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Nathan A. Summers Date

Predictors for Linkage to Care Among Persons Living with HIV and Co-Occurring Substance Use Disorder

By

Nathan A. Summers, M.D.
Master of Science
Clinical Research

____

Carlos del Rio, M.D.
Advisor

____

Mitchel Klein, Ph.D.
Committee Member

____

Amita Manatunga, Ph.D.
Committee Member

Accepted:

____

Lisa A. Tedesco, Ph.D.
Dean of the James T. Laney School of Graduate Studies

____

Date

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By

Nathan A. Summers
M.D., University of Tennessee, 2013
B.S., University of Tennessee, 2009

Advisor: Carlos del Rio, M.D.

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Abstract

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By Nathan A. Summers, M.D.

Background: Persons living with HIV (PLWH) with substance use disorders (SUD) progress along the HIV care continuum at lower rates than those without. Project HOPE was a randomized controlled trial assessing patient navigation with/without contingency management among hospitalized PLWH with SUD on viral suppression at 12 months. The purpose of this secondary analysis was to determine factors affecting linkage to care at 6 months among PLWH with SUD.

Methods: Project HOPE enrolled 801 participants from 11 hospitals in the United States from 2012 through 2014. Logistic regression was used to calculate the odds ratios (ORs) and 95% confidence intervals (CIs) for the estimated effect of socioeconomic factors, medical mistrust scores, and perceived discrimination within the healthcare setting on linkage to care at the 6-month follow-up assessment. These were then evaluated for effect modification on the intervention arms on linkage to care at 6 months. These factors were also evaluated for their effect on early linkage to care, within 30 days of enrollment, which was then evaluated for its effect on engagement in care.

Results: Participants who had not completed high school (aOR: 0.42; 95% CI: 0.26, 0.69) and those with severe food insecurity (aOR: 0.46; 95% CI: 0.25 to 0.83) were found to have lower odds of being linked to care at 6 months in the multivariable analysis.

Participants with low education (OR: 0.67, 95% CI: 0.49 to 0.93), medical mistrust (OR: 0.59, 95% CI: 0.38 to 0.93), and eligibility due to drug use (OR: 0.69, 95% CI: 0.48 to 0.98) had lower odds of early linkage to care, within 30 days of enrollment. Individuals who linked to care early were much more likely to be engaged in care at 6 months than those who linked later (OR: 4.03, 95% CI: 2.75 to 5.91).

Conclusions: Addressing social determinants of health such as education, income, and medical mistrust is critical to correcting the disparity seen in HIV care outcomes among PLWH with SUD. Determining factors that alter the effect of patient navigators with or without financial incentives could help target such interventions and identify patients who would benefit most.

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INTRODUCTION

There are an estimated 1.12 million persons living with HIV (PLWH) in the United States today, with approximately 40,000 new diagnoses occurring annually (1, 2). Unfortunately, despite advances in HIV care, nearly 15% of PLWH in the U.S. are not aware of their infection, nearly 1 in 5 newly diagnosed individuals present with advanced HIV, defined as a CD4 count below 200 cells/µL, almost 20% do not link to care within one month of diagnosis, and almost 50% drop out of care (3, 4). As such, significant effort has been invested to improve diagnosis and care for PLWH to help curtail the ongoing epidemic.

The HIV care continuum, originally described in 2011, outlines the steps an individual takes from HIV infection to virologic suppression on antiretroviral therapy (ART) (5, 6). Although the percentage of individuals virally suppressed on ART has improved from less than 30% in 2011 to just over 50% in 2015, there are several populations that continue to progress along the care continuum at slower rates (2, 6, 7). PLWH with substance use disorders (SUD) are one such group that has lagged behind (8).

Project HOPE (**H**ospital Visits as an **O**pportunity for **P**revention and **E**ngagement) was a multi-site clinical trial funded by the National Institutes of Health (NIH) through the National Institute of Drug Abuse (NIDA) Clinical Trials Network (CTN) that aimed to address the disparity in HIV outcomes for PLWH with SUD (9). By specifically targeting and recruiting hospitalized patients, Project HOPE aimed to find PLWH with SUD who had fallen out of HIV care. Study participants were then randomized to one of three treatment arms: (1) Patient navigator, (2) Patient navigator with contingency management, and (3) Usual care. Although the primary outcome, viral suppression at 12 months, was found to be not statistically different between the three treatment arms, there were improved outcomes at 6 months (NCT01612169) (9).

The work in this thesis project is a secondary analysis of the Project HOPE dataset in order to obtain a deeper understanding of factors affecting linkage to care, the first step in the HIV care continuum following diagnosis, among PLWH with SUD. Baseline patient characteristics, including socioeconomic factors, medical mistrust, and perceived discrimination, were evaluated for their effect on linkage to care at 6 months. These factors were also evaluated for effect modification on the intervention arms in order to identify particular groups in whom interventions may be most beneficial. Finally, these baseline patient characteristics were evaluated for their effect on time to linkage to care, which was lastly evaluated for its effect on engagement in care.

BACKGROUND

Significant work continues to be carried out to improve health outcomes for PLWH. Although the guidelines have changed as treatment options and understanding of HIV pathogenesis has improved, it is now generally recommended that all individuals with HIV be started on ART at the time of diagnosis irrespective of CD4 count (10, 11). Numerous studies have shown better long-term health outcomes with early initiation of ART, including lower rates of progression to Acquired Immune Deficiency Syndrome (AIDS), fewer HIV-related opportunistic infections, and improved overall survival (12-15). In fact, PLWH who maintain viral suppression now expect a life expectancy nearly equal to individuals without HIV infection (16). Not only does ART improve health outcomes for the individual taking the medications, it also provides a public health benefit. Randomized trials as well as large observational studies have shown that HIV cannot be transmitted to an uninfected partner when the PLWH is consistently virally suppressed on ART (17, 18). As such, effective ART benefits both the individual receiving the medications as well as their partners.

In light of the drastic benefits of achieving viral suppression on ART, there has been great effort to improve progression along the HIV care continuum for all PLWH. The HIV care continuum outlines the steps PLWH take from infection, diagnosis, linkage to care, engagement in care, prescription of ART, and finally viral suppression, defined as a serum HIV viral load ≤ 200 copies/mL (**Figure 1**) (2, 6, 7). Unfortunately, there is a drop-off with each step along the HIV care continuum, with 86% of PLWH estimated to have been diagnosed but only 51% achieving virologic suppression (7). Addressing this drop-off and in an attempt to end the HIV epidemic, the Joint United Nations Programme on HIV/AIDS (UNAIDS) formulated an action plan with its 90-90-90 campaign (19). In this plan, UNAIDS proposed three primary goals: (1) by 2020, 90% of all PLWH will know their status, (2) by 2020, 90% of all diagnosed PLWH will be prescribed sustained ART, and (3) by 2020, 90% of all people on ART will achieve viral suppression (19). As a result, many studies have been conducted to attempt to improve rates of viral suppression among PLWH through various interventions.

Although the National HIV/AIDS Strategy calls for linkage to care within one month of diagnosis, there is growing evidence that faster linkage to care may improve progression along the HIV care continuum (20). Rapid entry programs, in which an individual newly diagnosed with HIV is started on ART within days of diagnosis, are being implemented across the United States in order to improve and hasten rates of viral suppression. Studies have shown improved engagement in care and faster time to viral suppression, with excellent safety/tolerability (21-23). Implementation studies are ongoing to determine the durability of these interventions, evaluating whether the improved rates of viral suppression observed with short follow up remain significant over time.

Additionally, patient navigators have been widely implemented to improve progression along the HIV care continuum. Patient navigators are trained professionals who help PLWH access and understand medical and social services available to them (10). Brief, strengths-based case management via patient navigators was found to improve linkage to care by close to 20% at 6 months in both clinical trials and implementation studies (24, 25). These improvements were associated with long term benefits for the patients (24). As a result, HIV clinics are encouraged to provide patient navigators to improve linkage and engagement in care for PLWH.

Despite these advances, there are vulnerable populations that continue to progress along the HIV care continuum at slower rates than others. One population that has been particularly challenging to reach is PLWH with co-occurring SUD. It is estimated that close to half of all PLWH struggle with a co-occurring SUD, with 20% of PLWH evidencing polysubstance use disorder (26, 27). Additionally, several studies have demonstrated that PLWH with co-occurring SUD progress along the HIV care continuum at slower rates than those without and are less likely to remain virally suppressed when followed longitudinally (8, 28-30).

Not only do PLWH with co-occurring SUD exhibit poorer HIV care outcomes, they also appear to be less responsive to interventions. While no rapid entry programs have specifically targeted PLWH with co-occurring SUD, small observational studies suggest that these programs may be safe and successful for this unique population (21, 31). Also, although patient navigators were seen to be effective at improving linkage and engagement in care overall, there was minimal benefit observed for PLWH with co-occurring SUD (24, 25). This lack of response was observed to be mitigated somewhat when the individual had been in a drug treatment program, highlighting the importance of addressing substance use in this population (32).

Specifically seeking to address this disparity in HIV care outcomes, Project HOPE (**H**ospital Visits as an **O**pportunity for **P**revention and **E**ngagement) was a multi-site NIH-funded clinical trial evaluating the effect of a structured patient navigator with or without financial incentives to improve viral suppression among PLWH with co-occurring SUD (9). By recruiting hospitalized patients specifically, the authors aimed to target individuals who had fallen out of care and were not routinely attending clinic visits. Participants were PLWH with co-occurring SUD, were not virally suppressed, and were hospitalized at one of 11 sites across the United States. They then underwent baseline assessment before being randomized into one of three arms: (1) Patient navigator, (2) Patient navigator with contingency management, and (3) Usual care. In the contingency management arm, participants could incrementally earn up to $1,160 over the course of the study by meeting predetermined target behaviors, including attending HIV clinic visits, participating in SUD treatments, and achieving virologic suppression. The interventions were continued for 6 months and outcome data were collected at 6- and 12-month follow up visits.

Enrolling 801 participants, Project HOPE ultimately failed to find a significant improvement in the primary outcome of viral suppression at 12 months, but did see improved viral suppression in the two intervention arms at 6 months (9). The work in this thesis utilized the data from Project HOPE in order to identify factors affecting linkage to care among PLWH with SUD in an effort to improve HIV care outcomes in this unique patient population.

METHODS

Specific Aims

- Aim 1.1: To estimate the effect of baseline patient characteristics (i.e. socioeconomic factors, medical mistrust, and perceived discrimination within the healthcare system) on linkage to care at 6 months among PLWH with co-occurring SUD.
- Aim 1.2: To evaluate effect modification of baseline patient characteristics on the association between each of the two interventions compared to treatment as usual on linkage to care by 6 months among PLWH with co-occurring SUD.
- Aim 2.1: To estimate the association between baseline patient characteristics with early linkage to care (≤30 days).
- Aim 2.2: To estimate if the time to linkage to care (≤30 days or >30 days) improves engagement in care at 6 months among PLWH with co-occurring SUD.
    - Engagement in care is defined as attending a second HIV clinic appointment

Study Design

This work is a secondary analysis of data collected from participants in Project HOPE. Project HOPE had a three-parallel group, repeated-measures, longitudinal design in which patients were recruited from 11 hospitals across the United States from July 2012 through January 2014. Participants were living with HIV, had co-occurring SUD, uncontrolled HIV infection, and were hospitalized at the time of recruitment. Inclusion criteria required any reported opioid, stimulant (cocaine, ecstasy, or amphetamines), or heavy alcohol use as determined by the Alcohol Use Disorders Identification Test (AUDIT)-C within the past 12 months (9, 33). After providing written consent and being screened for eligibility, participants were enrolled, provided blood specimens, and completed a social and behavioral assessment through a computer-assisted personal interview at the time of enrollment. They were then randomly assigned in equal proportions to receive either (1) six months of patient navigation, (2) six months of patient navigation with contingency management, or (3) treatment as usual (**Figure 2**).

Study Variables

Socioeconomic Variables

Age was treated as a dichotomous variable, <45 years old and ≥45 years old. Socioeconomic variables were obtained from the computer-assisted personal interview at the time of enrollment and included income, educational level, insurance status, homelessness, and food insecurity. Income was defined as the individual's personal annual income based on self-report and was divided into two tiers (≤$10,000 and >$10,000 per year, approximating the federal poverty limit). Educational level was defined as the individual's highest grade or level of school completed, or the highest degree received based on self-report, divided into low (not achieving a high school diploma/GED) or high (graduating from high school or attaining a higher degree). Insurance status was defined as the individual's report at the time of taking the baseline survey and was divided into three groups (no; yes; unknown). Housing was defined as within the six months prior to answering the survey by self-report and was divided into two groups, unstable (homeless, living in a shelter, transitionally housed, or staying with family/friends) or stable (permanent long-stay hotel, HIV group home, drug treatment facility, halfway house, renting a house/apartment, owning a home, or other). Food scarcity was based on responses to a previously validated survey and participants were divided into quartiles (34).

Perceived Discrimination and Medical Mistrust

Perceived discrimination within the healthcare community and medical mistrust were obtained from the computer-assisted personal interview at the time of enrollment and were defined as follows. Perceived discrimination was based on survey data (yes/no/don't know/refuse to answer) for the following categories, with a least one affirmative answer qualifying as the individual perceiving discrimination: HIV status, Gender, Sexual orientation or practices, Race/ethnicity, and Drug use. Medical mistrust was based on responses to a previously validated survey and divided into two categories, present (score >36) or absent (score ≤36), using a cutoff score of 36 based on the original validation study (35).

Outcome Variables

Time to linkage to care was defined as early (first appointment for HIV care was completed within 30 days of study enrollment) or late (first appointment for HIV care was completed after 30 days of study enrollment). Linkage to care was defined as attending a first follow-up outpatient visit for HIV care. Engagement in care was defined as having two completed clinic visits for HIV within the 6-month time period (7). Attendance of HIV care visits for all outcome variables was determined by medical record abstraction, supplemented by self-report when the medical record was missing.

Statistical Analysis

All statistical analyses were performed using SAS software, version 9.4 (Cary, North Carolina). Descriptive statistics were calculated for covariates across the entire population as well as for each individual treatment arm as mean values with a standard deviation, or frequency and proportion within categories. All variables with more than two categories were treated as ordinal categorical variables. Power and sample size were not calculated as this work was a secondary analysis.

A bivariable analysis using logistic regression was performed to calculate the odds ratios (OR) and 95% confidence intervals (CI) between individual characteristics and the primary outcome of interest, linkage to care at 6 months. These analyses were performed on the treatment as usual arm to increase generalizability beyond the study population. A multivariable analysis was performed using complete-case analysis to assess the effect measure modification of the baseline characteristics on the intervention arms compared to treatment as usual on the outcome of interest, linkage to care at 6 months. Variables considered for inclusion into the multivariable model had p-values of <0.05 in the bivariable analysis. Additionally, age, gender, education, income, baseline CD4 count, and baseline HIV viral load were also considered for inclusion regardless of p-value. These variables were selected before statistical analysis to be of particular interest to evaluate for their effect measure modification on progression along the HIV care continuum. Iterative likelihood ratio tests (LRT) were performed to determine whether variables would be kept in the multivariable model and were repeated until all remaining interaction variables were considered to be statistically significant with LRT p-values <0.05. Adjusted OR (aOR) for linkage to care at 6 months were then obtained for each variable in the model, adjusting for all other variables included in the analysis. Participants with missing data for any variable in the multivariable model were not included in the multivariable analysis as this was a complete-case analysis.

A bivariable analysis using logistic regression was performed to assess the OR between individual characteristics and linkage to care within 30 days of enrollment. This was performed for the overall cohort as well as stratified by treatment arm. Bivariable analysis using logistic regression was then performed to assess the OR comparing early (linked to care within 30 days of enrollment) to late (linked to care after 30 days of enrollment) on engagement in care at 6 months. Participants who did not link to care by 6 months were excluded from this analysis as it would be impossible for an individual to attend a second visit without having attended a first. This analysis was performed for the overall cohort as well as stratified by treatment arm.

Sensitivity Analysis

Missing values were infrequent, with two notable exceptions. There were 74 of the 801 study participants (9%) who were lost to follow-up, for whom all outcome data were missing. These participants were excluded from all statistical analyses. There were 236 of 801 study participants (29%) who chose not to answer the survey on annual income. The primary bivariable and multivariable analyses were performed using complete-case analysis, including only participants without missing data. A sensitivity analysis was performed to evaluate the study participants with missing income data.

Baseline demographics were obtained for participants with missing income data, which was then compared to the demographics of participants with low and high incomes using Cochran-Mantel-Haenszel tests.

RESULTS

Baseline Participant Characteristics

All 801 study participants from the original Project HOPE were included in this study's analyses. Baseline participant characteristics are shown in **Table 1**. The mean age at enrollment was 45 years (standard deviation (SD): 9.98 years), approximately 33% of the study participants were women, and the majority were Black (73%). Seventy-seven percent of participants met eligibility criteria for drug use and 59% for heavy alcohol use. Thirty-two percent admitted to ever using injection drugs, with 18% having done so within the 12 months prior to enrollment. Additionally, 33% had no form of insurance, 40% had not completed high school, and 73% earned ≤$10,000 per year. At the time of study enrollment, 29% reported having perceived discrimination within the health care setting and 16% had scores suggesting medical mistrust. Median CD4 was 109 cells/µL and median HIV viral load was 52,826 copies/mL.

Linkage to Care at 6 Months

A bivariable analysis was performed for each baseline characteristic to evaluate its effect on linkage to care at 6 months among the participants randomized to usual treatment (**Table 2**). Participants with high levels of medical mistrust (OR: 0.34, 95% CI: 0.13, 0.91) and those that met eligibility criteria for drug use as opposed to alcohol use alone (OR: 0.49, 95% CI: 0.26, 0.91) were found to have lower odds of linkage to care at 6 months. Individuals who had recently engaged in injection drug use within the 12 months prior to enrollment were more likely to be linked to care at 6 months (OR: 2.81, 95% CI: 1.38, 5.75).

Age, gender, education, income, CD4 count, HIV viral load, and variables with p-values <0.05 from the bivariable analysis (medical mistrust, eligibility due to drug use, and injection drug use within the 12 months prior to enrollment) were considered for inclusion into the multivariable model to evaluate their effect modification on the intervention arms compared to the usual treatment arm on linkage to care at 6 months. There were no statistically significant effect measure modifiers, with an LRT evaluating the previously listed effect measure modifier terms resulting a p-value of 0.09. Although not statistically significant with an LRT p-value of 0.26, there was a trend toward improved responses to the intervention arms when stratifying by income. Participants with low income (Patient navigator aOR: 2.68; 95% CI: 1.44, 5.00; and Patient navigator with incentives aOR: 6.09; 95% CI: 2.93, 12.66) appeared to be more sensitive to intervention than those with high income (Patient navigator aOR: 1.81; 95% CI: 0.46, 7.07; and Patient navigator with incentives aOR: 2.17; 95% CI: 0.60, 7.80). Participants who had not completed high school (aOR: 0.42; 95% CI: 0.26, 0.69) and those with severe food insecurity (aOR: 0.46; 95% CI: 0.25, 0.83) were found to have lower odds of being linked to care at 6 months after adjusting for the included variables listed above. Participants randomized to the intervention arms (Patient navigator aOR: 2.60; 95% CI: 1.50, 4.51; and Patient navigator with incentives aOR: 4.44; 95% CI: 2.44, 8.10) were found to have higher odds of being linked to care at 6 months in the adjusted model. Results are shown in **Table 3**.

Early Linkage to Care

A bivariable analysis evaluating factors affecting early linkage to care among all Project HOPE participants is shown in **Table 4**. Participants with low education (OR: 0.67, 95% CI: 0.49, 0.93), high levels of medical mistrust (OR: 0.59, 95% CI: 0.38, 0.93), and those that met eligibility criteria for drug use (OR: 0.69, 95% CI: 0.48, 0.98) had lower odds of being linked to care within 30 days of study enrollment in the overall cohort. Participants with insurance at time of enrollment were found to have higher odds of being linked to care at 30 days (OR: 1.50, 95% CI: 1.08, 2.08).

The effect that early linkage to care had on engagement in care at 6 months is shown in **Table 5**. Participants who linked to care within 30 days of enrollment were found to have higher odds of being engaged in care at 6 months compared to participants who linked to care between 30 days and 6 months (OR: 4.03, 95% CI: 2.75, 5.91). This effect was seen to be consistent across all three study arms.

Sensitivity Analysis

Baseline characteristics for participants with missing income data are shown in **Table 6**. The mean age at enrollment was 45 years (SD: 9.88 years), 39% were women, and 78% were Black. Thirty-one percent admitted to ever using injection drugs, with 18% having done so within the 12 months prior to enrollment. Additionally, 42% had no form of insurance and 45% had not completed high school. At the time of study enrollment, 26% reported having perceived discrimination within the healthcare setting and 15% had scores suggesting medical mistrust. Median CD4 was 113 cells/µL and median HIV viral load was 56,477 copies/mL (**Table 6**).

The baseline demographics between participants with low, high, and missing income are compared in **Table 7**. Baseline demographics were mostly similar among the three income groups with a few exceptions. Participants with missing income data were more likely to be women compared to those with low income, were less likely to have completed high school than those with low income, were more likely to have unstable housing than those with low income, and were less likely to have insurance than those who reported income (all p-value: <0.05).

DISCUSSION

This work has identified several factors that affect linkage to care among PLWH with SUD. High levels of medical mistrust and meeting eligibility criteria for drug use disorder were associated with lower odds of linkage to care at both 30 days and 6 months, while low education was associated with lower odds of linkage to care at 30 days. Although many of these factors have previously been shown to be associated with poorer HIV care outcomes in other populations, this work was one of the largest to evaluate these factors in PLWH with SUD, a particularly vulnerable group (28, 36, 37).

Although not completing high school did not significantly lower a participant's odds of linking to care by 6 months in the bivariable analysis, (OR: 0.78, 95% CI: 0.42, 1.45), education level was significant in the multivariable analysis (aOR: 0.42; 95% CI: 0.26, 0.69) after adjusting for age, gender, eligibility due to drug use, insurance status, housing, income level, food insecurity, medical mistrust, viral load, CD4 count, and treatment intervention arm. Although low education has been seen in other populations to be associated with poorer HIV outcomes (38, 39), this finding is inconsistent, with some studies not finding an association (40). This suggests the need for continued efforts to identify interventions to improve linkage to care in people with low education, and the need to consider providing educational opportunities for PLWH.

It was surprising to find no association between income level and linkage to care at 6 months within this work, as an association between low income and poorer HIV care outcomes for PLWH has been seen previously in other populations (41-43). In this work, making less than $10,000 per year was not significantly associated with lower odds of linkage to care at 6 months in the bivariable (OR: 0.73, 95% CI: 0.31, 1.72) or multivariable analysis (aOR: 0.97; 95% CI: 0.53, 1.77). Additionally, income was not found to be a significant effect measure modifier when evaluated in the multivariable analysis. These findings were surprising in light of work done in other disciplines showing that programs with financial incentives may be most beneficial in improving clinical outcomes among individuals with lower incomes (44).

Participants with high levels of food insecurity were found to have lower odds of linking to care at 6 months (aOR: 0.46; 95% CI: 0.25, 0.83) compared to those without food insecurity. This has been seen previously in other populations, but has not been studied extensively among PLWH with co-occurring SUD (45-47). This work augments the growing body of literature that highlights the interaction between severe food insecurity and healthcare outcomes.

High levels of medical mistrust were associated with lower odds of both early linkage to care (within 30 days) and linkage to care at 6 months. When stratified by treatment arms, the effect seen on early linkage to care was only significant among the treatment as usual group (OR: 0.34, 95% CI: 0.13, 0.91) in the bivariable analysis. Previous reports have linked medical mistrust to poorer progression along the HIV care continuum at several steps, including linkage to care (48) and adherence to ART (49, 50), but none have specifically focused on PLWH with co-occurring SUD. Not only does this work support the importance of medical mistrust in the delivery of healthcare to PLWH with co-occurring SUD, it also suggests that this association may be mitigated by patient navigators. It is possible that patient navigators, using a strengths-based case management approach and motivational interviewing techniques, with or without financial incentives, may have reduced the negative impact medical mistrust had on early linkage to care in this study.

It was surprising that PLWH with injection drug use, particularly within the 12 months prior to enrollment, were found to have higher odds of linking to care by 6 months than those who had not. Although some reports have shown poorer linkage and engagement in care for PLWH with injection drug use (51, 52), this is not a consistent finding with other studies showing high rates of engagement in care within this population (53). Previous studies have shown that individuals with injection drug use may be quite receptive to interventions aimed at improving engagement in care (54, 55). Although the reason is not clear, it may be that the individuals with recent injection drug use were already connected to the healthcare system for their injection drug use and were therefore understood how to navigate the healthcare system making them more likely to link to HIV care more readily within this study.

A growing body of literature supports rapid entry into the HIV care continuum. Although many implementation studies are ongoing, several reports show improved engagement (56) as well as faster viral suppression (22, 23, 57-61) when patients link to care more quickly. Our findings support the rapid entry concept, showing that patients who linked to care early (within 30 days of study enrollment) were much more likely to be engaged in care at 6 months by following up with at least one subsequent appointment (OR: 4.03, 95% CI: 2.75, 5.91). As a secondary analysis, it is not clear whether the strong effect of early linkage to care is due to an intrinsically more motivated study participant or whether the act of linking more quickly causes a patient to remain engaged in care at higher rates, which is an important point that ongoing implementation studies aim to answer.

This work had a number of limitations. First, patient characteristics used in this work were collected at the time of enrollment primarily by self-report. Although the primary analysis in this work made the assumption that these factors were static throughout the duration of the study, it is possible that some may have changed over time. Utilizing self-report for baseline characteristics could result in misclassification if the participant made a mistake in reporting or misinterpreted a question. Second, as a secondary analysis, the original study was not powered to address the outcomes evaluated in this work. This limits the interpretation of the results somewhat and discourages over-reliance on p-values. An additional limitation was missing data. Although income was not found to be statistically significant, nearly one-third of participants did not report their income data. This limitation was addressed by performing a sensitivity analysis which found that individuals who did not report their income were largely similar to those who provided information on their income. Finally, confounding may also be a limitation. Although many socioeconomic factors were not found to be significant, these factors were not randomized so their estimated effects could be confounded by other unmeasured factors.

These findings suggest that interventions may need to be tailored or targeted to individuals based on specific factors such as poverty, educational level, or medical mistrust. It highlights the importance of social determinants of health in affecting health outcomes as well as healthcare access. This work can be used to guide future research targeting such individuals who may benefit most from patient navigators or financial incentives to improve progression along the HIV care continuum for a population that has remained difficult to reach.

REFERENCES

1. Centers for Disease Control and Prevention. Estimated HIV incidence and prevalence in the United States, 2010–2015. HIV Surveillance Supplemental Report 2018;23(No. 1). http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html. Published March 2018. Accessed August 2018.,
2. Centers for Disease Control and Prevention. HIV Surveillance Report, 2016; vol. 28. http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html. Published November 2017. Accessed August 2018.,
3. Centers for Disease Control and Prevention. Monitoring Selected National HIV Prevention and Care Objectives by Using HIV Surveillance Data—United States and 6 Dependent Areas, 2015. HIV Surveillance Supplemental Report. 2017;22(2). Available at: https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-supplemental-report-vol-22-2.pdf.,
4. Althoff KN, Gange SJ, Klein MB, et al. Late presentation for human immunodeficiency virus care in the United States and Canada. *Clin Infect Dis* 2010;50(11):1512-20.
5. Bradley H, Hall HI, Wolitski RJ, et al. Vital Signs: HIV diagnosis, care, and treatment among persons living with HIV--United States, 2011. *MMWR Morb Mortal Wkly Rep* 2014;63(47):1113-7.
6. Gardner EM, McLees MP, Steiner JF, et al. The spectrum of engagement in HIV care and its relevance to test-and-treat strategies for prevention of HIV infection. *Clin Infect Dis* 2011;52(6):793-800.
7. Centers for Disease Control and Prevention. Understanding the HIV Care Continuum. https://www.cdc.gov/hiv/pdf/library/factsheets/cdc-hiv-care-continuum.pdf. Published June 2018. Accessed August 2018.

8. Yehia BR, Stewart L, Momplaisir F, et al. Barriers and facilitators to patient retention in HIV care. *BMC Infect Dis* 2015;15:246.

9. 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):156-70.

10. Panel on Antiretroviral Guidelines for Adults and Adolescents. Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents Living with HIV. Department of Health and Human Services. Available at http://aidsinfo.nih.gov/contentfiles/lvguidelines/AdultandAdolescentGL.pdf. Accessed September, 2018.,

11. Saag MS, Benson CA, Gandhi RT, et al. Antiretroviral Drugs for Treatment and Prevention of HIV Infection in Adults: 2018 Recommendations of the International Antiviral Society-USA Panel. *Jama* 2018;320(4):379-96.

12. Danel C, Moh R, Gabillard D, et al. A Trial of Early Antiretrovirals and Isoniazid Preventive Therapy in Africa. *N Engl J Med* 2015;373(9):808-22.

13. Kitahata MM, Gange SJ, Abraham AG, et al. Effect of early versus deferred antiretroviral therapy for HIV on survival. *N Engl J Med* 2009;360(18):1815-26.

14. Lundgren JD, Babiker AG, Gordin F, et al. Initiation of Antiretroviral Therapy in Early Asymptomatic HIV Infection. *N Engl J Med* 2015;373(9):795-807.

15. Severe P, Juste MA, Ambroise A, et al. Early versus standard antiretroviral therapy for HIV-infected adults in Haiti. *N Engl J Med* 2010;363(3):257-65.

16. May MT, Gompels M, Delpech V, et al. Impact on life expectancy of HIV-1 positive individuals of CD4+ cell count and viral load response to antiretroviral therapy. *Aids* 2014;28(8):1193-202.

17. Cohen MS, Chen YQ, McCauley M, et al. Antiretroviral Therapy for the Prevention of HIV-1 Transmission. *N Engl J Med* 2016;375(9):830-9.

18. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med* 2011;365(6):493-505.

19. Joint United Nations Programme on HIV/AIDS (UNAIDS). 90-90-90 An ambitious target to help end the AIDS epidemic. http://www.unaids.org/sites/default/files/media_asset/90-90-90_en.pdf. Published October 2014. Accessed August 2018.,

20. National HIV/AIDS Strategy for the United States: Updated to 2020. The White House Office of National HIV Policy. July 2015. https://www.aids.gov. Accessed March 2018.,

21. Colasanti J, Sumitani J, Mehta CC, et al. Implementation of a Rapid Entry Program Decreases Time to Viral Suppression Among Vulnerable Persons Living With HIV in the Southern United States. *Open forum infectious diseases* 2018;5(6):ofy104.

22. Koenig SP, Dorvil N, Devieux JG, et al. Same-day HIV testing with initiation of antiretroviral therapy versus standard care for persons living with HIV: A randomized unblinded trial. *PLoS Med* 2017;14(7):e1002357.

23. Pilcher CD, Ospina-Norvell C, Dasgupta A, et al. The Effect of Same-Day Observed Initiation of Antiretroviral Therapy on HIV Viral Load and Treatment Outcomes in a US Public Health Setting. *J Acquir Immune Defic Syndr* 2017;74(1):44-51.

24. Craw JA, Gardner LI, Marks G, et al. Brief strengths-based case management promotes entry into HIV medical care: results of the antiretroviral treatment access study-II. *J Acquir Immune Defic Syndr* 2008;47(5):597-606.

25. Gardner LI, Metsch LR, Anderson-Mahoney P, et al. Efficacy of a brief case management intervention to link recently diagnosed HIV-infected persons to care. *AIDS* 2005;19(4):423-31.

26. Hartzler B, Dombrowski JC, Crane HM, et al. Prevalence and Predictors of Substance Use Disorders Among HIV Care Enrollees in the United States. *AIDS Behav* 2017;21(4):1138-48.

27. Kuo I, Golin CE, Wang J, et al. Substance use patterns and factors associated with changes over time in a cohort of heterosexual women at risk for HIV acquisition in the United States. *Drug and alcohol dependence* 2014;139:93-9.

28. Erickson A, Becker M, Shaw S, et al. Substance use and its impact on care outcomes among HIV-infected individuals in Manitoba. *AIDS Care* 2015;27(9):1168-73.

29. Monroe AK, Jabour SM, Pena S, et al. A qualitative study examining the benefits and challenges of incorporating patient-reported outcome substance use and mental health questionnaires into clinical practice to improve outcomes on the HIV care continuum. *BMC health services research* 2018;18(1):419.

30. Tolson C, Richey LE, Zhao Y, et al. Association of Substance Use With Hospitalization and Virologic Suppression in a Southern Academic HIV Clinic. *The American journal of the medical sciences* 2018;355(6):553-8.

31. Coffey S, Bacchetti P, Sachdev D, et al. RAPID ART: High virologic suppression rates with immediate ART initiation in a vulnerable urban clinic population. *Aids* 2018.

32. Gardner LI, Marks G, Strathdee SA, et al. Faster entry into HIV care among HIV-infected drug users who had been in drug-use treatment programs. *Drug and alcohol dependence* 2016;165:15-21.

33. Bush K, Kivlahan DR, McDonell MB, et al. The AUDIT alcohol consumption questions (AUDIT-C): an effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Archives of internal medicine* 1998;158(16):1789-95.

34. Coates J, Swindale A, Bilinsky P. Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3). Washington, D.C., August 2007, (Food and Nutrition Technical Assistance Project AfED

35. Thompson HS, Valdimarsdottir HB, Winkel G, et al. The Group-Based Medical Mistrust Scale: psychometric properties and association with breast cancer screening. *Prev Med* 2004;38(2):209-18.

36. Gwadz M, de Guzman R, Freeman R, et al. Exploring How Substance Use Impedes Engagement along the HIV Care Continuum: A Qualitative Study. *Frontiers in public health* 2016;4:62.

37. Meyer JP, Althoff AL, Altice FL. Optimizing care for HIV-infected people who use drugs: evidence-based approaches to overcoming healthcare disparities. *Clin Infect Dis* 2013;57(9):1309-17.

38. McFall AM, Mehta SH, Srikrishnan AK, et al. Getting to 90: linkage to HIV care among men who have sex with men and people who inject drugs in India. *AIDS Care* 2016;28(10):1230-9.

39. Sobrino-Vegas P, Rodriguez-Urrego J, Berenguer J, et al. Educational gradient in HIV diagnosis delay, mortality, antiretroviral treatment initiation and response in a country with universal health care. *Antiviral therapy* 2012;17(1):1-8.

40. Cohen GM, Werner L, Gengiah S, et al. Role of Education in HIV Clinical Outcomes in a Tuberculosis Endemic Setting. *Journal of the International Association of Providers of AIDS Care* 2014;13(5):402-8.

41. McManus KA, Rhodes A, Bailey S, et al. Affordable Care Act Qualified Health Plan Coverage: Association With Improved HIV Viral Suppression for AIDS Drug Assistance Program Clients in a Medicaid Nonexpansion State. *Clin Infect Dis* 2016;63(3):396-403.

42. Sprague C, Simon SE. Understanding HIV care delays in the US South and the role of the social-level in HIV care engagement/retention: a qualitative study. *International journal for equity in health* 2014;13:28.

43. Walcott M, Kempf MC, Merlin JS, et al. Structural community factors and sub-optimal engagement in HIV care among low-income women in the Deep South of the USA. *Culture, health & sexuality* 2016;18(6):682-94.

44. Lasser KE, Quintiliani LM, Truong V, et al. Effect of Patient Navigation and Financial Incentives on Smoking Cessation Among Primary Care Patients at an Urban Safety-Net Hospital: A Randomized Clinical Trial. *JAMA internal medicine* 2017;177(12):1798-807.

45. Spinelli MA, Frongillo EA, Sheira LA, et al. Food Insecurity is Associated with Poor HIV Outcomes Among Women in the United States. *AIDS Behav* 2017;21(12):3473-7.

46. Weiser SD, Fernandes KA, Brandson EK, et al. The association between food insecurity and mortality among HIV-infected individuals on HAART. *J Acquir Immune Defic Syndr* 2009;52(3):342-9.

47. Weiser SD, Yuan C, Guzman D, et al. Food insecurity and HIV clinical outcomes in a longitudinal study of urban homeless and marginally housed HIV-infected individuals. *Aids* 2013;27(18):2953-8.

48. Beer L, Fagan JL, Garland P, et al. Medication-related barriers to entering HIV care. *AIDS patient care and STDs* 2012;26(4):214-21.

49. Bogart LM, Wagner G, Galvan FH, et al. Conspiracy beliefs about HIV are related to antiretroviral treatment nonadherence among african american men with HIV. *J Acquir Immune Defic Syndr* 2010;53(5):648-55.

50. Kalichman SC, Eaton L, Kalichman MO, et al. Race-based medical mistrust, medication beliefs and HIV treatment adherence: test of a mediation model in people living with HIV/AIDS. *Journal of behavioral medicine* 2016;39(6):1056-64.

51. Alaei A, Nautiyal N, Mishkin K, et al. Factors associated with linkage to care for HIV patients in Tajikistan. *International journal of STD & AIDS* 2018;29(12):1183-9.

52. Ghiam MK, Rebeiro PF, Turner M, et al. Trends in HIV Continuum of Care Outcomes over Ten Years of Follow-Up at a Large HIV Primary Medical Home in the Southeastern United States. *AIDS research and human retroviruses* 2017;33(10):1027-34.

53. Braunstein SL, Robbins RS, Daskalakis DC. Missed Opportunities: Adapting the HIV Care Continuum to Reduce HIV-Related Deaths. *J Acquir Immune Defic Syndr* 2017;76(3):231-40.

54. Feder KA, Krawczyk N, Mojtabai R, et al. Health insurance coverage is associated with access to substance use treatment among individuals with injection drug use: Evidence from a 12-year prospective study. *Journal of substance abuse treatment* 2019;96:75-81.

55. Leon C, Cardoso L, Mackin S, et al. The willingness of people who inject drugs in Boston to use a supervised injection facility. *Substance abuse* 2018;39(1):95-101.

56. Philbin MM, Tanner AE, DuVal A, et al. HIV Testing, Care Referral, and Linkage to Care Intervals Affect Time to Engagement in Care for Newly Diagnosed HIV-Infected

Adolescents in 15 Adolescent Medicine Clinics in the United States. *J Acquir Immune Defic Syndr* 2016;72(2):222-9.

57. Hall HI, Tang T, Johnson AS, et al. Timing of Linkage to Care After HIV Diagnosis and Time to Viral Suppression. *J Acquir Immune Defic Syndr* 2016;72(2):e57-60.

58. Halperin J, Katz M, Pathmanathan I, et al. Early HIV Diagnosis Leads to Significantly Decreased Costs in the First 2 Years of HIV Care in an Urban Charity Hospital in New Orleans. *Journal of the International Association of Providers of AIDS Care* 2017;16(6):527-30.

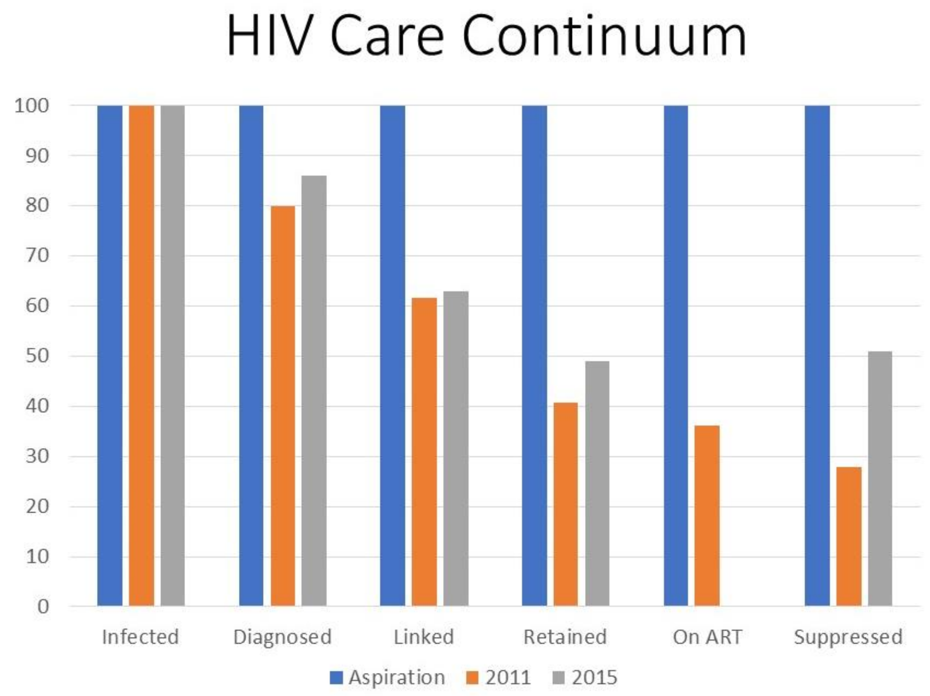
59. Onyeajam DJ, Eke R, Stephens TG, et al. Time to linkage to care and viro-immunologic parameters of individuals diagnosed before and after the 2006 HIV testing recommendations. *Southern medical journal* 2013;106(4):257-66.

60. Robertson M, Laraque F, Mavronicolas H, et al. Linkage and retention in care and the time to HIV viral suppression and viral rebound - New York City. *AIDS Care* 2015;27(2):260-7.

61. Rosen S, Maskew M, Fox MP, et al. Initiating Antiretroviral Therapy for HIV at a Patient's First Clinic Visit: The RapIT Randomized Controlled Trial. *PLoS Med* 2016;13(5):e1002015.

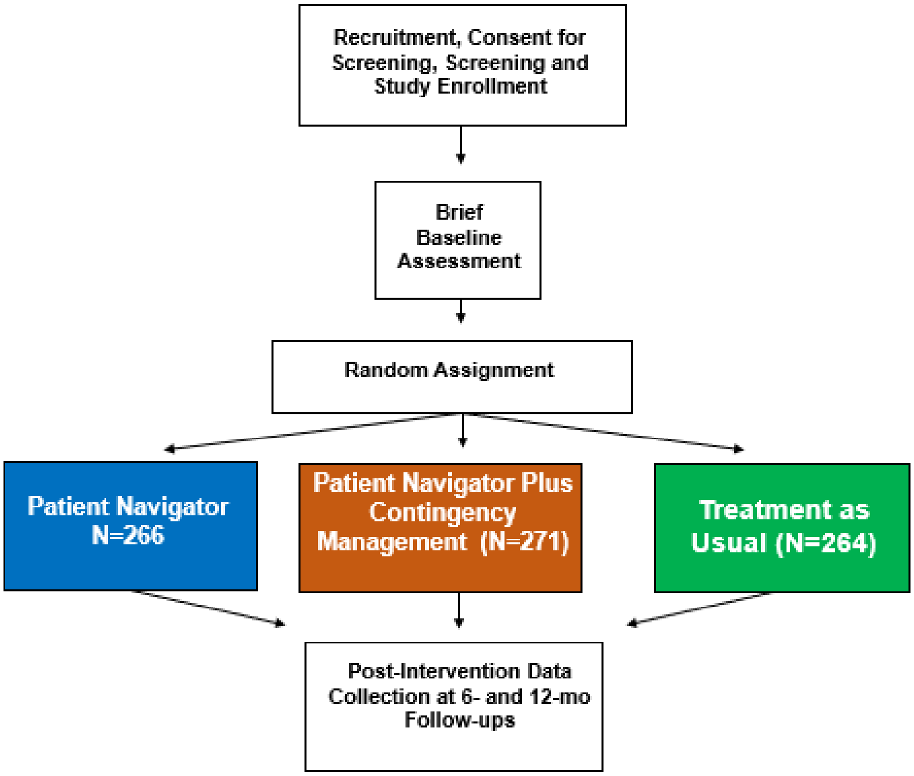
TABLES/FIGURES

Figure 1. The HIV care continuum.



Abbreviation: ART, antiretroviral therapy

Figure 2. Project HOPE study design.



Abbreviation: mo, month

Table 1. Baseline characteristics among Project HOPE (Hospital Visits as an Opportunity for Prevention and Engagement for HIV-infected Drug Users) study participants (N=801).

Demographic	**Overall (N=801)**	**Navigation (N=266)**	**Navigation + Incentives (N=271)**	**Usual Treatment (N=264)**
Age (years)	45 (9.98)	45 (9.85)	45 (10.04)	44 (10.09)
Female	261 (33)	87 (33)	94 (35)	80 (31)
Race/Ethnicity				
Black	579 (72)	195 (73)	194 (72)	190 (72)
White	97 (12)	27 (10)	41 (15)	29 (11)
Hispanic	84 (10)	26 (10)	25 (9)	33 (13)
Other	38 (5)	16 (6)	10 (4)	12 (5)
Missing	3 (0.4)	2 (0.8)	1 (0.4)	0 (0)
Eligibility due to*				
Drug Use	613 (77)	213 (80)	210 (77)	190 (72)
Alcohol Use	471 (59)	146 (55)	155 (57)	170 (64)
Ever IDU	260 (32)	90 (34)	85 (31)	85 (32)
IDU in the past 12 months	147 (18)	50 (19)	51 (19)	46 (17)
Insurance Status				
Some	534 (67)	176 (66)	182 (67)	176 (67)
None	261 (33)	88 (33)	88 (32)	85 (32)
Unknown	6 (0.8)	2 (1)	1 (0.4)	3 (1)
Not Completed High School	319 (40)	117 (44)	105 (39)	97 (37)
Unstable Housing Status	357 (45)	126 (47)	116 (43)	115 (44)
Annual Income ≤$10,000 (N=565)	414 (73)	143 (76)	140 (70)	131 (74)
Household Food Insecurity				
None (0)	327 (41)	110 (41)	109 (40)	108 (41)
Mild (0-2)	89 (11)	30 (11)	31 (11)	28 (11)
Moderate (2-11)	191 (24)	57 (21)	72 (27)	62 (23)
Severe (>11)	194 (24)	69 (26)	59 (22)	66 (25)
Perceived Health Care Discrimination (N=798)	232 (29)	76 (29)	73 (27)	83 (32)
Medical Mistrust Score	28.7 (7.78)	28.8 (8.11)	28.1 (7.42)	29.1 (7.78)
>36	128 (16)	50 (19)	30 (11)	48 (18)
<=36	673 (84)	216 (81)	241 (89)	216 (82)
Viral Load+	52,826 (194,038)	54,028.50 (186,476)	53,133 (194,535)	49,445.50 (215,227)
≤200 copies/mL	87 (11)	30 (11)	28 (10)	29 (11)
>200 copies/mL	714 (89)	236 (89)	243 (90)	235 (89)
CD4 Count+	109 (213)	95.50 (213)	123 (224)	105.50 (213.50)
≤200	534 (67)	174 (65)	179 (66)	181 (69)
>200	267 (33)	92 (35)	92 (34)	83 (31)

Abbreviation: IDU, Injection Drug Use

All values are listed as N (%) or as mean (standard deviation)

+HIV viral load and CD4 Count are reported as median (Interquartile range, IQR)

*Note: patients could be eligible for the study by more than one criterion

Table 2. Factors affecting linkage to care at 6 months among the control arm (N=264).

Predictor	**Usual Treatment**	
	OR (95% CI)	**P-value**
Age		
<45 years	0.96 (0.53, 1.74)	0.89
≥45 years	Reference	
Gender		
Female	0.62 (0.31, 1.21)	0.16
Male	Reference	
Ethnicity		
Black	0.90 (0.33, 2.42)	0.83
Hispanic	0.86 (0.25, 3.03)	0.82
Other*	1.42 (0.27, 7.52)	0.68
White	Reference	
Eligibility due to Drug Use	0.49 (0.26, 0.91)	0.02
Eligibility due to Alcohol	1.28 (0.67, 2.43)	0.56
IDU ever	1.82 (0.98, 3.37)	0.06
IDU in past 12 Months	2.81 (1.38, 5.75)	0.005
Insurance		
None	1.44 (0.78, 2.66)	0.25
Some	Reference	
Education		
Low	0.78 (0.42, 1.45)	0.43
High	Reference	
Housing		
Unstable	0.60 (0.32, 1.10)	0.10
Stable	Reference	
Income		
Low	0.73 (0.31, 1.72)	0.47
High	Reference	
Food Insecurity		
Mild (0-2)	1.06 (0.40, 2.82)	0.91
Moderate (2-11)	1.36 (0.66, 2.71)	0.43
Severe (>11)	0.43 (0.17, 1.07)	0.07
None (0)	Reference	
Perceived Discrimination		
Yes	0.93 (0.49, 1.77)	0.82
No	Reference	
Medical Mistrust		
>36	0.34 (0.13, 0.91)	0.03
<=36	Reference	
Viral Load		
>200 copies/mL	0.61 (0.25, 1.52)	0.29
≤200 copies/mL	Reference	
CD4		
≤200	1.75 (0.89, 3.43)	0.10
>200	Reference	

Abbreviation: IDU, injection drug use

*Other ethnicities include American Indian/Alaska Native, Native Hawaiian/Pacific Islander, and Other

Table 3. Multivariable analysis. Predictors for linkage to care at 6 months, Project HOPE (N=490).

Predictor	**Usual Treatment**	
	aOR (95% CI)*	**P-value**
Age		
<45 years	1.42 (0.87, 2.32)	0.17
≥45 years	Reference	
Gender		
Female	0.81 (0.48, 1.37)	0.44
Male	Reference	
Eligibility due to Drug Use	1.41 (0.78, 2.53)	0.26
Insurance		
None	1.46 (0.84, 2.53)	0.18
Some	Reference	
Education		
Low	0.42 (0.26, 0.69)	<0.001
High	Reference	
Housing		
Unstable	0.62 (0.37, 1.03)	0.06
Stable	Reference	
Income		
Low	0.97 (0.53, 1.77)	0.92
High	Reference	
Food Insecurity		
Mild (0-2)	0.54 (0.25, 1.19)	0.12
Moderate (2-11)	1.15 (0.58, 2.27)	0.69
Severe (>11)	0.46 (0.25, 0.83)	0.01
None (0)	Reference	
Medical Mistrust		
>36	1.20 (0.66, 2.21)	0.55
<=36	Reference	
Viral Load		
>200 copies/mL	0.74 (0.35, 1.56)	0.42
≤200 copies/mL	Reference	
CD4		
≤200	1.21 (0.73, 2.01)	0.45
>200	Reference	
Treatment intervention		
PN	2.60 (1.50, 4.51)	<0.001
PN + I	4.44 (2.44, 8.10)	<0.0001
Usual Care	Reference	

Abbreviations: PN, patient navigation; PN + I, patient navigation with incentives
*Adjusted for age, gender, eligibility due to drug use, insurance, education, housing, income, food insecurity, medical mistrust, viral load, CD4 count, and treatment intervention

Table 4. Predictors for early linkage to care among Project HOPE participants who linked to care (N=704).

Predictor	Overall			Patient Navigation (PN)		PN + Financial Incentives		Treatment as Usual	
	Proportion Linked at 30 Days	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Age									
<45 years	112/302	1.14 (0.84, 1.56)	0.41	1.29 (0.75, 2.22)	0.36	1.21 (0.72, 2.02)	0.47	0.96 (0.53, 1.74)	0.89
≥45 years	137/402	Reference							
Gender									
Female	71/231	0.74 (0.53, 1.03)	0.07	1.20 (0.68, 2.12)	0.54	0.50 (0.29, 0.87)	0.02	0.62 (0.31, 1.21)	0.16
Male	178/473	Reference							
Education									
Low	85/283	0.67 (0.49, 0.93)	0.02	0.54 (0.31, 0.94)	0.03	0.68 (0.40, 1.16)	0.15	0.78 (0.42, 1.45)	0.43
High	164/421	Reference							
Ethnicity									
Hispanic	22/72	0.60 (0.31, 1.18)	0.14	0.44 (0.12, 1.58)	0.21	0.75 (0.25, 2.24)	0.61	0.86 (0.25, 3.03)	0.82
Black	179/519	0.72 (0.44, 1.17)	0.18	0.67 (0.27, 1.66)	0.38	0.72 (0.34, 1.50)	0.38	0.90 (0.33, 2.42)	0.83
Other	13/32	0.93 (0.40, 2.15)	0.87	0.83 (0.21, 3.22)	0.78	0.80 (0.18, 3.50)	0.77	1.42 (0.27, 7.52)	0.68
White	33/78	Reference							
Eligibility due to Drug Use	178/535	0.69 (0.48, 0.98)	0.04	0.81 (0.42, 1.58)	0.54	0.64 (0.35, 1.18)	0.16	0.49 (0.26, 0.91)	0.02
No Drug Use	71/169	Reference							
Eligibility due to Alcohol	142/419	0.85 (0.62, 1.17)	0.32	0.47 (0.27, 0.82)	0.01	1.30 (0.78, 2.19)	0.32	1.28 (0.67, 2.43)	0.56
No Alcohol Use	107/285	Reference							
IDU ever	84/221	1.18 (0.85, 1.64)	0.32	0.93 (0.52, 1.65)	0.79	1.07 (0.62, 1.86)	0.80	1.82 (0.98, 3.37)	0.06
Never IDU	165/483	Reference							
IDU in past 12 Months	51/124	1.35 (0.91, 2.00)	0.14	0.77 (0.37, 1.60)	0.49	1.18 (0.61, 2.26)	0.62	2.81 (1.38, 5.75)	0.01
No IDU in past 12 Months	198/580	Reference							
Insurance									
None	96/230	1.50 (1.08, 2.08)	0.02	1.59 (0.90, 2.80)	0.11	1.60 (0.92, 2.76)	0.09	1.44 (0.78, 2.66)	0.25
Some	152/470	Reference							
Housing									
Unstable	107/315	0.90 (0.66, 1.22)	0.48	1.08 (0.63, 1.84)	0.79	1.01 (0.61, 1.70)	0.96	0.60 (0.32, 1.10)	0.10
Stable	142/389	Reference							
Income									
Low	112/359	0.71 (0.47, 1.08)	0.11	0.42 (0.19, 0.89)	0.02	1.02 (0.53, 1.96)	0.95	0.73 (0.31, 1.72)	0.47
High	51/131	Reference							
Food Insecurity									

Mild (0-2)	28/73	1.05 (0.63, 1.78)	0.85	1.05 (0.40, 2.73)	0.93	1.08 (0.45, 2.57)	0.87	1.06 (0.40, 2.82)	0.91
Moderate (2-11)	59/172	0.88 (0.59, 1.31)	0.53	0.65 (0.31, 1.37)	0.26	0.79 (0.41, 1.49)	0.46	1.36 (0.66, 2.71)	0.43
Severe (>11)	56/174	0.80 (0.54, 1.19)	0.28	0.80 (0.42, 1.53)	0.50	1.08 (0.56, 2.11)	0.82	0.43 (0.17, 1.07)	0.07
None (0)	106/285	Reference							
Perceived Discrimination									
Yes	72/200	1.04 (0.74, 1.46)	0.83	1.04 (0.58, 1.86)	0.91	1.26 (0.70, 2.25)	0.44	0.93 (0.49, 1.77)	0.82
No	176/501	Reference							
Medical Mistrust									
>36	29/112	0.59 (0.38, 0.93)	0.02	0.80 (0.40, 1.60)	0.53	0.76 (0.32, 1.82)	0.54	0.34 (0.13, 0.91)	0.03
<=36	220/592	Reference							
Viral Load									
>200 copies/mL	219/626	0.86 (0.53, 1.40)	0.55	0.99 (0.43, 2.29)	0.98	1.03 (0.46, 2.27)	0.95	0.61 (0.25, 1.52)	0.29
≤200 copies/mL	30/78	Reference							
CD4									
≤200	163/459	1.02 (0.74, 1.41)	0.91	0.63 (0.36, 1.11)	0.11	1.15 (0.67, 1.96)	0.61	1.75 (0.89, 3.43)	0.10
>200	86/245	Reference							

Abbreviation: IDU, injection drug use

Table 5. Effect of time to linkage to care on engagement in care at 6 months (N=486).

Predictor	**Proportion Engaged in Care at 6 Months**	**OR (95% CI)**	**P-value**
Overall (N=486)			
Time to Linkage			
≤30 days	149/249	4.03 (2.75, 5.91)	<0.0001
>30 days	64/237	--	--
Navigation (N=158)			
Time to Linkage			
≤30 days	49/86	3.01 (1.56, 5.82)	0.001
>30 days	22/72	--	--
Navigation + Incentives (N=188)			
Time to Linkage			
≤30 days	62/105	3.35 (1.82, 6.15)	0.0001
>30 days	25/83	--	--
Usual Care (N=140)			
Time to Linkage			
≤30 days	38/58	7.27 (3.40, 15.54)	<0.0001
>30 days	17/82	--	--

Table 6. Demographics of participants with missing income data, Project HOPE (N=236).

Demographic	Overall (N=236)	Navigation (N=79)	Navigation + Incentives (N=71)	Usual Treatment (N=86)
Age (years)	45 (9.88)	46 (9.49)	45 (9.84)	43 (10.10)
Female	91 (39)	34 (43)	34 (48)	23 (27)
Ethnicity				
Black	184 (78)	61 (77)	57 (80)	66 (77)
White	20 (8)	7 (9)	6 (8)	7 (8)
Hispanic	17 (7)	4 (5)	3 (4)	10 (12)
Other	13 (6)	6 (8)	4 (6)	3 (3)
Missing	2 (1)	1 (1)	1 (1)	0 (0)
Eligibility due to*				
Drug Use	167 (71)	66 (84)	49 (69)	52 (60)
Alcohol Use	154 (65)	44 (56)	44 (62)	66 (77)
Ever IDU	74 (31)	29 (37)	21 (30)	24 (28)
IDU in the past 12 months	42 (18)	14 (18)	15 (21)	13 (15)
Insurance Status				
Any	138 (58)	49 (62)	43 (61)	46 (53)
None	98 (42)	30 (38)	28 (39)	40 (47)
Not Completed High School	107 (45)	37 (47)	38 (54)	32 (37)
Unstable Housing Status	110 (47)	33 (42)	32 (45)	45 (52)
Household Food Insecurity				
None (0)	107 (45)	37 (47)	30 (42)	40 (47)
Mild (0-2)	27 (11)	9 (11)	11 (15)	7 (8)
Moderate (2-11)	55 (23)	14 (18)	17 (24)	24 (28)
Severe (>11)	47 (20)	19 (24)	13 (18)	15 (17)
Perceived Health Care Discrimination	61 (26)	21 (27)	16 (23)	24 (28)
Medical Mistrust Score	29.5 (7.75)	29.5 (8.32)	29.1 (7.75)	29.8 (7.26)
>36	36 (15)	15 (19)	7 (10)	14 (16)
<=36	200 (85)	64 (81)	64 (90)	72 (84)
Viral Load+	56,477 (221,261)	73,604 (321,725)	53,214 (230,360)	37,662.5 (179,526)
≤200 copies/mL	16 (7)	6 (8)	4 (6)	6 (7)
>200 copies/mL	220 (93)	73 (92)	67 (94)	80 (93)
CD4 Count+	113 (236)	95 (252)	136 (234)	100.5 (228)
≤200	151 (64)	49 (62)	45 (63)	57 (66)
>200	85 (36)	30 (38)	26 (37)	29 (34)

Abbreviation: IDU, Injection Drug Use

All values are listed as N (%) or as mean (standard deviation)

+HIV viral load, and CD4 Count are reported as median (IQR)

*Note: patients could be eligible for the study by more than one criterion

Table 7. Sensitivity analysis comparing participants with missing income to participants with low or high income, Project HOPE (N=801).

Demographic	**Low Income (N=151)**	**High Income (N=414)**	**Missing Income (N=236)**	**P-value**
Age <45 years	74 (49)	176 (43)	99 (42)	0.79
Female	22 (15)	148 (36)	91 (39)	<0.0001
Ethnicity				0.96
Black	90 (60)	305 (74)	184 (79)	
White	29 (19)	48 (12)	20 (9)	
Hispanic	24 (16)	43 (10)	17 (7)	
Other	7 (5)	18 (4)	13 (6)	
Eligibility due to*				
Drug Use	99 (66)	347 (84)	167 (71)	0.72
Alcohol Use	96 (64)	221 (53)	154 (65)	0.40
Ever IDU	38 (25)	148 (36)	74 (31)	0.36
IDU in the Past 12 Months	21 (14)	84 (20)	42 (18)	0.47
Had Some Insurance	97 (64)	299 (72)	138 (58)	0.01
Not Completed High School	28 (19)	184 (44)	107 (45)	<0.0001
Unstable Housing Status	41 (27)	206 (50)	110 (47)	0.001
Household Food Insecurity				0.34
None (0)	66 (44)	154 (37)	107 (45)	
Mild (0-2)	20 (13)	42 (10)	27 (11)	
Moderate (2-11)	26 (17)	110 (27)	55 (23)	
Severe (>11)	39 (26)	108 (26)	47 (20)	
Perceived Health Care Discrimination	42 (28)	129 (31)	61 (26)	0.47
Medical Mistrust >36	26 (17)	66 (16)	36 (15)	0.62
Viral Load >200 copies/mL	136 (90)	358 (86)	220 (93)	0.17
CD4 Count ≤200	110 (73)	273 (66)	151 (64)	0.09

Abbreviation: IDU, Injection Drug Use

All values are listed as N (%). Low and high income defined as an annual income of ≤$10,000 or >$10,000, respectively.

*Note: patients could be eligible for the study by more than one criterion