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The Economic Burden of Late Entry Into Medical Care for Patients With HIV Infection

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Abstract

Context—A large proportion of people with human immunodeficiency virus (HIV) infection enter care late in the HIV disease course. Late entry can increase expenditures for care.

Objective—To estimate direct medical care expenditures for HIV patients as a function of disease status at initial presentation to care. Late entry is defined as initial CD4 test result ≤200 cells/mm^3, intermediate entry as initial CD4 counts >200, and ≤500 cells/mm^3; and early entry as initial CD4 count >500.

Patients—The study included 8348 patients who received HIV primary care and who were newly enrolled between 2000 and 2006 at one of 10 HIV clinics participating in the HIV Research Network.

Design—We reviewed medical record data from 2000 to 2007. We estimated costs per outpatient visit and inpatient day, and monthly medication costs (antiretroviral and opportunistic illness prophylaxis). We multiplied unit costs by utilization measures to estimate expenditures for inpatient days, outpatient visits, HIV medications, and laboratory tests. We analyzed the association between cumulative expenditures and initial CD4 count, stratified by years in care.

Results—Late entrants comprised 43.1% of new patients. The number of years receiving care after enrollment did not differ significantly across initial CD4 groups. Mean cumulative treatment expenditures ranged from $27,275 to $61,615 higher for late than early presenters. After 7 to 8 years in care, the difference was still substantial.

Conclusions—Patients who enter medical care late in their HIV disease have substantially higher direct medical treatment expenditures than those who enter at earlier stages. Successful efforts to link patients with medical care earlier in the disease course may yield cost savings.

Keywords

HIV; AIDS; expenditures; late presentation

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Antiretroviral therapy has reduced morbidity and mortality among persons with human immunodeficiency virus (HIV).1–3 However, not all persons living with HIV access available therapies. Between 1996 and 2005, HIV surveillance data from 34 US states showed that 38.5% were diagnosed with acquired immune deficiency syndrome (AIDS) within 1 year of testing seropositive for HIV infection.4 Among members of a large United States managed care organization, 43% of newly diagnosed cases of HIV infection were late presenters, defined as first entering care with a CD4 lymphocyte count less than 200 cells/mm^3.[5] In 5 studies, the proportion with CD4 counts <200 cells/mm^3 at first presentation ranged from 24% to 43%.[6] Late entry into HIV care may occur because the person is unaware of his or her serostatus, or because persons who know they have HIV infection defer seeking treatment, due to stigma, mistrust, inaccessibility, or unaffordability of care.

Late entry into care is harmful.[7–9] Compared with patients who enter care early in the course of their HIV infection, those who present late have a worse prognosis, shorter survival, and less benefit from highly active antiretroviral therapy.[8,10,11] From a public health perspective, early recognition and treatment of individuals with HIV infection decreases the risk of HIV transmission.[12–14]

Late presentation also has a major effect on healthcare utilization and expenditure. In a study of 241 Canadian patients from 1996 to 2001, direct medical care costs were 200% higher for late presenters (CD4 count <200 cells/mm^3) compared with early presenters in the year following HIV diagnosis.[15]

Recent progress in HIV treatment, new testing methods, and increasing healthcare costs require an updated evaluation of medical expenditures of individuals who enter care late. This study compares direct medical care expenditures by CD4 count at presentation in a large multistate HIV cohort between 2000 and 2007.

METHODS

Site Selection

Sites in the HIV Research Network (HIVRN) provide primary and subspecialty care to HIV patients. To participate, a site had to have a minimum data set available electronically or through paper abstraction, including CD4 lymphocyte count, HIV-1 RNA (viral load) level, and prescribed antiretroviral medication. Fourteen HIVRN clinics treat adult patients; 11 also collect data on resource utilization. Data from 10 of these 11 sites, located in the East (6), Midwest (1), South (1), and West (2), were included in this analysis. The excluded site had incomplete inpatient utilization data. Nine sites have academic affiliations. Site sample sizes ranged from 205 to 2157. Yehia et al provide additional information describing HIVRN sites.[16]

Data Collection

Data were abstracted from medical records at each site and sent to a data coordinating center after personal identifying information was removed. Problematic data elements were reviewed with the site and corrected. After this quality assurance and verification process, the data were combined across sites to achieve a uniformly constructed multisite database. The study was approved by the Institutional Review Board at the Johns Hopkins School of Medicine as well as by Institutional Review Boards at each of the participating sites.

Dependent Variable

Data for this study cover the period between January 1, 2000 and December 31, 2007. Medical records indicated the month and year the patient was first enrolled in the HIV clinic. This study includes patients who enrolled between 2000 and 2006. Data on health service utilization prior to 2000 were not available.

The outcome variable is cumulative expenditures for HIV-related medical care services; that is, each patient's expenditures were aggregated across the multiyear observation period. Nonmedical services, such as case management, social work, and health education, were not included. In addition, outpatient medical care for non-HIV-related conditions (eg, comorbidities, psychopathology, or substance abuse) was not included. All expenditures were calculated in terms of constant 2006 dollars.

Because patients enrolled at different times, the observation period, and thus the opportunity to accrue expenditures, varied across patients. To provide a standardized time frame, analyses stratified expenditures by number of years in care, defined as having both ≥1 HIV outpatient visit, and ≥1 CD4 test in a calendar year. If patients met the “in care” criterion at any point in a given calendar year, they were credited with a full year in care. We adjusted this period by excluding months before enrollment (generally the first visit to the HIV clinic) in the first year in care, and months after death in the last year in care (where applicable). The resulting number of months in care was categorized as 1 to 12, 13 to 24, etc, up to 85 to 96.

Expenditure Calculations

Medical records provided information on inpatient days, outpatient visits, and start and stop dates of prescribed antiretroviral (ARV) or opportunistic illness prophylaxis (OI Px) medications. Service utilization was counted from the enrollment date to the date of death or, for nondecedents, to December 31, 2007. For each patient, we counted the total number of outpatient visits to the HIV primary care provider and the number of days that each medication had been prescribed between enrollment and the end of 2007. The number of CD4 tests and HIV-1 RNA tests was costed separately from outpatient visits.

For hospitalizations, we excluded admissions that were probably unrelated to HIV infection, those with a primary discharge ICD-9 code indicating traumatic injury or obstetrical treatment. Given the wide range of conditions that could be sequelae of HIV infection or side effects of medications, we opted to be conservative and included other admissions as probably HIV-related. We collapsed the primary ICD-9 codes into broader sets of clinically similar conditions, using Clinical Classifications Software.[17] Appendix A (Supplementary Digital Content, online only, available at: http://links.lww.com/MLR/A132) lists the excluded Clinical Classifications Software categories. A total of 10,119 inpatient admissions occurred over the observation period, of which 750 (7.4%) were deemed not HIV-related. We summed the number of HIV-related inpatient days for each patient. Excluding non-HIV admissions lowered the mean number of inpatient days per person from 20.9 to 19.2.

Expenditure calculations were performed from the perspective of a large-scale purchaser of services, such as the Federal government, which can often negotiate discounts from standard charges. For inpatient days, outpatient visits, CD4 tests, and HIV-1 RNA tests, we multiplied numbers of service units by an appropriate unit cost. Data on charges and cost-to-charge ratios for HIV-related inpatient admissions from the Healthcare Expenditure and Utilization Project State Inpatient Databases (HCUP/SID) were used to estimate a unit cost per inpatient day.[18,19] For ARV and OI Px drugs, we multiplied the number of months a medication was prescribed by an estimated monthly cost, based on discounted 2006 Red Book average wholesale price for that medication.[20] The estimated unit cost for an

outpatient visit was based on Medicare payment for an outpatient visit involving complex evaluation and management.21 We summed outpatient, inpatient, ARV, OI Px, CD4 and HIV-1 RNA expenditures to obtain cumulative expenditures between enrollment and December 31, 2007 (or death) for each patient. Appendix B (Supplementary Digital Content, online only, available at: http://links.lww.com/MLR/A132) provides detailed description of unit cost estimates.

Independent Variables

The major independent variable, presentation status, indicates when in the course of HIV disease the patient entered care. It was based on the first recorded CD4 test for each patient subsequent to the enrollment date ("initial CD4"). Late presenters were defined as those patients whose initial CD4 count was ≤200 cells/mm^3. Early presenters had initial CD4 counts >500. Because some have argued that CD4 counts ≤350 should define late entry,[22–24] we further subdivided the remaining group into those with initial CD4 counts >200 and <351 cells/mm^3 and those with initial CD4 counts >350 and ≤500 cells/mm^3.

Medical records provided information on patients' gender, age, race/ethnicity, and HIV transmission risk factor. Risk factor was coded as men who have sex with men (MSM), heterosexual transmission (HET), injection drug use (IDU, including IDU in conjunction with other risk factors), and other or unknown. Fifty patients who were coded as "transsexual" were combined with females. Age was categorized as 30 or younger, 31 to 40, 41 to 50, and 51 or older. Race/ethnicity was categorized as White, Black, Hispanic, and other/unknown. Insurance coverage at the first outpatient visit was categorized as private, Medicaid, Medicare, Ryan White or none, and other or missing.

Analyses

Included patients had an HIVRN enrollment date between 2000 and 2006, were 18 or older at time of enrollment, and had at least 1 calendar year in which both, an outpatient visit and a CD4 test were recorded. Patients were excluded if they received HIV care before enrollment, based on having outpatient visit dates, CD4, or HIV-1 RNA test dates, or medication start or end dates more than 1 month prior to the enrollment date (A 1-month grace period was allowed to accommodate possible administrative delays in recording enrollment). Patients with an initial HIV-1 RNA test <400 copies/mL recorded after enrollment were excluded, as this suggests that they might have received highly active antiretroviral therapy before enrollment and may be transferring rather than initiating care. To focus on patients likely to have received all of their care from the HIVRN provider, patients were also excluded if they had interruptions in care (ie, one or more calendar years in which the "in care" criterion was not satisfied, interspersed between years in care).

Analyses used the patient as the unit of analysis, not the patient-year. Analyses were cross-sectional, not longitudinal; incremental costs from one year to the next are not reported. Major analyses compared mean cumulative expenditures by presentation status, stratifying by number of years in care. Multivariate regression analyses of cumulative expenditures adjusted for gender, age, race/ethnicity, HIV risk factor, year of enrollment, and site (the latter to capture possible practice variations across providers). Because the distribution of expenditures is not normal, we used a generalized linear model with a log-link and a gamma distribution.[25]

It is possible that late presenters will have a shorter period of survival after enrollment than early presenters. If so, initial expenditures for late presenters could exceed expenditures for earlier presenters, but cumulative expenditures over a time period could be lower for late

presenters because shorter survival means less time to accrue expenditures. To examine this possibility, additional analyses compared the number of years in care by presentation status.

RESULTS

Analytic Sample

Overall, 20,659 adult patients enrolled between 2000 and 2006, inclusive. Of these, we excluded 6072 patients who had dates of outpatient visits, CD4 tests, HIV-1 RNA tests, or medication starts or stops more than 1 month prior to the month of enrollment. We further excluded 2028 patients who had incomplete information on outpatient visits, CD4 tests, HIV-1 RNA tests, medication start dates, or demographic characteristics; 331 who had been enrolled but were not in care in any year; and 2644 patients with the first HIV-1 RNA level after enrollment ≤400 copies/mL. Finally, we excluded 1236 patients with some years out of care interspersed between years in care. This resulted in an analytic sample of 8348 patients.

Table 1 reports characteristics of the analytic sample, across all enrollment years and by enrollment year. Demographic characteristics varied by enrollment year, but relatively little change occurred in gender and race/ethnicity proportions. For their first recorded CD4 test after enrollment, 43.1% had CD4 counts ≤200 cells/mm^3 (late presenters); 64.5% had CD4 counts ≤350 cells/mm^3; and 18.7% were early presenters. The proportion of patients entering care late fluctuated slightly and irregularly across enrollment cohorts. Initial CD4 category and enrollment year were not significantly associated ($\chi^2 = 23.0$, $df = 18$, $P = 0.19$).

Correlates of Late Entry

Table 2 reports associations between presentation status and demographic characteristics. Male gender, minority race/ethnicity, and older age were each significantly associated with late entry. Patients with HET risk were more likely to enter care late than either MSM or IDU patients. Those with private health insurance were more likely to enter care early than those with Medicaid or Medicare. These results were also obtained in a multivariate ordinal logistic regression of initial CD4 category, adjusting for HIVRN site and year of enrollment (results not shown). In this analysis, year of enrollment was associated with presentation status ($\chi^2 = 12.6$, $df = 6$, $P = 0.05$), with higher odds of early entry in 2002 (adjusted odds ratio = 1.16) and in 2005 (adjusted odds ratio = 1.26), compared with 2000.

HIV Treatment Expenditures

Table 3 shows mean cumulative HIV treatment expenditures, stratified by initial CD4 count and number of years in care. Analysis of variance revealed significant ($P < 0.001$) effects for presentation status ($F(3,8316) = 271$), years in care ($F(7,8316) = 259$), and their interaction ($F(21, 8316) = 3.85$). For all periods, treatment expenditures were substantially greater for late presenters than for those who entered care earlier in their disease course. The difference between late and early presenters increased from $27,275 for those with ≤1 year in care to $61,615 for those with up to 5 years in care, and then declined to $49,105 for those with up to 8 years in care. Differences in mean expenditures between early and late presenters were statistically significant ($P < 0.001$) for each separate years-in-care group.

When interpreting results in Table 3, it should be kept in mind that each cell is a different subgroup. Therefore, for example, the increase in cumulative expenditures between early presenters with 7 and 8 years in care ($58,724 –$86,721) does not represent incremental costs for the eighth year. In both groups, a substantial proportion of expenditures was incurred in the earlier years.

A multivariate regression analysis of cumulative expenditures (Table 4) used a generalized linear model with a log-link and gamma-distributed errors. Predictors included presentation status, years in care categories, their interaction, enrollment year, and demographic variables. After adjusting for presentation status and years in care, Black and Hispanic patients incurred significantly higher cumulative expenditures than whites; IDUs were more expensive than MSMs; and older patients, especially those older than 50, had higher expenditures than those aged less than 31.

On the basis of estimated model parameters, we calculated predicted means for each combination of presentation status and years in care, averaging over other covariates. These predicted values appear in Table 3. Adjusting for demographic characteristics and enrollment year produced predicted mean expenditures that were generally lower than observed means. However, the pattern of predicted expenditures was the same as that for observed means.

Sensitivity Analyses

Sensitivity analyses examined the effect of the following: (1) including patients with an initial HIV-1 RNA test <400, (2) including patients with interruptions in care, (3) broadening the “in care” criterion to be ≥1 outpatient visit or ≥1 CD4 test (rather than both), (4) removing inpatient costs from analyses, and (5) excluding decedents from analyses.

For each of these 5 analyses, Appendix C (Supplementary Digital Content, online only, available at: http://links.lww.com/MLR/A132) presents mean observed cumulative expenditures for each combination of presentation status and years in care. In all analyses, the basic pattern observed in the main analyses is preserved. Excluding decedents, or including patients with an interruption in care, did not greatly alter the overall pattern. When inpatient care expenditures are excluded, the difference between early and late entrants widens as the number of years in care increases, suggesting that differences between these groups are not attributable to one or a few inpatient episodes.

Years in Care

Patients were observed for varying periods of time. The mean numbers of total months in care were 30.0, 29.9, 29.2, and 28.0, from lowest to highest initial CD4 group, respectively. An analysis of variance of number of months in care by presentation status was significant ($F = 2.61$, $P = 0.049$), but the association was weak ($R^2 = 0.0009$). However, a trend for late presenters to be in care for a shorter period than early presenters was not observed.

Late presenters were more likely to die than early presenters. The percentage of deaths was 14.04%, 6.22%, 3.92%, and 3.84% by initial CD4 category, from low to high. On the other hand, late presenters were less likely to have interruptions in care. The percentage without a break in care was 89.61%, 86.81%, 85.19%, and 83.73% by initial CD4 category.

In a multivariate negative binomial regression, analysis of number of months in care, differences by presentation status were not significant (Table 5), after adjusting for demographic characteristics, HIVRN site, and enrollment year. Months in care were greater for women than men, for Hispanics than whites, and for older age groups. Patients with IDU risk had fewer months in care than MSM patients.

DISCUSSION

Persons with HIV infection who present late to care, as defined by an initial CD4 count <200 cells/mm^3, incur higher cumulative direct HIV treatment expenditures than those who present earlier in the disease process. Mean medical care expenditures for late presenters

were 1.5 to 3.7 times as high as expenditures for early presenters, similar to a Canadian study.[15] Although expenditure differences between late and early presenters narrowed for those with >5 years in care, late entry was still associated with higher cumulative expenditures than early entry, even among those with 7 to 8 years of primary HIV care.

Cumulative expenditures would be expected to increase the longer a patient received treatment. However, cumulative expenditures could be lower for late entrants if their mortality rate was higher, and they incurred expenditures over a shorter period than earlier entrants. However, the total time in care was similar across all initial CD4 groups. It is possible that over a longer observation period survival differences would appear more strongly and cumulative expenditures for late and early entrants would become closer.

In our sample, 43.1% of patients were late presenters, which is consistent with other studies that report between 24% and 43% late presenters (CD4 ≤ 200).[4–6,15,26–28] We cannot distinguish reasons for late presentation, such as being unaware of one's serostatus versus being aware but unable or unwilling to enter care. Consistent with prior studies, men, Blacks, Hispanics, patients with HET risk, and older patients were more likely to present later than their counterparts.[4,6,7,9,29–31]

Our expenditure estimates are conservative because outpatient expenditures for treating non-HIV-related comorbidities (eg, diabetes, liver-related problems, or psychiatric conditions) have not been included. Moreover, expenditures for outpatient visits were limited to visits to the HIV care provider; visits to other specialty clinics or non-HIV-focused providers (eg, nutritionists) were not included, as this information is not collected across all HIVRN sites. We surmise that differences by presentation status would remain if we are able to include these other categories of expenditures.

Expenditures may be further underestimated whether patients receive medical services outside HIVRN sites. It is possible that late presenters may be less attached to a particular site of care, and thus more likely to use multiple providers. If so, late presenters could have additional expenditures not captured in this study, which could serve to widen differences with early presenters. From the perspective of a single provider, use of multiple care sites could be reflected by moving in and out of care. Use of multiple primary care providers simultaneously might be rare. Therefore, people with interruptions in care may have received care elsewhere. However, when we included such patients in sensitivity analyses (Appendix C, Supplementary Digital Content, online only, available at: http://links.lww.com/MLR/A132), the main pattern of results persisted.

In addition, our estimates exclude expenditures for several types of service (eg, emergency department, home care, social services, and long-term care), as data were not available consistently across HIVRN sites. A study[32] examined emergency department (ED) use based on interviews with a nonprobability sample of 951 HIVRN patients in 2003; interviews may provide more comprehensive data on ED use than clinic records. In that study, 32% of patients reported an ED visit during the 6-month observation period, and ED use was more likely among patients with CD4 <200. Although this CD4 count was not assessed at entry into care, this result suggests that including ED expenditures in current analyses would not have narrowed differences between initial CD4 groups.

There are several other limitations to this study. First, sites in our sample are not nationally representative, although they do encompass a broad geographic distribution. Second, HIVRN sites are highly experienced in the treatment of HIV, with high rates of ARV usage and OI Px. Expenditure estimates may not generalize to locales with less provider experience with HIV or smaller caseloads of HIV patients. If less experienced providers offer suboptimal therapy, hospitalization rates could increase, but survival time could also

diminish; it is not clear how this would affect the cumulative expenditure differential between late and early presenters. Third, we could not observe lifetime costs; comparisons of lifetime costs of early versus late presenters await studies with longer observation periods.

We used average wholesale price, discounted by 23% (Supplemental Digital Content, Appendix B, online only, available at: http://links.lww.com/MLR/A132) for medications. Although average wholesale price is used by many states in determining reimbursement, it does not reflect actual market transactions and may not include rebates or other price adjustments. In addition, our methods of cost estimation varied by type of cost. Our goal was to approximate payments for drugs and services, but our method does not account for variation in prices, especially for drugs and laboratory tests. However, while such factors may affect the estimates of overall expenditure levels, they may not affect estimates of expenditure differentials between early and late presenters.

In conclusion, cumulative direct medical care expenditures for late presenters averaged from $27,436 to $64,040 more than early presenters, depending on time in care, and remained higher even for those with 7 to 8 years of HIV care. Continuation of higher expenditures over time among late presenters is consistent with recent longitudinal data demonstrating that late entry into care is associated with a less robust reconstitution of the immune system.[33,34] To the extent that patients with severely compromised immune systems are surviving longer, early entry into care could help to prolong patients at a relatively less costly disease stage, and thereby reduce aggregate expenditures. These findings highlight the importance of motivating at-risk individuals to seek HIV testing, and of reducing the time between first positive HIV test (or between HIV infection itself) and presentation for treatment. Unless these periods are reduced, late diagnosis and entry into care will continue to create a heightened economic burden.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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TABLE 1

Sample Characteristics, Overall and by Enrollment Year

Variable	All Patients N = 8348 (%)	Enrollment Year						
		2000 N = 1595 (%)	2001 N = 1429 (%)	2002 N = 1250 (%)	2003 N = 1060 (%)	2004 N = 1102 (%)	2005 N = 978 (%)	2006 N = 934 (%)
Gender								
Female	2271 (27.2)	30.0	27.8	25.5	25.6	27.7	25.4	27.1
Male	6077 (72.8)	70.0	72.2	74.5	74.4	72.3	74.6	72.9
Race/ethnicity								
White	2053 (24.6)	22.1	23.6	26.4	26.5	26.0	24.9	23.9
Black	3909 (46.8)	48.0	47.2	45.4	45.0	46.7	48.1	47.1
Hispanic	2091 (25.1)	28.5	26.5	25.5	25.8	24.3	21.2	20.6
Other/unknown	295 (3.5)	1.5	2.7	2.7	2.7	2.9	5.9	8.5
HIV transmission								
MSM	3056 (36.6)	31.0	35.0	37.7	43.2	34.8	40.3	38.0
HET	2925 (35.0)	36.7	35.6	29.8	31.2	35.9	36.4	40.3
IDU	1512 (18.1)	22.9	21.7	18.6	15.5	16.9	13.8	12.7
Other/unknown	855 (10.2)	9.4	7.7	13.9	10.1	12.4	9.5	9.0
Age in 2000 (yr)								
<30	2364 (28.3)	17.9	22.5	25.3	30.1	33.7	38.8	39.8
31–40	3491 (41.8)	44.3	41.7	44.2	42.4	39.4	41.0	37.7
41–50	1914 (22.9)	28.0	27.4	23.2	21.4	21.9	15.8	17.5
51+	579 (6.9)	9.8	8.3	7.4	6.0	5.1	4.5	5.0
CD4 cell count at entry (cell/mm^3)								
<201	3597 (43.1)	45.3	45.4	41.8	43.3	42.2	39.6	42.1
201–350	1784 (21.4)	21.5	21.3	21.8	21.5	22.3	20.1	20.7
351–500	1403 (16.8)	15.4	15.8	17.4	15.9	17.0	18.9	18.7
>500	1564 (18.7)	17.8	17.5	19.1	19.3	18.5	21.4	18.5
Insurance at entry								
Private	843 (10.1)	9.0	9.0	10.2	6.2	9.2	15.2	16.6
Medicaid	2797 (33.5)	39.0	40.3	33.8	28.3	26.7	27.8	33.3
Medicare	495 (5.9)	7.0	6.2	4.9	5.0	5.4	5.6	7.3

Variable	All Patients N = 8348 (%)	Enrollment Year						
		2000 N = 1595 (%)	2001 N = 1429 (%)	2002 N = 1250 (%)	2003 N = 1060 (%)	2004 N = 1102 (%)	2005 N = 978 (%)	2006 N = 934 (%)
Ryan White/uninsured	2940 (35.2)	29.0	37.0	34.5	41.1	37.6	35.3	34.7
Other/missing	1273 (15.3)	16.0	7.6	16.6	19.3	21.2	16.1	11.1

MSM indicates men who have sex with men; IDU, injection drug use; HET, heterosexual HIV transmission.

TABLE 2

Associations Between CD4 Cell Count at Entry and Patient Characteristics

Variable	CD4 <201 (%)	CD4 201–350 (%)	CD4 351–500 (%)	CD4 >500 (%)	Chi-Square Test of Independence
Gender					50.4, *df* = 3, *P* < 0.001
Female	37.6	21.8	17.8	22.8	
Male	45.1	21.2	16.5	17.2	
Race/ethnicity					60.4, *df* = 9, *P* < 0.001
White	37.4	21.9	17.4	23.3	
Black	44.4	20.8	17.4	17.4	
Hispanic	45.9	22.3	15.2	16.6	
Other/unknown	45.1	18.3	16.6	20.0	
HIV transmission					27.0, *df* = 9, *P* < 0.001
MSM	41.1	21.1	17.8	20.0	
HET	44.9	20.8	15.9	18.4	
IDU	40.9	23.9	16.9	18.2	
Other/unknown	48.0	19.7	16.0	16.5	
Age in 2000 (yr)					114.4, *df* = 9, *P* < 0.001
<30	35.0	22.3	20.1	22.6	
31–40	45.2	20.5	15.8	18.6	
41–50	47.4	21.7	15.8	15.1	
51 +	49.1	22.1	12.8	16.1	
Years in care					21.1, *df* = 21, *P* = 0.45
<1	42.3	21.1	16.4	19.6	
>1 and ≤2	42.3	21.0	17.5	19.2	
>2 and ≤3	42.5	22.0	17.0	18.5	
>3 and ≤4	42.0	20.9	18.0	19.2	
>4 and ≤5	42.8	22.0	16.1	18.0	
>5 and ≤6	42.2	23.2	18.1	16.5	
>6 and ≤7	49.8	20.4	15.0	14.8	
>7 and ≤8	48.5	21.6	13.5	16.5	
Insurance at entry					67.5, *df* = 12, *P* < 0.001
Private	36.9	20.8	20.2	22.1	

Variable	CD4 <201 (%)	CD4 201–350 (%)	CD4 351–500 (%)	CD4 >500 (%)	Chi-Square Test of Independence
Medicaid	44.1	22.3	15.7	17.9	
Medicare	57.0	16.8	12.9	13.3	
Ryan White/uninsured	42.8	21.4	16.9	19.0	
Other/missing	40.2	21.5	18.3	20.0	

MSM indicates men who have sex with men; IDU, injection drug use; HET, heterosexual HIV transmission.

TABLE 3

Mean HIV Treatment Expenditures (Unadjusted and Adjusted), by CD4 Cell Count at Entry and Number of Years in Care

Years in Care (Y)	CD4 <201 ("Late")	CD4 201 – 350	CD4 351 – 500	CD4 >500 ("Early")	Difference Late-Early
Y ≤ 1	$ 37,104 (1421) [1228] *35,006*	$ 15,465 (1104) [604] *13,668*	$10,509 (1027) [471] *9564*	$ 9,829 (933) [563] *8259*	$27,275 (1901) [2866]*
1 <Y ≤ 2	47,431 (1764) [838] *48,925*	26,704 (1756) [415] *26,451*	18,700 (1679) [347] *18,767*	15,402 (2439) [381] *14,853*	32,029 (2749) [1226]*
2 <Y ≤ 3	63,616 (2540) [450] *65,225*	38,661 (2780) [233] *39,213*	25,987 (2094) [180] *26,860*	21,798 (1910) [196] *23,072*	41,818 (3729) [1059]*
3 < Y ≤ 4	74,025 (2899) [318] *70,309*	51,391 (3281) [158] *46,956*	37,056 (3258) [136] *33,654*	27,059 (2961) [145] *26,399*	46,966 (4460) [757]*
4 < Y ≤ 5	92,213 (3899) [223] *92,101*	64,362 (3808) [120] *59,107*	53,552 (5394) [84] *51,659*	30,598 (2815) [94] *31,051*	61,615 (6003) [521]*
5 < Y ≤ 6	104,286 (4735) [200] *91,070*	78,992 (4336) [110] *63,729*	66,861 (6184) [86] *55,352*	45,223 (4566) [78] *40,941*	59,064 (7598) [474]*
6 < Y ≤ 7	118,264 (5619) [196] *109,672*	95,135 (5521) [80] *85,211*	75,605 (6404) [59] *71,627*	58,724 (8467) [58] *52,330*	59,540 (10,102) [393]*
7 < Y ≤ 8	135,827 (6876) [144] *118,665*	112,432 (9912) [64] *97,017*	89,871 (7729) [40] *80,387*	86,721 (8796) [49] *73,750*	49,105 (12,392) [297]*

Entries are observed mean cumulative expenditures (standard error in parentheses), sample size (in brackets), and predicted mean based on a generalized linear model, adjusting for gender, race/ethnicity, HIV transmission, enrollment year, site, and age. Predicted (adjusted) means are in italic font. Each cell is a different subgroup, and differences across rows do not represent incremental costs.

*Total observations in each row.

TABLE 4

Multivariate Generalized Linear Regression of Cumulative Costs

Independent Variable	Coefficient	95% Confidence Interval
CD4 <201 (A)	1.44*	1.30, 1.59
CD4 201–350 (B)	0.50*	0.34, 0.67
CD4 351–500 (C)	0.15	–0.03, 0.32
CD4 >500 (reference)	—	—
Years in care		
< 1 (reference)	—	—
1–2 (1)	0.59*	0.40, 0.78
2–3 (2)	1.03*	0.79, 1.26
3–4 (3)	1.16*	0.90, 1.42
4–5 (4)	1.32*	1.01, 1.64
5–6 (5)	1.60*	1.26, 1.94
6–7 (6)	1.85*	1.46, 2.23
7–8 (7)	2.19*	1.77, 2.61
CD4 by years in care		
A-1	–0.25†	–0.47, –0.03
A-2	–0.40‡	–0.68, –0.13
A-3	–0.46‡	–0.78, –0.15
A-4	–0.36	–0.73, 0.01
A-5	–0.64*	–1.04, –0.25
A-6	–0.70*	–1.14, –0.27
A-7	–0.97*	–1.44, –0.49
B-1	0.07	–0.18, 0.33
B-2	0.03	–0.29, 0.34
B-3	0.07	–0.29, 0.43
B-4	0.14	–0.28, 0.56
B-5	–0.06	–0.50, 0.38
B-6	–0.02	–0.52, 0.49
B-7	–0.23	–0.80, 0.32
C-1	0.09	–0.18, 0.36
C-2	0.01	–0.33, 0.34
C-3	0.10	–0.28, 0.47
C-4	0.36	–0.09, 0.81
C-5	0.12	–0.35, 0.59
C-6	0.17	–0.37, 0.71
C-7	–0.06	–0.68, 0.55
Enrollment year		
2000 (reference)		

Independent Variable	Coefficient	95% Confidence Interval
2001	–0.05	–0.16, 0.07
2002	0.01	–0.10, 0.13
2003	–0.12	–0.24, 0.01
2004	–0.14†	–0.26, –0.02
2005	–0.40*	–0.53, –0.28
2006	–0.37*	–0.50, –0.28
Male	–0.02	–0.09, 0.06
Race/ethnicity		
White (reference)	—	—
Black	0.17*	0.09, 0.26
Hispanic	0.21*	0.11, 0.30
Other	–0.11	–0.29, 0.07
HIV risk group		
MSM (reference)	—	—
HET	0.07	–0.01, 0.15
IDU	0.17‡	0.08, 0.28
Other	0.07	–0.05, 0.18
Age group		
< 30 (reference)	—	—
31–10	0.26*	0.19, 0.34
41–50	0.31*	0.22, 0.40
>50	0.41*	0.28, 0.54

Model had gamma-distributed errors, resulting in variance proportional to the square of the mean, and a logarithmic link. Model also included indicators for each clinical site.

MSM indicates men who have sex with men; HET, heterosexual HIV transmission; IDU, injection drug use HIV transmission

*$P < 0.001$.

†$P < 0.05$.

‡$P < 0.01$.

TABLE 5

Negative Binomial Regression of Number of Months in HIV Primary Care

Variable	Coefficient	95% Confidence Interval
CD4 cell count (cell/mm^3) at entry		
>500 (reference)	—	—
351–500	1.03	(0.98–1.07)
201–350	1.02	(0.97–1.07)
<201	1.04	(0.98–1.09)
Gender		
Female (reference)	—	—
Male	0.91*	(0.87–0.95)
Race/ethnicity		
White (reference)	—	—
Black	1.01	(0.97–1.06)
Hispanic	1.09*	(1.04–1.15)
Other/unknown	1.04	(0.92–1.12)
HIV transmission		
MSM (reference)	—	—
HET	0.97	(0.93–1.02)
IDU	0.85*	(0.80–0.89)
Other/unknown	0.64*	(0.60–0.68)
Age in 2000 (yr)		
< 30 (reference)	—	—
31–10	1.02	(0.98–1.06)
41–50	1.11*	(1.06–1.17)
51 +	1.19†	(1.11–1.27)
Enrollment year		
2000 (reference)	—	—
2001	0.92*	(0.87–0.97)
2002	0.89*	(0.84–0.94)
2003	0.80*	(0.76–0.85)
2004	0.68*	(0.64–0.73)
2005	0.57*	(0.53–0.61)
2006	0.41*	(0.39–0.44)

The analysis also included HIVRN site (results not shown). Entries are exponentiated coefficients (incidence rate ratios).

MSM indicates men who have sex with men; IDU, injection drug use; HET, heterosexual HIV transmission; HIVRN, HIV Research Network.

*$P < 0.001$.

†$P < 0.01$.