EFFECTS OF INCARCERATION ON HIV-INFECTED INDIVIDUALS

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Human immunodeficiency virus (HIV) infection is a critical problem among the incarcerated population, with rates as high as 17% being reported for prison systems in New York. The literature suggests that stressful living conditions and inherent defects in the immune system associated with HIV infection make prison populations more susceptible to a disproportionate decrease in their CD4 counts. To determine the effects of incarceration on HIV-infected individuals, the charts of 800 inmates were reviewed. Baseline (draw 1), 2- to 5-month (draw 2), and 6- to 12-month (draw 3) CD4 cell counts were obtained. Mean cell counts were calculated, and paired *t*-tests were used to identify differences. The group receiving antiretrovirals throughout showed no difference in mean CD4 cell count between draws 1 and 2 or between draws 1 and 3. The group not receiving HIV medications did not show a significant difference in CD4 cell counts between draws 1 and 2, but did show a significant difference between draws 1 and 3. For this group, the rate of decline in CD4 cells was greater than among an outpatient setting. The subsample of subjects initiating therapy prior to the second blood draw showed a significant increase in mean CD4 cell counts at draw 1 versus draw 2, but did not show a significant change when comparing draw 1 to draw 3. When examining subjects based on their antiviral status, the mean CD4 cell count at each of the draws was statistically associated with subjects' antiviral status. We conclude that incarceration causes a more rapid decrease in CD4 cells compared with an outpatient population, causing clinical significance on the normal course of HIV disease. (*J Natl Med Assoc.* 1996;88:639-644.)

Key words • incarceration • human immunodeficiency virus (HIV) • pharmaceutical intervention

The increasing incidence of infection with the human immunodeficiency virus (HIV) continues to affect nearly all segments of the US population. Since the first acquired immunodeficiency syndrome (AIDS) cases reported in the early 1980s, AIDS cases have nearly quadrupled,[1] and AIDS is now the number one killer of young adults ages 25 to 44 in several US metropolitan areas.[2,3] Nonmetropolitan areas of the United States also are reflecting the national trend toward a larger number of heterosexually transmitted cases of HIV disease, with a near double increase in the number of AIDS cases between 1992 and 1993.[4] Among ethnic groups in the United States, African Americans are disproportionately affected with HIV, possessing a death rate of 29.3/100,000. This compares to a death rate of 22.2 among Hispanics and 8.7 among whites.[3]

The epidemiology of AIDS, originally described in men, has evolved; women now constitute the fastest growing segment of the population with AIDS.[5,6] Between 1990 and 1991, diagnosed cases of AIDS increased by 15% in women compared with a 3% increase in men.[6] An explanation as to why women now constitute the fastest growing segment of individuals with AIDS has not yet been convincingly made.

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Researchers have suggested a number of reasons, most of which are related to poverty and lack of health insurance.[7] The perception of a society toward women with regard to women's power or powerlessness also has been suggested to be a significant predictor of their means to prevent infection.[8,9] Women of ethnic and racial minorities constitute 19% of all US women but comprise 72% of US women infected with HIV.[5] Women who possess little control regarding sexual relations with men, most of whom have attained a low level of education and self-empowerment, usually women of color, face the greatest risk of contracting HIV.[10]

Among other specific segments of the population for whom the rates of HIV infection are increasing are inmates in correctional facilities. For example, in 1989, correctional facilities in New York were experiencing HIV infection rates as high as 18.5%.[11] As infection with HIV increases in the general population, so too is the HIV infection rate in correctional facilities.[12,13] Infection among prison and jail populations is likely to contribute to infection among the poor and socially disenfranchised among the nonincarcerated population.

Incarcerated populations have high rates of infection due to the high-risk behaviors in which many engage. Reports indicate 40% to 80% of incarcerated individuals are intravenous drug users,[13] 2% to 4% of men are homosexual or bisexual,[14,15] and approximately 11% of men have had sex with prostitutes.[14] Sex with bisexual men also has been shown to be a significant reason for HIV infection among women.[16] Furthermore, earlier studies have reported that in nonemergency situations, individuals who are not insured are less likely to seek health care.[17] Because most of the inmates do not have health insurance, they are less likely to seek health care when not incarcerated.

Due to the rapid increase in the prison population and a slower increase construction of new correctional facilities, many jails are overcrowded with inmates. Often associated with overcrowding are stressful living conditions and a decreased access to health care, which may cause the diagnosis of AIDS or AIDS-related opportunistic infections to go undetected. Studies in New York have found that nonincarcerated individuals have a near double increase in mean survival rate from diagnosis of AIDS to death than individuals with HIV who are incarcerated.[13] This article describes a study that examined whether incarceration influences CD4 counts and the progression of AIDS. For some HIV-positive individuals, incarceration may provide an increased access to better health care while for others the stress and overcrowding may cause a disproportionate decrease in their CD4 counts.

METHODS

In June 1993, a retrospective review of charts dating back to July 1991 was initiated at the Harris County Correctional Facility Clinic in Houston, Texas. This research was submitted to the Internal Review Board, but has received exempt status due to its classification as a policy evaluation. Charts of all patients who were known to be HIV positive were considered for the study. A total of 800 charts were identified as potentially meeting the study criteria and reviewed. Study criteria included:

- a positive Western blot confirming HIV infection,
- a CD4 count taken while the inmate was incarcerated following a confirmed diagnosis of HIV (draw 1), and
- a second CD4 count taken 2 to 5 months following draw 1 (draw 2) or a third CD4 count taken 6 to 12 months after draw 1 (draw 3).

Blood samples obtained during these three draws were used to stage the level of HIV infection. Staging HIV infected patients based on T4 lymphocyte counts has become an accepted strategy for documenting progression of HIV disease.[18] If patients were released from jail during the intervals between blood draws, their charts were excluded from the study. It was not necessary for charts to document all three CD4 counts, but charts were included if at least two measures of CD4 cells were recorded. The chart review was limited to a 1-year period because most inmates of the Harris County Correctional Facility are transferred to a state prison or are released within 1 year. Patient charts that met the inclusion criteria were monitored by investigators. Data collected from charts included: birth date, race/ethnicity, gender, CD4 cell count at each specific blood draw, antiretroviral status, and antiretroviral medication used. Demographic data were reviewed to describe the study sample and to compare it with the general jail population at the time of the study.

Mean CD4 cell counts for the entire sample were calculated at each of the three blood draws, and paired *t*-tests were used to identify potential differences. Charts then were divided into subsamples based on ethnicity, gender, and antiretroviral status, and mean CD4 counts for each of the three draws were calculated and compared for the different groups. Mean CD4 cell counts were compared at draws 1, 2, and 3 for the group of patients who had started antiretroviral medication prior to draw 1, and for the group that was not on anti-

TABLE 1. BREAKDOWNS OF STUDY SAMPLE

	No. (%)	Mean Age (Years)	Mean CD4 Count (n, %) Draw 1	Draw 2	Draw 3
Sample	225 (100)	33.1	645.46 (225, 100)	608.25 (179, 80)	630.55 (94, 42)
Gender					
Male	145 (64)	33.9	598.16 (145, 64)	579.98 (123, 55)	595.44 (52, 23)
Female	80 (36)	31.6	723.55 (80, 36)	670.34 (56, 25)	674.02 (42, 19
Race					
African American	152 (68)	33.7	644.45 (152, 68)	600.92 (118, 52)	657.62 (66, 29)
Hispanic	14 (6)	37.6	572.00 (14, 6)	599.25 (12, 5)	465.57 (7, 3)
White	59 (26)	30.2	655.12 (59, 26)	628.10 (49, 22)	600.48 (21, 9)
Antiretroviral medication					
Yes	78 (35)	34.7	313.81 (78, 35)	363.00 (71, 32)	354.00 (23, 10)
No	146 (65)	32.1	819.63 (146, 65)	765.71 (109, 49)	729.16 (70, 31)

retrovirals throughout the study. Also calculated for the group that began an antiretroviral sometime after the first CD4 count was the mean at the first draw while not on an antiretroviral, compared with the mean at the second draw, while on an antiretroviral.

Charts for subjects were divided into two groups based on their antiretroviral status at any given time during the study. Mean CD4 cell counts for those receiving any antiretroviral medicines (azidothymidine, dideoxyinosine, and zaleitabine) were identified for each of the three blood draws as the dependent variables. An analysis of variance (ANOVA) model was constructed to explain the relationship between mean CD4 cell counts and the antiretroviral medication status. Because of the relatively small sample, antiretroviral regimens were not examined.

RESULTS

The correctional facility in which this research was conducted is a large county detention center in Harris County, with an HIV infection rate of 5.75%. This compares to a projected infection rate of 1 in 90 among the county population where the facility is located. In Harris County, individuals between the ages of 30 and 39 constitute the majority of persons infected with HIV. Of the persons in Houston infected with HIV through male-to-male contact, the majority are white (79%) while the lowest percentage is found in African Americans (50%). However, comparing persons infected with HIV through injection drug use, the highest percentage is found in African Americans (20%) and the lowest percentage is found in whites (4%). Men comprised 94% of AIDS cases in Houston, compared with 89% of cases in Harris County, non-Houston. These trends noted in Houston and the surrounding Harris County reflect what is seen on a national level.[19]

The final sample of charts that met the inclusion criteria was comprised of 145 male and 80 female patients, for a total of 225 charts. The mean CD4 cell count for all subjects at baseline was 645.46 cells/mm^3 (range: 7 to 1574 cells/mm^3). Sixty-eight percent of the study population was African American, 26% white, and 6% Hispanic with mean ages of 33.8 years, 37.6 years, and 30.2 years, respectively. The mean overall age of the 225 patients was 33.1 years (range: 18 to 62 years). Table 1 illustrates the demographic breakdown for the study sample.

For this sample of HIV patients, the average period between the first CD4 cell count and the second CD4 cell count was 3.3 months. The third CD4 cell count for subjects with three draws followed the first measurement by an average of 7.4 months. The sample included 46 (20%) subjects with three blood samples (draws 1, 2, and 3); 132 (59%) subjects with two samples (draws 1 and 2); and 47 (21%) subjects with two samples (draws 1 and 3).

One hundred seventy-nine patients had mean CD4 cell counts for draws 1 and 2. There was no observed difference in the sample between these pairs at the .05 level (Table 2). Ninety-four patients had mean CD4 cell counts at draws 1 and 3. There was a statistically significant difference found when examining this pair (Table 2).

Of the group not receiving HIV medications (146 patients), 109 patients had mean CD4 cell counts for draws 1 and 2, and 70 patients had mean CD4 cell counts for draws 1 and 3 (Table 2). This group did not show a significant difference in mean CD4 cell counts between draws 1 and 2, but did show a significant difference in mean cell counts between draws 1 and 3 (Table 2).

Thirty-five percent of the study population (n=78) was receiving antiretrovirals at some point in the study. A total of 31 patients were receiving antiretrovirals at

TABLE 2. COMPARISONS OF CD4 CELL COUNTS

Comparison	Pairs	Mean CD4 Count (cells/mm³) Measure 1	Measure 2	*P* Value	95% CI
All patients (n=225)					
Draw 1 versus draw 2	179	610.54	608.25	0.878	−27.20, 31.7929
Draw 1 versus draw 3	94	752.22	630.55	<.0001	50.93, 138.41
Patients receiving antiretroviral therapy throughout study period (n=31)					
Draw 1 versus draw 2	29	290.66	310.59	.346	−62.564, 22.702
Draw 1 versus draw 3	6	343.83	341.33	.980	−241.027, 246.027
Patients not receiving antiretroviral therapy throughout study period (n=146)					
Draw 1 versus draw2	109	800.31	765.71	.106	−7.474, 76.685
Draw 1 versus draw 3	70	855.03	729.16	<.0001	72.88, 178.86
Patients who started antiretroviral therapy during the study period (n=46)					
Draw 1 versus draw 2	41	332.29	400.17	.014	−120.97, −14.786
Draw 1 versus draw 3	17	366.00	358.47	.821	−62.076, 77.135

Abbreviations: CI=confidence interval.

some point in the study. From this group, 29 patients had mean CD4 cell counts at draws 1 and 2 (Table 2). A subset of 6 patients had mean CD4 cell counts at draws 1 and 3. There was no significant change in mean CD4 cell counts during either time interval (Table 2).

Forty-six patients began therapy after the first blood draw, but prior to the second blood draw. For this group, there was a significant increase in mean CD4 cell counts for the 41 patients with draws 1 and 2 (Table 2). However, there was no significant difference in mean CD4 cell counts for the 17 patients with draws 1 and 3 (Table 2).

CD4 cell counts at draws 1, 2, and 3 were then examined, and the patients' antiretroviral status was ascertained. Within each group (draws 1, 2, and 3), the mean CD4 cell counts were statistically associated with the antiretroviral status. That is, the mean CD4 cell count in each group for individuals on medicine was statistically significant from the mean CD4 cell count for individuals not on medicine. Eighty-eight percent of the subjects studied remained on azidothymidine without supplementation with dideoxyinosine or ddC throughout the study period.

DISCUSSION

Comparison of mean CD4 cell counts at draw 1 versus draws 2 and 3 provided interesting clinical results. For patients not taking any antiretroviral medication throughout the study period, there was no significant difference between mean counts at draw 1 versus draw 2. However, there was a significant decrease in CD4 cell counts when comparing counts at draw 1 and draw 3. These findings coincide with studies reporting defects in the immune system inherent in the disease that result in a decrease in CD4 cells over time.[20,21] In an outpatient setting, CD4 cell counts will decrease by approximately 4 to 11 cells/month while the patient is not receiving antiretroviral therapy.[22] In our sample, mean CD4 cell counts decreased by an average of 10.5 cells/month over the first 3 months and decreased an average of 17 cells/month over 7 months for patients who were not on therapy.

A possible explanation for the more rapid decrease in CD4 cells for inmates over a 7-month period may be due to the stressful conditions inherent in the correctional facilities compared with an outpatient environment. Initially, the decrease in intravenous drug usage resulting in increased health and nutrition, combined with an increased access to free medical care provided to HIV-positive inmates, may slow the decline in the CD4 cells. However, after several months, the stress of imprisonment may supersede the initial benefits, and CD4 cells may take an even greater decline than expected compared with an outpatient setting.

For patients beginning the study on antiretroviral medications (88% on azidothymidine), no significant changes were detected in their mean CD4 cell counts during the period from draw 1 to draw 3. However, for this study sample, clinical certainty regarding the length of time patients had been receiving antiretroviral therapy and compliance with the medication is difficult to

ascertain because patients may have initiated antiretroviral therapy prior to incarceration. For the sample of patients who started an antiretroviral following draw 1 (receiving antiretroviral therapy for 1 to 6 months before the second blood draw), a statistically significant increase in CD4 cell counts was observed when mean cell counts at draw 1 were compared with those at draw 2, but no difference was seen when comparing draw 1 with draw 3.

Earlier studies have shown that an increase in CD4 lymphocytes is seen after 4 weeks of therapy with azidothymidine.[23,24] Our results are consistent with earlier antiretroviral research, which suggests that azidothymidine, dideoxyinosine, and ddC are associated with a decrease of HIV replication in vivo and therefore causes an initial increase in CD4 cell counts lasting several weeks to months. The reduction in HIV replication results in a decreased rate of CD4 count decline and a delay in progression of the disease in the short term.[23,25,26] However, a decrease in sensitivity to azidothymidine is seen when receiving it for 6 months or longer,[27] which results in a decline in CD4 levels beginning approximately 24 weeks after therapy.[24] This decrease in sensitivity will result in CD4 lymphocyte counts returning to baseline levels by approximately 40 weeks of therapy, followed by further declines in CD4 lymphocytes due to the natural course of the disease.[24]

The intervals of 3.3 months and 7.4 months for assessing HIV disease in our patient population are consistent with the literature regarding time periods for staging HIV progression. When CD4 counts are >500 cells/mm^3, they should be monitored every 3 to 6 months, and CD4 counts <500 cells/mm^3 should be monitored every 2 to 3 months.[18] Prophylaxis for *Pneumocystis carinii* pneumonia and antiretroviral therapy are initiated when CD4 cell counts reach specific levels. Also, the revised Centers for Disease Control and Prevention's definition for clinical diagnosis of AIDS requires a CD4 count <200 cells/mm^3 and infection with HIV. In part, the reason for changing the definition of AIDS was to emphasize the importance, clinically, of CD4 cell counts.[28] However, due to differences between laboratories used to perform the cell count (normal for our laboratory was 660 to 1980 cells/mm^3) and diurnal variations in T lymphocytes, care must be taken when monitoring lymphocyte counts. When evaluating patients on follow-up examinations, pertinent laboratory tests and physical examinations should be performed, with focus on weight changes, enlarged lymph nodes, thrush and mouth sores, recurrent pneumonia, pulmonary tuberculosis, neurologic changes, and cancer, especially of the cervix.

To more accurately describe CD4 count changes occurring in a patient sample while on antiretroviral medication, certain factors must be controlled. Medicine noncompliance (either not taking the medicine at all or taking it inappropriately) and differences in antiretrovirals could skew the results. Although 88% of our study sample was receiving azidothymidine therapy without supplementation with other antiretrovirals, 12% of our study sample was receiving dideoxyinosine, azidothymidine with ddC, or changed from azidothymidine to dideoxyinosine during the course of the study. Differences in CD4 counts resulting from changes in antiretroviral therapy were not considered due to the small number of patients in each of these three alternative cells (five patients receiving dideoxyinosine, two receiving azidothymidine/ddC, one changed from azidothymidine to dideoxyinosine, and one changed from dideoxyinosine to azidothymidine).

In this study, patients were not divided into groups depending on stage of disease. The range of initial CD4 cell counts was wide (7 cells/mm^3 to 1775 cells/mm^3), and all of the patients were analyzed together. In preparing this study, the investigators' aim was to determine the effect of incarceration on progression of HIV disease, with or without pharmaceutical intervention. The inclusion of all patients in these analyses, however, may have resulted in a minor distortion of our conclusions because of the demonstrated trend of CD4 cells to decrease as the disease progresses.

CONCLUSION

In this chart review of 225 incarcerated HIV-infected patients at the Harris County Correctional Facility, the results indicate that incarceration does result in a more rapid decrease in CD4 cells for individuals not taking antiretroviral therapy, which may have clinical significance on the normal course of HIV disease. The increased access to medical care does not supersede the overcrowding and stressful living conditions associated with correctional facilities and therefore causes the CD4 cells to decrease greater than expected compared with an outpatient population.

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