Published in final edited form as:

AIDS. 2013 October 23; 27(16): 2559–2566. doi:10.1097/QAD.0b013e328363bff2.

Longitudinal changes in engagement in care and viral suppression for HIV-infected injection drug users

Ryan P. Westergaard^a, Timothy Hess^b, Jacquie Astemborski^c, Shruti H. Mehta^c, and Gregory D. Kirk^d

^aDepartments of Medicine and Population Health Sciences, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin

^bDepartment of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin

^cDepartment of Epidemiology, Epidemiology and Oncology, Johns Hopkins University, Baltimore, Maryland, USA.

^dDepartments of Medicine, Epidemiology and Oncology, Johns Hopkins University, Baltimore, Maryland, USA.

Abstract

Objective—To examine temporal trends and predictors of linkage to HIV care, longitudinal retention in care and viral suppression among injection drug users (IDUs) infected with HIV.

Design—Community-based, prospective cohort study

Methods—We prospectively studied 790 HIV-infected IDUs participating in the AIDS Linked to the Intravenous Experience (ALIVE) study from 1998 through 2011. IDUs were considered linked to care if they attended any HIV care visit during follow-up and retained in care if they reported HIV clinic attendance at every semiannual study visit. We used logistic regression to identify predictors of poor retention in care and failure to achieve sustained viral suppression in response to ART.

Results—Of 790 HIV-infected IDUs studied, 740 (93.6%) were ever linked to care. The majority of IDUs (76.7%) received ART at some point during observation and of these, most (85.4%) achieved viral suppression. However, over a median of 8.7 years of follow-up, only 241 (30.5%) IDUs were continuously retained with no 6-month lapses in HIV care and only 63 (10.2%) had sustained viral suppression at every study visit after first receiving ART. Suboptimal engagement in care was associated with poor access to medical care, active drug use, and incarceration.

Conclusion—Compared with national estimates of retention in care and virologic suppression in the United States, IDUs are substantially less likely to remain fully engaged in HIV care. Strategies to optimize HIV care should acknowledge the elevated risk of poor engagement in care among IDUs.

Keywords

antiretroviral therapy; drug users; human immunodeficiency virus; primary care; retention in care

Introduction

Regular attendance at HIV-oriented clinical care appointments facilitates optimal delivery of ART and improves clinical outcomes for patients infected with HIV. Engagement in care, a concept embodying linkage to care after diagnosis and retention in care after care is established, has been associated with increased odds of achieving virologic suppression [1,2] and improved survival [3,4] for persons living with HIV/AIDS. Data from clinical cohorts have shown poor engagement in care to be associated with development of antiretroviral drug resistance [5] and progression to AIDS [2]. Engagement in care indirectly benefits public health through lowering individuals' HIV viral load and, by extension, community viral load, which often accompanies measurable reductions in HIV incidence [6–8].

Prior research has shown that injection drug users (IDUs) have lower levels of engagement in HIV care than other risk groups. IDUs are less likely to establish care after receiving an HIV diagnosis [9–11] and are more likely to miss scheduled appointments [12] and become lost to follow-up [13–15]. These disparities in engagement in care likely lead to inferior clinical and virologic outcomes [16]. In large, multiclinic cohort studies, patients identified as IDUs have substantially lower odds of achieving sustained virologic suppression in response to ART [17], a disparity possibly mediated through differences in retention in care and ART initiation [18].

In the United States, IDUs represent a socially marginalized group with substantial disparities in healthcare access and outcomes. Suboptimal HIV care among IDUs is likely multifactorial, influenced by relative socioeconomic disadvantage, unhealthy behaviors driven by addiction, and structural factors such as stigma and criminalization [19]. A better understanding of the role these factors play in the propagation of health disparities is needed. Toward this end, the goals of this study were to characterize the degree of engagement in care among a community-based cohort of HIV-infected IDUs. Specifically, we sought to determine the proportion of HIV-infected IDUs who were linked to a source of HIV care, retained in care, achieved suppression of HIV RNA below the limit of detection while receiving ART, and maintained durable virologic suppression. Using prospectively collected clinical and behavioral data, we identified independent predictors of failure to achieve important benchmarks related to HIV care.

Methods

Study design and population

The AIDS Linked to the Intravenous Experience (ALIVE) study is a community-based, longitudinal cohort study that has followed IDUs in Baltimore since 1988. Study methods for recruitment and data collection have been described previously [20]. Since 1996, when effective combination ART became available, ALIVE has followed 1067 IDUs who were either HIV seropositive at the time of enrollment ($n = 790$) or seroconverted during follow-up ($n = 277$). Participants are predominantly low-income, African-American, inner-city residents, characteristics that are representative of the population of individuals who inject drugs in Baltimore and similar cities in the Northeastern and Mid-Atlantic United States [21]. At baseline and semiannual follow-up interviews, participants provided information about sociodemographic characteristics, drug injecting and other HIV risk behaviors, and general medical history. Since 1998, researchers collected self-report of receipt of HIV-

oriented outpatient clinical care and utilization of antiretroviral medications. The institutional review board at the Johns Hopkins Bloomberg School of Public Health reviewed and approved the study procedures, and all participants provided written informed consent.

Participants were included in the present analysis if they attended two or more ALIVE study visits between January 1998 and December 2011. Data from study visits prior to seroconversion were dropped for participants who were uninfected at the time of enrollment. We excluded 115 participants who had only one study visit and 20 others because they had missing outpatient HIV care data. Compared with those included in the study sample, the IDUs excluded from the analysis were similar with respect to age, sex, race, frequency of drug injecting, and insurance status. Those excluded had a significantly lower median baseline CD4 cell count (222 vs. 319 cells/ μ l, $P < 0.001$), were less likely to report crack cocaine use in the 6 months prior to the study (22.8 vs. 32.1%, $P = 0.004$), and had a smaller median number of total study visits (2 vs. 11, $P < 0.001$).

Drug use-related variables were assessed by self-report of specific behaviors in the 6 months preceding each study visit, and included alcohol use, crack cocaine use, and injection of heroin and/or cocaine. Recent incarceration was captured by self-report of any jail or prison stay lasting longer than 7 days within the previous 6 months. We assessed access to healthcare using three interview items: having any type of health insurance; having a regular source of primary care; and seeing the same provider more than 90% of the time they receive medical care (provider constancy).

Statistical analysis

To assess temporal trends in engagement in care across the entire cohort, we calculated the proportion of participants reporting HIV care visits in each calendar year. Using a linear trend time-series model with a first-order auto-regressive covariance [22], we determined whether there were significant improvements from 1998 to 2011 in the annual proportion of the cohort that was fully engaged in care (in care all at both ALIVE visits during the year), was partially engaged in care (in care at 1 of 2 study visits) and achieved an undetectable HIV RNA level.

Longitudinal engagement in care was characterized for individual patients by summarizing their HIV care visit attendance over the entire duration of their participation in ALIVE. Those not reporting HIV care at any study visits were considered not linked to care. Participants who were linked to care but reported at least one lapse in care (defined as a 6-month interval when no HIV care was reported) were considered partially retained in care. We considered participants to be fully retained in care if they reported attending an HIV care visit at every semiannual assessment after the ALIVE visit when they first reported linkage to care. We used descriptive statistics to compare the baseline characteristics of IDUs in these three categories of engagement in care.

Among the subset ever linked to care, we evaluated whether IDUs initiated ART at any time during study follow-up. We categorized participants into three mutually exclusive groups: those never achieving viral suppression (defined as HIV RNA level ≥ 400 copies/ml), those who demonstrated viral suppression at some but not all study visits, and those demonstrating sustained viral suppression at every study visit after ART initiation. We then performed univariate comparisons of IDUs in these three categories with respect to baseline characteristics.

We next investigated time-varying factors associated with the two main negative outcomes, lapses in HIV care and virologic failure. The outcomes were assessed at every follow-up

study visit and thus could be experienced multiple times during the study. A lapse in care was defined as reporting that no HIV care visits were attended in the prior 6 months after being in care at the previous study visit. Virologic failure was evaluated using the same framework: study visits at which a participant was noted to have viral suppression were analyzed to determine whether the viral load remained suppressed at the subsequent visit (success) or had increased above the limit of detection (failure). To identify significant predictors of the outcomes while accounting for intra-subject correlation resulting from repeated measures per participant, we used logistic regression models with generalized estimating equations (GEE) with robust variance estimates. An alpha level of 0.10 and 0.05 were used for model entry and retention, respectively. To account for the potential confounding effects of secular trends favoring improved engagement in care over time and differential loss to follow-up among higher-risk IDUs, we forced into the adjusted models variables for calendar year and total follow-up time, respectively.

Results

Description of study population

A total of 790 IDUs contributing 8076 study visits were included in the analysis. The median age at study enrollment was 43.4 years, the median duration of follow-up was 8.7 years, and the median time between study visits was 183 days. The sample was 33% women and 93.3% African-American. Most participants (83.8%) were unemployed at baseline, 20.4% were homeless and 27.8% had no private or government-sponsored health insurance. Over half of participants (61.5%) reported active IDU during the 6 months prior to the first ALIVE study visit; nearly one third (32.4%) reported injecting drugs daily over that period. The baseline characteristics of study participants are shown in Table 1, stratified according to the level of retention in care over the study.

Temporal trends in HIV care outcomes

Analysis of year-to-year HIV care visit attendance and HIV viral load measurement for the entire cohort demonstrated significant improvement in the proportion of IDUs receiving care and achieving virologic suppression between 1998 and 2011 (Fig. 1). Over the study period, the proportion of IDUs followed in ALIVE who reported being in care at every study visit during each calendar year increased from 42.8 to 71.4%. The proportion receiving at least some HIV care during a single year reached as high as 87% in 2011. Concomitant with improved engagement in care, overall rates of virologic suppression significantly improved over the 12-year study period. In 1998, only 15.7% of the HIV-infected ALIVE cohort had at least one HIV RNA measurement below 400 copies/ml. By 2008, the percentage achieving virologic suppression increased to 41.4%, and this number reached 60% during 2011.

Linkage to care

Over 90% of ALIVE participants attended at least one HIV care visit during the study period. Compared with those receiving at least some care, the 50 participants never linked to care were more likely to inject drugs daily and to drink alcohol. They were less likely to use a single primary care clinic for routine care, and were less likely to report seeing the same provider at 90% of clinic visits (low provider constancy). Those never linked to care had significantly shorter duration of ALIVE study participation in terms of the total number of study visits (median of 3 visits vs. 9 visits) and total months in the study (19 months vs. 60 months; $P < 0.05$ for all comparisons).

Retention in care

While the majority of IDUs participating in ALIVE were linked to HIV care, far fewer participants were consistently retained in care after initially establishing care. Of the 740 IDUs who attended at least one HIV care visit, 84 of these (11.3%) never returned for a second HIV clinic visit; 415 (56.1%) had multiple HIV care visits but at least one lapse in care greater than 6 months; only 241 (32.6%) attended an HIV care visit in every semester during their participation in the study and were considered fully retained in care. Participants were more likely to be fully retained in care if they were older at the time of their first HIV care visit, and if their first visit occurred in later years in the study. Those who reported at baseline having health insurance and provider constancy also had higher retention in care.

Use of antiretroviral therapy and viral suppression

Of 740 IDUs who were linked to care and therefore eligible to receive ART, 604 (81.6%) reported ART use at one or more study visits. Approximately one-third of these were in care and receiving ART at the time of enrollment and the remainder initiated ART a median of 24 months after their first ALIVE visit. Table 2 shows characteristics of study participants within the three categories of viral suppression. The 220 participants who never achieved viral suppression included 136 IDUs who never initiated ART and 84 others who reported ART use but were never found to have a virologic response. The majority of ART initiators (457 of 604, 75.6%) had viral suppression at some but not all study visits after they first reported receiving ART. Only 63 (10.2%) went on to have viral suppression at every study visit after they initiated treatment (Fig. 2). Participants who were older and who established HIV care during later years of the study had higher rates of viral suppression in univariate analyses. Individuals with low CD4 cell counts at the time of ART initiation were significantly less likely to achieve viral suppression. Recent incarceration, alcohol use and active drug use at the time of enrollment were associated with lower likelihood of achieving viral suppression. We detected a dose-response relationship between intensity of IDU and the likelihood of achieving virologic suppression: daily injectors were 13.7% less likely to achieve virologic suppression than occasional injectors, and 24.4% less likely than those not injecting at all at the time of ART initiation (data not shown). Having health insurance and provider constancy were positively associated with viral suppression.

Predictors of lapses in care and virologic failure

We developed multivariable logistic regression models in order to investigate risk factors associated with lapses in care and virologic failure in this cohort (Table 3). Analyzing the subset of person-visits at which participants were in care, we found that subsequent lapses in care (i.e., a gap of greater than 6 months without an HIV care visit) occurred in 19.1% of instances. After adjusting for age and calendar year, active IDU and recent incarceration were significantly associated with lapses in care, with adjusted odds ratios (aOR) of 1.25 (95% CI 1.06–1.49) and 1.49 (95% CI 1.09–2.03), respectively. All three measures of healthcare access were significantly associated with lower odds of lapses in care. Of these, the strongest predictor of avoiding lapses in care was having a regular source of primary care (aOR 0.29; 95% CI 0.17–0.49), followed by provider constancy (aOR 0.40; 95% CI 0.29–0.56) and having health insurance (aOR 0.68; 95% CI 0.52–0.90).

The 520 participants who received ART and achieved viral suppression at least once during follow-up contributed 2784 person-visits when the HIV RNA was below the limit of detection. Virologic failure was noted at 714 (25.6%) of the subsequent visits, which occurred a median of 182 days after the index visit. Predictors of virologic failure included any IDU, crack use, alcohol use, homelessness and recent incarceration (Table 3). The odds of virologic failure were seven-fold higher when the CD4 cell count was below 200 cells/ μ l, compared with visits when the CD4 cell count exceeded 500 cells/ μ l (aOR 7.44; 95% CI

5.53–10.02). Of the three healthcare access measures, only provider constancy remained significantly associated with virologic failure in the adjusted model (aOR 0.55; 95% CI 0.39–0.77). Reporting no HIV care visit in the past 6 months was significantly associated with virologic failure (OR 1.35; 95% CI 1.10–1.66) in univariate analysis, but this association was not significant after adjustment for other factors in the model.

Discussion

In this prospective study of current and former IDUs, long-term retention without any lapses in HIV care was uncommon. Over a median follow-up period of 8.7 years, fewer than one in three HIV-infected IDUs attended an HIV care visit in every 6-month interval following the first clinic visit. Sustained viral suppression was achieved even less frequently: Only one in 10 participants who initiated ART were found to have plasma HIV RNA below the limit of detection at every post-ART visit.

Our data confirm previous studies suggesting that IDUs have a strong tendency to be transient or intermittent users of HIV care [11,13,23]. Two-thirds of IDUs in ALIVE linked to HIV care were not retained in care over the long term. Whereas national data indicate that the majority of HIV-infected persons linked to care are successfully retained in care [24], lapses in care are the rule among IDUs in ALIVE, rather than the exception. This finding is consistent with prior observations that IDUs are slower to initiate ART [25], more likely to discontinue ART [23], and have less stability in their ART regimens over time [26]. This constellation of findings represents a general tendency toward sporadic healthcare utilization, and plausibly contributes to poorer responses to treatment [27,28] and lower life expectancy [29] among IDUs infected with HIV.

The relatively low level of engagement in care among IDUs in this cohort contrasts with the more encouraging observation that the proportion of participants who achieved viral suppression has improved significantly between 1998 and 2011 (Fig. 1). In 2010, the percentage of IDUs in ALIVE achieving viral suppression was 53.9%, a rate approximately three times greater than the estimate for the same cohort in 2001. Despite this improvement however, virologic suppression in ALIVE appears to remain significantly lower than the estimates of 72–77% derived for patients receiving HIV care using nationally representative data during the same year [17,30]. It is also considerably lower than the 87% of patients found to have virologic suppression in 2010 while receiving care at the Johns Hopkins HIV Clinic, which is the largest provider of HIV care for IDUs in Baltimore [31].

Through our analyses of predictors of lapses in care and virologic failure, we identified several modifiable risk factors for suboptimal HIV treatment outcomes. IDUs without health insurance had poorer engagement in care across every category studied. Whether insurance directly facilitates retention in care by removing financial barriers to care or is a marker of relative socioeconomic stability remains unclear. A second notable observation is the association between provider constancy and improved retention in care and virologic outcomes. IDUs who reported that they saw the same provider at more than 90% of clinic visits were more than twice as likely to be retained in care in every semester of follow-up. Provider constancy has been examined in only a few previous studies and in a single early study was not found to be associated with adherence to HIV care appointments [32]. In the present context, however, provider constancy may reflect qualities of patient-physician relationships that have been linked to improved adherence and treatment outcomes. For example, a survey of HIV patients in Baltimore found that those who perceived that their provider knew them ‘as a person’ were significantly less likely have missed appointments and more likely to have an undetectable viral load [33].

Although lapses in care were predominantly associated with factors related to healthcare access, virologic failure was more strongly predicted by social and behavioral factors such as substance use and incarceration. Three behavioral variables, any drug injecting, alcohol use and crack cocaine use, were independently associated with virologic failure in multivariate analysis. Active injecting was a significant predictor of lapses in care, although alcohol and crack use were not. Our findings complement prior studies that showed homelessness and incarceration to be important predictors of virologic failure among IDUs treated with ART [34,35].

A limitation of our study is its reliance upon participant self-report for assessment of several of the main variables of interest. Because of the large amount and varying types of data collected from ALIVE participants at every study encounter, it has not been feasible to routinely query medical records of every participant to confirm dates of clinic attendance. To ensure the reliability of HIV care data, the study employs trained nurses to conduct detailed interviews about each participants' healthcare utilization, and in selected instances, medical records are requested to confirm details about treatment. However, most reports of attendance at routine HIV care visits used in this study reflect self-report only, and are thus may potentially be subject to misclassification due to inaccurate recall or bias due to socially desirable responding.

A counterbalancing strength of our study methods is the completeness with which HIV viral load data are collected. As a community-based cohort study, plasma specimens are obtained from participants at every study visit regardless of whether they are receiving HIV care or not. This may allow a more accurate estimation of HIV treatment effectiveness in the community than analyses of clinical cohort data, which are necessarily only able to collect data from individuals who attend clinic visits. This may explain some of the discrepancy between estimates of retention in care and virologic suppression in our study when compared with estimates published elsewhere. As noted above, only 54% of ALIVE participants achieved virologic suppression during 2010, which is lower than the level reported in other studies. However, when we restricted the analysis to include only person-visits at which participants reported being in care, viral suppression was evident 68.5% of the time. This level is comparable to the 72% of patients found to have viral suppression in large multicohort studies [17,36], but still lower than the success rate reported in the Johns Hopkins HIV Clinical Cohort [31].

In summary, this analysis of a community-recruited cohort of HIV-infected IDUs with a long duration of follow-up suggests that in general, IDUs are substantially less engaged in HIV care than the general population of PLWHA in the United States. Efforts to improve engagement in HIV care should acknowledge the unique barriers to care and heightened risk for poor treatment outcomes that are characteristic of many patients who inject drugs.

Acknowledgments

R.P.W., S.H.M. and G.D.K. were responsible for the study design and statistical approach. J.A. and T.M.H. were responsible for data analysis and preparation of data tables and figures. R.P.W. wrote the article. All authors reviewed and approved the final version of the article.

The authors are most grateful to the ALIVE study staff and to all study participants, without whose cooperation this study would not have been possible.

Sources of Funding: R.P.W. receives grant funding from the National Institutes of Health (NIH), National Institute on Drug Abuse (NIDA) (K23DA032306); SHM and GDK receive grant funding from NIH/NIDA (R01-DA12568 & R01-DA04334 to support ALIVE).

References

1. Lucas GM, Chaisson RE, Moore RD. Highly active antiretroviral therapy in a large urban clinic: risk factors for virologic failure and adverse drug reactions. *Ann Intern Med.* 1999; 131:81–87. [PubMed: 10419445]
2. Berg MB, Safren SA, Mimiaga MJ, Grasso C, Boswell S, Mayer KH. Nonadherence to medical appointments is associated with increased plasma HIV RNA and decreased CD4 cell counts in a community-based HIV primary care clinic. *AIDS Care.* 2005; 17:902–907. [PubMed: 16120506]
3. Giordano TP, Gifford AL, White AC Jr, Suarez-Almazor ME, Rabeneck L, Hartman C, et al. Retention in care: a challenge to survival with HIV infection. *Clin Infect Dis.* 2007; 44:1493–1499. [PubMed: 17479948]
4. Mugavero MJ, Lin HY, Willig JH, Westfall AO, Ulett KB, Routman JS, et al. Missed visits and mortality among patients establishing initial outpatient HIV treatment. *Clin Infect Dis.* 2009; 48:248–256. [PubMed: 19072715]
5. Sethi AK, Celentano DD, Gange SJ, Moore RD, Gallant JE. Association between adherence to antiretroviral therapy and human immunodeficiency virus drug resistance. *Clin Infect Dis.* 2003; 37:1112–1118. [PubMed: 14523777]
6. Das M, Chu PL, Santos GM, Scheer S, Vittinghoff E, McFarland W, et al. Decreases in community viral load are accompanied by reductions in new HIV infections in San Francisco. *PLoS One.* 2010; 5:e11068. [PubMed: 20548786]
7. Wood E, Kerr T, Marshall BD, Li K, Zhang R, Hogg RS, et al. Longitudinal community plasma HIV-1 RNA concentrations and incidence of HIV-1 among injecting drug users: prospective cohort study. *BMJ.* 2009; 338:b1649. [PubMed: 19406887]
8. Montaner JS, Lima VD, Barrios R, Yip B, Wood E, Kerr T, et al. Association of highly active antiretroviral therapy coverage, population viral load, and yearly new HIV diagnoses in British Columbia, Canada: a population-based study. *Lancet.* 2010; 376:532–539. [PubMed: 20638713]
9. Giordano TP, Visnegarwala F, White AC Jr, Troisi CL, Frankowski RF, Hartman CM, et al. Patients referred to an urban HIV clinic frequently fail to establish care: factors predicting failure. *AIDS Care.* 2005; 17:773–783. [PubMed: 16036264]
10. Torian LV, Wiewel EW, Liu KL, Sackoff JE, Frieden TR. Risk factors for delayed initiation of medical care after diagnosis of human immunodeficiency virus. *Arch Intern Med.* 2008; 168:1181–1187. [PubMed: 18541826]
11. Fleishman JA, Yehia BR, Moore RD, Korthuis PT, Gebo KA. For the HIVRN. Establishment, retention, and loss to follow-up in outpatient HIV care. *J Acquir Immune Defic Syndr.* 2012; 60:249–259. [PubMed: 22531758]
12. Arici C, Ripamonti D, Maggiolo F, Rizzi M, Finazzi MG, Pezzotti P, et al. Factors associated with the failure of HIV-positive persons to return for scheduled medical visits. *HIV Clin Trials.* 2002; 3:52–57. [PubMed: 11819186]
13. Schepens T, Morreel S, Florence E, Koole O, Colebunders R. Incidence and risk factors associated with lost to follow-up in a Belgian cohort of HIV-infected patients treated with highly active antiretroviral therapy. *Int J STD AIDS.* 2010; 21:765–769. [PubMed: 21187359]
14. Lanoy E, Mary-Krause M, Tattevin P, Dray-Spira R, Duvivier C, Fischer P, et al. Predictors identified for losses to follow-up among HIV-seropositive patients. *J Clin Epidemiol.* 2006; 59:829–835. [PubMed: 16828676]
15. Torian LV, Wiewel EW. Continuity of HIV-related medical care, New York City, 2005–2009: do patients who initiate care stay in care? *AIDS Patient Care STDS.* 2011; 25:79–88. [PubMed: 21284498]
16. Mugavero MJ, Lin HY, Allison JJ, Giordano TP, Willig JH, Raper JL, et al. Racial disparities in HIV virologic failure: do missed visits matter? *J Acquir Immune Defic Syndr.* 2009; 50:100–108. [PubMed: 19295340]
17. Yehia BR, Fleishman JA, Metlay JP, Moore RD, Gebo KA. Sustained viral suppression in HIV-infected patients receiving antiretroviral therapy. *JAMA.* 2012; 308:339–342. [PubMed: 22820781]

18. Hanna DB, Buchacz K, Gebo KA, Hessel NA, Horberg MA, Jacobson LP, et al. Trends and disparities in antiretroviral therapy initiation and virologic suppression among newly treatment-eligible HIV-infected individuals in North America, 2001–2009. *Clin Infect Dis*. 2013; 56:1174–1182. [PubMed: 23315317]
19. Krusi A, Wood E, Montaner J, Kerr T. Social and structural determinants of HAART access and adherence among injection drug users. *Int J Drug Policy*. 2010; 21:4–9. [PubMed: 19747811]
20. Vlahov D, Anthony JC, Munoz A, Margolick J, Nelson KE, Celentano DD. The ALIVE study, a longitudinal study of HIV-1 infection in intravenous drug users: description of methods and characteristics of participants. *NIDA Res Monogr*. 1991; 109:75–100. [PubMed: 1661376]
21. Centers for Disease C, Prevention. HIV infection among injection-drug users: 34 states, 2004–2007. *MMWR Morb Mortal Wkly Rep*. 2009; 58:1291–1295. [PubMed: 19940834]
22. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika*. 1986; 73:13–22.
23. Kavasery R, Galai N, Astemborski J, Lucas GM, Celentano DD, Kirk GD, et al. Nonstructured treatment interruptions among injection drug users in Baltimore, MD. *J Acquir Immune Defic Syndr*. 2009; 50:360–366. [PubMed: 19214124]
24. Marks G, Gardner LI, Craw J, Crepaz N. Entry and retention in medical care among HIV-diagnosed persons: a meta-analysis. *AIDS*. 2010; 24:2665–2678. [PubMed: 20841990]
25. Celentano DD, Galai N, Sethi AK, Shah NG, Strathdee SA, Vlahov D, et al. Time to initiating highly active antiretroviral therapy among HIV-infected injection drug users. *AIDS*. 2001; 15:1707–1715. [PubMed: 11546947]
26. Morris J, Golub E, Mehta S, Jacobson L, Gange S. Injection drug use and patterns of highly active antiretroviral therapy use: an analysis of ALIVE, WIHS, and MACS cohorts. *AIDS Res Ther*. 2007; 4:12. [PubMed: 17553140]
27. Mehta SH, Lucas G, Astemborski J, Kirk GD, Vlahov D, Galai N. Early immunologic and virologic responses to highly active antiretroviral therapy and subsequent disease progression among HIV-infected injection drug users. *AIDS Care*. 2007; 19:637–645. [PubMed: 17505924]
28. Henrich TJ, Lauder N, Desai MM, Sofair AN. Association of alcohol abuse and injection drug use with immunologic and virologic responses to HAART in HIV-positive patients from urban community health clinics. *J Commun Health*. 2008; 33:69–77.
29. Hogg, R.; Samji, H.; Cescon, A.; Modur, S.; Napravnik, S.; Martin, J., et al. Temporal changes in life expectancy of HIV+ individuals: North America. Abstract #137.. 19th Conference on Retroviruses and Opportunistic Infections; Seattle. 2012;
30. Centers for Disease Control & Prevention. Vital signs: HIV prevention through care and treatment, United States. *MMWR Morb Mortal Wkly Rep*. 2011; 60:1618–1623. [PubMed: 22129997]
31. Moore RD, Bartlett JG. Dramatic decline in the HIV-1 RNA level over calendar time in a large urban HIV practice. *Clin Infect Dis*. 2011; 53:600–604. [PubMed: 21844006]
32. Catz SL, McClure JB, Jones GN, Brantley PJ. Predictors of outpatient medical appointment attendance among persons with HIV. *AIDS Care*. 1999; 11:361–373. [PubMed: 10474634]
33. Beach MC, Keruly J, Moore RD. Is the quality of the patient-provider relationship associated with better adherence and health outcomes for patients with HIV? *J Gen Intern Med*. 2006; 21:661–665. [PubMed: 16808754]
34. Milloy MJ, Kerr T, Buxton J, Rhodes T, Krusi A, Guillemi S, et al. Social and environmental predictors of plasma HIV RNA rebound among injection drug users treated with antiretroviral therapy. *J Acquir Immune Defic Syndr*. 2012; 59:393–399. [PubMed: 22134149]
35. Westergaard RP, Kirk GD, Richesson DR, Galai N, Mehta SH. Incarceration predicts virologic failure for HIV-infected injection drug users receiving antiretroviral therapy. *Clin Infect Dis*. 2011; 53:725–731. [PubMed: 21890777]
36. Althoff KN, Buchacz K, Hall HI, Zhang J, Hanna DB, Rebeiro P, et al. U.S. trends in antiretroviral therapy use, HIV RNA plasma viral loads, and CD4 T-lymphocyte cell counts among HIV-infected persons, 2000 to 2008. *Ann Intern Med*. 2012; 157:325–335. [PubMed: 22944874]

Fig. 1.
Proportion of injection drug users reporting attendance at HIV clinic appointments and achieving viral suppression over time.

Fig. 2. Stages of engagement in care for injection drug users in ALIVE, 1998–2011.

Table 1

Baseline characteristics of injection drug users participating in ALIVE from 1998–2011, by linkage to care status ($N = 790$).

	Never linked to HIV care	Linked but not fully retained in care	Fully retained in care	P^*
Overall	50 (100)	499 (100)	241 (100)	
Age, median, (IQR)	42.4 (38.5–48.6)	43.7 (39.2–43.7)	46.3 (41.4–50.4)	<0.01
Female sex ^r	17 (34.0)	170 (34.1)	74 (30.7)	0.65
African–American	46 (92.0)	468 (93.8)	223 (92.5)	0.76
Unemployed	39 (78.0)	412 (82.2)	216 (89.6)	0.03
Homeless	8 (16.0)	86 (17.4)	45 (18.7)	0.87
CD4 cell count, median, (IQR)	304 (179–456)	299 (156–468)	272 (139–417)	0.79
Alcohol use – past 6 months	39 (78.0)	227 (45.8)	139 (57.7)	<0.01
Crack use - past 6 months	15 (30.0)	101 (20.4)	64 (26.6)	0.08
Injected any drug - past 6 months	37 (74.0)	254 (51.4)	122 (50.8)	<0.01
Methadone treatment – past 6 months	5 (10.0)	109 (21.9)	51 (21.2)	0.14
Incarcerated in past 6 months	8 (16.3)	82 (16.6)	39 (16.3)	0.99
Had health insurance	31 (62.0)	393 (79.1)	211 (87.6)	<0.01
Had usual source of care	30 (60.0)	478 (95.8)	236 (98.3)	<0.01
Had same provider at >90% of general clinic visits	22 (44.0)	439 (88.7)	234 (97.5)	<0.01
ALIVE visits, median (IQR)	3 (2–5)	10 (5–15)	4 (3–7)	<0.01
Total study days, median (IQR)	565 (359–1101)	1910 (951–3612)	742 (391–1515)	<0.01

Data are presented as $N(\%)$ unless otherwise specified; IQR, interquartile range.

* P -values derived from Chi-squared test for categorical variables; ANOVA for continuous variables.

Table 2

Characteristics associated with viral suppression for injection drug users ever linked to HIV care ($N = 740$).

	HIV RNA never suppressed	HIV RNA intermittently suppressed	HIV RNA always suppressed	P^b
Overall	220 (100) ^a	457 (100)	63 (100)	
Age, median, (IQR)	44 (39–49)	47 (43–51)	49 (46–54)	<0.01
Female sex	71 (33.7)	149 (32.6)	20 (31.8)	0.97
African-American	195 (92.4)	430 (94.1)	58 (92.1)	0.65
Unemployed	185 (88.1)	376 (82.6)	53 (84.1)	0.20
Homeless	42 (20.2)	58 (12.8)	11 (17.5)	0.05
CD4 cell count, median, (IQR)	187 (91 – 335)	287 (168–446)	410 (278–562)	<0.01
Alcohol use – past 6 months	119 (56.7)	188 (41.3)	28 (44.4)	<0.01
Crack use – past 6 months	63 (30.1)	78 (17.1)	10 (15.9)	<0.01
Injected any drug – past 6 months	129 (61.4)	147 (32.2)	18 (28.6)	<0.01
Methadone treatment – past 6 months	40 (19.0)	112 (24.6)	13 (20.6)	0.25
Incarcerated in past 6 months	45 (21.6)	37 (8.1)	4 (6.4)	<0.01
Had health insurance	163 (77.3)	393 (86.2)	59 (93.7)	<0.01
Had usual source of care	187 (88.6)	435 (95.2)	63 (100)	<0.01
Had same provider at >90% of general clinic visits	174 (83.7)	411 (90.1)	62 (98.4)	<0.01
ALIVE visits, median (IQR)	6 (3–10)	11 (6–19)	4 (3–6)	<0.01
Total study days, median (IQR)	1167 (544–2015)	2239 (1251–4510)	545 (359–1091)	<0.01

Data are presented as $N(\%)$ unless otherwise specified; IQR, interquartile range.

^aIncludes 136 IDUs who never reported ART initiation and 84 who initiated ART but never achieved viral suppression.

^b P -values derived from Chi-squared test for categorical variables; ANOVA for continuous variables.

Table 3

Adjusted correlates of lapses in HIV care and virologic failure.

	<u>Lapses in care^a</u>		<u>Virologic failure^b</u>	
	^a OR	95% CI	^a OR	95% CI
CD4 count				
>500			1	
351–500			1.79	1.36–2.36
201–350			2.78	2.12–3.65
<200			7.44	5.53–10.02
Sociobehavioral variables				
Homeless				
No			1	
Yes			1.52	1.12–2.09
Injected any drug, past 6 mo.				
No	1		1	
Yes	1.25	1.06–1.49	1.28	1.02–1.61
Alcohol use, past 6 months				
No			1	
Yes			1.36	1.09–1.70
Crack use, past 6 months				
No			1	
Yes			1.40	1.05–1.87
Recent incarceration				
No	1		1	
Yes	1.49	1.09–2.03	1.68	1.13–2.51
Healthcare access variables				
Had health insurance				
No	1			
Yes	0.68	0.52–0.90		
Had usual source of care				
No	1			
Yes	0.29	0.17–0.49		
Same provider at >90% of visits				
No	1		1	
Yes	0.40	0.29–0.56	0.55	0.39–0.77

Results from multivariate logistic regression with generalized estimating equations (GEE).

Models adjusted for age, calendar year, and all other variables listed.

^aData represent 2878 study visits at which participants reported being in care ($N = 529$).^bData represent 2784 study visits at which participants had viral suppression ($N = 520$).^aOR, adjusted odds ratio; 95% CI, 95% confidence interval.