Published in final edited form as:

Addict Behav. 2018 October ; 85: 88–93. doi:10.1016/j.addbeh.2018.05.031.

Viral suppression among HIV-infected methadone-maintained patients: The role of ongoing injection drug use and adherence to antiretroviral therapy (ART)

Roman Shrestha^{a,b,*} and Michael M. Copenhaver^{a,b}

^aDepartment of Allied Health Sciences, University of Connecticut, Storrs, CT, USA

^bInstitute for Collaboration on Health, Intervention, and Policy, University of Connecticut, Storrs, CT, USA

Abstract

Introduction: Methadone maintenance therapy (MMT) is associated with improved virologic outcomes, yet no studies have explored factors associated with viral suppression in HIV-infected patients on MMT. Given the critical role of sustained viral suppression in maximizing benefits of antiretroviral therapy (ART), we sought to assess factors associated with viral suppression in patients stabilized on MMT.

Methods: A sample of 133 HIV-infected, methadone-maintained patients who reported HIV-risk behaviors were assessed using an audio-computer assisted self-interview (ACASI). Multivariable logistic regression was used to identify significant correlates of viral suppression.

Results: Among all participants, self-reported HIV risk behaviors were highly prevalent and over 80% had achieved viral suppression. Independent correlates of viral suppression were: having optimal adherence to ART (aOR = 4.883, $p = .009$), high CD4 count (aOR = 2.483, $p = .045$), and ongoing injection drug use (aOR = 0.081, $p = .036$). Furthermore, results revealed a significant interaction effect that involved optimal ART adherence and injection of drug use on viral suppression (aOR = 2.953, $p = .029$).

Conclusion: Overall, our findings highlight unaddressed HIV-related treatment challenges faced by certain group of methadone-maintained patients. These findings have significant implications for the HIV treatment as prevention efforts and, thus, indicate the need for comprehensive efforts to promote viral suppression in this risk population.

Keywords

Viral suppression; HIV; Methadone; Opioid use disorder; Injection drug use; ART adherence; HIV risk behavior

*Corresponding author at: 358 Mansfield Road, Unit 1101 Storrs, CT, 06269-1101, USA., roman.shrestha@uconn.edu (R. Shrestha).

Declarations of interest

None.

1. Introduction

Achieving optimal adherence to antiretroviral therapy (ART) and sustaining viral suppression are essential to reduce morbidity and mortality associated with HIV among people living with HIV (PLWH) (Mocroft et al., 2003; Rodger et al., 2013). Further, recent clinical trials have demonstrated that people who achieve and maintain an undetectable viral load effectively have no risk of sexually transmitting HIV. This has contributed to an increasing global consensus regarding the use of antiretroviral medications for HIV prevention, as HIV treatment-as-prevention (TasP) initiatives for PLWH (Bavinton et al., 2017; Cohen et al., 2016; Cohen et al., 2011; Rodger et al., 2016) and, hence, underscores the importance of viral suppression in improving health outcomes and preventing HIV transmission. Given this evidence, the US National HIV/AIDS Strategy has called for linking PLWH to high- quality HIV care and sustained viral suppression (The White House, 2016).

Unfortunately, not all risk groups have benefited equally from scientific advancements in HIV care and treatment. Among HIV-infected people who use drugs (PWUD), in particular, serious gaps exist in the rates of engagement in HIV care services, uptake of ART, and viral suppression - a series of stages referred to as the “HIV care cascade” (Azar et al., 2015; Li et al., 2017; Meyer, Althoff, & Altice, 2013; Zhang et al., 2018). Despite these challenges, recent studies have demonstrated potential benefits of opioid substitution therapies (OST), such as methadone maintenance treatment (MMT), buprenorphine, or naltrexone, on optimal treatment outcomes - uptake and adherence to ART and viral suppression among HIV-infected opioid-dependent individuals. For example, Low et al. showed that OST was associated with a 69% increase in recruitment onto ART, a 2-fold increase in adherence, and 45% increase in odds of viral suppression (Low et al., 2016). These findings support the use of OST as part of the integrated approach to improve HIV treatment and care continuum.

Opioid-dependent individuals stabilized on MMT are highly diverse and beyond the benefit of HIV TasP efforts. In the broader literature, several factors have been associated with viral suppression (Aibibula et al., 2018; Arthur et al., 2015; Bowen et al., 2017; Crepaz, Tang, Marks, & Hall, 2017; Ferrand et al., 2016; Socías et al., 2016). Despite substantial research in this area, prior studies have not explored theoretically informed correlates among HIV-infected opioid-dependent patients within drug treatment settings. Thus, given the critical role of sustained viral suppression in maximizing the individual- and population-level benefits of ART, the aim of this study was to assess factors associated with viral suppression in patients stabilized on MMT. Identifying subgroups at-risk for not achieving viral suppression and addressing factors causing the disparities could inform approaches to optimize HIV treatment outcomes and prevention efforts (e.g., HIV TasP).

2. Methods

2.1. Participants

Participants were HIV-infected, opioid-dependent individuals enrolled in a community-based methadone maintenance drug treatment facility in New Haven, Connecticut. Between September 2012 and January 2018, 133 individuals were recruited if they were a) 18 years

or older, b) HIV positive, c) reported drug- or sex-related risk behavior (past 6 months), d) met DSM-V criteria for opioid use disorder and stabilized on methadone, and e) able to provide informed consent.

2.2. Study design and procedures

Data for the current study was derived from the Holistic Health for HIV (3H+) project, a randomized controlled trial designed to improve HIV risk reduction and medication adherence among high-risk HIV- infected PWUD. The study design has been described previously (Shrestha, Karki, Huedo-Medina, & Copenhaver, 2016; Shrestha, Krishnan, Altice, & Copenhaver, 2015). Participants were recruited through clinic-based advertisements and flyers, word-of-mouth, and direct referral from counselors in the methadone clinic. Individuals who met inclusion criteria and expressed interest in participating provided informed written consent and were administered a baseline assessment. Participants were assessed using an audio computer-assisted self-interview (ACASI) program. We utilized data collected at the baseline assessment.

The study protocol was approved by the Institutional Review Boards at the University of Connecticut and Yale University, and received board approval from the methadone clinic. Clinical trial registration is available at www.ClinicalTrials.gov (NCT01741311).

2.3. Measures

General demographic variables including age, gender, sexual orientation, ethnicity, marital status, educational status, employment status, annual income, living arrangement, methadone dose (mg), HIV diagnosis duration, and ART status were collected.

We collected chart abstracted viral load and CD4 cell counts from medical records. Viral suppression, which was defined as clinic-recorded HIV-1 RNA test value < 200 copies/mL whereas high CD4 count was defined as CD4 count ≥ 500 cells/mm³ (Bowen et al., 2017; Crepaz et al., 2017).

Other variables included participants' adherence to ART (in the past 30 days), which was assessed using an empirically validated, self-report visual analog scale (VAS) approach (Giordano, Guzman, Clark, Charlebois, & Bangsberg, 2004). We used a standardized cut-off, adherence of 95% or greater, as optimal adherence (Paterson et al., 2000). We assessed participants' motivation to adhere to ART using the 18- item Motivation for ART adherence scale. Items were rated in a 4-point scale ranging from not at all (0) to extremely (Azar et al., 2015), with higher score indicating greater motivation for adherence ($\alpha = 0.72$).

Measures of the information-motivation-behavioral skills (IMB) model constructs related to HIV risk reduction (Huedo-Medina, Shrestha, & Copenhaver, 2016) were also collected. Domains of the IMB constructs included: (a) Information - HIV risk-related knowledge (range: 0–4); (b) Motivation - readiness to change and intentions to change HIV risk behavior (range: 0–32); and (c) Behavioral Skills - risk reduction skills (range: 0–16).

We used a validated HIV Stigma Mechanism Measure to assess participants' internalized, anticipated, and enacted HIV-related stigma (Earnshaw, Smith, Chaudoir, Amico, &

Copenhaver, 2013). Internalized HIV stigma ($\alpha = 0.91$) was measured with 6 items including *"I feel ashamed of having HIV."* Anticipated HIV stigma ($\alpha = 0.90$) was measured with 9 items including *"Healthcare workers will treat me with less respect."* Enacted HIV stigma ($\alpha = 0.91$) was measured with 9 items including *"Family members have avoided me."* Items were rated on 5- point Likert-type scales. Items were averaged to create composite scores, with higher scores indicating greater stigma.

Disclosure of HIV status, which was defined as having any sex with disclosure of HIV-positive status to the partners in the past six months. Serostatus disclosure to partners was measured by asking, *"In the past six months, did you have sex with anyone who you told your HIV status sometime before you had sex?"* Responses were reported using a "yes" or "no".

The HIV risk assessment, adapted from NIDA's Risk Behavior Assessment (Dowling-Guyer et al., 1994) was used to measure several aspects of HIV risk behaviors in the past 30 days, including a measurement of "any" high risk behavior (sexual or drug-related) as well as measurements of event-level (i.e., partner-by-partner) behaviors.

2.4. Data analysis

We computed descriptive statistics, including frequencies and percentages for categorical variables, and means and standard deviations for continuous variables. After conducting bivariate analyses to examine significant associations with the dependent variable (i.e., viral suppression), we conducted multivariable logistic regression analyses on any bivariate associations found to be significant at $p < .10$. Additionally, we examined the interactive effect of pairs of variables in the main effects model to determine the moderated effect on viral suppression. Stepwise forward entry and backward elimination methods both showed the same results when examining the independent correlates ($p < .05$) expressed as adjusted odds ratios (aOR) and their 95% confidence intervals. Model fit was assessed using a Hosmer and Lemeshow Test (Hosmer, Hosmer, Le Cessie, & Lemeshow, 1997). Analyses were conducted using SPSS version 23 (IBM Corp., 2015)

3. Results

3.1. Participant characteristics

Table 1 summarizes participant characteristics. The mean age of participants was 49.3 (± 8.3) years. The mean duration of HIV diagnosis was 14.1 (± 9.6) years and 63.2% of participants reported to have disclosed their HIV status to a sexual partner. Of 121 (91.0%) individuals who were taking ART, 57.9% had achieved optimal adherence, and 80.4% had achieved viral suppression. Self-reported HIV risk behaviors were highly prevalent among study samples. Almost half of participants (46.6%) reported injecting illicit drugs in the past 30 days. Of those, 58.1% reported having shared injection equipment. Similarly, 21.1% of participants reported having sex with more than one sexual partner, and only 14.3% reported always using condoms with their sexual partners in the past 30 days.

3.2. Correlates of viral suppression

Table 2 shows the bivariate correlates of viral suppression. Of note, factors associated with viral suppression were longer HIV diagnosis duration ($p < .038$), being employed ($p < .041$), and having optimal ART adherence ($p < .008$). Table 3 shows the independent correlates associated with this outcome in multivariate modeling. First, having optimal adherence to ART was associated with an over four-fold odds (aOR = 4.883, $p = .009$) and having high CD4 count was associated with a two-fold odds of being virally suppressed (aOR = 2.483, $p = .045$). Additionally, participants who reported having injected drugs in the past 30 days (aOR = 0.081, $p = .036$) were significantly less likely to achieve viral suppression. Furthermore, we also found a significant interaction effect that involved optimal ART adherence and injection of drugs on viral suppression (aOR = 2.953, $p = .029$).

4. Discussion

The current study contributes to the extant literature examining factors associated with viral suppression patterns among HIV-infected methadone-maintained patients. Although MMT has previously been shown to enhance access and adherence to ART and sustained viral suppression (Karki, Shrestha, Huedo-Medina, & Copenhaver, 2016; Low et al., 2016), our findings demonstrate that one in five participants was not able to achieve viral suppression. It is important to further note that suboptimal adherence has been shown to significantly reduce the effectiveness of ART, resulting in poorer virologic outcomes (Carballo et al., 2004; Colbert Alison, Sereika Susan, & Erlen Judith, 2012; Paterson et al., 2000), as was further supported by the pattern of associations between ART adherence and viral suppression in the current study. These findings indicate that even opioid-dependent individuals who are stabilized on methadone remain at high risk for poor virologic suppression and transmission of HIV infection, and thus support the need for intervention approaches to strongly promote ART adherence in this risk group.

Furthermore, our findings are consistent with prior research that has generally found HIV risk behaviors, including injection of drugs, to be highly prevalent among opioid-dependent individuals in a MMT program (Copenhaver, Lee, Margolin, Bruce, & Altice, 2011; Shrestha, Altice, Karki, & Copenhaver, 2018; Shrestha, Huedo-Medina, Altice, Krishnan, & Copenhaver, 2016; Shrestha, Karki, et al., 2016). This is particularly concerning given that engagement in injection-related practices has been inextricably linked to sub-optimal ART outcomes, including detectable viral load - as suggested in our findings (Azar et al., 2015; Blank et al., 2014). Suboptimal virologic outcomes in the context of frequent injections and elevated HIV risk behavior may amplify the risk of HIV transmission among this group and have potential to undermine the effectiveness of HIV TasP efforts in preventing HIV transmission (Bavinton et al., 2017; Cohen et al., 2016; Cohen et al., 2011; Rodger et al., 2016). These findings, thus, demonstrate the need for comprehensive efforts to promote viral suppression in this risk group (Wolfe, Carrieri, & Shepard, 2010; Wood, Milloy, & Montaner, 2012).

Our findings further demonstrated that there is a complex interplay between optimal ART adherence, current injection-related practices, and viral suppression. As discussed, optimal ART adherence promotes effectiveness of ART, resulting in sustained virologic suppression

(Carballo et al., 2004; Colbert Alison et al., 2012; Paterson et al., 2000). As an extension of prior findings, our results showed an interactive effect of optimal ART adherence and injection of illicit drugs on viral suppression. That is, the influence of optimal ART adherence on viral suppression was reduced due to ongoing injection drug use practices. Collectively, these findings highlight the importance of precisely targeting the impact of drug-related risk behaviors, while enhancing ART adherence among this risk groups.

The findings from this study are not without limitations. First, the participants enrolled in this study were recruited from a MMT clinic using a convenience sampling strategy. Thus, our findings may not generalize well to the larger population of HIV-infected individuals that includes other settings. Second, we relied on self-reported measures, which may have introduced response biases into our results, particularly over-estimating adherence and underreporting risk behaviors. Third, the cross-sectional nature of the current study limits our ability to determine causality and, thus, only associations can be established. Finally, the study sample was relatively small, which may have limited our ability to detect small to moderate associations.

5. Conclusions

Overall, our findings illustrated how the benefit of MMT programs may be negated among a significant segment of methadone-maintained patients and highlights unaddressed HIV-related treatment challenges faced by this risk group. These findings have important implications for the recently identified concept of HIV TasP as a clinical care strategy to reduce the harmful impact of ongoing HIV replication (Panel on Antiretroviral Guidelines for Adults and Adolescents, 2018) among HIV-infected individuals as well as transmission risk between sero-discordant couples (Bavinton et al., 2017; Cohen et al., 2016; Cohen et al., 2011; Rodger et al., 2016). As advocates have recently called for the recognition of “undetectable = untransmittable” (U = U) campaign, clinical care of HIV-infected individuals, including those for methadone-maintained patients, could be enhanced by improving communication and counseling about the importance of consistent ART adherence and viral suppression (Mustanski et al., 2018). As such, future interventions should encourage both HIV-infected individuals and their partners to discuss options for HIV and other sexually transmitted infections (STIs) prevention, including HIV and STI treatment, condoms, pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) within substance abuse treatment settings (Prevention Access Campaign, 2018).

References

- Aibibula W, Cox J, Hamelin AM, Moodie E, Naimi A, McLinden T, & Brassard P (2018). Food insecurity may lead to incomplete HIV viral suppression and less immune reconstitution among HIV/hepatitis C virus-coinfected people. *HIV Medicine*, 19(2), 123–131. 10.1111/hiv.12561. [PubMed: 29094807]
- Arthur B, Jason F, Niko V, Iliana G, Oni B, & Chinazo C (2015). Factors associated with retention and viral suppression among a cohort of HIV+ women of color. *AIDS Patient Care and STDs*, 29(S1), S27–S35. 10.1089/apc.2014.0272. [PubMed: 25458205]
- Azar P, Wood E, Nguyen P, Luma M, Montaner J, Kerr T, & Milloy M (2015). Drug use patterns associated with risk of non-adherence to antiretroviral therapy among HIV-positive illicit drug users

in a Canadian setting: A longitudinal analysis. *BMC Infectious Diseases*, 15(1), 193. [PubMed: 25927573]

Bavinton B, Grinsztejn B, Phanuphak N, Jin F, Zablotska I, Prestage G, & Grulich A (2017). HIV treatment prevents HIV transmission in male serodiscordant couples in Australia. (Thailand and Brazil). Paper presented at the Journal of the International AIDS Society).

Blank AE, Fletcher J, Verdecias N, Garcia I, Blackstock O, & Cunningham C (2014). Factors associated with retention and viral suppression among a cohort of HIV+ women of color. *AIDS Patient Care and STDs*, 29(S1), S27–S35. 10.1089/apc.2014.0272. [PubMed: 25458205]

Bowen EA, Canfield J, Moore S, Hines M, Hartke B, & Rademacher C (2017). Predictors of CD4 health and viral suppression outcomes for formerly homeless people living with HIV/AIDS in scattered site supportive housing. *AIDS Care*, 29(11), 1458–1462. 10.1080/09540121.2017.1307920. [PubMed: 28335616]

Carballo E, Cadarso-Suarez C, Carrera I, Fraga J, de la Fuente J, Ocampo A, & Prieto A (2004). Assessing relationships between health-related quality of life and adherence to antiretroviral therapy. *Quality of Life Research*, 13(3), 587–599. 10.1023/B:QURE.0000021315.93360.8b. [PubMed: 15130023]

Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, & Burns D (2011). Prevention of HIV-1 infection with early antiretroviral therapy. *The New England Journal of Medicine*, 365 10.1056/NEJMoa1105243.

Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, & Fleming TR (2016). Antiretroviral therapy for the prevention of HIV-1 transmission. *New England Journal of Medicine*, 375(9), 830–839. 10.1056/NEJMoa1600693. [PubMed: 27424812]

Colbert Alison M, Sereika Susan M, & Erlen Judith A (2012). Functional health literacy, medication-taking self-efficacy and adherence to antiretroviral therapy. *Journal of Advanced Nursing*, 69(2), 295–304. 10.1111/jm365-2648.2012.06007.x. [PubMed: 22489684]

Copenhaver MM, Lee IC, Margolin A, Bruce RD, & Altice FL (2011). Testigan optimized community-based human immunodeficiency virus (HIV) risk reduction and antiretroviral adherence intervention for HIV-infected injection drug users *Subst Abus.* Vol. 32, 16–26 (England). [PubMed: 21302180]

IBM Corp (2015). IBM SPSS statistics for windows, version 23. Armonk, NY: IBM Corp.

Crepaz N, Tang T, Marks G, & Hall HI (2017). Viral suppression patterns among persons in the United States with diagnosed HIV infection in 2014. *Annals of Internal Medicine*, 167(6), 446–447. 10.7326/117-0278. [PubMed: 28785761]

Dowling-Guyer S, Johnson ME, Fisher DG, Needle R, Watters J, Andersen M, & Tortu S (1994). Reliability of drug Users' self-reported HIV risk behaviors and validity of self-reported recent drug use. *Assessment*, 1(4), 383–392. 10.1177/107319119400100407.

Earnshaw VA, Smith LR, Chaudoir SR, Amico KR, & Copenhaver MM (2013). HIV stigma mechanisms and well-being among PLWH: A test of the HIV stigma framework. *AIDS and Behavior*, 17(5), 1785–1795. 10.1007/s10461-013-0437-9. [PubMed: 23456594]

Ferrand RA, Briggs D, Ferguson J, Penazzato M, Armstrong A, MacPherson P, ... Kranzer K (2016). Viral suppression in adolescents on antiretroviral treatment: Review of the literature and critical appraisal of methodological challenges. *Tropical Medicine & International Health*, 21(3), 325–333. 10.1111/tmi.12656. [PubMed: 26681359]

Giordano TP, Guzman D, Clark R, Charlebois ED, & Bangsberg DR (2004). Measuring adherence to antiretroviral therapy in a diverse population using a visual analogue scale. *HIV Clinical Trials*, 5 10.1310/jfxh-g3x2-eym6-d6ug.

Hosmer DW, Hosmer T, Le Cessie S, & Lemeshow S (1997). A comparison of goodness-of-fit tests for the logistic regression model. *Statistics in Medicine*, 16(9), 965–980. [PubMed: 9160492]

Huedo-Medina TB, Shrestha R, & Copenhaver M (2016). Modeling a theory-based approach to examine the influence of neurocognitive impairment on HIV risk reduction behaviors among drug users in treatment. *AIDS and Behavior*, 20(8), 1646–1657. 10.1007/s10461-016-1394-x. [PubMed: 27052845]

- Karki P, Shrestha R, Huedo-Medina TB, & Copenhaver M (2016). The impact of methadone maintenance treatment on HIV risk behaviors among high-risk injection drug users: A systematic review. *Evid Based Med. Public Health*, 2(pii: e1229).
- Li L, Chunqing L, Sung-Jae L, Le Anh T, Nan F, & Nguyen Anh T (2017). Antiretroviral therapy adherence and self-efficacy among people living with HIV and a history of drug use in Vietnam. *International Journal of STD & AIDS*, 28(12), 1247–1254. 10.1177/0956462417696431. [PubMed: 28632477]
- Low AJ, Mburu G, Welton NJ, May MT, Davies CF, French C, & Vickerman P (2016). Impact of opioid substitution therapy on antiretroviral therapy outcomes: A systematic review and meta-analysis. *Clinical Infectious Diseases*, 63(8), 1094–1104. 10.1093/cid/ciw416. [PubMed: 27343545]
- Meyer JP, Althoff AL, & Altice FL (2013). Optimizing care for HIV-infected people who use drugs: Evidence-based approaches to overcoming healthcare disparities. *Clinical Infectious Diseases*, 57(9), 1309–1317. 10.1093/cid/cit427. [PubMed: 23797288]
- Mocroft A, Ledergerber B, Katlama C, Kirk O, Reiss P, d'Arminio Monforte A, & Lundgren JD (2003). Decline in the AIDS and death rates in the EuroSIDA study: An observational study. *Lancet*, 362(9377), 22–29. [PubMed: 12853195]
- Mustanski B, Ryan DT, Remble TA, D'Aquila RT, Newcomb ME, & Morgan E (2018). Discordance of self-report and laboratory measures of HIV viral load among young men who have sex with men and transgender women in Chicago: Implications for epidemiology, care, and prevention. *AIDS and Behavior*. 10.1007/s10461-018-2112-7.
- Panel on Antiretroviral Guidelines for Adults and Adolescents (2018). Guidelines for the Use of Antiretroviral Agents in HIV-1-Infected Adults and Adolescents.
- Paterson DL, Swindells S, Mohr J, Brester M, Vergis EN, Squier C, & Singh N (2000). Adherence to protease inhibitor therapy and outcomes in patients with HIV infection. *Annals of Internal Medicine*, 133(1), 21–30. [PubMed: 10877736]
- Prevention Access Campaign (2018). Risk of sexual transmission of HIV from a person living with HIV who has undetectable viral load (Retrieved from) <https://www.preventionaccess.org/consensus>.
- Rodger AJ, Cambiano V, Bruun T, Vernazza P, Collins S, van Lunzen J, & Lundgren J (2016). Sexual activity without condoms and risk of HIV transmission in Serodifferent couples when the HIV-positive partner is using suppressive antiretroviral therapy. *JAMA*, 316(2), 171–181. 10.1001/jama.2016.5148. [PubMed: 27404185]
- Rodger AJ, Lodwick R, Schechter M, Deeks S, Amin J, Gilson R, & Phillips A (2013). Mortality in well controlled HIV in the continuous antiretroviral therapy arms of the SMART and ESPRIT trials compared with the general population. *AIDS*, 27(6), 973–979. 10.1097/QAD.0b013e32835cae9c. [PubMed: 23698063]
- Shrestha R, Altice FL, Karki P, & Copenhaver MM (2018). Integrated bio-behavioral approach to improve adherence to pre-exposure prophylaxis and reduce HIV risk in people who use drugs: A pilot feasibility study. *AIDS and Behavior*. 10.1007/s10461-018-2099-0.
- Shrestha R, Huedo-Medina T, Altice F, Krishnan A, & Copenhaver M (2016). Examining the acceptability of mHealth technology in HIV prevention among highrisk drug users in treatment. *AIDS and Behavior*. 10.1007/s10461-016-1637-x.
- Shrestha R, Karki P, Huedo-Medina T, & Copenhaver M (2016). Treatment engagement moderates the effect of neurocognitive impairment on antiretroviral therapy adherence in HIV-infected drug users in treatment. *Journal of the Association of Nurses in AIDS Care*, 28(1), 85–94. 10.1016/j.jana.2016.09.007.
- Shrestha R, Krishnan A, Altice FL, & Copenhaver M (2015). A non-inferiority trial of an evidence-based secondary HIV prevention behavioral intervention compared to an adapted, abbreviated version: Rationale and intervention description. *Contemporary Clinical Trials*, 44, 95–102. <http://dx.doi.org/10.1016/j.cct.2015.08.002>. [PubMed: 26253181]
- Socias ME, Wood E, Small W, Dong H, Shoveller J, Kerr T, & Milloy MJ (2016). Methadone maintenance therapy and viral suppression among HIV-infected opioid users: The impacts of crack and injection cocaine use. *Drug & Alcohol Dependence*, 168, 211–218. <http://dx.doi.org/10.1016/j.drugalcdep.2016.09.013>. [PubMed: 27701042]

- The White House. (2016). National HIV/AIDS strategy for the United States: Updated to 2020. Retrieved from <https://files.hiv.gov/s3fs-public/nhas-indicators-supplement-dec-2016.pdf>
- Wolfe D, Carrieri MP, & Shepard D (2010). Treatment and care for injecting drug users with HIV infection: A review of barriers and ways forward. *The Lancet*, 376(9738), 355–366. 10.1016/S0140-6736(10)60832-X.
- Wood E, Milloy MJ, & Montaner JS (2012). HIV treatment as prevention among injection drug users. *Current Opinion in HIV and AIDS*, 7(2), 151–156. 10.1097/C0H.0b013e32834f9927. [PubMed: 22227587]
- Zhang Y, Wilson TE, Adedimeji A, Merenstein D, Milam J, Cohen J, & Golub ET (2018). The impact of substance use on adherence to antiretroviral therapy among HIV-infected women in the United States. *AIDS and Behavior*, 22(3), 896–908. 10.1007/s10461-017-1808-4. [PubMed: 28560499]

HIGHLIGHTS

- Methadone maintenance therapy (MMT) is associated with improved virologic outcomes.
- No studies have explored factors associated with viral suppression in HIV-infected patients on MMT.
- We found that one in five participants was not able to achieve viral suppression.
- The benefit of MMT may be negated among a significant segment of methadone-maintained patients.
- These findings have important implications for the recently identified concept of HIV treatment as prevention.

Table 1:

Participant characteristics and HIV transmission risk behaviors of study sample.

Variables	Entire sample(<i>N</i> = 133)	
	Frequency	%
Characteristics of participants		
Age: Mean (± SD) ^a	49.3 (± 8.3)	
Gender		
Male	78	58.6
Female	55	41.4
Heterosexual sexual orientation		
No	102	76.7
Yes	31	23.3
Ethnicity		
Non-white	95	71.4
White	38	28.6
Currently married		
No	118	88.7
Yes	15	11.3
High school graduate		
No	60	45.1
Yes	73	54.9
Employed		
No	127	95.5
Yes	6	4.5
Income level		
< \$10,000	113	85.0
\$10,000	20	15.0
Living with family/friends		
No	78	58.6
Yes	55	41.4
Methadone Dose: Mean (± SD) ^a	64.5 ± 39.1)	
HIV diagnosis duration (Years): (±SD) ^a	14.1 (± 9.6)	
Taking ART ^b		
No	12	9.0
Yes	121	91.0
Optimal ART adherence ^c	<i>n</i> = 121	
No	44	33.1
Yes	77	57.9
Virally suppressed ^d	<i>n</i> = 112	
No	22	19.6

Variables	Entire sample(<i>N</i> = 133)	
	Frequency	%
Yes	90	80.4
High CD4 count ^c	<i>n</i> = 114	
No	55	48.2
Yes	59	51.8
HIV risk reduction related		
Information: Mean (± SD) ^a	3.1 (± 0.7)	
Motivation: Mean (± SD) ^a	27.4 (± 4.0)	
Behavioral skills: Mean (± SD) ^a	9.8 (± 3.8)	
Motivation for ART adherence: Mean (± SD) ^a	30.1 (± 6.8)	
HIV-related Stigma: Mean (± SD) ^a		
Internalized HIV Stigma: Mean (± SD) ^a	2.3 (± 1.0)	
Anticipated HIV Stigma: Mean (± SD) ^a	1.8 (± 0.8)	
Enacted HIV Stigma: Mean (± SD) ^a	1.8 (± 0.8)	
Disclosed HIV status		
No	49	36.8
Yes	84	63.2
HIV transmission risk behaviors		
Duration of drug use: Mean (± SD) ^a	24.7 (± 9.7)	
Ever injected illicit drug		
No	15	11.3
Yes	118	88.7
Injected illicit drug ^f	<i>n</i> = 118	
No	56	47.5
Yes	62	52.5
Shared injection equipment ^f	<i>n</i> = 62	
No	26	41.9
Yes	36	58.1
Multiple sex partner ^f		
No	105	78.9
Yes	28	21.1
Consistent condom use ^f		
No	114	85.7
Yes	19	14.3

^aSD: Standard deviation.

^bART: Antiretroviral therapy.

^cOptimal ART adherence: Adherence ≥ 95%.

^dVirally suppressed: Viral load < 200 copies/mL.

^eHigh CD4 count: CD4 count ≥ 500 cells/mm³

^fIn the past 30 days.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 2.

Bivariate models of factors associated with viral suppression status.

Variables	Virally Suppressed ^e		OR ^f (95% CI ^g)	p
	No (n = 22)	Yes (n = 90)		
Characteristics of participants				
Age: Mean (± SD) ^a	48.0 (± 7.7)	49 (± 7.6)	1.027 (0.968, 1.091)	0.378
Gender				
Male	12 (10.7)	52 (46.4)	-	-
Female	10 (8.9)	38 (33.9)	0.877 (0.343, 2.240)	0.784
Heterosexual sexual orientation				
No	4 (3.6)	20 (17.9)	-	-
Yes	18 (16.1)	70 (62.5)	0.778 (0.236, 2.562)	0.679
Ethnicity				
Non-White	12 (10.7)	68 (60.7)	-	-
White	10 (8.9)	22 (19.6)	0.388 (0.148, 1.021)	0.055
Currently married				
No	21 (18.8)	78 (69.6)	-	-
Yes	1 (0.9)	12 (10.7)	3.231 (0.397, 26.281)	0.273
High school graduate				
No	11 (9.8)	41 (36.6)	-	-
Yes	11 (9.8)	49 (43.8)	1.195 (0.470, 3.038)	0.708
Employed				
No	19 (17.0)	88 (78.6)	-	-
Yes	3 (2.7)	2 (1.8)	0.144 (0.022, 0.922)	0.041
Income level				
< \$10,000	20 (17.9)	78 (69.6)	-	-
\$10,000	2 (1.8)	12 (10.7)	1.538 (0.318, 7.436)	0.592
Living with family/friends				
No	15 (13.4)	52 (46.4)	-	-
Yes	7 (6.3)	38 (33.9)	1.566 (1.082, 4.214)	0.046

Variables	Virally Suppressed ^e		OR ^f (95% CI ^g)	p
	No (n = 22)	Yes (n = 90)		
Methadone Dose: Mean (± SD) ^a	89.2 (± 103.5)	80 (±76.9)	0.999 (0.993, 1.004)	0.652
HIV diagnosis duration (Years): Mean (± SD) ^a	11.7 (10.5)	15.0 (8.9)	1.140 (1.098, 1.396)	0.038
Optimal ART adherence ^b				
No	11 (10.7)	30 (29.1)	-	-
Yes	4 (3.9)	58 (56.3)	5.317 (1.560, 18.123)	0.008
High CD4 count ^c				
No	14 (12.6)	39 (35.1)	-	-
Yes	7 (6.3)	51 (45.9)	2.615 (0.964, 7.099)	0.059
HIV risk reduction related				
Information: Mean (± SD) ^a	3.8 (0.3)	3.8 (0.5)	0.973 (0.384, 2.463)	0.953
Motivation: Mean (± SD) ^a	27.0 (3.7)	27.6 (3.6)	1.041 (0.920, 1.179)	0.521
Behavioral skills: Mean (± SD) ^a	9.9 (4.6)	9.9 (3.6)	1.005 (0.889, 1.136)	0.939
Motivation for ART adherence: Mean (± SD) ^a	30.0 (6.6)	30.3 (6.3)	1.008 (0.935, 1.087)	0.839
HIV-related Stigma: Mean (± SD) ^a				
Internalized HIV Stigma	2.2 (1.0)	2.3 (1.1)	1.077 (0.696, 1.665)	0.739
Anticipated HIV Stigma	2.0 (0.7)	1.7 (0.7)	0.652 (0.362, 1.174)	0.154
Enacted HIV Stigma	1.8 (0.9)	1.7 (0.8)	0.937 (0.539, 1.628)	0.817
Disclosed HIV status				
No	9 (8.0)	33 (29.5)	-	-
Yes	13 (11.6)	57 (50.9)	1.196 (0.462, 3.098)	0.713
HIV transmission risk behaviors				
Duration of drug use: Mean (± SD) ^a	23.2 (6.7)	25.3 (10.1)	1.023 (0.973, 1.076)	0.368
Ever injected illicit drug				
No	2 (1.8)	12 (10.7)	-	-
Yes	20 (17.9)	78 (69.6)	0.650 (0.134, 3.142)	0.592
Injected illicit drug ^d				

Variables	Virally Suppressed ^e		OR ^f (95% CI ^g)	p
	No (n = 22)	Yes (n = 90)		
No	7 (7.1)	44 (44.9)	-	-
Yes	13 (13.3)	34 (34.7)	0.416 (0.150, 1.156)	0.093
Shared injection equipment ^d				
No	8 (16.0)	14 (28.0)	-	-
Yes	5 (10.0)	23 (46.0)	2.629 (0.716, 9.645)	0.145
Multiple sex partner ^d				
No	13 (14.9)	52 (59.8)	-	-
Yes	3 (3.4)	19 (21.8)	1.583 (0.406, 6.175)	0.508
Consistent condom use ^d				
No	15 (17.2)	67 (77.0)	-	-
Yes	1 (1.1)	4 (4.6)	0.896 (0.093, 8.596)	0.924

^aSD: Standard deviation.

^bOptimal ART adherence: Adherence 95%.

^cHigh CD4 count: CD4 count 500 cells/mm³.

^dIn the past 30 days.

^eVirally suppressed: Viral load < 200 copies/mL.

^fOdds ratio;

^gConfidence interval.

Table 3.

Multivariate logistic regression models of factors associated with viral suppression status.

Variables	Virally suppressed ^d		
	aOR ^e	95% CI ^f	p
Ethnicity			
Non-White	-	-	-
White	0.248	0.053, 1.148	0.075
Employed			
No	-	-	-
Yes	0.021	0.001, 1.086	0.055
Living with family/friends			
No			
Yes	1.117	0.166, 7.516	0.910
HIV diagnosis duration (Years)	1.040	0.943, 1.147	0.432
Optimal ART adherence ^a			
No	-	-	-
Yes	4.883	1.703, 8.926	0.009
High CD4 count ^b			
No	-	-	-
Yes	2.483	1.061, 4.690	0.045
Injected illicit drug ^c			
No	-	-	-
Yes	0.081	0.008, 0.854	0.036
Optimal ART adherence * Injected illicit drug	2.953	1.667, 4.087	0.029

^aOptimal ART adherence: Adherence ≥ 95%.^bHigh CD4 count: CD4 count ≥ 500 cells/mm³.^cIn the past 30 days.^dVirally suppressed: Viral load < 200 copies/mL^eaOR: Adjusted odds ratio.^fCI: Confidence interval.