Improved Virologic Suppression With HIV Subspecialty Care in a Large Prison System Using Telemedicine: An Observational Study With Historical Controls

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Correctional populations have an elevated human immunodeficiency virus (HIV) prevalence, yet many individuals lack access to subspecialty care. Our study showed that HIV-infected inmates had significantly greater virologic suppression and higher CD4 T-lymphocyte counts when managed by a multidisciplinary team of subspecialists conducting clinics via telemedicine. In other studies, these outcomes have been associated with reductions on HIV-related morbidity and mortality, as well as HIV transmission.

Keywords. telemedicine; telehealth; HIV; prisons.

The human immunodeficiency virus (HIV) prevalence for persons held in US correctional facilities is at least 3 times higher than in the general population [1, 2]. About 14% of HIV-infected persons—and 20% of African Americans and Hispanics who are HIV-positive—pass through jails or prisons annually [3]. Those with characteristics common to incarcerated populations are likely to be tested later [4], have more advanced disease upon entering care [5–8], initiate antiretroviral therapy (ART) later [7, 9], less often receive ART [9–11], and more often discontinue ART [12–14]. Therefore, prisoners represent a high-risk, high-prevalence subpopulation for HIV infection. To optimize individual and community outcomes and reduce HIV-related morbidity, we need improved HIV treatment strategies for incarcerated persons.

Access to experts remains a barrier to optimal HIV management in the incarcerated population. Correctional physicians are rarely trained in the care of those with HIV [15], for whom management issues can be complex. Prisons are frequently located in rural areas, relatively far from tertiary care providers and consultants [16]. As a result, HIV-infected prisoners often have limited access to the multidisciplinary subspecialty care available to the general population. Some facilities transport offenders to local clinics; however, this is expensive and often impractical.

Studies have shown improved outcomes and adherence to ART when practitioners with experience and training in managing HIV infection are involved in care [17–20]. Expert management can significantly influence survival, lower the risk of opportunistic infections, decrease the risk of adverse ART effects, and decrease the risk of drug–drug interactions [21–23]. Early and appropriate ART may not only benefit the HIV-infected individual [24], but also reduce transmission in the communities to which they return after release [25].

The barriers of geography and transportation can be removed if clinics are conducted using telemedicine, where a confidential, encrypted, interactive audio and video teleconference replaces the in-person clinic visit. Software, high-definition cameras, monitors, and equipment used to perform physical examinations, such as electronic stethoscopes, are widely available. Telemedicine has few limitations, and several studies have reported successful outcomes in psychiatric management [26], surgical services [27], and emergency medicine [28], with enhanced, more timely access to care, cost savings, and high patient satisfaction. Ours is the first study to evaluate the efficacy of subspecialty care for HIV infection with the use of telemedicine.

METHODS

Study Population

Two cohorts were compared: (1) the pretelmedicine population, managed on-site by correctional physicians; and (2) the telemedicine population, managed by a university-based, multidisciplinary subspecialty team via telemedicine clinics. The subjects in both cohorts included all offenders in every Illinois Department of Corrections (IDOC) facility who were ≥18 years of age, who where known to be HIV infected, and who consented to medical
care. To be included, each subject had to have data from at least 2 clinic visits. Stable patients on ART were seen every 3 months, with more frequent visits as indicated. Each telemedicine clinic visit involved a board-certified infectious disease physician, an infectious disease–trained pharmacist, and a case manager. Telemedicine clinics utilized an encrypted link to a dedicated telemedicine suite in the prison infirmary, where the patient and correctional nurse participated in the visit.

**Study Design**

This cohort study, performed as part of a larger study funded by the National Institute on Drug Abuse, compared the efficacy of HIV subspecialty management via telemedicine in a large prison population vs on-site management by a correctional physician without subspecialty training. Continuity data for all HIV-infected offenders in IDOC are kept in a secure database. De-identified versions of the pretelemedicine and telemedicine clinic databases were used for all analyses.

Our primary outcome of interest was virologic suppression, used as a marker for the prescription of, and adherence to, appropriate ART, which we analyzed and report here as (1) the proportion of subjects in each cohort with complete virologic suppression at any of the first 6 visits; (2) the proportion of subjects in each cohort with complete virologic suppression at any of the first 6 visits in each of 3 CD4 T-lymphocyte strata (<350 cells/µL, 350–500 cells/µL, and >500 cells/µL); (3) the mean community HIV viral load (CVL) for the first 6 visits; and (4) the mean in-care HIV load on the final laboratory draw of each study period. We chose to evaluate laboratory values from only the first 6 visits for both cohorts to adjust for the longer period of observation in the telemedicine group. Virologic suppression was stratified by CD4 count to help control for the changing literature and guidelines regarding the minimum CD4 count at which ART initiation is recommended.

Mean CVL and mean in-care viral load are ways to measure the total virologic burden of a community, and lower CVL has been associated with reductions in transmission [29]. Mean CVL was computed as the geometric mean of the average viral load of each subject. The mean in-care HIV load is the geometric mean of the last viral load of the study period, which provides more of an assurance that a given patient is under stable medical care. The geometric mean was calculated by averaging the log-transformed values, then transforming the average back to the original linear scale. To allow for statistical analysis, all fully suppressed viral loads reported (<48 copies/mL, <20 copies/mL, or undetectable) were counted as 10 copies/mL in calculations of mean viral load. All blood samples were analyzed by the University of Illinois clinical laboratory.

The Institutional Review Board at the University of Illinois at Chicago, including a prison representative, approved the study protocol.

**Statistical Analysis**

We compared the proportions of patients with virologic suppression using the Pearson $\chi^2$ test and computed odds ratios (ORs) and 95% confidence intervals (CIs), and controlled for the total number of visits in a logistic regression analysis. Mean CVL and in-care HIV load were compared by conducting Student $t$ tests on log-transformed viral load measures. CD4 estimates were also compared using a Student $t$ test. A $P$ value of <.05 was considered to be indicative of statistical significance.

**RESULTS**

The pretelemedicine database contained continuity data for 514 HIV-infected offenders with laboratory values available from 1 July 2009 through 30 June 2010. Six hundred eighty-seven offenders were included in the HIV telemedicine database, seen in the clinic between 13 July 2010, and 30 June 2012. The baseline mean CD4 count for each group at the first laboratory draw showed no difference between the 2 groups (pre-telemedicine = 485.4 cells/µL, telemedicine = 502.9 cells/µL, $t$ = −0.97; $P$ = .322).

The proportion of subjects with complete virologic suppression during the first 6 visits was significantly greater in the telemedicine group (91.1% vs 59.3%; OR, 7.0 [95% CI, 5.1–9.8]; $P$ < .001), even when removing all subjects who were suppressed at the first visit (75.8% vs 23.0%; OR, 10.5 [95% CI, 6.9–16.1]; $P$ < .001), and controlling for the total number of clinic visits in a logistic regression analysis (OR, 4.2 [95% CI, 2.5–7.0]; $P$ < .001). The telemedicine cohort also had significantly greater virologic suppression regardless of baseline CD4 count (Table 1).

The telemedicine cohort had a lower mean CVL during the first 6 visits (89.5 copies/mL vs 206 copies/mL; $P$ < .001) and a lower mean in-care HIV load at the final visit (19.2 copies/mL vs 107.4 copies/mL; $P$ < .001). Despite the fact that there was no difference in baseline mean CD4 counts between the cohorts, the overall mean CD4 value was significantly higher in those managed in the subspecialty telemedicine clinic (527.9 cells/µL).

**Table 1. Proportion of Subjects With a Suppressed HIV Load (First 6 Visits), Stratified by Baseline CD4 T-Lymphocyte Count**

<table>
<thead>
<tr>
<th>CD4 Category</th>
<th>Outcome a</th>
<th>Pretelemedicine</th>
<th>Telemedicine</th>
<th>$\chi^2$ Value</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;350 cells/µL</td>
<td>1</td>
<td>59.2%</td>
<td>92.8%</td>
<td>69.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>28.6%</td>
<td>83.7%</td>
<td>66.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>351–500 cells/µL</td>
<td>1</td>
<td>49.1%</td>
<td>95.8%</td>
<td>73.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>19.4%</td>
<td>89.1%</td>
<td>58.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;500 cells/µL</td>
<td>1</td>
<td>64.4%</td>
<td>87.6%</td>
<td>39.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>17.8%</td>
<td>59.1%</td>
<td>33.0</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

* 1 = first 6 visits, 2 = visits 2–6, viral load not suppressed at first visit.
vs 491.6 cells/µL; $P = .032$), indicating a greater CD4 rise for those managed via telemedicine.

**DISCUSSION**

Ours is the first study to compare HIV outcomes with non-expert care vs subspecialist management using telemedicine. Subspecialty care with telemedicine resulted in a significantly greater proportion of patients with virologic suppression and a lower CVL, markers for the use of appropriate ART, and patient compliance. This association remained significant when stratifying by CD4 count, suggesting that it was not merely changes in expert guidelines regarding when to initiate ART that led to this effect. In addition, we found a higher mean CD4 count in those receiving expert care with telemedicine. These outcomes have been associated with lower HIV-associated morbidity, mortality, and transmission.

Some limitations of this study include the observational, retrospective nature of the study design and some potential overlap of study subjects in each group, as well as the exclusion of some inmates who were incarcerated for such a short time that, logistically, they could not be seen in the telemedicine clinic. Cross-over of some subjects should have been partially controlled for in the analysis, excluding those with an undetectable baseline viral load. In addition, it may be difficult to extrapolate these results to other populations, such as jails, which have much shorter durations of incarceration, or in non-offender populations that may have limited access to care, such as those in rural areas or nursing facilities. Indeed, the overall proportion virologically suppressed in our pretelemedicine cohort compares favorably with many expert clinics in the nonincarcerated population, likely due to improved follow-up and compliance with ART in a structured prison environment, as inmates are removed from many of the factors leading to poor adherence to care in the community.

Despite these limitations, our results suggest that HIV subspecialists can provide highly effective, up-to-date, evidence-based care using telemedicine. Given the relatively large burden of HIV in the correctional population, utilizing telemedicine can impact the quality of HIV care nationally. By improving access to subspecialty care, telemedicine can affect patient outcomes in our prison systems and transmission in the community.

**Notes**

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**Author contributions.** All authors contributed equally to this work.

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**References**


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