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Patterns of Substance Use and Arrest Histories among Hospitalized HIV Drug Users: A Latent Class Analysis

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Abstract

Using baseline data from the NIDA Clinical Trials Network 0049 study (Project HOPE), we performed latent class analyses (LCA) to identify discrete classes, or clusters, of people living with HIV (PLWH) based on their past year substance use behaviors and lifetime arrest history. We also performed multinomial logistic regressions to identify key characteristics associated with class membership. We identified 5 classes of substance users (minimal drug users, cocaine users, substantial cocaine/hazardous alcohol users, problem polysubstance users, substantial cocaine/heroin users) and 3 classes of arrest history (minimal arrests, non-drug arrests, drug-related arrests). While several demographic variables such as age and being Black or Hispanic were associated with class membership for some of the latent classes, participation in substance use treatment was the only covariate that was significantly associated with membership in all classes in both substance use and arrest history LCA models. Our analyses reveal complex patterns of behaviors among substance using PLWH and suggest that HIV intervention strategies may need to take into consideration such nuanced differences to better inform future studies and program implementation.

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Compliance with Ethical Standards:

Ethical Approval: All study procedures involving human participants in CTN-0049 (Project HOPE) were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All procedures received IRB approval from study sites.

Informed Consent: Informed consent was obtained from all participants included in the study.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Keywords

HIV/AIDS; substance abuse; arrest; criminal justice; latent class analysis

INTRODUCTION

People living with HIV (PLWH) who use substances continue to have shorter life expectancies and worse health outcomes than PLWH who do not use substances [1–9]. Substance use is an important contributor to factors that worsen the health of PLWH such as tenuous engagement and retention in medical care, delayed antiretroviral therapy (ART) initiation, and ART non-adherence [1, 8–15]. While the correlations between substance use and poor HIV health outcomes have been widely studied, there remains a shortage of knowledge on the dynamics behind distinct patterns of substance use among PLWH.

Another important contributor to factors that can affect the health of PLWH who use substances is these individuals' frequent interactions with the criminal justice system [16]. It is estimated that nearly half of the 185,740 inmates in US federal prisons and 16% of the 1.3 million inmates in US state prisons are incarcerated for drug-related offenses [17, 18]. Among a cohort of HIV-infected current and former injection drug users, short-term incarceration (30 days or less) was significantly associated with virologic failure [19]. Furthermore, in a study that reported on interviews with recently released PLWH who use substances, the authors showed that severed meaningful relationships with families as a result of incarceration were found to hinder ART adherence [20]. Similar to substance use, while there have been many studies on the effects of incarceration on HIV outcomes of PLWH who use substances, there is a paucity of research on the associations of other forms of criminal justice involvement (e.g., arrest) and the dynamics behind patterns of criminal justice involvement (e.g., overall arrest and incarceration history) with substance use behaviors.

This analysis aims to expand the current literature examining the complex relationships between PLWH who use substances' substance use behaviors and criminal justice involvement by taking a detailed approach, examining for more nuanced patterns of substance use rather than depending on bivariate analyses or other more generalized approaches. Using latent class analysis (LCA) we identified classes of participants, with unique patterns of substance use and arrest history, among a multi-site sample of hospitalized PLWH who use substances. Additionally, we described several key characteristics that are associated with study participants' membership in the identified classes of substance users and profiles of arrest history.

METHODS

Sample and Design

We analyzed baseline data from Project HOPE, a multi-site randomized controlled trial of hospitalized PLWH who use substances [21]. The primary goal of the study was to compare the efficacy of six months of patient navigation (PN) and six months of patient navigation

with financial incentives (PN+FI), versus treatment as usual (TAU), on increasing 12-month HIV viral suppression rates. Primary outcomes of the trial are published [21].

Project HOPE took place at 11 U.S. hospitals. Each hospital had at least 200 unduplicated PLWH inpatients per year and had a high prevalence of substance use among PLWH inpatients. The study protocol was reviewed and approved by the institutional review boards of all study sites. Eligible inpatients who provided written informed consent received a blood draw for HIV-1 viral load assessment, completed a social/behavioral assessment, and were randomized in 1:1:1 ratio to study groups (PN, PN+FI, or TAU). All study participants were compensated for their time and efforts.

PLWH were eligible for Project HOPE if they: (1) were hospitalized at any of the study sites during recruitment, (2) reported or had documentation of any opioid, stimulant, and/or heavy alcohol use within the past 12 months, (3) were at least 18 years old, (4) were able to communicate with project staff in English, (5) lived near study sites, (6) had minimal functional impairment as determined by the Kranofsky Performance Scale Index [22], (7) were willing to authorize a medical record release, (8) were willing to provide locator information, (9) were willing to complete the baseline assessment and blood draw, and (10) met at least 1 of 3 HIV-related criteria (i.e., had an AIDS-defining illness, had a CD4 cell count <350 cells/ μL and a viral load >200 copies/mL within the past 6 months, or had a CD4 count <500 cells/ μL and a viral load >200 copies/mL within the past 12 months).

Measures Selected for Latent Class Analysis (LCA)

All measures were collected using computer-assisted personal interview. Substance use measures selected for LCA included self-report past 12-month illicit drug use for any of 11 substances (marijuana, GHB, hallucinogens, PCP, poppers, ketamine, tranquilizers, ecstasy, heroin, methamphetamines, and cocaine; yes or no), self-report past 12-month nonmedical use of any prescription medications (yes or no), participants' Alcohol Use Disorder Identification Test (AUDIT) score [23], and participants' Drug Abuse Screening Test (DAST-10) score [24]. AUDIT scores of 8 or more are considered to indicate hazardous and harmful alcohol use while DAST-10 scores from 3–5 and 6 or higher are considered indicators of moderate and substantial levels of problems related to drug abuse, respectively.

Arrest history measures selected for LCA included self-report lifetime arrest for any of 25 illegal activities (public intoxication, driving under the influence, using/possessing illegal drugs, possession of drugs with intent to distribute, possession of drug paraphernalia, manufacturing/growing drugs, sale of drugs, forgery, fencing, illegal gambling, prostitution/pandering, burglary, larceny, auto theft, robbery, assault, kidnapping, terrorist threats/acts, homicide, arson offenses, weapons offenses, vandalism, sex offenses, parole/probation violation, and other crimes)

Measures Selected for Associations with Latent Classes

Demographic measures selected to describe differences in substance use and arrest history latent class membership included participants' age, gender, race/ethnicity, and annual income. Other measures included whether participants had a same-sex sex partner within the past year and whether participants were homeless (i.e., lived or slept on the street, in a park,

in a bus station, etc. most of the time) within the past 6 months. Participants' mental health status was measured using the Brief Symptom Inventory (BSI-18) [25]. Participants' lifetime participation in substance use treatment, defined as having ever participated in any alcohol or drug treatment (yes or no), was also selected.

Statistical Analysis

We conducted LCA to identify distinct classes of Project HOPE participants based on similarities in their responses to the measures listed above [26, 27]. Results of the LCA also provided estimates of class membership probabilities and within-class probabilities of specific substance use behaviors, substance use severities, and arrest history. All LCA models were estimated using Mplus 7.0 [28].

The analysis involved a series of steps. First, we determined the appropriate number of classes of distinct patterns of substance use. We began with a 1-class model and increased the number of classes in each subsequent model by one, until the models would no longer converge. We then compared each model, seeking to minimize the Bayesian Information Criteria (BIC) and to maximize the entropy statistic, to find the best-fitting solution [29]. We repeated this process to determine the number of appropriate classes for arrest history. Second, we estimated a combined LCA model for both substance use and arrest history. We fixed the number of classes for each latent measure to the best-fitting solution determined during the previous step. We retained the class probabilities for each participant determined from this combined model.

Third, we ran 20 pseudo-class draws for each participant using Stata12 [30] and "assigned" the participant to a class for each of those 20 draws based on class probabilities determined during the previous analytical step [30, 31]. This approach preserved the probabilistic nature of class assignment and ensured appropriate statistical tests of differences can be performed in later stages of the analysis. Using the multiple imputation routines in Mplus, we then estimated summary statistics for important covariates to characterize the classes. These routines estimated the LCA models for each of the pseudo-class draws independently and then combined them into a final estimate that accounted for within- and between-sample variability using standard rules for combining [32]. In the final step, we used multinomial logistic regressions, again combining across all 20 pseudo-class draws, to regress class assignment on the covariates listed above.

RESULTS

Eight hundred and one participants enrolled in Project HOPE. Table 1 summarizes the socio-demographics of the sample, which was predominantly male (67%) and non-Hispanic Black/African American (75%), with a mean age of 45 years old (S.D. = 9.99). Half of the participants were temporarily or permanently disabled from work and 89% of the 590 participants who reported a past-year personal income made \$20,000 or less. Eighty-one percent of the sample had used an illegal drug or used a prescription medication for nonmedical purposes within the prior 12 months. The mean AUDIT score was 9.04 (S.D. = 9.53) and the mean DAST-10 score was 4.69 (S.D. = 2.93). More than half (55%) of all participants had ever received some form of substance use treatment. A majority (87%) of

the participants had been arrested at least once in their lifetime and of those, 44% had been incarcerated.

Latent class analyses

Table 2 presents the results of successive LCA models. A five-class model provided the best overall fit statistics (BIC=14,443.49, entropy=0.88) for substance use and a three-class model provided the best overall fit statistics (BIC=5,860.14, entropy=0.82) for arrest history. A cross-tabulation of the independent LCA models found participants' most likely class assignment across both models were either cocaine users with minimal arrest history (24.3%) or minimal drug users with minimal arrest history (21.7%).

Table 3 and Table 4 summarize the class-specific conditional probabilities for substance use and for arrest history, respectively. Members of three out of five classes had moderate to high probabilities (> 0.50) of reporting marijuana use. Class 1 (minimal drug users) made up 25% of the sample. Participants assigned to this class had minimal probabilities of using any illicit drugs or prescription drugs recreationally in the past year. Although members of this class had an average AUDIT score of 8.17, a score indicative of likely active alcohol use disorder, this is no higher than the average AUDIT score across the entire sample. Class 2 (cocaine users) accounted for 34% of the sample and consisted of participants who had high probabilities of marijuana and cocaine use within the last year. Class 3 (substantial cocaine/hazardous alcohol users) accounted for 20% of the baseline sample and was comprised of individuals with moderate probabilities of marijuana use, high probabilities of past-year cocaine use, severe hazardous drinking behaviors as indicated by the average AUDIT score, and severe drug use as indicated by the average DAST-10 score. Class 4 (problem polysubstance users) was the smallest class, accounting for only 6% of the sample. Members in this class were likely to have moderate problems with using marijuana, GHB, hallucinogens, PCP, poppers, ketamine, tranquilizers, ecstasy, methamphetamines, and prescription medication within the past year. Finally, Class 5 (substantial cocaine/heroin users) accounted for 15% of the sample, and individuals in this class had high probabilities of using both heroin and cocaine within the past 12 months. Additionally, members of this class had an average DAST-10 score of 7.39, indicating likelihood of substantial problems related to drug abuse.

In terms of arrest history, Class 1 (minimal arrests) was the largest, accounting for 74% of the sample. Members of this class had less than 0.10 probability of having been arrested for any of the 25 illegal activities. Class 2 (non-drug arrests) was 16% of the sample. Members of this class had probabilities above 0.20 for having been arrested for forgery, prostitution/pandering, larceny, and parole/probation violation. Class 3 (drug-related arrests) made up 10% of the participants. Members in this class had probabilities above 0.45 for having been arrested for drug-related activities, such as possession of drugs with intent to distribute, possession of drug paraphernalia, and sale of drugs. Members of this class also had a moderate probability (0.24) of having been arrested for assault.

Characterizing the Latent Classes

Table 5 presents the results of multinomial logistic regressions comparing, separately, the distinct classes of past year substance use (reference = minimal drug users, Class 1) and the distinct classes of arrest history (reference = minimal arrests, Class 1) against the characteristics previously listed. With regards to substance use, the odds of being in the non-referent classes were significantly higher for participants who had ever received substance use treatment. Higher odds of membership in Class 2 (cocaine users), compared to the minimal drug users class, were significantly associated with being non-Hispanic Black (OR = 3.82, 95% CI = 1.79 – 8.13), Hispanic (OR = 5.22, 95% CI = 1.82 – 14.92), and homeless (OR = 2.95, 95% CI = 1.01–8.56). Higher odds for membership in Class 3 (substantial cocaine/hazardous alcohol users) were also significantly associated with homelessness (OR = 5.10, 95% CI = 1.78 – 14.58). Odds of membership in the problem polysubstance users class (Class 4) were significantly associated with age, (OR = 0.95, 95% CI = 0.90 – 0.99), being of non-Hispanic Black race (OR = 0.26, 95% CI = 0.10–0.66), and having had a same-sex sex partner in the last year (OR = 4.01, 95% CI = 1.58–10.16). Finally, odds of membership in Class 5 (substantial cocaine/heroin users), compared to odds of membership in the minimal drug users class, were significantly associated with age (OR = 1.06, 95% CI = 1.02 – 1.09), being male (OR = 0.39, 95% CI = 0.21 – 0.73), and being of Hispanic ethnicity (OR = 4.56, 95% CI = 1.56 – 13.38).

With regards to arrest history, odds of membership in Class 2 (non-drug arrests) relative to membership in Class 1 (minimal arrests) were significantly associated with being male (OR = 0.58, 95% CI = 0.37 – 0.92) and having received substance use treatment (OR = 1.73, 95% CI = 1.10 – 2.72). Similarly, odds of membership in Class 3 (drug-related arrests) were also significantly associated with having received substance use treatment (OR = 1.94, 95% CI = 1.05–3.56) compared to members in the minimal arrests class.

DISCUSSION

With latent class analysis, we were able to take into consideration multiple substance use variables and multiple arrest history variables to reveal subgroups within a large sample of hospitalized PLWH who use substances who have heterogeneous patterns of substance use behaviors and criminal justice involvements. The classes of study participants we identified are a more multifaceted and representative assessment of the complexity of these behaviors compared with analyzing any single substance use or arrest history variable.

We found five latent classes of substance use behavior. Minimal drug users had low probabilities of any substance use. Cocaine users had very high probabilities of having used cocaine within the past year. Substantial cocaine/hazardous alcohol users class had high probabilities of cocaine use and a very high level of alcohol consumption. Problem polysubstance users reported moderately problematic use of several “club drugs,” especially methamphetamines. Finally, substantial cocaine/heroin users had high probabilities of heavy uses of both cocaine and heroin in the past year.

The identification of 3 distinct patterns of substance use that involved cocaine suggests that these HIV-infected substance users’ use of cocaine may not be the only driver of their poor

health outcomes and that interventions designed to increase retention in care among HIV-infected cocaine users, and more generally substance users, may need to take into account individuals' overall substance use profiles; that is what substances they use, how they use them, and the severity of their substance use. Specifically, the identification of the substantial cocaine/hazardous alcohol users class suggests that for some PLWH who use substances, their alcohol use may be more severe than their cocaine use, as indicated by the extremely high average AUDIT score of class members, and that their alcohol consumption can be a more prominent contributor to their poor health outcomes than their cocaine use. While excessive alcohol consumption and use of illicit substances have both been shown to independently reduce ART utilization, lower medication adherence, and impede virologic suppression [33–35], there have not been any studies that have specifically examined the combined effects of alcohol and cocaine on HIV clinical outcomes.

We found that membership in the problem polysubstance users class (compared to membership in the minimal drug users class) was significantly associated with younger age and with having had a same-sex sex partner within the last year. Although this group comprises only a small percentage of study participants, their pattern of substance use behaviors differs dramatically from the overall sample of mostly middle-aged, mostly non-Hispanic Black, male PLWH who most frequently reported cocaine use within the past year, and may not have been readily recognized if not for the use of LCA. Drug using men who have sex with men (MSM) who have HIV experience poor health outcomes associated not only with their substance use but also with their high-risk sexual behaviors [36] and our analysis shows a small but meaningful proportion of drug using MSM who have uncontrolled HIV infections requiring hospitalization. Given that MSM have the highest HIV incidence in the US [37], our analysis reinforces the need to focus on addressing the substance use patterns, risk behaviors, and HIV care of this group.

Our analysis identified three latent classes of lifetime arrest history. The minimal arrests class included participants who had low probabilities of ever being arrested. The non-drug arrests class consisted of participants who had been arrested almost exclusively for non-drug related crimes (e.g., forgery, larceny). Finally, the drug-related arrests class consisted of participants who had been arrested mostly for drug-related crimes (e.g., possession of drugs with intent to distribute). Class membership was not a function of demographics except that women had higher odds of having been arrested for non-drug related crimes compared to participants who have only had minimal arrests. The emergence of the non-drug arrests class was unexpected given that less than one-fifth of participants reported having ever been arrested for these crimes. The identification of the non-drug arrests class is important because it shows that efforts of alternative sentencing strategies such as drug courts, which have been shown to be an effective method for reducing substance use and recidivism [38], may be a missed opportunity to provide substance use disorder treatment to PLWH who use substances but who are not interacting with the criminal justice system based on drug-related crimes.

Our analysis found that any lifetime participation in substance use treatment was associated with higher odds of membership in all other subgroups of substance use patterns, compared to minimal drug users. Our analysis also showed that participation in substance use

treatment was associated with higher odds of membership in the non-drug and drug-related arrests classes. Even though substance use treatment programs have been shown to be an effective venue for the delivery of HIV services [39,40] and services to reduce criminal recidivism [41], these services remain not readily available and ineffective [42–44], as supported by the probabilities of substance use, lifetime arrests, and uncontrolled HIV infection in the sample of study participants.

Our analysis had limitations. The study sample, although it included many individuals from multiple sites across the US, was recruited for an intervention trial and participants were recruited from hospital settings, and therefore are not representative of all PLWH who use substances. Additionally, our cross-sectional analysis examined only associations and participants' substance use and arrest history class membership were measured with different time intervals (past year vs. lifetime). We relied on self-reported data, which may be prone to social desirability and recall biases. Despite these limitations, our analysis represents an important step to better understanding the nuanced patterns of substance use in a population that has been long underserved and have not benefited from medical advances to the same degree as PLWH who do not use substances.

CONCLUSIONS

This analysis supports the utility of latent class analysis in revealing complex patterns of behaviors. The findings of this analysis are a first step towards better understanding the complex dynamics of substance use and of criminal justice system involvement among PLWH they may be useful in informing the future direction of research studies aiming to examine the complex interactions among substance use, criminal justice involvement, and HIV care.

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References

1. Arnsten JH, Demas PA, Grant RW, et al. Impact of Active Drug Use on Antiretroviral Therapy Adherence and Viral Suppression in HIV-infected Drug Users. *J Gen Intern Med.* 2002; 17:377–381. [PubMed: 12047736]
2. Palepu A, Tyndall MW, Yip B, O'Shaughnessy MV, Hogg RS, Montaner JSG. Impaired Virologic Response to Highly Active Antiretroviral Therapy Associated with Ongoing Injection Drug Use. *J Acquir Immune Defic Syndr.* 2003; 32:522–526. [PubMed: 12679704]

3. Samji H, Cescon A, Hogg RS, et al. Closing the Gap: Increases in Life Expectancy among Treated HIV-Positive Individual in the United States and Canada. *PLoS ONE*. 2013; 8(12):e81355. [PubMed: 24367482]
4. Westergaard RP, Hess T, Astemborski J, Mehta SH, Kirk GD. Longitudinal Changes in Engagement in Care and Viral Suppression for HIV-Infected Injection Drug Users. *AIDS*. 2013; 27(16):2559–2566. [PubMed: 23770493]
5. Kipp AM, Rebeiro PF, Shepherd BE, et al. Daily marijuana use is associated with missed clinic appointments among HIV-infected persons engaged in HIV care. *AIDS Behav*. 2017 [ePub ahead of print].
6. Qian H-Z, Mitchell VJ, Bebawy S, et al. Current drug use and lack of HIV virologic suppression: point-of-care urine drug screen versus self-report. *BMC Infectious Diseases*. 2014; 14:508. [PubMed: 25234368]
7. Viswanathan S, Detels R, Mehta SH, Macatangay BJC, Kirk GD, Jacobson LP. Level of adherence and HIV RNA suppression in the current era of Highly Active Antiretroviral Therapy (HAART). *AIDS Behav*. 2015; 19(4):601–611. [PubMed: 25342151]
8. Howe CJ, Cole SR, Napravnik S, et al. The role of at-risk alcohol/drug use and treatment in appointment attendance and virologic suppression among HIV+ African Americans. *AIDS Res Hum Retroviruses*. 2014; 30(3):233–240. [PubMed: 24325326]
9. Lucas GM, Griswold M, Gebo KA, Keruly J, Chaisson RE, Moore RD. Illicit drug use and HIV-1 disease progression: a longitudinal study in the era of highly active antiretroviral therapy. *Am J Epidemiol*. 2006; 163(5):412–420. [PubMed: 16394200]
10. Baum MK, Rafie C, Lai S, Sales S, Page B, Campa A. Crack-cocaine use accelerates HIV disease progression in a cohort of HIV-positive drug users. *J Acquir Immune Defic Syndr*. 2009; 50(1):93–99. [PubMed: 19295339]
11. Altice FL, Mostashari F, Friedland GH. Trust and the Acceptance of and Adherence to Antiretroviral Therapy. *J Acquir Immune Defic Syndr*. 2001; 28(1):47–58. [PubMed: 11579277]
12. Celentano DD, Galai N, Sethi AK, et al. Time to Initiating Highly Active Antiretroviral Therapy Among HIV-infected Injection Drug Users. *AIDS*. 2001; 15(13):1707–1715. [PubMed: 11546947]
13. Lucas GM, Cheever LW, Chaisson RE, Moore RD. Detrimental Effects of Continued Illicit Drug Use on the Treatment of HIV-1 Infection. *J Acquir Immune Defic Syndr*. 2001; 27(3):251–259. [PubMed: 11464144]
14. Lucas GM, Gebo KA, Chaisson RE, Moore RD. Longitudinal Assessment of the Effects of Drug and Alcohol Abuse on HIV-1 Treatment Outcomes in an Urban Clinic. *AIDS*. 2002; 16(5):767–774. [PubMed: 11964533]
15. Schoenbaum EE, Lo Y, Floris-Moore M. Predictors of Hospitalization for HIV-Positive Women and Men Drug Users, 1996–2000. *Public Health Reports*. 2002; 117(Suppl 1):S60–S66. [PubMed: 12435828]
16. Rhodes T, Singer M, Bourgois P, Friedman SR, Strathdee SA. The social structural production of HIV risk among injecting drug users. *Soc Sci Med*. 2005; 61(5):1026–1044. [PubMed: 15955404]
17. Federal Bureau of Prisons. [Accessed 09/30/2017] Inmate Statistics - Offenses. Aug, 2017. https://www.bop.gov/about/statistics/statistics_inmate_offenses.jsp
18. Carson EA. [Accessed 04/27/2017] Prisoners in 2015. Dec, 2016. <http://www.bjs.gov/content/pub/pdf/p14.pdf>
19. 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]
20. Rozanova J, Brown S-E, Bhushan A, Marcus R, Altice FL. Effect of social relationships on antiretroviral medication adherence for people living with HIV and substance use disorders and transitioning from prison. *Health & Justice*. 2015; 3:18. [PubMed: 26709367]
21. Metsch LR, Feaster DJ, Gooden L, et al. Effect of patient navigation with or without financial incentives on viral suppression among hospitalized patients with hiv infection and substance use: A randomized clinical trial. *JAMA*. 2016; 316(2):156–170. [PubMed: 27404184]

22. Kranofsky DA, Burchenal JH. The Clinical Evaluation of Chemotherapeutic Agents in Cancer. In: MacLeod CM, editor Evaluation of Chemotherapeutic Agents. New York, NY: Columbia University Press; 1949. 191–205.
23. Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care (2). 2001
24. Skinner HA. The Drug Abuse Screening Test. *Addict Behav.* 1982; 7(4):363–371. [PubMed: 7183189]
25. Derogatis LR, Fitzpatrick M. The SCL-90-R, the Brief Symptom Inventory (BSI), and the BSI-18. In: Maruish ME, editor The Use of Psychological Testing for Treatment Planning and Outcomes Assessment: Instruments for Adults. 3. Vol. 3. Mahwah, NJ: Lawrence Erlbaum Associates Publishers; 2004. 1–41.
26. Lanza ST, Collins LM, Lemmon DR, Schafer JL. PROC LCA: A SAS Procedure for Latent Class Analysis. *Structural equation modeling : a multidisciplinary journal.* 2007; 14(4):671–694. [PubMed: 19953201]
27. Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural equation modeling.* 2007; 14(4):535–569.
28. Mplus Version 7.0 [computer program]. Version 7th. Los Angeles, California: Muthén & Muthén; 2012.
29. Stata Statistical Software: Release 12 [computer program]. College Station, Texas: StataCorp LP; 2011.
30. Bandeen-Roche K, Miglioretti DL, Zeger SL, Rathouz PJ. Latent Variable Regression for Multiple Discrete Outcomes. *Journal of the American Statistical Association.* 1997; 92(440):1375–1386.
31. Wang C-P, Hendricks Brown C, Bandeen-Roche K. Residual Diagnostics for Growth Mixture Models. *Journal of the American Statistical Association.* 2005; 100(471):1054–1076. [2005/09/01]
32. Rubin DD. Multiple Imputation for Nonresponse in Surveys. New York, New York: John Wiley & Sons; 1987.
33. Chander G, Lau B, Moore RD. Hazardous alcohol use: a risk factor for non-adherence and lack of suppression in HIV infection. *J Acquir Immune Defic Syndr.* 2006; 43(4):411–417.
34. Palepu A, Tyndall MW, Joy R, et al. Antiretroviral adherence and HIV treatment outcomes among HIV/HCV co-infected injection drug users: The role of methadone maintenance therapy. *Drug and Alcohol Dependence.* 2006; 84:188–194. [PubMed: 16542797]
35. Korthuis PT, Fiellin DA, MCGinnis KA, et al. Unhealthy Alcohol and Illicit Drug Use are Associated with Decreased Quality of HIV Care. *J Acquir Immune Defic Syndr.* 2012; 61(2):171–178. [PubMed: 22820808]
36. Reilly KH, Neaigus A, Wendel T, Marshall DM IV, Hagan H. Bisexual behavior among male injection drug users in New York City. *AIDS Behav.* 2016; 20(2):405–416. [PubMed: 26607927]
37. CDC. HIV Surveillance Report, 2015. 2016; 27 [Accessed 03/23/2017] <https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-report-2015-vol-27.pdf>.
38. Lurigio AJ. The first 20 years of drug treatment courts: a brief description of their history and impact. *Fed Probate.* 2008; 72(1):13–17.
39. Tross S, Campbell AN, Cohen LR, et al. Effectiveness of HIV/STD sexual risk reduction groups for women in substance abuse treatment programs: results of a NIDA Clinical Trials Network trial. *J Acquir Immune Defic Syndr.* 2008; 48(5):581–589. [PubMed: 18645513]
40. Metsch LR, Feaster DJ, Gooden L, et al. Implementing rapid HIV testing with or without risk-reduction counseling in drug treatment centers: results of a randomized trial. *American journal of public health.* 2012; 102(6):1160–1167. [PubMed: 22515871]
41. Alemi F, Taxman F, Baghi H, Vang J, Thanner M, Doyon V. Costs and benefits of combining probation and substance abuse treatment. *J Ment Health Policy Econ.* 2006; 9(2):57–70. [PubMed: 17007484]
42. Abraham AJ, O'Brien LA, Knudsen HK, Bride BE, Smith GR, Roman PM. Patient characteristics and availability of onsite non-rapid and rapid HIV testign in US substance use disorder (SUD) treatment programs. *J Subst Abuse Treat.* 2014; 44(1):120–125.

43. Aletaris L, Roman PM. Provision of onsite HIV services in substance use disorder treatment programs: a longitudinal analysis. *J Subst Abuse Treat.* 2015; 57:1–8. [PubMed: 25934459]
44. Feletcher BW, Lehman WEK, Wexler HK, Melnick G, Taxman FS, Young DW. Measuring collaboration and integration activities in criminal justice and substance abuse treatment agencies. *Drug and Alcohol Dependence.* 2009; 103(Supplement 1):S54–S64. [PubMed: 20088023]

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Table I

Characteristics of Project HOPE Baseline Participants

	Total (N = 801)	
	N	%
Age, mean (SD)	44.68 (9.99)	
Sex		
Male	540	67.42
Female	261	32.58
Race/Ethnicity		
White, non-Hispanic	100	12.48
Black, non-Hispanic	602	75.16
Hispanic	88	10.99
Other	11	1.37
Education		
Less than high school	319	39.83
High school diploma, GED	271	33.83
More than high school	211	26.34
Employment Status		
Employed, full time or part time	93	11.61
Unemployed	281	35.08
Retired	19	2.37
Temporarily or permanently disabled	399	49.94
Other	9	1.12
Annual Personal Income		
< \$20,000	526	65.67
\$20,000–\$40,000	47	5.87
> \$40,000	17	2.12
Had Sex with Same Sex Partner within Past Year		
No	634	79.15
Yes	168	20.97
Any Substance Use within Past Year		
No	153	19.10
Yes	648	80.90
AUDIT Score, mean (SD)	9.04 (9.53)	
DAST-10 Score, mean (SD)	4.69 (2.93)	
Ever Received Substance Abuse Treatment		
No	357	44.57
Yes	443	55.38
Ever Been Arrested		
No	107	13.36
Yes	694	86.64
Ever Spent Time in Jail or Prison		

	Total (N = 801)	
	N	%
No	499	62.30
Yes	302	37.70

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Table II
Fit Statistics for Independent LCA Models for Substance Use and Arrest History

Model	Substance Use LCA Models			Arrest History LCA Models		
	Entropy	BIC	CAIC	Entropy	BIC	CAIC
1 Class		15,005.58	15,036.04		6,413.95	6,334.52
2 Classes	0.775	14,786.92	14,700.67	0.805	5,798.79	5,657.15
3 Classes	0.809	14,638.58	14,510.60	0.822	5,860.14	5,646.30
4 Classes	0.821	14,491.02	14,321.31	0.819	5,953.38	5,667.33
5 Classes	0.882	14,443.49	14,232.04		*	
6 Classes		*			*	

Bold indicates the best-fitting LCA model.

* LCA model was not estimable for the corresponding number of classes.

BIC: Bayesian Information Criterion. CAIC: Consistent Akaike Information Criterion.

Overall Prevalence and Conditional Probabilities of Participants' Past Year Substance Use for a 5-class LCA Model^a

Table III

	Overall Prevalence	Class 1 Minimal Drug Users	Class 2 Cocaine Users	Class 3 Substantial Cocaine / Hazardous Alcohol Users	Class 4 Problem Polysubstance Users	Class 5 Substantial Cocaine/Heroin Users
		25%	34%	20%	6%	15%
Past Year Substance Use						
Marijuana	0.45	0.33	0.52	0.50	0.79	0.28
GHB	0.03	0.00	0.00	0.01	0.41	0.00
Hallucinogens	0.01	0.00	0.00	0.01	0.17	0.00
PCP	0.01	0.01	0.00	0.04	0.04	0.01
Poppers	0.04	0.01	0.03	0.05	0.34	0.00
Ketamine	0.01	0.00	0.00	0.01	0.15	0.01
Tranquilizers	0.04	0.01	0.01	0.07	0.06	0.10
Ecstasy	0.05	0.02	0.03	0.05	0.31	0.02
Heroin	0.18	0.01	0.02	0.16	0.06	0.76
Methamphetamines	0.09	0.07	0.00	0.04	0.79	0.04
Cocaine (Powdered, Rock)	0.64	0.00	1.00	0.71	0.35	0.66
Prescription Medication	0.06	0.02	0.02	0.09	0.09	0.14
Mean AUDIT Score	9.04	8.17	4.40	24.75	2.55	2.82
Mean DAST-10 Score	4.69	1.93	4.26	6.39	4.90	7.39

Bold indicates item-response probabilities of >0.1 and above the overall prevalence to facilitate interpretation.

^aConditional probabilities were fixed between 0.00 and 1.00 by Mplus.

Table IV

Conditional Probabilities of Participants' Arrest History for a 3-class LCA Model^a

	Overall Prevalence	Class 1 Minimal Arrests	Class 2 Non-Drug Arrests	Class 3 Drug-Related Arrests
Class Prevalence	-	74%	16%	10%
Public Intoxication	0.31	0.06	0.19	0.16
Driving Under the Influence	0.36	0.03	0.08	0.17
Using/Possessing Illegal Drugs	0.85	0.08	0.61	0.79
Possession of Drugs with Intent to Distribute	0.22	0.01	0.00	0.82
Possession of Drug Paraphernalia	0.43	0.00	0.36	0.45
Manufacturing/Growing Drugs	0.07	0.00	0.00	0.02
Sale/Distribution of Drugs	0.30	0.01	0.08	0.67
Forgery, Fraud	0.13	0.01	0.24	0.08
Fencing (buying or selling stolen property)	0.08	0.00	0.08	0.01
Illegal Gambling	0.04	0.00	0.01	0.00
Prostitution, Pandering	0.15	0.00	0.21	0.13
Burglary, Attempted Burglary, Breaking & Entering	0.11	0.01	0.14	0.15
Shoplifting, Larceny, Embezzlement	0.21	0.02	0.29	0.21
Auto Theft, Carjacking	0.09	0.00	0.10	0.07
Robbery, Attempted Robbery, Mugging	0.07	0.01	0.04	0.11
Assault, Aggravated Assault, Battery	0.16	0.02	0.18	0.24
Kidnapping, Hostage Taking	0.00	0.00	0.00	0.00
Terrorist Treats/Acts	0.01	0.00	0.01	0.02
Homicide, Manslaughter, Attempted Homicide	0.03	0.00	0.03	0.03
Arson Offense	0.01	0.00	0.00	0.02
Weapons Offense	0.05	0.01	0.02	0.12
Vandalism, Property Damage, Tagging	0.03	0.00	0.00	0.02
Sex Offense	0.01	0.00	0.01	0.00
Parole/Probation Violation	0.29	0.03	0.47	0.45
Other Crimes	0.05	0.02	0.01	0.00

Bold indicates item-response probabilities of >0.1 and above overall prevalence to facilitate interpretation.

^aConditional probabilities were fixed between 0.00 and 1.00 by Mplus.

Results of Multinomial Logistic Regressions for Project HOPE Participants and LCA Membership in Past Year Substance Use and Arrest History Classes

Table V

	Past Year Substance Use (Reference = minimal drug users, Class 1)				
	Class 2 Cocaine Users	Class 3 Substantial Cocaine/ Hardcore Alcohol Users	Class 4 Problem Polysubstance Users	Class 5 Substantial Cocaine/ Heroin Users	Class Size
	257	157	60	134	
	OR	95% CI	OR	95% CI	OR
	95% CI	OR	95% CI	OR	95% CI
Age	1.03	1.00–1.05	1.02	0.99–1.05	0.95
Male	0.57	0.32–1.00	0.68	0.36–1.31	6.75
Non-Hispanic Black	3.82	1.79–8.13	1.38	0.66–2.92	0.26
Hispanic	5.22	1.82–14.92	2.65	0.89–7.89	1.41
High Income (<\$40,000)	0.94	0.25–3.50	*	*	0.98
Same-Sex Sex Partner	1.38	0.75–2.54	1.27	0.64–2.54	4.01
Homelessness	2.95	1.01–8.56	5.10	1.78–14.58	1.78
Psychological Symptoms (BSI score)	0.99	0.98–1.01	1.00	0.98–1.02	1.00
Ever in Substance Use Treatment	4.23	2.55–7.03	10.46	5.66–19.36	4.42
					1.77–11.02
					5.77
					3.17–10.48

	Arrest History (Reference = minimal arrests, Class 1)		
	Class 2 Non-Drug Arrests	Class 3 Drug-Related Arrests	Class Size
	138	90	
	OR	95% CI	OR
	95% CI	OR	95% CI
Age	0.99	0.97–1.02	1.00
Male	0.58	0.37–0.92	0.79
Non-Hispanic Black	0.75	0.43–1.30	1.44

		Arrest History (Reference = minimal arrests, Class 1)			
	Class 2 Non-Drug Arrests	Class 3 Drug-Related Arrests			
Class Size	138	90			
	OR	95% CI	OR	95% CI	
Hispanic	0.47	0.20–1.11	0.94	0.27–3.30	
High Income (<\$40,000)	*	*	0.75	0.09–6.62	
Same-Sex Sex Partner	0.82	0.46–1.46	0.41	0.16–1.06	
Homelessness	1.52	0.81–2.87	1.30	0.56–3.04	
Psychological Symptoms (BSI score)	1.01	1.00–1.02	1.00	0.98–1.02	
Ever in Substance Use Treatment	1.73	1.10–2.72	1.94	1.05–3.56	

* Odds ratio (OR) could not be estimated due to high rates of missing data.