Optimization of Human Immunodeficiency Virus Treatment During Incarceration
Viral Suppression at the Prison Gate

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IMPORTANCE Human immunodeficiency virus (HIV) management in correctional settings is logistically feasible, but HIV-related outcomes before release have not been recently systematically examined.

OBJECTIVE To evaluate HIV treatment outcomes throughout incarceration, including jail and prison.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort study of longitudinally linked demographic, pharmacy, and laboratory data on 882 prisoners within the Connecticut Department of Correction (2005-2012) with confirmed HIV infection, who were continually incarcerated 90 days or more, had at least 2 HIV-1 RNA and CD4 lymphocyte measurements, and were prescribed antiretroviral therapy.

MAIN OUTCOMES AND MEASURES Three electronic databases (correctional, laboratory, and pharmacy) were integrated to assess HIV viral suppression (HIV-1 RNA levels, <400 copies/mL) on intake and release. Secondary outcomes were mean change in log-transformed HIV-1 RNA levels and mean change in CD4 lymphocyte count during incarceration. Demographic characteristics, prescribed pharmacotherapies, receipt of directly observed therapy, and duration of incarceration were analyzed as possible explanatory variables for HIV viral suppression in logistic regression models.

RESULTS Among 882 HIV-infected prisoners with 1185 incarceration periods, mean HIV-1 RNA level decreased by 1.1 log_{10} and CD4 lymphocyte count increased by 98 cells/μL over time, with a higher proportion achieving viral suppression by release compared with entry (70.0% vs 29.8%; P < .001); 36.9% of antiretroviral therapy (ART) regimens were changed during incarceration. After adjusting for baseline HIV-1 RNA level, prerelease viral suppression correlated with female sex (adjusted odds ratio, 1.81; 95% CI, 1.26-2.59) and psychiatric disorder severity below the sample median (adjusted odds ratio, 1.50; 95% CI, 1.12-1.99), but not race/ethnicity, incarceration duration, ART regimen or dosing strategy, or directly observed therapy.

CONCLUSIONS AND RELEVANCE Though just one-third of HIV-infected prisoners receiving ART entered correctional facilities with viral suppression, HIV treatment was optimized during incarceration, resulting in the majority achieving viral suppression by release. Treatment for HIV within prison is facilitated by a highly structured environment and, when combined with simple well-tolerated ART regimens, can result in viral suppression during incarceration. In the absence of important and effective community-based resources, incarceration can be an opportunity of last resort to initiate continuous ART for individual health and, following the “treatment as prevention” paradigm, potentially reduce the likelihood of HIV transmission to others after release if continuity of HIV care is sustained.
Among the 1.2 million people living with human immunodeficiency virus (HIV)/AIDS (PLWHA) in the United States, one-sixth cycle through correctional settings annually, and HIV prevalence is 3-fold greater in prisons compared with community settings. The treatment needs of HIV-infected prisoners are protected by law, and HIV management in correctional settings can be acceptable, especially when under court supervision. In the United States, incarceration commonly affects individuals disenfranchised from health care systems, who experience complex medical, psychiatric, and social comorbidities that contribute to poor health care engagement. Among this complex patient population, incarceration affords opportunities to initiate or resume antiretroviral therapy (ART) within highly structured settings.

Human immunodeficiency virus treatment outcomes during incarceration for prisoners have not been explored for the past decade; to our knowledge, outcomes during incarceration for jail detainees have not yet been studied. While simpler and better-tolerated medication regimens have now become available, to our knowledge, the extent to which this has resulted in better outcomes among prisoners has not been examined, and correlates of achieving viral suppression among prisoners during incarceration have never been assessed. Integration of multiple longitudinal databases allow for comparisons between historical and more contemporary treatment periods.

Methods

Setting and Study Population
This retrospective review involves HIV-infected prisoners within the Connecticut Department of Correction (CTDOC), an integrated system of 15 male and 1 female facilities that includes pretrial jail detainees and sentenced prisoners. Unlike elsewhere, integrated systems allow assessment of data from jail entry to prison discharge. The average daily census is 16,347 individuals; 94% are men, 41% are black, 31% are white, and 26% are Hispanic. Despite PLWHA constituting a relatively small and declining proportion of Connecticut’s prisoners (1.6% of men; 3.9% of women), their care is disproportionately expensive. Prisoners’ ART is one of the state’s highest pharmacy expenditures, beyond treatment for comorbid psychiatric and substance use disorders (SUDs), sexually transmitted infections, and chronic viral hepatitis.

Human immunodeficiency virus care within the CTDOC is managed by an Infection Control nurse and provided by Infectious Diseases specialists contracted through a university-based managed health care system. Few formulary restrictions exist for ART medications, which are prescribed in accordance with Department of Health and Human Services (DHHS) guidelines and provided as either directly observed (DOT) or self-administered therapy (SAT) based on patient or health care provider preference. Patients coinfected with HIV and hepatitis C virus (HCV) are eligible for HCV treatment if they otherwise meet clinical treatment criteria and if they are sentenced for an 18-month continual period. Licensed social workers and nurses screen for psychiatric disorders on intake and refer individuals to an on-site psychiatrist for treatment as needed. All HIV-infected prisoners receive transitional case management 30 days before release to 3 months after release and receive 14 days of medications on release.

Individuals included in the final analysis met the following criteria: (1) confirmed HIV seropositive; (2) incarcerated in the CTDOC at least once for 90 consecutive days or longer; (3) had 2 or more sets of laboratory data 90 days apart available during incarceration; (4) were prescribed ART; and (5) had pharmacy data available, limiting the sample to those incarcerated between March 1, 2005, and June 29, 2012 (Figure 1).

Data Sources
Three primary CTDOC data sources were integrated for analyses: (1) correctional database that included all demographic and custody information; (2) laboratory database; and (3) pharmacy database. All files were merged using inmate number to create an integrated database after removing unique personal identifiers to protect anonymity. All procedures were independently approved by the institutional review board at Yale School of Medicine and Research Advisory Committee at CTDOC, including guidance and oversight by the Office of Human Research Protections.

Measures
The primary outcome was viral suppression, defined as an HIV-1 RNA level less than 400 copies/mL, within 90 days of entry (“entry value”) and within 90 days of release (“release value”). Secondary outcomes included mean change in log-transformed HIV-1 RNA viral load (VL) and mean change in CD4 lymphocyte count over time. Resistance profiles by HIV genotype or phenotype were not available.

Demographic information collected on intake into the CTDOC included age, sex, race/ethnicity, marital status, number of dependents in one’s care, highest level of education attained, and possession of medical insurance. Custody information included dates and types of movement in and out of facilities. Inmate classification scores, used by the CTDOC to quantify severity of criminal offenses and health related to underlying medical and psychiatric disorders, were derived from intake evaluations. For each individual over all incarceration periods, represent the greatest overall intake severity per individual and correlating with requiring medications. Scores were examined as both continuous and binary variables dichotomized with high severity being above the sample median.

Antiretroviral therapy regimens were defined by included components, and the following derived categories were mutually exclusive: (1) protease inhibitor (PI)-based, which included at least 1 PI (with or without ritonavir boosting) and 2

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nucleoside reverse transcriptase inhibitors (NRTIs) (but no non-
nucleoside reverse transcriptase inhibitors [nNRTIs] or inte-
grase inhibitors [INSTIs]); (2) nNRTI-based, which included at
least 1 nNRTI and 2 NRTIs (but no PIs or INSTIs); (3) fixed-dose
combination, a subset of nNRTI-based regimens, which in-
cluded either tenofovir/emtricitabine/efavirenz or tenofovir/
emtricitabine/rilpivirine; (4) NRTIs only; (5) INSTI-containing
regimens; or (6) other combination regimens, including entry
inhibitors, fusion inhibitors, or regimens with more than 2 in-
volved drug classes. Antiretroviral therapy regimen type was de-
scribed in terms of dosing strategy and type of medication ad-
ministration (ie, DOT or SAT). We accounted for 4 potential
dynamic scenarios: (1) continuous DOT; (2) continuous SAT;
(3) transitional DOT if ART was prescribed initially as DOT then
changed to SAT before release; and (4) transitional SAT if ART
was prescribed initially as SAT and then changed to DOT be-
fore release. Receipt of antipsychotics, antidepressants, or HCV
treatment (with interferon and ribavirin) was coded dichoto-
mously. All pharmacy data were categorized at intake and re-
lease. We examined psychiatric medications in reference to (1)
the incarceration periods in which they were prescribed and (2)
the individuals to whom they were prescribed during any in-
carceration in the observation period; further information on
psychiatric diagnoses was not available.

**Statistical Analysis**

The unit of analysis was an incarceration period, defined as
the time between a new admission to a CTDOC facility (“in-
take” or “entry”) and the first of conditional release, dis-
charge, or death (“release”), as in previous studies. For in-
dividuals with more than 1 incarceration, each period was
examined separately. We described individual demographic
characteristics and incarceration periods in terms of pre-
scribed medications and HIV treatment outcomes. We com-
pared mean changes in log-transformed VL and CD4 lympho-
cyte counts from intake to discharge, using unpaired t tests.
We evaluated correlates of viral suppression on release, using
unadjusted logistic regression followed by multivariate logis-
tic regression by backward selection with inclusion of vari-
ables with bivariate associations of P < .10; we controlled for
age and intake VL a priori. We also modeled prerelease viral
suppression using generalized estimating equations to adjust
for previous incarcerations for the small number of individu-
als who had repeated incarceration periods and found that the
magnitude of the coefficients and significance remained un-
changed. We therefore report the simpler multiple logistic re-
gression results. All analyses were performed using SAS ver-
sion 9.3 (SAS Institute Inc).

**Results**

The final sample comprised 1185 incarceration periods, involv-
ing 882 HIV-infected prisoners receiving ART (Figure 1). Table 1
indicates that the majority of individuals are unmarried (n = 748 [84.4%]), black (n = 419 [47.5%]), and male (n = 714
[81.0%]), with a mean (SD) age of 42.6 (8.4) years, which is
generally consistent with prisoners in Connecticut and the United

States. On intake, 144 participants (16.3%) reported hav-
ing health insurance with evidence of relatively severe medi-
cal and psychiatric disorders, reflecting a high need for con-
tinuing medical and psychiatric health services. Highest-
severity intake psychiatric score (score = 5) was assigned to 159
individuals (18.0%), indicating a crisis-level psychiatric dis-
order requiring one-to-one observation (data not shown). Most
individuals (n = 661 [74.9%]) were incarcerated once during the
observation period for a mean (SD) of 536 (541) days.

As indicated in Table 2, PI-based regimens were pre-
scribed most commonly for ART (n = 1125 [47.4%]), followed
by nNRTI-based regimens (n = 914 [38.6%]), of which half were
fixed-dose combination medications. Approximately one-
third of incarceration periods involved switches between ART
regimens, which is in sharp contrast to earlier reports of HIV-
infected prisoners in the CTDOC, in which 84% switched ART
regimens during incarceration (1997-2002). Proportions of
participants prescribed each ART regimen class on intake and
on release are graphically depicted in the eFigure in the Supple-
ment. Approximately half of all incarceration periods in-
volved administration of ART by DOT at any point, although
almost all transitioned to SAT (n = 877 [74.0%]) by the time of
release with once-daily regimens (n = 698 [72.3%]).

Despite an estimated prevalence of HIV/HCV coinfection
of 38% to 65% among HIV-infected prisoners and jail
detainees, only 20 incarceration periods for 19 individu-
als involved HCV treatment (Table 2). Of incarcerations, 17%
and 36% involved a prescription of antipsychotics or antide-
pressants, respectively, which is reflective of the prevalence
depression and psychotic disorders among all US state pris-
ioners, and specifically among HIV-infected prisoners in
Connecticut. On an individual level, 402 individuals (45.6%)
were prescribed either antipsychotics or antidepressants
during the observation period and 88 individuals (10.0%) were si-
multaneously prescribed antipsychotics and antidepressants
at any point, which is indicative of dually diagnosed psy-
chotic and mood disorders (Table 2). There was a strong con-
sistent association between psychiatric disorder severity at in-
take and prescription of an antipsychotic (odds ratio [OR], 4.27;
95% CI, 3.30-5.52; Cramér V measure of association, 0.41) and

![Figure 1. Data Scheme and Determination of Final Sample](http://archinte.jamanetwork.com/pdfaccess.ashx?url=/data/journals/intemed/930064/ on 06/19/2017)
between intake psychiatric disorder severity and prescription of an antidepressant (OR, 3.52; 95% CI, 2.93-4.22; Cramér V, 0.41) (data not shown).

The main treatment outcomes of interest are represented in the eTable in the Supplement. During incarceration, mean CD4 lymphocyte count increased significantly (98.0 cells/μL) (P < .001), and mean HIV VL decreased by 1.12 log_{10} (P < .001). While just 29.8% of incarceration periods began with individuals having viral suppression (6.2% with maximal viral suppression), 70% of incarceration periods resulted in individuals persistently meeting these criteria by the time of discharge (Figure 2).

In logistic regression models (Table 3), prerelease viral suppression correlated with female sex (adjusted OR [AOR], 1.81; 95% CI, 1.26-2.59) and lower psychiatric disorder severity (AOR, 1.50; 95% CI, 1.12-1.99). Viral suppression was not significantly associated with race/ethnicity, duration of incarceration, type of ART regimen or dosing frequency, or receipt of DOT in bivariate or multivariate models (Table 3).

**Discussion**

In this longitudinal analysis of treatment characteristics and outcomes among 882 HIV-infected prisoners, representing the largest cohort of HIV-infected prisoners evaluated for ART outcomes in the past 10 years, there were significant increases in CD4 lymphocyte count and reductions in VL during incarceration. Importantly, 70% of individuals achieved viral suppression before release, more than 3-fold the estimate of PLWHA with viral suppression in US community-based settings.23 Viral suppression was achieved irrespective of age, race/ethnicity, duration of incarceration, or type of ART regimen, suggesting that even 90 days of incarceration was sufficient to stabilize prisoners with regard to important HIV treatment outcomes. In multivariate logistic regression models, prerelease viral suppression was strongly and directly associated with gender and lower psychiatric disorder severity.

Women in our cohort had an 80% higher odds of achieving viral suppression during incarceration compared with men, a finding consistent with earlier published studies.8 It is unclear, however, why women seem to derive greater benefit from ART, with higher levels of viral suppression during incarceration, when they fare worse than men in community settings after release.24 Although we were unable to disentangle contributing factors, gender differences in HIV treatment outcomes may relate to structural stability. Unlike for men, who experience multiple interinstitutional transfers, Connecticut’s sole facility for women potentially fosters continuity of care with a single HIV health care provider, building trust and streamlining engagement in care.25-27 Despite these positive outcomes during incarceration, women transitioning from jail to community settings are significantly less likely than their male counterparts to engage in care,26 adhere to ART,27 or achieve viral suppression (30% vs 18%; P < .001).24 Other data suggest that medical, psychiatric, and social instability among released HIV-infected female prisoners is reflected by more frequent use of emergency department resources, though not necessarily for HIV-related issues.28 Further research is needed to develop gender-specific interventions for HIV-infected women that will build on and sustain their successes during incarceration throughout the tumultuous postrelease period.

Beyond the effect of gender, prerelease viral suppression also directly correlated negatively with severity of psychiatric disorders. We found a high prevalence of severe and untreated psychiatric disorders: nearly one-fifth of our cohort met criteria for crisis-level psychiatric disorders on entry. Underdiagnosis and inadequate treatment of psychiatric disorders
On intake and release, the latter of which has been associated with improved overall retention in HIV care and are a critical component of transitional interventions.\textsuperscript{13,35,36} Incarceration can be an opportunity to identify and treat mental illness—many prisoners in our sample (45.6\%) were prescribed psychiatric medications, including 16\% receiving antipsychotics and 35\% prescribed antidepressants (all administered as DOT for Connecticut prisoners), which is reflective of the prevalence of major depression and psychotic disorders among all US state prisoners and among HIV-infected prisoners in Connecticut.\textsuperscript{21,22} Despite apparently adequate treatment coverage, we found that individuals with poorly controlled and more severe psychiatric disorders on intake had decreased odds of achieving viral suppression on release. After controlling for psychiatric disorder severity, prescription of antipsychotic or antidepressant medications was not significantly associated with prerelease viral suppression, either because receipt of psychiatric medications was highly correlated with psychiatric disorder severity or because of other unmeasured factors such as medication nonadherence. Nonetheless, prisoner health providers may target resources to those with higher psychiatric severity on intake and promote sustained linkages to psychiatric treatment after release, the latter of which has been associated with improved overall retention in HIV care and are a critical component of transitional interventions.\textsuperscript{13,35,36}

Given the long-standing use of directly administered antiretroviral therapy in correctional settings with documented efficacy,\textsuperscript{27} it was somewhat surprising to find an insignificant correlation between DOT and prerelease viral suppression. Accounting for 4 potential dynamic scenarios involving DOT, we found that 70\% of those ever prescribed DOT during incarceration experienced viral suppression prerelease, compared with 69.2\% of those who never received DOT during incarceration. The apparent lack of contribution of DOT to HIV treatment outcomes may be explained by other unmeasured factors, including medication adherence\textsuperscript{38} or facility resource allocation.

### Table 2. Medication Prescription During 1185 Incarceration Periods

<table>
<thead>
<tr>
<th>Medication Prescription</th>
<th>Incarceration Periods During Which Prescribed, No. (%)\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ART Medications</strong></td>
<td></td>
</tr>
<tr>
<td>ART regimen overall</td>
<td></td>
</tr>
<tr>
<td>PI-based</td>
<td>1125 (47.4)</td>
</tr>
<tr>
<td>nNRTI-based</td>
<td>914 (38.6)</td>
</tr>
<tr>
<td>Fixed-dose combination</td>
<td>410 (44.9 of nNRTI regimens)</td>
</tr>
<tr>
<td>NRTI only</td>
<td>218 (9.2)</td>
</tr>
<tr>
<td>INSTI-based</td>
<td>88 (3.7)</td>
</tr>
<tr>
<td>Other</td>
<td>25 (0.8)</td>
</tr>
<tr>
<td>ART regimen at intake</td>
<td></td>
</tr>
<tr>
<td>PI-based</td>
<td>553 (46.7)</td>
</tr>
<tr>
<td>nNRTI-based</td>
<td>474 (40.0)</td>
</tr>
<tr>
<td>Fixed-dose combination</td>
<td>142 (30.0 of nNRTI regimens)</td>
</tr>
<tr>
<td>NRTI only</td>
<td>122 (10.3)</td>
</tr>
<tr>
<td>INSTI-based</td>
<td>25 (2.1)</td>
</tr>
<tr>
<td>Other</td>
<td>11 (0.9)</td>
</tr>
<tr>
<td>ART regimen at discharge</td>
<td></td>
</tr>
<tr>
<td>PI-based</td>
<td>572 (48.3)</td>
</tr>
<tr>
<td>nNRTI-based</td>
<td>572 (48.3)</td>
</tr>
<tr>
<td>Fixed-dose combination</td>
<td>440 (37.1)</td>
</tr>
<tr>
<td>NRTI only</td>
<td>96 (8.1)</td>
</tr>
<tr>
<td>INSTI-based</td>
<td>63 (5.3)</td>
</tr>
<tr>
<td>Other</td>
<td>14 (1.2)</td>
</tr>
<tr>
<td>ART regimen switch during incarceration</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>748 (63.1)</td>
</tr>
<tr>
<td>Yes</td>
<td>437 (36.9)</td>
</tr>
<tr>
<td>Type of medication administration at discharge</td>
<td></td>
</tr>
<tr>
<td>SAT</td>
<td>877 (74.0)</td>
</tr>
<tr>
<td>DOT</td>
<td>308 (26.0)</td>
</tr>
<tr>
<td>Ever prescribed DOT during incarceration</td>
<td>672 (56.7)</td>
</tr>
<tr>
<td>Type of medication administration overall\textsuperscript{b}</td>
<td></td>
</tr>
<tr>
<td>Never DOT</td>
<td>858 (72.4)</td>
</tr>
<tr>
<td>Transitional DOT</td>
<td>19 (1.6)</td>
</tr>
<tr>
<td>Continuous DOT</td>
<td>29 (2.5)</td>
</tr>
<tr>
<td>Transitional SAT</td>
<td>279 (23.5)</td>
</tr>
<tr>
<td>Dosing frequency at discharge</td>
<td></td>
</tr>
<tr>
<td>Once daily</td>
<td>698 (72.3)</td>
</tr>
<tr>
<td>Twice daily</td>
<td>267 (27.7)</td>
</tr>
<tr>
<td>Ever prescribed HCV Treatment</td>
<td>20 (1.7)</td>
</tr>
</tbody>
</table>

**Psychiatric Medications per Incarceration**

<table>
<thead>
<tr>
<th>Medication</th>
<th>Count (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antipsychotic</td>
<td>196 (16.6)</td>
</tr>
<tr>
<td>Antidepressant</td>
<td>422 (35.6)</td>
</tr>
<tr>
<td>Psychiatric medications per individual (n = 882)</td>
<td></td>
</tr>
<tr>
<td>Antipsychotic or antidepressant at any time</td>
<td>402 (45.6)</td>
</tr>
<tr>
<td>Antipsychotic and antidepressant at any time</td>
<td>88 (10.0)</td>
</tr>
</tbody>
</table>

Abbreviations: ART, antiretroviral therapy; DOT, directly observed therapy; HCV, hepatitis C virus; INSTI, integrase strand transfer inhibitor; nNRTI, nonnucleoside reverse transcriptase inhibitor; NRTI, nucleoside reverse transcriptase inhibitor; PI, protease inhibitor; SAT, self-administered therapy.\textsuperscript{a} Unless otherwise specified.\textsuperscript{b} See Methods section for definition of categories.
Patient and health care provider preferences likely also play a role in DOT selection in that patients may opt against DOT because of concerns about inadvertent disclosure of HIV status, and health care providers may triage patients for DOT who they perceive as being nonadherent. Alternatively, DOT may have limited additional benefit when ART regimens are well tolerated and provided within a highly structured correctional setting, where patients have considerable access to psychiatric medications and less access to mind-altering substances like alcohol or drugs that are all associated with decreased adherence. In community settings, however, DOT has a clearly documented beneficial effect on HIV treatment outcomes for certain populations, especially those with SUDs and among released prisoners.

This analysis uniquely affords a retrospective assessment of HIV treatment outcomes during incarceration. Compared with a similarly analyzed historical control (1997-2002), viral suppression levels were higher during incarceration with markedly fewer ART regimen switches. Our findings reconfirm that

Table 3. Correlates of Viral Suppression on Release

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Achieved Viral Suppression on Release, No. (%)</th>
<th>Adjusted Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>43.1 (8.3)</td>
<td>...</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>656 (68.0)</td>
<td>1 [Referent]</td>
</tr>
<tr>
<td>Women</td>
<td>174 (79.1)</td>
<td>1.81 (1.26-2.59)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>166 (72.5)</td>
<td>...</td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>380 (67.6)</td>
<td>...</td>
</tr>
<tr>
<td>Hispanic</td>
<td>281 (72.2)</td>
<td>...</td>
</tr>
<tr>
<td>American Indian</td>
<td>2 (66.7)</td>
<td>...</td>
</tr>
<tr>
<td>Asian</td>
<td>1 (50.0)</td>
<td>...</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>699 (69.1)</td>
<td>1 [Referent]</td>
</tr>
<tr>
<td>Married</td>
<td>131 (75.7)</td>
<td>1.45 (0.99-2.11)</td>
</tr>
<tr>
<td>No. of dependents in care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>475 (70.1)</td>
<td>...</td>
</tr>
<tr>
<td>≥2</td>
<td>355 (70.0)</td>
<td>...</td>
</tr>
<tr>
<td>Highest education level attained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;High school</td>
<td>383 (68.3)</td>
<td>...</td>
</tr>
<tr>
<td>≥High school</td>
<td>447 (71.6)</td>
<td>...</td>
</tr>
<tr>
<td>Had medical insurance on entry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>137 (75.6)</td>
<td>1 [Referent]</td>
</tr>
<tr>
<td>No</td>
<td>693 (69.0)</td>
<td>0.89 (0.59-1.35)</td>
</tr>
<tr>
<td>Max offense severity score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥Median</td>
<td>427 (71.1)</td>
<td>...</td>
</tr>
<tr>
<td>&lt;Median</td>
<td>403 (69.0)</td>
<td>...</td>
</tr>
<tr>
<td>Max medical severity score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥Median</td>
<td>521 (71.8)</td>
<td>1 [Referent]</td>
</tr>
<tr>
<td>&lt;Median</td>
<td>309 (67.3)</td>
<td>1.24 (0.96-1.61)</td>
</tr>
<tr>
<td>Max psychiatric severity score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥Median</td>
<td>182 (63.6)</td>
<td>1 [Referent]</td>
</tr>
<tr>
<td>&lt;Median</td>
<td>648 (72.1)</td>
<td>1.50 (1.12-1.99)</td>
</tr>
<tr>
<td>Duration of incarceration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥Median</td>
<td>405 (68.8)</td>
<td>...</td>
</tr>
<tr>
<td>&lt;Median</td>
<td>425 (71.3)</td>
<td>...</td>
</tr>
<tr>
<td>Intake year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005-2007</td>
<td>455 (68.8)</td>
<td>...</td>
</tr>
<tr>
<td>2008-2010</td>
<td>318 (73.3)</td>
<td>...</td>
</tr>
<tr>
<td>2011-2012</td>
<td>57 (63.3)</td>
<td>...</td>
</tr>
<tr>
<td>ART regimen at intake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PI-based</td>
<td>378 (68.4)</td>
<td>...</td>
</tr>
<tr>
<td>nNRTI-based</td>
<td>341 (71.9)</td>
<td>...</td>
</tr>
<tr>
<td>Fixed-dose combination</td>
<td>107 (70.9)</td>
<td>...</td>
</tr>
<tr>
<td>NRTI only</td>
<td>84 (68.9)</td>
<td>...</td>
</tr>
<tr>
<td>INSTI-based</td>
<td>18 (72.0)</td>
<td>...</td>
</tr>
<tr>
<td>Other</td>
<td>9 (81.8)</td>
<td>...</td>
</tr>
</tbody>
</table>

Abbreviations: ART, antiretroviral therapy; DOT, directly observed therapy; HCV, hepatitis C virus; INSTI, integrase strand transfer inhibitor; Max, maximum; nNRTI, nonnucleoside reverse transcriptase inhibitor; NRTI, nucleoside reverse transcriptase inhibitor; PI, protease inhibitor; SAT, self-administered therapy; ellipses, not included in multivariate model.

* Among 882 HIV-infected prisoners with 1185 incarceration periods.

* Unless otherwise specified.
viral suppression can be successfully achieved during incarceration when appropriate resources are provided. Contributors to successful HIV management within correctional facilities include highly structured settings, in which medications may be given as DOT when clinically indicated, especially on entry when psychiatric disorders and withdrawal symptoms may interfere with ART adherence. Retention in HIV care during incarceration is facilitated by systems that ensure that, at a minimum, recommended follow-up examinations are completed. Unfortunately, although prisons can provide equitable access to basic medical care and subsistence needs, it is not so in most community settings. Findings from previous studies suggest that individuals who cycle through the criminal justice system are frequently marginalized from community-based medical and social systems; face homelessness, food insecurity, and intimate partner violence; have untreated psychiatric conditions and SUDs; and lack of medical insurance—all of which are commonly disruptive to continuous HIV care and detrimental in terms of treatment outcomes. In the absence of important and effective community-based resources, incarceration is an opportunity of last resort to initiate continuous ART for individual health and, following the “treatment as prevention” paradigm, potentially reduce the likelihood of HIV transmission to others.

From ethical, practical, and economic standpoints, however, incarceration cannot and should not be the panacea for managing HIV among the urban poor. Prisons and jails are designed to meet public safety goals—not serve as a safety net to improve health care. Depending on location and setting, health care delivery during incarceration is frequently complicated by conflicting priorities and inmate mistrust of health systems. Lack of routine HIV testing and inmate reluctance to disclose HIV status because of privacy concerns further contribute to inadequate management of HIV in correctional settings. As an example, only 29% of HIV-infected prisoners in the United States meeting ART eligibility criteria in 2004 actually received it during incarceration. Even when coverage is higher and treatment is optimized during incarceration, viral suppression may be unsustained following release to communities.

Beyond diagnosis and management of HIV during incarceration, effective treatment as prevention requires a comprehensive package of services including treatment for SUDs. Although available data limited our assessment of SUD prevalence or severity, upwards of 70% of HIV-infected prisoners in New York experienced a 12-fold increase in mortality compared with the general population within the 2 weeks following release, mostly due to opioid overdose. In contrast, MAT provided either during incarceration or immediately after release reduces substance use relapse and recidivism, increases retention in drug treatment, and improves HIV treatment outcomes after release. Although empirical data supporting how MAT affected HIV treatment outcomes during incarceration were not available here, this effect serves as an important future area of investigation, especially as MAT becomes more widely available.

Despite analysis of data derived from nearly 2 decades of observation, some limitations remain. First, data were derived from 3 distinct databases not originally designed to measure health outcomes, but rather to manage correctional populations. As a result, some measures, including those for medical and psychiatric severity, were not standardized. Nonetheless, the prevalence of these comorbidities is similar to that reported elsewhere for HIV-infected prisoners using standardized measures. We were unable to thoroughly disentangle the negative effects of SUDs or substance use itself on HIV treatment outcomes, although substance use during incarceration is markedly less frequent and severe than reported in community settings. Other unmeasured contributors to HIV treatment outcomes include ART resistance, reasons for ART regimen switches (eg, adverse or toxic effects, adherence issues, virologic failures), and assessment of hepatitis B virus and HCV coinfection. The lower limits of detection for viral suppression changed dramatically over the 15-year observation period, limiting consistent measurement of maximal viral suppression over time, although we addressed this by using the most conservative possible estimates. Lastly, despite the large sample size, our present findings may not be entirely generalizable to all prisoner populations; however, at least the demographic characteristics are consistent with those of other US HIV-infected prisoners.

These limitations notwithstanding, this study represents, to our knowledge, the largest evaluation of ART outcomes during incarceration in the past decade and the only observational study of HIV treatment outcomes to include both pretrial jail detainees and sentenced prisoners within an integrated correctional system. The findings demonstrate successful management of HIV in correctional settings, especially when coupled with treatment for psychiatric disorders, with implications for public health and safety and HIV care of individuals who cycle through the criminal justice system.

Conclusions

Among 882 incarcerated PLWHA in Connecticut, the majority achieved viral suppression during incarceration, providing evidence that HIV treatment can be optimized during incarceration when combined with adequate resources. Compared with a historical control (1997-2002) in the same setting, this more contemporary cohort (2005-2012) experienced a higher proportion of individuals achieving viral suppression before release and doing so with markedly fewer ART regimen changes, which is potentially reflective of more contemporary ART regimens with reduced pill burden, improved tolerability, and higher barriers to resistance.
ARTICLE INFORMATION

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Author Contributions: Dr Meyer had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Meyer, Altice, Springer.
Acquisition, analysis, or interpretation of data: Meyer, Cepeda, Wu, Trestman, Altice, Springer.
Drafting of the manuscript: Meyer, Cepeda, Altice, Springer.
Critical revision of the manuscript for important intellectual content: Meyer, Wu, Trestman, Altice, Springer.
Statistical analysis: Meyer, Cepeda, Altice, Springer.
Obtained funding: Meyer, Altice.
Administrative, technical, or material support: Meyer, Wu, Trestman.
Study supervision: Meyer, Altice, Springer.

Conflict of Interest Disclosures: None reported.

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