Published in final edited form as:

AIDS Care. 2020 October ; 32(10): 1262–1267. doi:10.1080/09540121.2020.1772955.

Behavioural, social and structural-level risk factors for developing AIDS among HIV-positive people who use injection drugs in a Canadian setting, 1996-2017

S Ickowicz¹, H Dong¹, L Ti^{1,2}, S Nolan^{1,2}, N Fairbairn^{1,2}, R Barrios^{3,4}, M-J Milloy^{1,2}

¹British Columbia Centre on Substance Use, St. Paul's Hospital, Vancouver, BC, CANADA

²Department of Medicine, University of British Columbia, St. Paul's Hospital, 608-1081 Burrard Street, Vancouver, BC, CANADA, V6Z 1Y6

³BC Centre for Excellence in HIV/AIDS, University of British Columbia, Vancouver, BC, CANADA

⁴Faculty of Medicine, School of Population and Public Health, Vancouver, BC, CANADA

Abstract

Background: People who use injection drugs (PWID) experience high rates of HIV acquisition and, as a result of lower rates of optimal access and adherence to combination antiretroviral therapy (ART), experience worse HIV treatment outcomes compared to other key affected populations. However, the incidence and risk factors for the development of AIDS among HIV-positive PWID have not been completely described.

Methods: We used data from a community-recruited prospective cohort of HIV-positive PWID in Vancouver, Canada, a setting with universal no-cost ART and a comprehensive clinical monitoring registry. We used multivariable extended Cox models to identify factors associated with time to AIDS.

Results: Between 1996 and 2017, 396 participants, including 140 (35.4%) women, were followed for a median of 39.0 months (interquartile range: 16.6 - 76.2), among whom 165 (41.7%) developed AIDS. In a multivariable model, homelessness (Adjusted Hazard Ratio [AHR] = 1.76 (1.18-2.61) and injection drug use within the preceding six months (AHR = 1.74 (1.17-2.58) were independently associated with higher risk of developing AIDS.

Conclusions: Despite widespread scale-up of programs to improve ART utilization, significant risk factors for development of AIDS remain among HIV-positive PWID in this setting.

Keywords

HIV Infections; AIDS; Treatment Outcome; Antiretroviral Therapy; Substance Abuse

Send correspondence to: M-J Milloy, PhD, Research Scientist, B.C. Centre on Substance Use, Canopy Growth Professor of Cannabis Science, Assistant Professor, Department of Medicine, University of British Columbia, St. Paul's Hospital, 608-1081 Burrard Street, Vancouver, B.C., Canada, V6Z 1Y6, **Tel:** (604) 558-6677, **Fax:** (604) 806-9044, bccsu-mjms@cfe.net.ubc.ca.

CONFLICTS OF INTEREST

The authors have no conflict of interest to declare.

Introduction

The incidence of AIDS-related deaths has continued to decrease globally owing to improved HIV prevention and diagnosis, as well as increased availability of combination antiretroviral therapy (ART) (UNAIDS, 2017; WHO, 2016). In 2016, there were 1.0 million AIDS-related deaths globally, a decrease of 48% since 2010 (UNAIDS, 2017; WHO, 2016). Among people who have HIV, 77% are now on treatment and 82% of those on treatment are virally suppressed (UNAIDS, 2017). Despite these successes, key populations, including people who use injection drugs (PWID), remain at increased risk of HIV acquisition, with 8% of new HIV infections occurring among PWID in 2015 (UNAIDS, 2017).

AIDS is a syndrome of autoimmune deficiency secondary to advanced HIV infection. It is associated with a range of complications including opportunistic infection and malignancy, and carries a high mortality rate if left untreated (Poorolajal, Hooshmand, Mahjub, Esmailnasab, & Jenabi, 2016). It is estimated that the global expansion of ART since the early 1990's has prevented millions of AIDS-related deaths (Granich et al., 2015). Those who initiate ART early in the course of HIV infection now live a life span similar to the general population, with significantly decreased rates of HIV-related complications and transmission (Grinsztejn et al., 2014; Samji et al., 2013). Despite this, many low income countries continue to have high rates of AIDS deaths, largely related to limitations in early initiation of ART (Granich et al., 2015). In addition, previous studies have shown that among people living with HIV, ongoing stigma and low socioeconomic status negatively impact health-related quality of life, whereas early detection and availability of health services are associated with higher health-related quality of life (Ghiasvand et al., 2020, 2019).

Within high-income countries, barriers to ART initiation and treatment retention persist among members of key affected populations, including PWID (Michael-John Milloy, Montaner, & Wood, 2012; Nosyk et al., 2015). Although suboptimal rates of ART initiation, adherence and virologic suppression are well documented among people living with HIV who inject drugs (Steffanie A Strathdee et al., 2010), to our knowledge, behavioural, social and structural risk factors that have previously been associated with worsened HIV outcomes, including injection drug use, incarceration and homelessness (Michael-John Milloy et al., 2012), have not been investigated longitudinally in the context of AIDS-related events. Therefore, the objective of this study is to identify behavioural, social, and structural risk factors associated with developing AIDS among a cohort of community-recruited HIV-positive PWID.

Methods

Data were derived from the AIDS Care Cohort to evaluate Exposure to Survival Services (ACCESS) study, an ongoing observational prospective cohort of HIV-positive PWID in Vancouver's Downtown Eastside (DTES) neighbourhood. The DTES neighbourhood is home to a large population of PWID with high levels of HIV infection, marginalization and criminalization (Maas et al., 2007; M. J. Milloy et al., 2011). The ACCESS study has been described in detail previously (M-J Milloy et al., 2012; S A Strathdee et al., 1998).

Participants are recruited through community-based strategies, including word-of-mouth, posters, and snowball sampling. Eligible participants are HIV-positive as demonstrated by serology, are aged 18 years, and have used illicit drugs other than cannabis in the 30 days prior to the baseline interview. All participants provide written informed consent. The ACCESS study has been approved by the University of British Columbia/Providence Healthcare Research Ethics Board.

Following study recruitment and every 180 days thereafter, all ACCESS participants complete an interviewer-administered questionnaire to elicit information including socio-demographic characteristics, drug-use patterns and HIV/AIDS risk behaviours such as syringe sharing. They also complete an examination by a study nurse, and a blood sample is drawn to determine HIV VL and CD4 count. At recruitment, individuals provide their personal health number (PHN), a unique and persistent identifier issued to all residents of British Columbia. Using this identifier, a confidential linkage is established 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, funded by British Columbia's no-cost universal medical system. A complete retrospective and prospective clinical profile is available for all ACCESS participants through the DTP, including CD4 cell counts drawn as part of the study or ongoing clinical care. Physician report of AIDS-defining events using the United States Centres for Disease Control classification system (Castro, Ward, Slutsker, Jaffe, & Berkelman, 1993) is also documented within the DTP clinical profile.

In this study, we included all individuals recruited to the ACCESS study between May 1996 and May 2017 who had 1 plasma VL (copies/mL) observation and 1 CD4 cell count (per 100 cells/mL) observation within $\pm$ 180 days of their baseline interview and self-reported any history of intravenous drug use at baseline. In addition, we restricted these analyses to individuals with no CD4 cell counts < 200 cells/mL and no history of AIDS-defining illnesses prior to recruitment, based on the Centres for Disease Control and Prevention's AIDS surveillance case definition (Castro et al., 1993).

For these analyses, the primary outcome of interest was time to AIDS within the study period, defined the date of the first CD4 cell count < 200 or first physician report of an AIDS-defining illness within the DTP database, whichever occurred first.

Data regarding behavioural, social, and structural risk factors was derived from baseline and follow-up ACCESS study questionnaires. The explanatory variables of interest included: gender (male vs. non-male); age at baseline (per year older); self-reported ethnicity (Caucasian vs. non-Caucasian); homelessness (yes vs. no); illegal income generation including theft or selling drugs (yes vs. no); highest level of education (high school diploma vs. $<$ high school diploma); employment (yes vs. no); injection drug use (yes vs. no); non-injection drug use (yes vs. no); incarceration (yes vs. no); and current methadone maintenance therapy (MMT) (yes vs. no). Buprenorphine/naloxone treatment was not included due to low numbers over the study time period. In addition, we included a variable representing the year of observation. The time period of 1996-1999 was compared to 2000-2006, 2007-2011, and after 2011. The time period of 2007-2011 was significant due to

scale-up of treatment as prevention initiatives within our study context. We also included variables representing the year of the study enrolment and baseline CD4 cell count, defined as the most recent observation immediately prior to recruitment (per 100 cells/mL), using data from the BC-CfE clinical registry. All variable definitions were identical to earlier studies . (Miller et al., 2002; S A Strathdee et al., 1997) All behavioural variables were treated as time-updated covariates and referred to the six-month period prior to each interview unless otherwise indicated.

As a first step, we examined the characteristics of all individuals at baseline stratified by development of AIDS over the study period. Next, using extended Cox survival analysis, we estimated the hazard ratio, 95% confidence intervals (95% CI) and p-values for time to developing AIDS associated with each explanatory variable. In light of the strong effects observed for the CD4 cell count at baseline and the year of study recruitment, we recalculated the effect measure for each explanatory variable, adjusting for both year of recruitment and baseline CD4 cell count. Finally, to fit the multivariable model, we included all covariates with $p < 0.05$ in bivariate analyses.

Results

Between May 1996 and May 2017, we recruited 396 HIV-seropositive participants. These individuals contributed 3114 interviews during the study period, equal to 1557 person-years of observation. Table 1 presents the baseline characteristics of the sample. A total of 165 (41.6%) of participants developed AIDS during the study period. Those who developed AIDS were more likely to be younger, to use injection drugs, and to have been incarcerated in the preceding six months.

Table 2 presents the survival analysis for risk of developing AIDS. Participants who developed AIDS were more likely to be younger (HR 0.97, CI 0.95-0.98), and more likely to report injection drug use (HR 2.16, CI 1.48-3.15), homelessness (HR 1.65, CI 1.14-2.39), and incarceration (HR 2.02, CI 1.43-2.85) in the preceding six months. When compared to the observation period of 1996-1999, AIDS events were less likely from 2007-2011 (HR 0.52, CI 0.31-0.86), and after 2011 (HR 0.14, CI 0.08-0.27), but were not found to be lower for the time period of 2000-2006. Based on year of baseline interview, risk of developing AIDS decreased per year later (HR 0.90, CI 0.88-0.93). As expected, higher baseline CD4 count was associated with decreased risk for developing AIDS (HR 0.76, CI 0.69-0.84).

The third column of Table 2 shows the bivariate analysis of factors associated with AIDS events following correction for CD4 count. In this analysis, injection drug use (HR 1.81, $p=0.003$), homelessness (HR 2.04, $p < 0.001$), and incarceration (HR 1.48, $p=0.03$) were associated with an increased risk of developing AIDS. When compared to the observation period of 1996-1999, risk of AIDS was decreased from 2007-2011 (HR 0.18, CI (0.05-0.69) and after 2011 (HR 0.04, CI (0.01-0.21)).

In the final multivariable model (Table 2), AIDS was independently associated with homelessness (HR 1.76, CI 1.18-2.61) and injection drug use (HR 1.74, CI 1.17-2.58). Risk of AIDS was decreased per year later (HR 1.12, CI 1.01-1.25), with significant reductions

from 2007-2011 (HR 0.18 $p=0.009$) and after 2011 (HR 0.03, CI 0.01-0.18) when compared to 1996-1999. Higher baseline CD4 count was associated with decreased risk of developing AIDS (HR 0.76, CI 0.69-0.84)

Discussion

The objective of the present study was to identify risk factors associated with developing AIDS among a cohort of community-recruited HIV-positive PWID. We have observed an association between risk of developing AIDS and injection drug use, homelessness, and incarceration. To our knowledge, an association between behavioural, social, and structural risk factors and risk of AIDS among people who use illicit drugs has not been previously described. In addition, a strength of this study is the long duration of observations, which has allowed us to demonstrate that the risk of AIDS events has decreased among HIV-positive PWID since 2006, coinciding with a community-wide treatment-as-prevention initiative in this setting (Nosyk et al., 2015, 2013).

Unfortunately, despite universal no-cost access to all HIV care including ART within Vancouver's DTES, PWID remain at high risk for HIV infection, experience worse HIV treatment outcomes, and have increased mortality due to both AIDS-related and non-AIDS-related causes (Lappalainen et al., 2015; Michael-John Milloy et al., 2012; Obel et al., 2011; Samji et al., 2013). Though community-wide treatment-as-prevention and harm reduction efforts have led to improvements in ART access and adherence, treatment disparities persist among PWID (Fraser et al., 2017; M-J Milloy et al., 2016; Nosyk et al., 2017). Because this study took place in the context of no-cost universal access to ART and complete province-wide records of CD4 count measurements, we were able to avoid confounding due to financial barriers to access.

Our findings are consistent with existing evidence. Illicit drug use has previously been identified as a barrier to accessing ART for people with HIV, and injection drug use has been linked to reduced retention in ART (Cooney, Hiransuthikul, & Lertmaharit, 2015; Easterbrook et al., 2000; Nosyk et al., 2015). Multiple incarcerations have been linked to ART interruptions in a dose-response relationship (M. J. Milloy et al., 2011). Incarceration and residential eviction represent disruptive life events that can lead to breakdown in continuity of HIV care (Kennedy et al., 2017; McNeil et al., 2017). Lack of stable, secure and adequate housing has been linked to ART interruptions and worsened treatment outcomes (Aidala et al., 2016; Hayashi et al., 2016). Programs targeted at reducing barriers to treatment, for example housing interventions for HIV-positive PWID and access to comprehensive HIV and addiction treatment including OAT, have been shown to improve ART adherence (Malta, Strathdee, Magnanini, & Bastos, 2008; Marshall et al., 2016).

This study has some additional limitations. Self-reported measures may be subject to reporting bias. However, self-reported data has been previously used to measure drug use patterns and other characteristics in studies involving PWID and found to be valid (Darke, 1998). In addition, the primary outcome of interest was based on serological testing and physician report and was obtained from a central province-wide database. Though this study has identified important associations, our outcomes are potentially subject to unmeasured

confounding and causal inference cannot be drawn. Due to the observational and geographically contained nature of this study, it is possible that the current findings are not generalizable to other PWID populations. Finally, low event counts in later years produced effect estimates with wide confidence intervals. Future studies involving a greater number of participants would produce more precise estimates.

The introduction of combination ART in the mid-1990s led to sharp reductions in AIDS incidence rates that have continued to decline (Schwarcz, Chen, Vittinghoff, Hsu, & Schwarcz, 2013; UNAIDS, 2017). Despite this, disparities in HIV treatment and AIDS rates continue to exist among specific vulnerable groups including PWID (Pouget et al., 2014; UNAIDS, 2017; West et al., 2015). The present study has demonstrated that despite significant reduction in AIDS cases among PWID since 2006, those who report injection drug use, homelessness, and incarceration remain at elevated risk. Interventions to improve continuity of HIV care and to expand access to addiction treatment for PWID will be critical to improving HIV treatment outcomes and reducing HIV transmission within this marginalized group.

ACKNOWLEDGMENTS

The authors thank the study participants for their contribution to the research, as well as current and past researchers and staff.

The study was supported by the US National Institutes of Health (U01DA021525, R25-DA037756). MJM is supported by National Institute on Drug Abuse (U01-DA021525), a Canadian Institutes of Health Research New Investigator award and a Michael Smith Foundation for Health Research (MSFHR) Scholar Award. His institution has received an unstructured gift from NG Biomed Ltd., a private firm applying to the Canadian federal government for a license to produce medical cannabis, to support him. LT is supported by a MSFHR Scholar Award. NF is supported by MSFHR and St. Paul's Foundation Scholar awards.

References

- Aidala AA, Wilson MG, Shubert V, Gogolishvili D, Globberman J, Rueda S, ... Rourke SB (2016). Housing Status, Medical Care, and Health Outcomes Among People Living With HIV/AIDS: A Systematic Review. *American Journal of Public Health*, 106(1), e1–e23. 10.2105/AJPH.2015.302905
- Castro KG, Ward JW, Slutsker JW, Jaffe HW, & Berkelman RL (1993). 1993 Revised Classification System for HIV Infection and Expanded Surveillance Case Definition for AIDS Among Adolescents and Adults. Retrieved December 10, 2017, from www.cdc.gov/mmwr/preview/mmwrhtml/00018871.htm
- Cooney N, Hiransuthikul N, & Lertmaharit S (2015). HIV in young people: characteristics and predictors for late diagnosis of HIV. *AIDS Care*, 27(5), 561–569. 10.1080/09540121.2014.986049 [PubMed: 25671409]
- Darke S (1998). Self-report among injecting drug users: a review. *Drug and Alcohol Dependence*, 51(3), 253–258. [PubMed: 9787998]
- Easterbrook PJ, Yu LM, Goetghebeur E, Boag F, McLean K, & Gazzard B (2000). Ten-year trends in CD4 cell counts at HIV and AIDS diagnosis in a London HIV clinic. *AIDS (London, England)*, 14(5), 561–571.
- Fraser H, Mukandavire C, Martin NK, Hickman M, Cohen MS, Miller WC, & Vickerman P (2017). HIV treatment as prevention among people who inject drugs - a re-evaluation of the evidence. *International Journal of Epidemiology*, 46(2), 466–478. 10.1093/ije/dyw180 [PubMed: 27524816]
- Ghiasvand H, Higgs P, Noroozi M, Ghaedamini Harouni G, Hemmat M, Ahounbar E, ... Armoon B (2020). Social and demographical determinants of quality of life in people who live with HIV/AIDS

infection: evidence from a meta-analysis. *Biodemography and Social Biology*, 65(1), 57–72. 10.1080/19485565.2019.1587287 [PubMed: 30882251]

- Ghiasvand H, Waye KM, Noroozi M, Harouni GG, Armoon B, & Bayani A (2019). Clinical determinants associated with quality of life for people who live with HIV/AIDS: a Meta-analysis. *BMC Health Services Research*, 19(1), 768 10.1186/s12913-019-4659-z [PubMed: 31665007]
- Granich R, Gupta S, Hersh B, Williams B, Montaner J, Young B, & Zuniga JM (2015). Trends in AIDS Deaths, New Infections and ART Coverage in the Top 30 Countries with the Highest AIDS Mortality Burden; 1990–2013. *PLoS ONE*, 10(7), e0131353 10.1371/journal.pone.0131353 [PubMed: 26147987]
- Grinsztejn B, Hosseinipour MC, Ribaudo HJ, Swindells S, Eron J, Chen YQ, ... Team H. 052-A. S. (2014). Effects of early versus delayed initiation of antiretroviral treatment on clinical outcomes of HIV-1 infection: results from the phase 3 HPTN 052 randomised controlled trial. *The Lancet. Infectious Diseases*, 14(4), 281–290. 10.1016/S1473-3099(13)70692-3 [PubMed: 24602844]
- Hayashi K, Wood E, Kerr T, Dong H, Nguyen P, Puskas CM, ... Milloy M-J (2016). Factors associated with optimal pharmacy refill adherence for antiretroviral medications and plasma HIV RNA non-detectability among HIV-positive crack cocaine users: a prospective cohort study. *BMC Infectious Diseases*, 16(1), 455 10.1186/s12879-016-1749-y [PubMed: 27568002]
- Kennedy MC, Kerr T, McNeil R, Parashar S, Montaner J, Wood E, & Milloy M-J (2017). Residential Eviction and Risk of Detectable Plasma HIV-1 RNA Viral Load Among HIV-Positive People Who Use Drugs. *AIDS and Behavior*, 21(3), 678–687. 10.1007/s10461-016-1315-z [PubMed: 26906022]
- Lappalainen L, Hayashi K, Dong H, Milloy MJ, Kerr T, & Wood E (2015). Ongoing impact of HIV infection on mortality among people who inject drugs despite free antiretroviral therapy. *Addiction (Abingdon, England)*, 110(1), 111–119. 10.1111/add.12736
- Maas B, Fairbairn N, Kerr T, Li K, Montaner JSG, & Wood E (2007). Neighborhood and HIV infection among IDU: place of residence independently predicts HIV infection among a cohort of injection drug users. *Health & Place*, 13(2), 432–439. 10.1016/j.healthplace.2006.05.005 [PubMed: 16798055]
- Malta M, Strathdee SA, Magnanini MMF, & Bastos FI (2008). Adherence to antiretroviral therapy for human immunodeficiency virus/acquired immune deficiency syndrome among drug users: a systematic review. *Addiction (Abingdon, England)*, 103(8), 1242–1257. 10.1111/j.1360-0443.2008.02269.x
- Marshall BDL, Elston B, Dobrer S, Parashar S, Hogg RS, Montaner JSG, ... Milloy M-J (2016). The population impact of eliminating homelessness on HIV viral suppression among people who use drugs. *AIDS (London, England)*, 30(6), 933–942. 10.1097/QAD.0000000000000990
- McNeil R, Kerr T, Coleman B, Maher L, Milloy MJ, & Small W (2017). Antiretroviral Therapy Interruption Among HIV Positive People Who Use Drugs in a Setting with a Community-Wide HIV Treatment-as-Prevention Initiative. *AIDS and Behavior*, 21(2), 402–409. 10.1007/s10461-016-1470-2 [PubMed: 27351192]
- Miller CL, Tyndall M, Spittal P, Li K, Palepu A, & Schechter MT (2002). Risk-taking behaviors among injecting drug users who obtain syringes from pharmacies, fixed sites, and mobile van needle exchanges. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, 79(2), 257–265. 10.1093/jurban/79.2.257
- Milloy M-J, Kerr T, Bangsberg DR, Buxton J, Parashar S, Guillemi S, ... Wood E (2012). Homelessness as a structural barrier to effective antiretroviral therapy among HIV-seropositive illicit drug users in a Canadian setting. *AIDS Patient Care and STDs*, 26(1), 60–67. 10.1089/apc.2011.0169 [PubMed: 22107040]
- Milloy M-J, Wood E, Kerr T, Hogg BV, Guillemi S, Harrigan PR, & Montaner J (2016). Increased Prevalence of Controlled Viremia and Decreased Rates of HIV Drug Resistance Among HIV-Positive People Who Use Illicit Drugs During a Community-wide Treatment-as-Prevention Initiative. *Clinical Infectious Diseases : An Official Publication of the Infectious Diseases Society of America*, 62(5), 640–647. 10.1093/cid/civ929 [PubMed: 26553011]
- Milloy MJ, Kerr T, Buxton J, Rhodes T, Guillemi S, Hogg R, ... Wood E (2011). Dose-response effect of incarceration events on nonadherence to HIV antiretroviral therapy among injection drug users.

The Journal of Infectious Diseases, 203(9), 1215–1221. 10.1093/infdis/jir032 [PubMed: 21459814]

Michael-John Milloy, Montaner J, & Wood E (2012). Barriers to HIV treatment among people who use injection drugs: implications for “treatment as prevention”. *Current Opinion in HIV and AIDS*, 7(4), 332–338. 10.1097/COH.0b013e328354bcc8 [PubMed: 22576468]

Nosyk B, Lourenco L, Min JE, Shopin D, Lima VD, & Montaner JSG (2015). Characterizing retention in HAART as a recurrent event process: insights into “cascade churn”. *AIDS (London, England)*, 29(13), 1681–1689. 10.1097/QAD.0000000000000746

Nosyk B, Min J, Lima VD, Yip B, Hogg RS, & Montaner JSG (2013). HIV-1 disease progression during highly active antiretroviral therapy: an application using population-level data in British Columbia: 1996–2011. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 63(5), 653–659. 10.1097/QAI.0b013e3182976891 [PubMed: 24135777]

Nosyk B, Zang X, Min JE, Krebs E, Lima VD, Milloy M-J, ... Montaner JSG (2017). Relative effects of antiretroviral therapy and harm reduction initiatives on HIV incidence in British Columbia, Canada, 1996–2013: a modelling study. *The Lancet. HIV*, 4(7), e303–e310. 10.1016/S2352-3018(17)30045-0 [PubMed: 28366707]

Obel N, Omland LH, Kronborg G, Larsen CS, Pedersen C, Pedersen G, ... Gerstoft J (2011). Impact of Non-HIV and HIV Risk Factors on Survival in HIV-Infected Patients on HAART: A Population-Based Nationwide Cohort Study. *PLOS ONE*, 6(7), e22698. [PubMed: 21799935]

Poorolajal J, Hooshmand E, Mahjub H, Esmailnasab N, & Jenabi E (2016). Survival rate of AIDS disease and mortality in HIV-infected patients: a meta-analysis. *Public Health*, 139, 3–12. 10.1016/j.puhe.2016.05.004 [PubMed: 27349729]

Pouget ER, West BS, Tempalski B, Cooper HLF, Hall HI, Hu X, & Friedman SR (2014). Persistent racial/ethnic disparities in AIDS diagnosis rates among people who inject drugs in U.S. metropolitan areas, 1993–2007. *Public Health Reports (Washington, D.C. : 1974)*, 129(3), 267–279. 10.1177/003335491412900309

Samji H, Cescon A, Hogg RS, Modur SP, Althoff KN, Buchacz K, ... IeDEA, for T. N. A. A. C. C. on R. and D. (NA-A. of. (2013). Closing the Gap: Increases in Life Expectancy among Treated HIV-Positive Individuals in the United States and Canada. *PLOS ONE*, 8(12), e81355. [PubMed: 24367482]

Schwarcz L, Chen M-J, Vittinghoff E, Hsu L, & Schwarcz S (2013). Declining incidence of AIDS-defining opportunistic illnesses: results from 16 years of population-based AIDS surveillance. *AIDS*, 27(4).

Strathdee SA, Palepu A, Cornelisse PG, Yip B, O'Shaughnessy MV, Montaner JS, ... Hogg RS (1998). Barriers to use of free antiretroviral therapy in injection drug users. *JAMA*, 280(6), 547–549. [PubMed: 9707146]

Strathdee SA, Patrick DM, Currie SL, Cornelisse PG, Rekart ML, Montaner JS, ... O'Shaughnessy MV (1997). Needle exchange is not enough: lessons from the Vancouver injecting drug use study. *AIDS*, 11(8), F59–65. [PubMed: 9223727]

Strathdee, Steffanie A, Hallett TB, Bobrova N, Rhodes, Booth R, Abdool R, & Hankins CA (2010). HIV and risk environment for injecting drug users: the past, present, and future. *Lancet (London, England)*, 376(9737), 268–284. 10.1016/S0140-6736(10)60743-X

UNAIDS. (2017). Ending AIDS: Progress towards the 90–90–90 targets (No. JC2900E). Geneva: UNAIDS.

West BS, Pouget ER, Tempalski B, Cooper HLF, Hall HI, Hu X, & Friedman SR (2015). Female and male differences in AIDS diagnosis rates among people who inject drugs in large U.S. metro areas from 1993 to 2007. *Annals of Epidemiology*, 25(4), 218–225. 10.1016/j.annepidem.2015.01.006 [PubMed: 25724830]

WHO. (2016). Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000–2015. Geneva: World Health Organization.

Table 1.

Baseline characteristics of 396 HIV-positive AIDS-free people who inject drugs, Vancouver, 1996-2017

	Total, n (%) (N=396)	Developed AIDS during study period		p-value
		No (n=231) n (%)	Yes (n=165) n (%)	
Age (median, IQR)		41 (34-48)	35 (29-41)	< 0.001
Caucasian ancestry	184 (46.5)	100 (43.3)	84 (50.9)	0.153
Male gender	256 (64.6)	154 (66.7)	102 (61.8)	0.338
Homeless *	323 (81.6)	189 (81.8)	134 (81.2)	0.896
Injection drug use *	78 (19.7)	59 (25.5)	19 (11.5)	0.001
Non-injection drug use *	44 (11.1)	29 (12.6)	15 (9.1)	0.332
Employment *	323 (81.6)	178 (77.1)	145 (87.9)	0.008
Illegal income *	328 (82.8)	198 (85.7)	130 (78.8)	0.080
Recent incarceration *	308 (77.8)	194 (84.0)	114 (69.1)	0.001
Methadone maintenance program *	270 (68.2)	151 (65.4)	119 (72.1)	0.189
High school diploma	152 (38.4)	104 (45.0)	48 (29.1)	0.002
Year of baseline (median, IQR)		2009 (2000-2011)	1997 (1996-2002)	<0.001
CD4 at baseline (median, IQR)		4.9 (4.1-6.6)	3.8 (2.9-5.1)	<0.001

* Refers to activities in the six months prior to follow-up interview

Table 2.

Bivariate and multivariable analysis of factors associated with time to development of AIDS

	Unadjusted Hazard Ratio (95% CI)	Adjusted for Baseline CD4 Hazard Ratio (95% CI)	Multivariable Hazard Ratio (95% CI)
Age (per year older)	0.97 (0.95-0.98)	0.98 (0.96-1.00)	0.99 (0.97-1.01)
Male gender	0.81 (0.59-1.12)	0.79 (0.58-1.09)	
Caucasian ethnicity	0.82 (0.61-1.12)	0.97 (0.71-1.32)	
High school diploma	1.58 (1.14-2.21)	0.99 (0.69-1.43)	
Employment	0.45 (0.26-0.79)	0.64 (0.36-1.14)	
Illegal income *	1.35 (0.91-2.02)	0.97 (0.64-1.47)	
Homeless *	1.65 (1.14-2.39)	2.04 (1.40-2.96)	1.76 (1.18-2.61)
Injection drug use *	2.16 (1.48-3.15)	1.81 (1.22-2.67)	1.74 (1.17-2.58)
Non-injection drug use *	1.45 (0.91-2.32)	1.13 (0.71-1.82)	
Recent incarceration *	2.02 (1.43-2.85)	1.48 (1.04-2.10)	1.25 (0.87-1.79)
Methadone Maintenance Therapy *	0.82 (0.60-1.13)	0.91 (0.66-1.26)	
Year of observation			
2000-2006 v. 1996-1999	0.92 (0.58-1.46)	0.78 (0.44-1.38)	0.73 (0.41-1.30)
2007-2011 v. 1996-1999	0.52 (0.31-0.86)	0.18 (0.05-0.69)	0.18 (0.05-0.65)
> 2011 v. 1996-1999	0.14 (0.08-0.27)	0.04 (0.01-0.21)	0.03 (0.01-0.18)
Year of baseline interview (per year later)	0.90 (0.88-0.93)		1.12 (1.01-1.25)
CD4 at baseline (per 100 cells/uL)	0.76 (0.69-0.84)		0.76 (0.69-0.84)

* Refers to activities in the six months prior to follow-up interview

CI: Confidence Interval