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Predictors of Linkage to HIV Care and Viral Suppression Levels Following Release from Jails and Prisons: A Retrospective Cohort Study

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Contributors

KBL obtained funding for the project and designed the study, with guidance from FLA and JPM. KBL conducted all data analyses with guidance from and data interpretation by FLA, MMD, MMC, CG, and JPM. KBL drafted primary versions of the manuscript, with input from FLA, MMD, MMC, CG, and JPM. All authors have contributed significantly to the work and reviewed and approved the final version for submission.

Declaration of interests

We declare that we have no conflicts of interest.

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Summary

Background—Incarceration can offer the opportunity for HIV care engagement, but is associated with poor HIV treatment outcomes after release. This study comprehensively assesses post-release linkage to HIV care (LTC) and the impact of transitional case management services.

Methods—To create a retrospective cohort of all adults with HIV released from Connecticut jails and prisons (2007–2014), we linked administrative custody and pharmacy databases with mandatory HIV/AIDS surveillance monitoring and case management data. We examined time to LTC (defined as first post-release HIV-1 RNA level) and viral suppression at time of LTC. Generalized estimating equations identified predictors of LTC within 14 and 30 days post-release.

Findings—Among 3,302 incarceration periods for 1,350 individuals, 21.1% (n=672/3181) and 34.0% (n=1042/3064) had LTC within 14 and 30 days post-release, respectively, and 28.9% (n=301/1042) had detectable viral levels at LTC. Factors positively associated with 14-day LTC included intermediate incarceration duration (31–364 days), year of release, transitional case management (reported in 34.2% [n=1128/3302] of releases), receipt of within-prison antiretroviral medications, and higher medical co-morbidity. Re-incarceration and conditional release were negatively associated with LTC. Race/ethnicity, bonded release, and psychiatric co-morbidity were additionally associated with 30-day LTC, but re-incarceration was not.

Interpretation—LTC post-release is suboptimal but improves when inmates' medical, psychiatric, and case management needs are identified and addressed before release. Persons rapidly cycling through jail facilities are particularly vulnerable to missed linkage opportunities. Aligning justice and healthcare goals through integrated programming has great potential to improve long-term HIV treatment outcomes.

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Introduction

The United States has the highest incarceration rate globally (910 per 100,000 adults), concentrating people with both substance use disorders (SUDs) and HIV (1, 2). Annually, twelve million people transition from prisons and jails to communities, with one-sixth of the 1.2 million people living with HIV (PLH) passing through these settings (3). Criminal justice (CJ) settings are highly structured and can be positioned to diagnose, engage, and treat PLH with antiretroviral therapy (ART), which reduces within-prison morbidity and mortality (4, 5). Short-term detentions within and release from jails, however, are destabilizing and can undermine HIV treatment outcomes (6–8). Recidivism is often influenced by untreated SUDs and psychiatric disorders and can also negatively impact engagement in HIV care, resulting in suboptimal viral suppression (5–7, 9). Yet the longitudinal impact of incarceration and community reentry on continuity of HIV care remains poorly understood in part because prior observational studies have relied on either CJ or community data with limited ability to comprehensively link these two administrative sources.

Along the HIV care continuum towards viral suppression, linkage to community-based HIV care (LTC) is an early critical step (10). When transition is planned, PLH are often provided 10–30 days of ART, relying on community clinics to assume care thereafter. Medication refills typically require clinical assessment, including laboratory monitoring. Prior studies show that up to 80% of PLH released from prison fail to access ART medications within this timeframe, but it is unknown how this impacts LTC and viral suppression rates (11, 12). Moreover, none of these studies have evaluated enabling resources, such as case management, that may facilitate utilization of healthcare services during this transition. This study examines factors related to LTC post-release by evaluating a large cohort of PLH over an extended time period where viral loads (VL) drawn in both custodial and community settings are available and in a state where all healthcare delivery is integrated.

Methods

Study population

In 2013, the average daily census in the Connecticut Department of Correction (CTDOC) was 17,600 inmates (620 incarcerations per 100,000 adults) in 16 facilities, representing the highest incarceration rate in the Northeast (1). As one of six integrated CJ systems nationally, facilities house both sentenced and pre-trial detainees, and utilize a single healthcare provider, ensuring consistent delivery of medical treatment and other services.

All HIV testing in the CTDOC is voluntary, and HIV prevalence is 1.7%. After confirming HIV status, on-site HIV specialists prescribe guideline-concordant ART (10). Specialty nurses coordinate HIV care and referrals for assessment and treatment of psychiatric disorders. The CTDOC may also refer PLH for “transitional LTC” case management (TCM) services, initiated within 30 days before planned release and continued for up to 60 days post-release; they assist with transitional needs like housing, re-activation of medical insurance, and linkage to a community provider (13). Pre-trial detainees seldom receive TCM services. Upon release, PLH may receive a pharmacy voucher for 14 days of medications, including ART.

Individuals included in our final analysis met the following criteria (Figure 1): 1) adults ≥18 years old with confirmed HIV; 2) included in all administrative databases; 3) incarcerated in Connecticut at least once for ≥24 hours; and 4) released before the end of the 8-year observation period (January 1, 2007 – December 31, 2014).

Data sources

We merged two CTDOC and two Connecticut Department of Public Health (CTDPH) data sources for analyses. CTDOC sources (2007–2015) included: 1) a custody database (demographics, entry and release dates, CJ conditions of release, health severity levels); and 2) a pharmacy database (all medications prescribed during incarceration, including ART). CTDPH data sources (2006–2014) included the: 1) enhanced HIV/AIDS Reporting System (eHARS) surveillance database that has mandatory laboratory reporting for HIV; and 2) CAREWARE TCM services database. With verified ≥95% completeness, Connecticut’s eHARS includes all longitudinal HIV-1 RNA monitoring data for all PLH from 2007

onwards, regardless of testing site (14). eHARS is cross-referenced with the National Death Index and Social Security databases for mortality and treatment outcomes outside Connecticut. AIDS service organizations use the CAREWare database, overseen by the CTDPH, to record any TCM provided according to required benchmarks; funding is based on services provided (15). Services provided through other community providers are not consistently available in CAREWare.

The CTDOC securely transferred their databases to the CTDPH, where on-site data managers used the Plus Link probabilistic record linkage program to match individuals using inmate number, name, and birthdate (16). The dataset was further restricted to PLH currently living in Connecticut. After merging, personal identifiers were removed and a de-identified database was provided for analysis. Institutional review boards at Yale University and CTDPH and the CTDOC Research Advisory Committee approved all procedures.

Study design

In this retrospective cohort study, we assessed LTC, defined as the first VL measured in the community, during the first year post-release. Recorded VLs serve as a proxy for routine HIV clinical care visits (both within the CTDOC and in the community) (17). After release, laboratory testing is often required before prescription refill because clinical data are not shared between CTDOC and community providers in real-time. CD4 data were not used because only AIDS-defining CD4 counts were reliably reported to CTDPH during the study observation period. As a secondary outcome, we defined viral suppression at the time of LTC as <400 copies/mL (4, 10). To avoid interruptions in ART, transitioning PLH must access care within 14–30 days. Thus, our primary outcomes were LTC within these two post-release timeframes (14 and 30 days).

We selected covariates based on the Behavioral Model for Vulnerable Populations adapted for CJ populations, which posits that an individual has predisposing, enabling or disabling, and need severity factors that impact healthcare utilization (18). Unlike most factors, enabling resources during community reintegration are most potentially amenable to intervention.

Predisposing factors—*Predisposing factors* included demographic information like age, sex, race/ethnicity, highest level of education attained, and marital status. Injection drug use (IDU) was based on the CTDPH original report for HIV exposure. Duration of HIV infection was calculated by subtracting HIV diagnosis dates from release dates.

Enabling/disabling factors—Using dates and types of movements into and out of facilities, we calculated length of incarceration as time spent in any CTDOC facility, and analyzed it continuously and categorically. In general, ≤30-day incarcerations took place in jail facilities, intermediate incarcerations of 31–364 days often included time spent in both jail and prison, and ≥365 day incarcerations included only sentenced prisoners. Recidivists (binary) were defined as those who were re-incarcerated at least once over the 8-year period. We categorized conditions of release as unsupervised, conditional release (to community-based supervision like parole or transitional housing), or bonded release. From CAREWare, we used dates of pre- and post-release encounters with case managers to create a

dichotomous variable for receipt of TCM within 90 days pre-release and/or 14–30 days post-release.

Need factors—We defined viral suppression within 90 days before release as VL<400 copies/mL. Using pharmacy data, we assigned medications to the incarceration periods in which they were prescribed. Receipt of ART at any point during incarceration was coded dichotomously. We categorized additional medications into those for opioid use disorder (i.e., methadone, buprenorphine, or naltrexone, which were only available for brief supervised withdrawal), psychiatric disease (i.e., antipsychotics, antidepressants, or other neuropsychiatric medications), or other medical co-morbidities, which were all coded dichotomously. We further categorized medical co-morbidity by summing the number of medical conditions other than HIV requiring medication during the incarceration period, consistent with a co-morbidity index that reflects the burden of cumulative conditions in an individual.

Upon intake, CTDOC medical staff assign a psychiatric and addiction severity score (scale 1–5) to indicate level of service needs. These intake classification scores are used to determine the types of clinical care needed during incarceration and anticipated need for psychiatric and SUD treatment referrals upon release. We dichotomized psychiatric scores as 1–2 (low severity: no psychiatric history or a history of a currently inactive disorder not requiring treatment) vs. 3–5 (higher severity: mild, moderate, or severe disorder). A score of 4 indicated a need for special services and pharmacologic treatment and 5 indicated a crisis-level psychiatric disorder requiring close supervision or intensive support. Addiction scores of 3 indicated a moderate SUD requiring treatment, with scores 4–5 indicating a serious SUD requiring residential or intensive outpatient treatment. For individuals for whom severity scores were measured multiple times during a single incarceration period, we used the maximum score, representing the greatest overall severity for that incarceration period. Further information on psychiatric and SUD diagnoses was not available. To better reflect whether an inmate was identified as having a psychiatric issue and whether treatment was provided, the psychiatric severity score and treatment variables were combined to create a four-level categorical psychiatric need variable (1: low severity, untreated; 2: low severity, treated; 3: high severity, untreated; 4: high severity, treated).

Statistical analysis

The unit of analysis was a post-release period rather than an individual because most individuals had multiple incarcerations and post-release periods. We defined post-release periods as the time between the first day of (any type of) release from a CTDOC facility and the individual's death, re-incarceration, or end of the observation period. For individuals with more than one incarceration, we examined each post-release period separately using generalized estimating equations (GEE) for binary outcomes to account for intra-subject correlation. Each post-release period included demographic characteristics of the individual and the characteristics of the incarceration and post-release period itself. We first described LTC within 14- and 30-day time periods following release. We then evaluated unadjusted predictors of having LTC within 14 and 30 days after release. Variables with bivariate associations of $p<0.20$ were included in the respective full multivariable model. Using

backward selection, final parsimonious models included all variables with multivariable *p*-values <0.10. Because individuals on average were incarcerated fewer than 3 times during the observation period, we assumed the m-dependent correlation structure with m=3, which allowed for a correlation between the first three repeated measures and also minimized the quasi-likelihood under the independence model criterion (QIC). Findings were robust to changes in correlation structure. Sensitivity analyses exploring associations between addiction severity score, IDU risk, conditional release, re-incarceration, and incarceration duration found no significant collinearities or interactions that required inclusion. Age was initially modeled as continuous but ultimately dichotomized at the sample median for model fit. "Years since HIV diagnosis" was modeled both continuously and categorically based on quartiles and multiple clinically significant time points, but demonstrated a linear trend and was ultimately modeled as continuous. All analyses were performed using SAS version 9·4 (SAS Institute Inc.).

Role of the funding source

The funders played no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all study data and had final responsibility for the decision to submit for publication.

Results

Description of post-release periods

Of 3,302 eligible post-release periods, most were over 45 years old at the time of release (52.4% [n=1729]), male (77.6% [n=2562]), racial/ethnic minorities (82.7% [n=2731]), and unmarried (86.4% [n=2752/3184]). Most (70.2% [n=2317]) HIV infections were related to IDU and the median time since HIV diagnosis was 12.7 years (interquartile range [IQR]: 6.8–18.0).

On average, inmates were incarcerated 2.5 (± 2.0) times during the 8-year observation period. Median incarceration lengths and post-release periods were 73 (IQR: 25-201) and 296 (IQR: 104-817) days, respectively. There were 179 post-release periods during which the observed individual died. Most (60.7% [n=2003]) post-release periods were unsupervised. At least one TCM visit was recorded for 34.2% (n=1128) of periods, with 29.1% (n=962) having both pre- and post-release visits. During 66.4% (n=2191) and 39.0% (n=1287) of incarceration periods, respectively, inmates were prescribed ART and achieved pre-release viral suppression. Provision of TCM services, pre-release ART prescription, and viral suppression levels were higher for more contemporary releases (Supplementary Table 1).

In 55.1% (n=1818) of incarceration periods, individuals were solely being treated with ART, while 20.2% (n=668) had multiple medical co-morbidities. Almost half (45.3% [n=1497]) had low psychiatric severity scores on intake and never received any psychiatric medication, while 31.7% (n=1048) had high scores and received treatment. Addiction severity scores were high in 18.2% (n=591/3247) of periods, and 1.5% (n=50/3302) included medication prescriptions for an opioid use disorder.

Time to linkage to care and viral suppression

One-fifth of post-release periods involved LTC within 14 days after release, at which time 25.7% had a detectable VL (Figure 2). When the post-release time frame was extended to 30 days, an additional 12.9% had LTC (34.0% total), among which 33.5% had a detectable VL. By 90 days post-release, 60.7% of post-release periods involved LTC, but among the 26.5% of the sample that accessed care solely within the 31–90 day window, 38.9% had detectable virus. The proportion with detectable levels rose to 59.8% when the first VL assessed was between 6–12 months after release.

Factors associated with linkage to care within 14 days

In the 14-day multivariable model (Table 1), there were no significant predisposing factors that independently predicted LTC. Enabling resources that improved LTC included intermediate incarceration duration (31–364 days, but not longer) and receipt of TCM. Re-incarceration and conditional release were negatively associated with LTC. Two need factors were associated with LTC: receipt of ART during incarceration and having higher medical co-morbidity.

Factors associated with linkage to care within 30 days

In Table 2, age >45 years and Hispanic ethnicity were predisposing factors that predicted LTC with borderline statistical significance. Enabling resources again included intermediate incarceration duration (31–364 days) and TCM. Conditional release (including bonded release) was negatively associated with 30-day LTC, but re-incarceration no longer remained significant. Releases in 2009–2010 had higher odds of 30-day LTC than 2007–2008 releases, but in a sensitivity analysis restricting the sample to 2009–2014 and excluding year of release as a covariate, findings were robust. Need factors, including pre-release treatment with ART, higher medical co-morbidity, and higher psychiatric severity, also predicted LTC.

Discussion

To our knowledge, this is the largest and most complete cohort of PLH transitioning from prison or jail to communities. LTC post-release is extraordinarily low: 21% by 14 days and 34% by 30 days – critical times when PLH must access post-release care. By 6 months, 76% had at least one VL recorded, which suggests a gradual increase in LTC over time, but does not infer treatment retention after initial linkage. Incarceration experiences, including duration, conditions of release, and medical and psychiatric care, significantly influenced likelihood of LTC, as did TCM.

Using a validated healthcare utilization framework, integrated databases allowed us to examine the effect of factors that might influence LTC, especially TCM. PLH who are isolated from systems of structural and social support or unable to navigate resources are more likely to engage in high-risk HIV behaviors, relapse to substance use, be re-incarcerated, and default from ART (19, 20). TCM aims to mitigate some of these issues and better position PLH to engage in healthcare after release (21, 22). Jail-based longitudinal demonstration projects have found TCM to improve HIV treatment outcomes, but lacked a control group (21–24). While prospective trials show no benefit of TCM interventions on

post-release outcomes, the control groups received pre-release discharge planning or "standard of care" TCM, which may have been sufficient (25–27).

These trials were also not designed to target high-risk PLH who are most likely to benefit from such services and were conducted in settings that may have lacked enabling resources (e.g., housing, addiction treatment) amenable to TCM intervention. Findings from this observational study in a real-world setting suggest that TCM is beneficial for LTC, but is not applied universally (only 34% of releases involved TCM, and unsentenced inmates were rarely eligible). Expanded TCM programming combined with an increase in CTDOC referrals could considerably improve LTC. When resources are limited, however, TCM should be targeted to those who need them most, especially those with short-term detentions and conditional releases.

We found that the duration and frequency of detention in prison/jail impacts continuity of HIV care. Short-term detentions (≤30 days) are especially destabilizing, likely due to the social and legal ramifications of CJ-involvement combined with an interruption in HIV care. Incarceration, especially within the first year after starting ART, predicts ART non-adherence and virologic failure (6, 28). Incarceration also has a dose-dependent negative effect on ART adherence (9). Once incarcerated, however, and when appropriate resources are applied, PLH detained for longer are more likely to achieve viral suppression than those with shorter incarcerations (6, 28). Though modeling studies suggest that eliminating incarceration of high-risk individuals would reduce HIV incidence, in settings where policies still promote incarceration of such individuals, PLH with longer incarcerations can be stabilized on effective ART and provided sufficient time to have their post-release needs identified and addressed (2, 4). For PLH who are otherwise unable to access or navigate community-based resources, CJ facilities may inadvertently serve as "medical homes", particularly during longer incarcerations where discharge planning can occur much like that provided in hospital settings (4). Incarcerations over one year, however, may compromise self-sufficiency, which creates additional barriers to community reintegration (29, 30). The majority of inmates eventually return to communities and, while incarceration may be an opportunity to engage PLH in care, frequent or brief re-incarcerations are disruptive and detrimental to LTC. PLH who frequently and rapidly cycle through CJ systems should be targeted for intensive medical and TCM services.

Contrary to previous findings showing a positive association between supervised release and filling an ART prescription, we found that conditional release was associated with poor LTC (12). PLH conditionally released on parole, bond, or to transitional housing may face numerous health and legal challenges that can undermine LTC (19, 20). Conditional release may be disabling in that it imposes legal obligations that limit autonomy, adds to reintegration responsibilities, and competes with healthcare priorities during the post-release period. PLH released under conditions, especially bond, are more likely to have shorter incarceration periods with fewer opportunities to be receive ART or TCM prior to release, though we controlled for these associations in our multivariable models. Although TCM is available through parole offices, it is not well integrated into the supervision plan. Thus, conditional release is an important but missed opportunity to align public health and safety by integrating TCM into supervision plans and connecting PLH to care (23).

Receiving ART while incarcerated predicted post-release LTC (31, 32). Although ART was prescribed in only 66% of all incarcerations, prescription increased during more contemporary incarcerations. Reasons for these temporal changes are multifactorial and include changes in guidelines favoring treatment and simplified and more tolerable ART regimens. Moreover, PLH incarcerated for shorter periods, even if prescribed ART, may not have achieved viral suppression before release. In addition to ART, PLH who were treated for medical or psychiatric co-morbidities were also more likely to have LTC post-release, perhaps because of their flagged need for continuity of care and potentially more comprehensive discharge planning (22, 33). Psychiatric care may also serve as a conduit to general health and HIV care. In the United States, CJ systems are often disjointed and managed by various jurisdictions. While some CJ facilities may already have effective strategies to identify vulnerable PLH and connect them to services in the community, there needs to be more consistency in identifying healthcare and social needs immediately on CJ intake, followed by effective TCM targeted to people with greatest need (21). In the setting of national healthcare reform, TCM could help enroll inmates in expanded Medicaid/Medicare programs prior to release.

While multiple combined datasets allowed a comprehensive assessment of LTC, including viral suppression rates, clinical and treatment data, and potential explanatory factors, we acknowledge some limitations inherent to this secondary data analysis. Because CTDOC data were collected for custodial purposes, they missed granularity for some patient-level factors, such as housing status, medical insurance coverage, and substance use; addiction severity scores were our best proxy for current SUDs. The use of VL as the primary indicator of LTC may underrepresent LTC, especially if laboratory testing was provided just prior to release. That 60% of the released inmates who linked to care 91–180 days post-release were virally suppressed suggests that some people continued to receive ART and/or clinical care without reported VL monitoring. For example, some PLH with short incarceration periods may have prior active prescriptions and refills that were not discontinued during their incarceration, allowing them to delay seeking medical care after release. Previous studies using clinic data, however, relied on databases that do not include all PLH in the state and have documented inconsistencies in the accuracy and completeness of data (15, 31, 34). In contrast, our use of reliably reported biological data allowed for a direct and verifiable analysis of post-release LTC and viral suppression. Moreover, we included data on short-term detentions, which are not available in most studies of prisoners because most jail and prison systems are not integrated. More complete databases, reliable subject matching, and CTDPH database managers with extensive experience merging data mitigated challenges common in database linkage studies. While these findings are not generalizable to all CJ settings, they can inform directions for intervention in settings with similar syndemics including HIV, incarceration, SUDs, and psychiatric disorders.

As the first comprehensive, statewide, longitudinal study assessing LTC and viral suppression following release from prison or jail, this study informs health policy targeting at-risk, CJ-involved PLH. It lays groundwork for future studies that use “big data” to assess and improve HIV treatment outcomes, including data-to-care strategies that position health authorities to intervene when patients are out-of-care (35). Our findings indicate that CJ systems can provide highly effective healthcare resources to PLH during and following

incarceration to achieve UNAIDS targets for optimizing care and ending the global HIV pandemic. Yet the potential long-term benefit of these resources is limited by the fragmented nature of CJ systems and segregation between penal and healthcare priorities after release. Comprehensive discharge planning and TCM for PLH should begin immediately after intake into facilities and center on integration of public safety and health. The most cost-effective, ethical, and beneficial strategy for preserving HIV continuity of care, however, is likely to avoid incarceration altogether.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Panel: Research in Context

Evidence before this study

We searched PubMed for original research articles published between Jan 1, 2000, and August 25, 2017, using the following MeSH terms: [“prison”, “jail”, or “incarceration”] AND [“HIV”] AND [“treatment”, “outcomes”, “linkage to care”, or “retention in care”]. We identified 19 North American studies that examined outcomes for people living with HIV (PLH) released from criminal justice (CJ) settings. Findings show that a history of CJ involvement, recidivism, and detention for short periods are associated with poor HIV treatment outcomes (e.g., failure to engage in care, medication non-adherence, or virologic failure) in the community. Antiretroviral therapy (ART) provided during incarceration results in high viral suppression rates but studies of recidivists show that benefits do not persist after release. Three studies assessed post-release linkage to HIV care (LTC) by matching multiple pre-existing databases; ≤20% visited an HIV clinic or filled ART prescriptions within the 30-day post-release window necessary to avoid treatment interruption, and <50% had a clinic visit within 90 days. Major limitations included incomplete reporting of clinic visits and inability to assess viral suppression. A supplementary search by adding the MeSH term “case management” identified 14 publications. Jail-based demonstration projects showed that case management provided during community re-entry can improve post-release HIV treatment outcomes, yet three prison-based randomized controlled trials did not demonstrate a clear benefit.

Added value of this study

This study innovatively combines administrative statewide CJ, pharmacy, clinical, and objective HIV surveillance data in a state where custody data includes both prisoners and jail detainees and delivery of care is integrated. Additionally, this study uses a validated healthcare utilization framework, the Behavioral Model for Vulnerable Populations, to better assess factors associated with LTC. Prior studies have failed to explain how complex interactions with the CJ system (e.g., conditional release, short-term detentions) influence HIV treatment outcomes. This study is not limited by incomplete databases, loss to follow-up, recall or social desirability bias, or sample restrictions to recidivists, PLH actively taking ART, or other sub-populations of inmates (e.g., jail detainees vs. sentenced prisoners). Here, viral load provides an objective surrogate for LTC, verified through mandatory reporting from all certified laboratories in the entire state over an observation period of eight years. This is the first comprehensive, statewide assessment of post-release LTC and viral suppression for all CJ-involved PLH. It is also the first to objectively assess, in a real-world CJ setting, the impact of transitional case management services on HIV treatment outcomes.

Implications of all the available evidence

Previous studies show that CJ-involved PLH can achieve viral suppression during incarceration but, for reasons yet unclear, demonstrate poor HIV-related health outcomes after release. There has also been conflicting evidence on the effectiveness of transitional case management services in improving longitudinal HIV treatment outcomes. By comprehensively assessing post-release LTC for all CJ-involved PLH in Connecticut,

USA using multiple administrative databases, this study confirms that LTC is suboptimal, but identifies salient targets for intervention. We show that the consistent targeted provision of transitional case management and integration of healthcare and CJ services are key to improving HIV treatment outcomes during and following the transition to community settings.

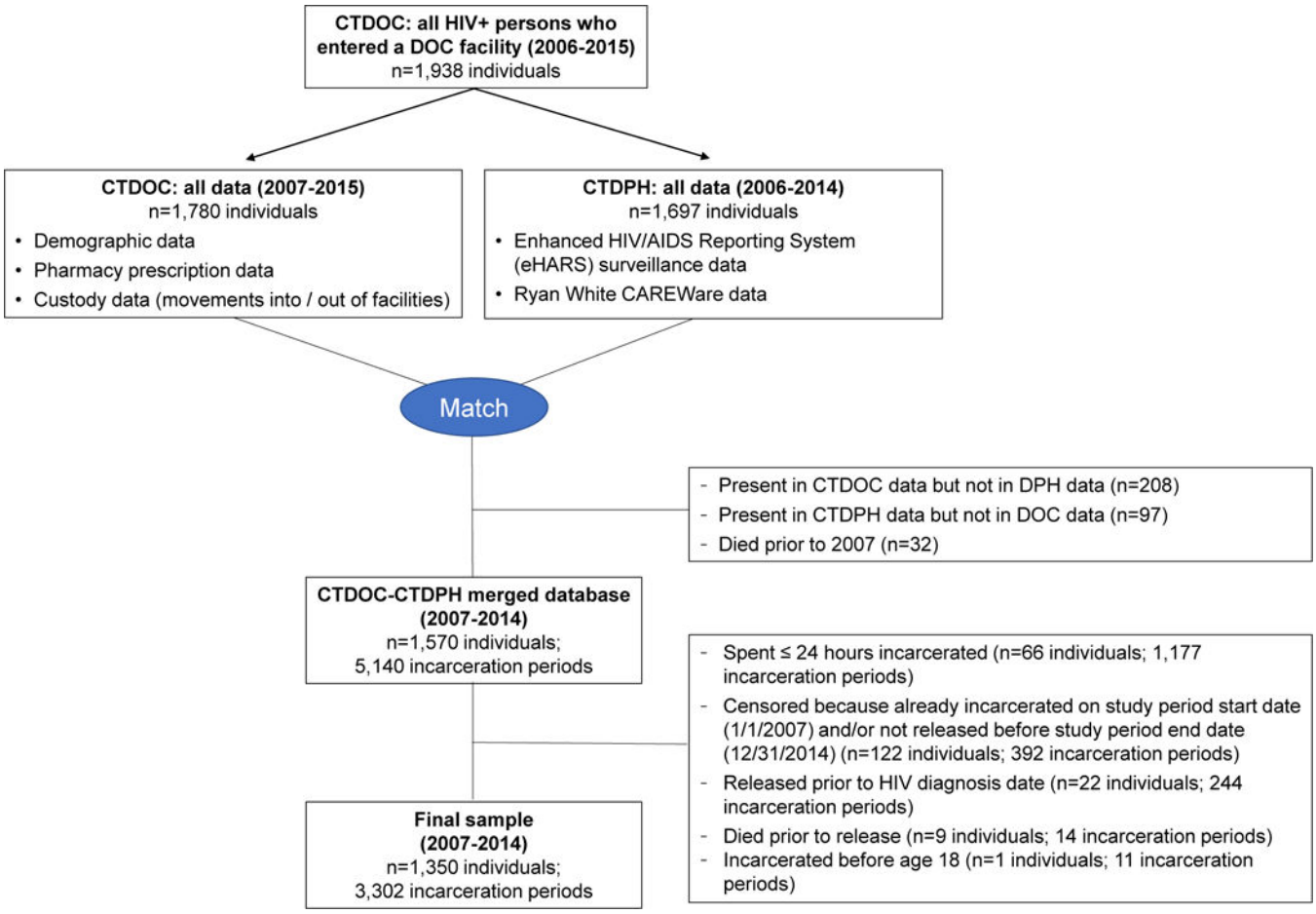
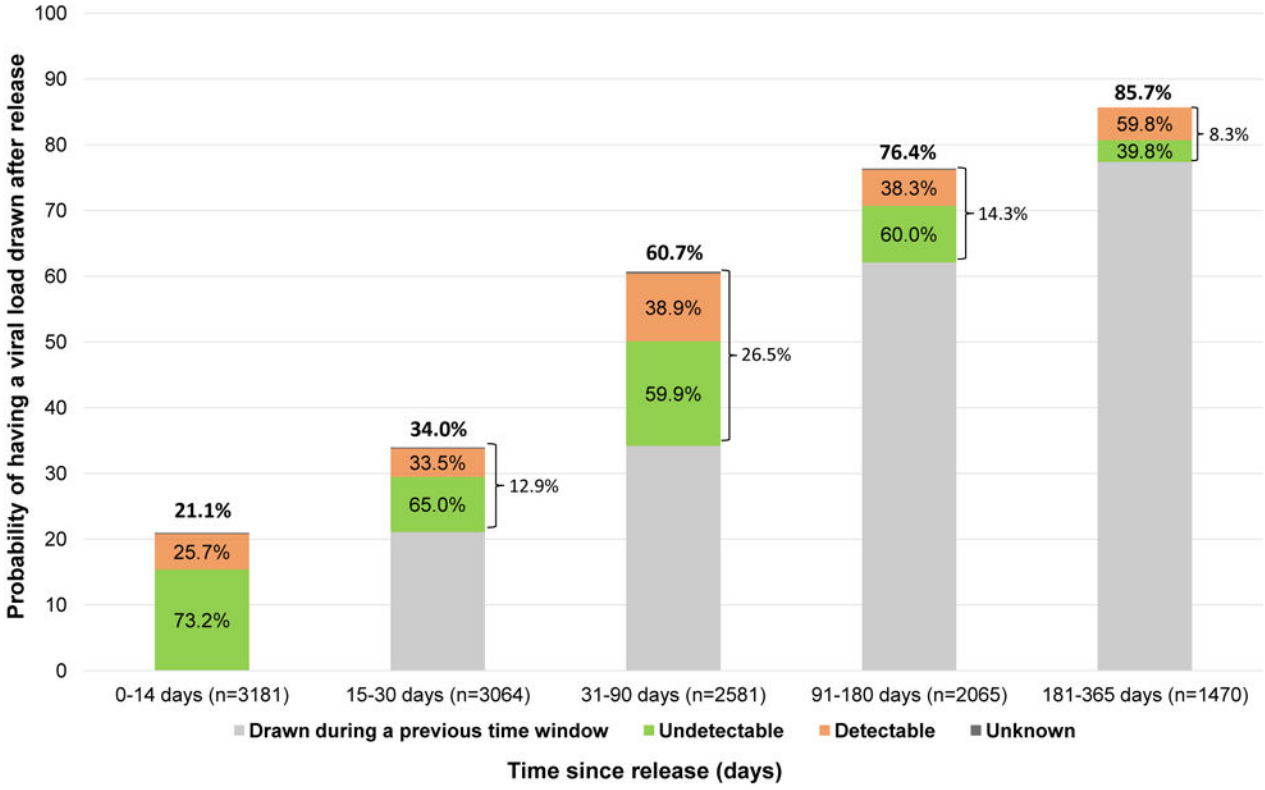


Figure 1. Consort Diagram

CTDOC: Connecticut Department of Correction; CTDPH: Connecticut Department of Public Health.



Time since release	0-14 days	15-30 days	31-90 days	91-180 days	181-365 days
N, cases eligible for analysis	3181	3064	2581	2065	1470
% of total cases with first viral load drawn during the post-release time window	21.1% (672/3181)	12.9% (394/3064)	26.5% (683/2581)	14.3% (295/2065)	8.3% (122/1470)
% with ≥400 viral copies/mL at time of first viral load *	25.7% (173/672)	33.5% (132/394)	38.9% (266/683)	38.3% (113/295)	59.8% (73/122)
% with <400 viral copies/mL at time of first viral load *	73.2% (492/672)	65.0% (256/394)	59.9% (409/683)	60.0% (177/295)	39.8% (49/122)
% of total cases with first viral load drawn during an earlier time window	Not applicable	21.1% (648/3064)	34.2% (883/2581)	62.1% (1282/2065)	77.4% (1138/1470)

* Total N (%) may not sum to 100% due to a small number (<2%) of viral load values being unreported (unknown) during each time window.

Figure 2.

Time to linkage to care as measured by first HIV RNA viral load drawn after release from prison or jail

Table 1

Binomial generalized estimating equations model assessing factors associated with having a viral load drawn within 14 days after release, adjusting for intra-subject correlation [a]

Variable	n (%)[b]	Unadjusted Model OR (95% CI)	*p*-value	Full Adjusted Model OR (95% CI)	*p*-value	Parsimonious Adjusted Model OR (95% CI)	*p*-value
Predisposing factors							
Age at time of release							
≤ 45 years	1516 (47.7%)	referent		referent			
> 45 years	1665 (52.3%)	1.35 (1.12–1.63)	**0.001**	1.15 (0.93–1.42)	0.19		
Sex[c]							
Female	717 (22.5%)	referent					
Male	2464 (77.5%)	0.93 (0.75–1.16)	0.53				
Race/Ethnicity							
White	553 (17.4%)	referent					
Black	1326 (41.7%)	0.94 (0.71–1.23)	0.65				
Hispanic	1185 (37.3%)	1.16 (0.88–1.53)	0.29				
Other	117 (3.7%)	0.89 (0.56–1.42)	0.63				
Education level							
< High school	1451 (45.6%)	referent					
≥ High school	1730 (54.4%)	0.89 (0.74–1.07)	0.22				
Marital status[d]							
Not married	2651 (86.5%)	referent					
Married	413 (13.5%)	0.93 (0.71–1.21)	0.58				
Injection drug use-related HIV risk							
No	955 (30.0%)	referent		referent			
Yes	2226 (70.0%)	1.28 (1.04–1.58)	**0.02**	1.14 (0.91–1.42)	0.27		
Years since HIV diagnosis (median, interquartile range)	12.6						

Variable	n (%)[b]	Unadjusted Model OR (95% CI)	*p*-value	Full Adjusted Model OR (95% CI)	*p*-value	Parsimonious Adjusted Model OR (95% CI)	*p*-value
Continuous (years)	(6.7–17.8)	1.02 (1.00–1.03)	**0.02**	1.00 (0.99–1.02)	0.88		
Enabling or disabling factors							
Length of incarceration							
≤ 30 days	974 (30.6%)	referent		referent		referent	
31–364 days	1798 (56.5%)	2.11 (1.71–2.59)	**<0.0001**	1.52 (1.18–1.96)	**0 001**	1.52 (1.19–1.95)	**0.001**
≥ 365 days	409 (12.9%)	2.07 (1.55–2.76)	**<0.0001**	1.27 (0.89–1.81)	0.18	1.25 (0.88–1.78)	0.20
Re-incarcerated							
No	582 (18.3%)	referent		referent		referent	
Yes	2599 (81.7%)	0.78 (0.63–0.97)	**0.02**	0.71 (0.57–0.89)	**0.003**	0.70 (0.56–0.88)	**0.002**
Year of release							
2007–2008	818 (25.7%)	referent		referent		referent	
2009–2010	928 (29.2%)	1.48 (1.18–1.87)	**0.0009**	1.30 (1.01–1.66)	**0.04**	1.28 (1.00–1.64)	**0.05**
2011–2012	782 (24.6%)	1.71 (1.34–2.18)	**<0.0001**	1.24 (0.94–1.62)	0.13	1.22 (0.93–1.60)	0.14
2013–2014	653 (20.5%)	1.35 (1.03–1.76)	**0.03**	0.90 (0.66–1.23)	0.51	0.88 (0.65–1.18)	0.39
Conditions of release							
Unsupervised	1935 (60.8%)	referent		referent		referent	
Conditional release	836 (26.3%)	0.79 (0.65–0.97)	**0.03**	0.63 (0.50–0.78)	**<0.0001**	0.62 (0.50–0.78)	**<0.0001**
Released on bond	410 (12.9%)	0.46 (0.34–0.62)	**<0.0001**	0.77 (0.54–1.09)	0.14	0.75 (0.53–1.06)	0.11
Transitional case management received							
Neither pre-nor post-release	2109 (66.3%)	referent		referent		referent	
Pre-release, post-release, or both	1072 (33–7%)	2.00 (1.69–2.37)	**<0 0001**	1.64 (1.36–1.99)	**<0.0001**	1.65 (1.36–1.99)	**<0.0001**
Need factors							
Prescribed ART during incarceration							
No	1063 (33.4%)	referent		referent		referent	
Yes	2118 (66.6%)	2.02 (1.66–2.45)	**<0.0001**	1.35 (1.07–1.70)	**0.01**	1.39 (1.11–1.74)	**0.004**
Virally suppressed prior to release							

Variable	n (%)[b]	Unadjusted Model OR (95% CI)	*p*-value	Full Adjusted Model OR (95% CI)	*p*-value	Parsimonious Adjusted Model OR (95% CI)	*p*-value
No/viral load value not reported	1240 (39.0%)	referent		referent			
Yes	1247 (39.2%)	1.20 (1.00–1.44)	0.06	0.95 (0.77–1.17)	0.63		
Viral load not drawn prior to release	694 (21.8%)	0.74 (0.58–0.95)	**0.02**	0.86 (0.67–1.12)	0.27		
Number of medical co-morbidities other than HIV							
0	1751 (55.1%)	referent		referent		referent	
1	786 (24.7%)	1.49 (1.21–1.82)	**0.0002**	1.19 (0.95–1.49)	0.13	1.23 (0.98–1.54)	0.07
≥ 2	644 (20.3%)	2.26 (1.85–2.78)	**<0.0001**	1.77 (1.39–2.25)	**<0.0001**	1.86 (1.48–2.36)	**<0.0001**
Psychiatric need							
Low severity score, untreated	1446 (45.5%)	referent		referent			
Low severity score, treated	201 (6.3%)	1.52 (1.09–2.13)	**0.02**	1.18 (0.82–1.71)	0.38		
High severity score, untreated	527 (16.6%)	1.07 (0.82–1.40)	0.60	1.14 (0.87–1.49)	0.35		
High severity score, treated	1007 (31.7%)	1.52 (1.24–1.86)	**<0.0001**	1.15 (0.93–1.42)	0.19		
Addiction severity score[e]							
1–2	371 (11.9%)	referent		referent		referent	
3	2189 (70.0%)	1.70 (1.25–2.30)	**0.0006**	1.26 (0.92–1.73)	0.15	1.32 (0.97–1.81)	0.08
4–5	566 (18.1%)	2.05 (1.45–2.91)	**<0.0001**	1.33 (0.92–1.92)	0.13	1.41 (0.98–2.03)	0.06
Underwent supervised withdrawal for an opioid use disorder							
No	3135 (98.6%)	referent					
Yes	46 (1.5%)	1.04 (0.52–2.09)	0.91				

[a] Sample is restricted to individuals who spent at least 14 days in the community prior to re-incarceration or death. There were 3181 post-release periods (1347 individual-based clusters) eligible for analysis. In both the full model and final parsimonious model, there were 665/3126 (21.3%) post-release periods with a viral load drawn within 14 days.

[b] Numbers listed are n (%) or, for variables modeled as continuous, median (interquartile range). Percentages may not sum to 100% due to rounding.

[c] Incarceration periods for transgender males (n=6) and transgender females (n=5) have been included in the male and female categories, respectively.

[d] Incarceration periods for individuals with missing/unreported marital status (n=117) were excluded from the bivariate analysis such that total n=3064.

[e] Incarceration periods where the addiction severity score was never assessed (n=55) were excluded from the bivariate analysis such that total n=3126. Sensitivity analysis comparing full and final parsimonious models both including and excluding the addiction severity score variable did not significantly change the models.

Table 2

Binomial generalized estimating equations model assessing factors associated with having a viral load drawn within 30 days after release, adjusting for intra-subject correlation [a]

Variable	n (%)[b]	Unadjusted OR (95% CI)	*p*-value	Full Model Adjusted OR (95% CI)	*p*-value	Parsimonious Model Adjusted OR (95% CI)	*p*-value
Predisposing factors							
Age at time of release							
Age ≤ 45 years	1465 (47.8%)	referent		referent		referent	
Age > 45 years	1599 (52.2%)	1.26 (1.07–1.49)	**0.005**	1.16 (0.96–1.40)	0.12	1.18 (0.99–1.40)	0.07
Sex[c]							
Female	698 (22.8%)	referent					
Male	2366 (77.2%)	1.01 (0.82–1.23)	0.96				
Race/Ethnicity							
White	527 (17.2%)	referent		referent		referent	
Black	1266 (41.3%)	1.01 (0.79–1.30)	0.92	1.09 (0.84–1.42)	0.52	1.08 (0.83–1.40)	0.57
Hispanic	1158 (37.8%)	1.20 (0.94–1.54)	0.15	1.31 (1.00–1.70)	**0.05**	1.31 (1.01–1.70)	**0.046**
Other	113 (3.7%)	1.10 (0.69–1.77)	0.68	1.17 (0.74–1.87)	0.51	1.17 (0.73–1.85)	0.51
Education level							
< High school	1401 (45.7%)	referent					
≥ High school	1663 (54.3%)	0.93 (0.78–1.10)	0.38				
Marital status[d]							
Not married	2552 (86.5%)	referent					
Married	387 (13.5%)	1.01 (0.80–1.29)	0.91				
Injection drug use-related HIV risk							
No	924 (30.2%)	referent		referent			
Yes	2140 (69.8%)	1.22 (1.02–1.47)	**0.03**	1.04 (0.85–1.28)	0.68		
Years since HIV diagnosis (median, interquartile range)	125						

Variable	n (%)[b]	Unadjusted OR (95% CI)	*p*-value	Full Model Adjusted OR (95% CI)	*p*-value	Parsimonious Model Adjusted OR (95% CI)	*p*-value
Continuous (years)	(6.7–17.8)	1.02 (1.00–1.03)	**0.01**	1.00 (0.99–1.02)	0.90		
Enabling or disabling factors							
Length of incarceration							
≤ 30 days	926 (30.2%)	referent		referent		referent	
31–364 days	1741 (56.8%)	2.03 (1.71–2.42)	**<0.0001**	1.41 (1.14–1.74)	**0.002**	1.43 (1.16–1.76)	**0.001**
≥ 365 days	397 (13.0%)	2.02 (1.57–2.59)	**<0.0001**	1.18 (0.87–1.60)	0.28	1.20 (0.89–1.63)	0.23
Re-incarcerated							
No	577 (18.8%)	referent					
Yes	2487 (81.2%)	0.96 (0.79–1.17)	0.69				
Year of release							
2007–2008	791 (25.8%)	referent		referent		referent	
2009–2010	892 (29.1%)	1.52 (1.25–1.84)	**<0.0001**	1.29 (1.05–1.60)	**0.02**	1.30 (1.06–1.61)	**0.01**
2011–2012	752 (24.5%)	1.46 (1.18–1.80)	**0.0005**	1.00 (0.79–1.28)	0.98	1.02 (0.80–1.29)	0.87
2013–2014	629 (20.5%)	1.51 (1.21–1.88)	**0.0002**	1.01 (0–79–1.31)	0.91	1.00 (0.78–1.28)	1.00
Conditions of release							
Unsupervised	1868 (61.0%)	referent		referent		referent	
Conditional release	805 (26.3%)	0.97 (0.81–1.16)	0.75	0.79 (0.65–0.96)	**0.02**	0.79 (0.65–0.96)	**0.02**
Released on bond	391 (12.8%)	0.47 (0.36–0.60)	**<0.0001**	0.70 (0.53–0.94)	**0.02**	0.75 (0.56–0.99)	**0.04**
Transitional case management received							
Neither pre- nor post-release	2013 (65.7%)	referent		referent		referent	
Pre-release, post-release, or both	1051 (34.3%)	1.86 (1.60–2.17)	**<0.0001**	1.47 (1.24–1.74)	**<0.0001**	1.48 (1.25–1.76)	**<0.0001**
Need factors							
Prescribed ART during incarceration							
No	1029 (33.6%)	referent		referent		referent	
Yes	2035 (66.4%)	2.10 (1.77–2.49)	**<0.0001**	1.46 (1.18–1.81)	**0.0006**	1.53 (1.25–1.87)	**<0.0001**
Virally suppressed prior to release							

Variable	n (%)[b]	Unadjusted OR (95% CI)	*p*-value	Full Model Adjusted OR (95% CI)	*p*-value	Parsimonious Model Adjusted OR (95% CI)	*p*-value
No/viral load value not reported	1196 (39.0%)	referent		referent			
Yes	1198 (39.1%)	1.32 (1.12–1.56)	**0.001**	0.99 (0.83–1.21)	0.99		
Viral load not drawn prior to release	670 (21.9%)	0.87 (0.71–1.07)	0.18	0.98 (0.79–1.22)	0.87		
Number of medical co-morbidities other than HIV							
0	1684 (55.0%)	referent		referent		referent	
1	760 (24.8%)	1.43 (1.20–1.71)	**<0.0001**	1.15 (0.94–1.39)	0.18	1.13 (0.93–1.37)	0.21
≥ 2	620 (20.2%)	2.08 (1.71–2.53)	**<0.0001**	1.57 (1.25–1.97)	**<0.0001**	1.61 (1.29–2.02)	**<0.0001**
Psychiatric need							
Low severity score, untreated	1391 (45.4%)	referent		referent		referent	
Low severity score, treated	193 (6.3%)	1.75 (1.28–2.39)	**0.0004**	1.37 (0.98–1.91)	0.06	1.42 (1.03–1.98)	**0.03**
High severity score, untreated	509 (16.6%)	1.28 (1.03–1.61)	**0.03**	1.39 (1.09–1.76)	**0.01**	1.42 (1.12–1.80)	**0.003**
High severity score, treated	971 (31.7%)	1.61 (1.34–1.94)	**<0.0001**	1.26 (1.03–1.54)	**0.02**	1.28 (1.05–1.56)	**0.02**
Addiction severity score[e]							
1–2	363 (12.1%)	referent		referent			
3	2119 (70.4%)	1.53 (1.19–1.97)	**0.001**	1.16 (0.89–1.52)	0.27		
4–5	529 (17.6%)	1.91 (1.42–2.57)	**<0.0001**	1.28 (0.93–1.77)	0.12		
Underwent supervised withdrawal for an opioid use disorder							
No	3020 (98.6%)	referent					
Yes	44 (1.4%)	1.02 (0.54–1.92)	0.95				

[a]Sample is restricted to individuals who spent at least 30 days in the community prior to re-incarceration or death. There were 3064 post-release periods (1342 individual-based clusters) eligible for analysis. For the full model and final parsimonious model, respectively, there were 1031/3011 (34.2%) and 1042/3064 (34.0%) post-release periods with a viral load drawn within 30 days.

[b]Numbers listed are n (%) or, for variables modeled as continuous, median (interquartile range). Percentages may not sum to 100% due to rounding.

[c]Incarceration periods for transgender males (n=6) and transgender females (n=5) have been included in the male and female categories, respectively.

[d]Incarceration periods for individuals with missing/unreported marital status (n=115) were excluded from the bivariate analysis such that total n=2949.

[e]Incarceration periods where the addiction severity score was never assessed (n=53) were excluded from the bivariate analysis such that total n=3011.