populations such as Seek-Test-Treat-Retain have gained significant traction and have been integrated within criminal justice settings including both correctional facilities and community supervision [37, 38]. In addition, programs that combine ART with opioid substitution have shown success during incarceration and early community re-entry when care can be continued into the community setting [39]. Despite this, a minority of recently released prisoners avoid ART interruptions [28]. Strategies to improve ART utilization among recently incarcerated individuals, to support individuals engaged in the CJS, and to ease transition into the community by promoting continuous engagement in HIV care and improving socioeconomic stability through housing, food and material security, and viable income generation, are warranted.

This study has some limitations. Several measures, including history of criminal justice involvement and history of illicit drug use, were self-reported and may have been subject to reporting bias. Participants in this cohort were recruited by community-based methods (e.g., street outreach, postering, referral from low-barrier harm reduction facilities) and thus do not represent a random sample. As such, it is possible that these findings cannot be generalized outside of our setting. In particular, the older age of cohort participants (e.g., 44 years at baseline) and the de facto decriminalization of personal drug possession in our setting might hinder generalization to other settings with different law enforcement patterns. Because this study took place in the context of no-cost universal access to ART and complete province-wide records of CD4 count and HIV VL measurements, we were able to avoid confounding due to financial barriers to access. As this is an observational cohort study, causality cannot be inferred, though we do note that prior evidence exists for a causal relationship between criminal justice involvement and worsened ART adherence [8]. Information regarding duration of incarceration or non-custodial supervision was not collected in this study, therefore the impact of brief versus longer incarcerations on viral suppression and post-release HIV care could not be assessed. In addition, specifics regarding diversion were not collected. This could potentially impact the results as diversion sentences requiring residential treatment could potentially improve ART adherence. We note however that this

would most likely bias the results toward non-significance. In addition, details regarding sentencing and length of incarceration were not available in the context of this study.

In the present study, data from a community-recruited sample of HIV-positive PWUD followed over a period of 9 years has demonstrated an important independent relationship between CJS involvement and worsened HIV treatment outcomes. The outcomes of this study highlight the need for improved delivery of comprehensive HIV care within the CJS, both in custodial and non-custodial settings.

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