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Contemporary Costs of HIV Health Care in the HAART Era

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Keywords

cost; HIV; utilization; CD4 count; HAART; HIV Research Network

Background

Delivery of HIV-related health care in the U.S. is expensive. Bozzette et al. estimated that the annual costs of treating a person with HIV infection were $20,300 per patient in 1996 and $18,300 in 1998. [1] Estimates of the cost of treating HIV infection appeared early in the epidemic [2,3] and consistently thereafter [1;4–14]. With some exceptions, [12–14] most of the estimates were produced prior to the development of highly active antiretroviral therapy (HAART) or early in the HAART era. Antiretroviral therapy decreases morbidity and reduces inpatient utilization [15–17]. Estimates of costs derived prior to the widespread use of HAART are now primarily of historical interest. Recent data are needed to produce updated estimates of the costs of care for HIV infection.

Costs of care are higher for patients with lower CD4 cell counts [5;12–14;18]. For one provider in Alabama in 2001, health care expenditures for HIV patients increased as immunosuppression worsened; medication costs accounted for 71%–84% of annual expenses [12]. These results, although informative, are limited by being based on data from a single provider. Cost estimates based on a diverse set of providers and a heterogeneous patient population would have wider applicability. Other multi-site studies provided estimates of inpatient and outpatient costs, but did not include medication costs [5].

To estimate costs of HIV-related health care, we used 2006 data from the HIV Research Network (HIVRN), a multisite consortium of high volume HIV care providers across the United States. The goals of the present study are to estimate costs of care using relatively recent data on a large sample of patients from multiple providers; to identify the proportion

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of costs due to antiretroviral medications; and to quantify differences in expenditures as a function of demographic and clinical characteristics. Because costs may be higher for patients who die, we also compare costs among decedents and non-decedents.

Methods

Sites

The HIV Research Network (HIVRN) is a consortium of primary and subspecialty medical care providers to HIV-infected adult and pediatric patients. Participating sites abstract specified data elements from patients' medical records; abstracted data are assembled into a uniform database [5, 18–20]. Thirteen sites treat adult patients; analyses included 10 sites that collect comprehensive inpatient and outpatient utilization data. Sites are located in the Eastern (6), Midwestern (1), Southern (1), and Western U.S. (2). Nine sites have academic affiliations; one is community-based. Analyses were limited to adult patients (≥18 years old) at these sites who were in HIV primary care, defined by having at least 1 visit to the primary HIV care provider and a CD4 count drawn between January 1, 2006 and December 31, 2006.

Medical Record Data

Medical records provided information on patients' sex, age, and HIV transmission risk factor. Risk factor was coded as injection drug use (IDU, including IDU in conjunction with other risk factors), men who have sex with men (MSM), heterosexual (HET), or other. Race/ethnicity categories were White, Black, Hispanic, and other. Age and median CD4 count were categorized to capture possible non-linear associations with costs. Age as of July 1, 2006 was categorized as 18–29, 30–39, 40–49, and 50 or older. We categorized the median CD4 count recorded in 2006 as ≤ 50 cells/mm^3, 51–200 cells/mm^3, 201–350 cells/mm^3, 351–500 cells/mm^3, and > 500 cells/mm^3.

All 10 sites provided data on inpatient days, outpatient visits, CD4 and viral load tests, and HIV-related medications. We refer to these as "major cost components". Based on medical record data, we counted the total numbers of outpatient visits to the HIV primary care provider, inpatient days, CD4 tests, and HIV-1 RNA tests in 2006 for each patient. Medical record data provided detailed information on all prescribed antiretroviral (ARV) and opportunistic illness (*Pneumocystis jiroveci* pneumonia and *Mycobacterium avium* complex) prophylaxis (OI Px) medications, including start and stop dates. For each patient, we calculated the number of months in 2006 that each medication had been prescribed. In addition, 3 of the 10 sites provided information on visits to the emergency department, use of non-HIV medications (i.e., other than antiretrovirals and OI Px medications), and resistance tests (genotype and phenotype).

Cost Calculations

Cost 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. Because information on payments was not directly available, we estimated expenditures by multiplying utilization data for inpatient days, outpatient visits, ED visits, and lab tests (CD4, resistance, and HIV-1 RNA) 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. [21,22] The estimated unit cost for an outpatient visit was based on the 2006 Medicare payment for an outpatient visit involving complex evaluation and management. For ARV and OI Px medications, 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. We performed analogous calculations for non-HIV medications, based on AWP for generic versions where available. Appendix 1 provides detailed description of unit cost estimation; Appendix 2 reports monthly cost estimates for ARV, OI Px, and other medications.

Analyses

We estimated mean expenditures as a function of median CD4, for total expenditures and for each separate cost component. Using data from three sites, we estimated total expenditures, which included major cost components plus expenditures for ED visits, non-HIV medications, and resistance tests. To maximize sample size, we also used data from all 10 sites to calculate total major expenditures (i.e., the sum of outpatient, inpatient, ARV, OI Px, CD4 and HIV-1 RNA expenditures) in 2006 for each patient.

We identified 15,064 adult patients in the 10 sites who had at least one outpatient visit and one CD4 test in 2006. We removed from analyses 9 patients with death dates prior to dates of service use, 7 missing CD4 test results, 15 with enrollment date after 2006, 11 missing demographic data, 3 missing all medication start dates, and 328 whose medication data were not abstracted at one site, resulting in an analytic sample of 14,691.

Of these, 4,258 were from 3 sites that provided data on all cost components, while 10,433 came from 7 sites that provided data on only major cost components. Initial analyses focused on data from the 3 sites with all cost components; to provide corroborating data from a larger sample, parallel analyses were conducted using data from the 7 other sites.

Most patients (88%) had enrolled in their respective clinics prior to 2006; 1,809 enrolled during 2006. Two hundred thirty four patients died in 2006. Thus, most patients' data reflected costs for the full one-year period. We annualized costs for patients who enrolled in 2006, as they had partial-year data; we did not annualize costs for patients who died during 2006, as this would represent extrapolating beyond death. As in other analyses of medical care costs, [23] we compensated for annualizing costs by using weights for partial-year patients in analyses, where the weight was the proportion of months in 2006 that the patient provided data. Patients with full-year data (and decedents) had analytic weights equal to one.

To examine demographic variations in costs of care, we estimated multiple regression models that included gender, race/ethnicity, HIV risk factor, age, and CD4 category. Ordinary least-squares (OLS) regression can perform sub-optimally when used to analyze data that are skewed or have heavy tails, a feature characteristic of expenditure data. [24,25] Generalized linear models have been recommended as an alternative mode of estimation for such data. [25,26] We used a generalized linear model with a log link and a gamma distribution. Because the coefficients of such models are on a log scale and difficult to interpret, we present predicted values on the original scale. To calculate predictions, the indicator variable for a specific category was set to "1" for all observations, other variables remained unchanged, and predicted values were averaged over the sample. Finally, we compared costs for patients known to have died in 2006 (n=234) with patients not known to have died (n=14,164), and also with patients who died in 2007 (n=240). Analyses were conducted using Stata 9.0.

Results

Table 1 presents the distributions of demographic and clinical characteristics for 14,691 patients receiving primary care for HIV infection in 2006. We present the overall distribution, as well as the distributions within the two groups of sites (3 that had all cost components, and 7 that reported major cost components). Overall, twenty-nine percent were

women; 26% were at least 50 years old. Patients of White race/ethnicity comprised 27% of the sample; Black and Hispanic patients were 49% and 21%, respectively. Forty-two percent had median CD4 counts ≤ 350 cells/mm^3 during 2006.

The two groups of sites differed significantly in the distribution of demographic and clinical characteristics. Two of the three sites providing all cost components were located on the West Coast, while 5 of the 7 other sites were on the East Coast. Consistent with epidemiological trends, the proportions of female patients, minorities, and those with an IDU risk factor were greater in the latter group.

Three Sites with All Cost Components

Averaging over all CD4 count categories and summing all cost types, the mean total cost per person for HIV care in 2006 in the three sites with all cost components was $19,912, with an interquartile range from $11,045 to $22,626. The full range was $317 to $513,202. However, variation by disease stage was considerable. (Table 2) Total costs were substantially lower for patients with less advanced HIV disease. For patients with a median CD4 of 50 or lower in 2006, total costs averaged $40,678 [95% CI: $33,566, $47,789]. In contrast, total costs were considerably lower for those with median CD4 between 351 and 500 ($16,859; 95% CI: 15,798, 17,920) and for those with median CD4 higher than 500 ($16,614; 95% CI: 16,052, 17,177). Costs for patients with median CD4 between 50 and 200 were lower in comparison with those with the greatest immunosuppression ($26,011; 95% CI: 23,730, 28,292), but higher than those with median CD4 > 350. Nevertheless, even among those with the highest CD4 counts, annual medical care costs were substantial.

Table 2 also reports mean costs (95% confidence intervals) for each cost category, stratified by median CD4 count in 2006. For each cost category, overall differences in mean costs across CD4 categories were statistically significant, as assessed by one-way analyses of variance. Inpatient costs were considerably higher for patients with median CD4 ≤ 50 cells/mm^3, compared with patients with higher CD4 counts. Of those with CD4 counts >200 cells/mm^3, 8–18% had any inpatient expenditures, compared with 49% of those with CD4 counts >200 cells/mm^3. Mean outpatient costs declined as median CD4 count increased.

Although statistically significant, variation in costs of CD4 and HIV-1 RNA tests was minimal across CD4 categories. Only 15.1% of patients had resistance tests, consistent with the practice of administering such tests only when initiating or changing antiretroviral regimens. The percentage of patients with a resistance test varied by CD4 category, from 40.7% for those with CD4 counts ≤ 50 cells/mm^3 to 5.7% for those with CD4 counts ≥ 500 cells/mm^3.

Costs for OI prophylaxis medications were minimal for patients with CD4 > 200 cells/mm^3. Non-HIV medication costs were similar across CD4 categories; one-way analysis of variance was not significant (p=0.13). Costs for emergency department visits were twice as high for patients with CD4 <50 cells/mm^3, compared with the 51> CD4 > 200 cells/mm^3 group; overall, ED costs declined as CD4 increased. The percentage of patients with any ED cost dropped from 43% among those with CD4 <50 cells/mm^3 to 18% among those in the highest CD4 count category.

It is notable that costs for antiretroviral medications were lower for patients with CD4 counts ≤ 50 cells/mm^3 than for patients with CD4 counts between 51 and 200 cells/mm^3. The lower mean costs for the most severely immunosuppressed patients derives in part from the lower proportion taking these medications. The percentages of patients with zero ARV costs were 15%, 10%, 15%, 24% and 16% in the respective CD4 count categories, from lowest to highest. Excluding patients with zero ARV costs, the mean ARV costs for those

taking medications were $10,775 for patients with CD4 counts ≤ 50 cells/mm^3 and were $13,140, $13,783, $14,437, and $14,430 for the other respective CD4 categories; only the difference between the two lowest CD4 categories was significant. In absolute terms, antiretroviral medication costs remained substantial for all patients, regardless of CD4 count.

ARV medications accounted for 61% to 74% of costs for those with CD4 counts >200 cells/mm^3, 45% of costs for those with CD4 counts between 51 and 200 cells/mm^3, and 23% of costs for those with CD4 counts ≤ 50 cells/mm^3. For those with CD4 counts ≤ 50 cells/mm^3, inpatient services accounted for the greatest proportion of total costs. Overall, costs for laboratory tests and for ED use were relatively small proportions of total costs. Costs for non-HIV medications exceeded those for OI Px medications, even among patients with CD4 counts ≤ 200 cells/mm^3.

Seven Sites with Major Cost Components

Table 3 reports additional cost estimates, from 7 sites without data on resistance tests, ED use, and non-HIV medications. As noted above, these cost components were minor contributors to total costs. For comparison, mean total major costs (i.e., the sum of inpatient, outpatient, antiretroviral medications, OI PX medication, and lab tests) are also presented for the three sites with full data. Analysis of variance of total major costs revealed significant main effects for CD4 category and for site group (3 versus 7), but the interaction of CD4 category and site group was not significant (P=0.07), suggesting that total major costs followed the same pattern across CD4 categories for both groups of sites. Total major costs were higher for the group of 3 sites than the group of 7, especially for patients with CD4 counts ≤ 50 cells/mm^3. For each major cost component, results from 7 sites were generally similar to those from 3 sites; however, mean ARV costs among patients with median CD4 counts >500 cells/mm^3 were lower ($9,082) than among patients from other 3 sites ($12,313).

Demographic Variations

Analyses of demographic variations examined total costs (for 3 sites) and total major costs (for 10 sites). Table 4 shows results of generalized linear model regression analyses of these cost variables. The ratio of the deviance to the degrees of freedom was 1.15, indicating some overdispersion. However, we used robust estimates of standard errors. Examining a scatterplot of deviance residuals by predicted values indicated no obvious areas of poor fit. Removing 72 cases with deviance residuals > 3 produced only minor changes in results.

Although predicted means for total major costs were lower than predicted means for total costs, as would be expected, the general pattern of results of both analyses was similar. After adjusting for median CD4 count, total costs were significantly higher for IDUs than for those with an MSM risk factor. Total costs were higher in older age categories. Differences in costs were not statistically significant by gender or risk group. Although Black patients did not differ significantly from white patients, Hispanic patients incurred higher costs than whites.

Costs for Decedents

Table 5 presents mean total major costs in 2006 by decedent status and median CD4 category. To maximize sample size, data from all 10 sites were used. Total major costs were substantially higher for patients who died in 2006 (mean =$44,331, 95% CI: 37,667, 50,994) than for non-decedents (mean=$14,932, 95% CI: 14,645, 15,219). Patients who died in 2007 had mean total major costs in 2006 that were higher than non-decedents' costs, but lower than costs for those who died in 2006 (mean = $31,201, 95% CI: 26,142, 36,260). For all groups, however, mean total costs rose as median CD4 cell count dropped. For decedents,

differences between means for adjacent CD4 categories were not statistically significant, reflecting the small samples in each cell.

Discussion

This study provides the most recent estimates of the cost of treating HIV infection, using data from a large sample of patients from multiple provider sites. HIV-infected individuals in this cohort reported high utilization of inpatient and outpatient care and antiretroviral medications, resulting in high costs of HIV care at all CD4 strata. Overall costs of care increased as patients became more immunosuppressed. A substantial proportion of costs was attributable to antiretroviral medication. In patients with severe immunosuppression, inpatient services were the most expensive cost category.

The cost of HAART has been previously estimated to exceed $10,000 per year.[12,27] Our ARV medication cost estimate, across CD4 categories, was $10,315 (95% CI: 10,183, 10,448, n=14,691). However, the mean includes people who were not taking antiretroviral medications. Among those with nonzero ARV costs, the mean was $13,251 (95% CI: 13,124, 13,378). Thus, our overall estimate of annual ART costs is consistent with prior estimates, despite the fact that some prior estimates were implicitly based on average wholesale prices, which we discounted by 23%. On the other hand, our analyses are based on prescribed medications, not actual purchases; to the extent that patients did not purchase all the medications prescribed for them, our estimates would overstate costs.

Mean ARV costs were lower for patients with CD4 counts ≤ 50 cells/mm^3 than for those with CD4 counts between 51 and 200 cells/mm^3. In the former CD4 category, 78% had some ARV medications prescribed, versus 86% in the latter CD4 category. People with severe immunosuppression may have extensive resistance, with few available HAART options, or may not be able to tolerate these medications.

Antiretroviral medication costs remained substantial for patients with CD4 counts > 350 cells/mm^3. Presumably, the higher ARV costs in the higher CD4 strata in this study, compared to the 1998 estimates, are due to the effectiveness of maintenance HAART in increasing the CD4 count.

Our overall per-person annual cost estimate ($19,912) is slightly higher than the overall mean of $18,300 in 1998 obtained in HCSUS [1]. Estimated HIV care costs from HCSUS ranged from $28,128 for those with CD4 counts less than 50 cells/mm^3, to $16,332 for those with CD4 counts between 50 and 200 cells/mm^3, and $6,384 for those with CD4 counts over 500 cells/mm^3.[1] Adjusted to 2006 dollars, these figures are $33,987, $19,734, and $7,714, respectively. The first estimate is broadly similar to current results, but the last two are lower than current estimates. Differences in antiretroviral regimens between 1998 and 2006 may contribute to differences between the current estimates and those derived from HCSUS. In HCSUS, the proportion of costs due to medications was under 20% for all CD4 strata, except for those with CD4> 500 cells/mm^3. In contrast, the proportion of costs due to medications was greater in the current analyses.

Based on data from 635 patients in one clinic in Alabama in 2001, Chen et al. estimated a mean total cost of $18,640 per patient per year, ranging from $36,532 for those with CD4 counts ≤ 50 cells/mm^3 to $13,885 for those with CD4 counts ≥350 cells/mm^3. [12] Our estimates were higher in all CD4 strata. Inpatient expenditure estimates were considerably higher in our study (e.g., $19,658 versus $8,353 in Chen et al. for inpatient care for those with CD4 count ≤ 50 cell/mm^3). Our results point to variation in average expenditures from site to site, which highlights the importance of basing estimates on data from multiple sites.

In all CD4 strata, some of the costs are likely due to treatment of non-HIV comorbidities. Rates of hospitalizations for liver-related complications, comorbid psychiatric disease, and substance abuse disorders have increased in HIV-infected populations [28–33]. It is likely that costs will continue to increase in the next decade due to non-HIV-related complications, including age-related conditions such as cardiovascular disease, cerebrovascular disease, and malignancies [34–37]. The higher costs for persons in older age groups in this study may arise from their having more comorbid conditions.

The cost estimates in this study do not include expenditures for other services, such as treatment for alcohol or substance abuse, mental health care (beyond the costs of psychotropic medications), and non-reimbursable costs for services provided by case managers, adherence counselors, nutritionists, expanded access nurses, and other social service providers. It is clear that the costs of treating HIV infection are high, and the costs of caring for persons with HIV are higher still. Yet, improved efforts are needed to link those who have tested positive into care as quickly as possible to improve long term clinical outcomes.

Although our study is one of the most comprehensive assessments of health care costs among HIV-infected patients in the United States, our sample is not nationally representative and may not generalize to all HIV patients. However, the sites from which patients were sampled do encompass a broad geographic distribution, and multi-site studies afford greater generalizeability than single-site studies. The sites in the HIVRN were all highly experienced in the treatment of HIV; results may differ for patients at sites with less provider experience with HIV or smaller caseloads of HIV patients. It is possible that patients received medical care from multiple providers, and data from one provider might not capture all services used. Provider staff believed that most of their patients received all their HIV care at their site, and we removed from the analysis data from 5 sites where staff were less sure that this was the case. Nevertheless, our cost estimates are lower bounds to the extent that patients received services from multiple providers.

In conclusion, the annual per-person costs of care for HIV-infected patients in the United States are high. It is misleading to focus on a single number as representing “the” cost of treating HIV infection. Costs estimates varied greatly, depending on severity of illness. Within each CD4 stratum, confidence intervals for total costs could cover a range of $600 to $6,000. Such variation should be considered in resource allocation decisions. ARV regimens containing “boosted” protease inhibitors are now increasingly prevalent and may also be more costly. Given the potential increases in costs of therapeutic agents, toxicities and comorbidities due to HAART, and aging-related comorbidities, it is likely that the aggregate costs of HIV care will continue to increase for the foreseeable future.

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Senior Services; New York State Department of Health; Washington State Department of Health. HCUP is sponsored by AHRQ.

Appendix

Participating Sites

Alameda County Medical Center, Oakland, California (Howard Edelstein, M.D.)

Children's Hospital of Philadelphia, Philadelphia, Pennsylvania (Richard Rutstein, M.D.)

Community Health Network, Rochester, New York (Roberto Corales, D.O.)

Community Medical Alliance, Boston, Massachusetts (James Hellinger, M.D.)

Drexel University, Philadelphia, Pennsylvania (Sara Allen, C.R.N.P., Peter Sklar, M.D.)

Henry Ford Hospital Detroit, Michigan (Norman Markowitz, M.D.)

Johns Hopkins University, Baltimore, Maryland (Kelly Gebo, M.D., Richard Moore, M.D)

Montefiore Medical Group, Bronx, New York (Robert Beil, M.D.)

Montefiore Medical Center, Bronx, New York (Lawrence Hanau, M.D.)

Nemechek Health Renewal, Kansas City, Missouri (Patrick Nemechek, D.O.)

Oregon Health and Science University, Portland, Oregon (P. Todd Korthuis, M.D.)

Parkland Health and Hospital System, Dallas, Texas (Laura Armas, M.D.)

St. Jude's Children's Hospital and University of Tennessee, Memphis, Tennessee (Aditya Gaur, M.D.)

St. Luke's Roosevelt Hospital Center, New York, New York (Victoria Sharp, M.D.)

Tampa General Health Care, Tampa, Florida (Charurut Somboonwit, M.D.)

University of California, San Diego, La Jolla, California (Stephen Spector, M.D.)

University of California, San Diego, California (W. Christopher Mathews, M.D.)

Wayne State University, Detroit, Michigan (Jonathan Cohn, M.D.)

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Health Resources and Services Administration, Rockville, Maryland (Alice Kroliczak, Ph.D., Robert Mills, Ph.D.)

Data Coordinating Center

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Table 1

Demographic and Clinical Characteristics of HIV-Infected Patients

Characteristic	N (%)	3 Sites	7 Sites
Age (Years)			
18–29	1,204 (8.2)	247 (5.8)	956 (9.2)
30–39	3,527 (24.0)	995 (23.4)	2,532 (24.3)
40–49	6,148 (41.9)	1,887 (44.3)	4,261 (40.8)
≥50	3,813 (26.0)	1,129 (26.5)	2,684 (25.7)
Race/Ethnicity			
White	4,006 (27.3)	1,864 (43.8)	2,142 (20.5)
Black	7,188 (48.9)	1,692 (39.7)	5,495 (52.7)
Hispanic	3,036 (20.7)	525 (12.3)	2,511 (24.1)
Other/Missing	462 (3.1)	177 (4.2)	285 (2.7)
Sex			
Female	4,277 (29.1)	965 (22.7)	3,312 (31.7)
Male	10,414 (70.9)	3,293 (77.3)	7,121 (68.3)
HIV Risk Factor			
MSM	5,697 (38.8)	1,939 (45.5)	3,757 (36.0)
HET	5,226 (35.6)	994 (23.3)	4,232 (40.6)
IDU	2,974 (20.2)	1,064 (25.0)	1,910 (18.3)
Other/Missing	795 (5.4)	261 (6.1)	534 (5.1)
Median CD4 in 2006 (cells/mm^3)			
≤ 50	850 (5.8)	226 (5.3)	624 (6.0)
51–200	2,158 (14.7)	623 (14.6)	1,535 (14.7)
201–350	3,201 (21.8)	945 (22.2)	2,255 (21.6)
351 – 500	3,351 (22.8)	1,034 (24.3)	2,317 (22.2)
>500	5,132 (34.9)	1,430 (33.6)	2,317 (22.2)

Table 2

Mean Annualized Costs (and 95% Confidence Interval) of HIV Care by CD4 Stratum and Cost Category – 3 Sites

	CD4 Stratum (cells/mm^3)				
	≤ 50	**51–200**	**201–350**	**351–500**	**>500**
ARV Costs	$9,360 (8,234 – 10,485) *	$11,813 (11,127 – 12,499)	$11,769 (11,214– 12,324)	$11,126 (10,599 – 11,654) *	$12,313 (11,911– 12,714)
OI Prophylaxis Costs	$1,214 (1,037 – 1,391) *	$638 (554 – 723) *	$135 (99 – 171) *	$49 (33 – 64) *	$30 (21– 38)
Inpatient Costs	$24,730 (18,414– 31,045) *	$9,626 (7,561 – 11,692) *	$4,372 (3,520 – 5,225) *	$2,470 (1,698 – 3,242) *	$1,071 (771– 1,371)
Outpatient Costs	$689 (595 – 783)	$634 (588 – 680) *	$551 (522 – 579) *	$492 (468 – 516) *	$459 (440 – 477)
CD4 Test Costs	$145 (130 – 159)	$149 (141 – 156)	$139 (133 – 145) *	$128 (124 – 133) *	$121 (118 – 124)
HIV-1 RNA Test Costs	$362 (325 – 398)	$373 (354 – 393) *	$346 (330 – 362) *	$315 (305 – 326) *	$301 (293 – 310)
ED Costs	$998 (333 – 1,664)	$450 (372 – 528) *	$259 (221 – 297) *	$191 (159 – 223) *	$139 (119 – 159)
Non-HIV Medications	$2,020 (1,675, 2,366)	$1,961 (1,754 – 2,167)	$1,811 (1,658 --1964)	$1,843 (1,697– 1,989) *	$2,055 (1,915 – 2196)
Genotype Test Costs	$220 (176 – 265) *	$153 (131 – 176) *	$83 (69 – 97) *	$55 (44 – 67) *	$25 (18 – 32)
Phenotype Test Costs	$58 (22 – 94)	$37 (20 – 54) *	$10 (3 – 16)	$4 (0.6 – 8)	$3 (−0.1 – 6)
Total Costs	$40,678 (33,566 – 47,789) *	$26,011 (23,730–28,292) *	$19,565 (18,472–20,658) *	$16,859 (15,798–17,920)	$16,614 (16,052–17,177)
N	226	623	945	1034	1430

* Mean is significantly different from next higher CD4 category (p<.05).

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Table 3

Mean Annualized Costs (and 95% Confidence Interval) of HIV Care by CD4 Stratum and Cost Category – 7 Sites

	CD4 Stratum (cells/mm^3)				
	≤ 50	**51–200**	**201–350**	**351–500**	**>500**
ARV Costs	$9,772 (9,018 – 10,526) *	$11,662 (11,229 – 12,094)	$10,368 (10,044– 10,692) *	$9,019 (8,704 – 9,335)	$9,082 (8,835– 9,329)
OI Prophylaxis Costs	$909 (822 – 996) *	$581 (527 – 635) *	$235 (205 – 265) *	$141 (119 – 163) *	$96 (84– 109)
Inpatient Costs	$18,376 (15,186– 21,566) *	$7,584 (6,403 – 8,765) *	$3,303 (2,675 – 3,932) *	$2,071 (1,726 – 2,417) *	$1,620 (1,3702 – 1,869)
Outpatient Costs	$571 (520 – 621)	$620 (595 – 645)	$605 (585 – 624) *	$576 (558 – 594)	$558 (545– 572)
CD4 Test Costs	$104 (99 – 110) *	$117 (114 – 120) *	$112 (109 – 114)	$110 (108 – 112) *	$105 (104 – 107)
HIV-1 RNA Test Costs	$253 (240 – 266) *	$282 (274 – 289) *	$266 (260 – 271)	$264 (259 –269) *	$252 (248 – 255)
Total Major Costs	$30,203 (29,932 – 33,474) *	$21,081 (19,776–22,387) *	$14,919 (14,1993–15,639) *	$12,193 (11,708–12,679)	$11,736 (11,376–12,095)
N	624	1,535	2,255	2,317	3,702
Corresponding Total Major Costs for 3 Sites	$36,932 (30,415 – 43,448) *	$23,410 (21,190 – 25,629) *	$17,394 (16,357 – 18,431) *	$14,691 (13,730 – 15,652)	$14,345 (13,839 – 14,851)

* Mean is significantly different from next higher CD4 category (p<.05).

Table 4

Generalized Linear Regression Models of Total Costs ($U.S.) [a]

Independent Variable	Total Costs[b]	Predicted Mean[b]	Total Major Costs[c]	Predicted Mean[c]
Gender				
Female	(reference)	19,851	(reference)	14,738
Male	−0.05 (−0.13, 0.30)	18,874	0.01 (−0.04, 0.04)	14,713
Race/Ethnicity				
White	(reference)	19,034	(reference)	14,460
Black	−0.02 (−0.09, 0.05)	18,587	−0.01 (−0.05, 0.03)	14,316
Hispanic	0.09 (0.01, 0.17)*	20,856	0.12 (0.07, 0.16)**	16,239
Other	0.03 (−0.09, 0.14)	19,589	−0.02 (−0.07, 0.07)	14,225
Risk Group				
MSM	(reference)	18,990	(reference)	14,771
HET	−0.05 (−0.13, 0.03)	18,087	−0.02 (−0.07, 0.02)	14,412
IDU	0.06 (−0.02, 0.13)	20,143	0.02 (−0.03, 0.07)	15,076
Other/Missing	0.03 (−0;09, 0.15)	19,612	0.03 (−0.05, 0.12)	15,290
Age				
18–29	(reference)	11,854	(reference)	10,161
30–39	0.42 (0.25, 0.58)**	17,978	0.29 (0.22, 0.37)**	13,660
40–49	0.50 (0.34, 0.65)**	19,549	0.41 (0.34, 0.49)**	15,395
50+	0.59 (0.44, 0.75)**	21,474	0.49 (0.41, 0.56)**	16,541
Median CD4				
above 500	(reference)	16,459	(reference)	12,018
351–500	0.01 (−0.05, 0.07)	16,623	0.05 (0.01, 0.09)*	12,608
201–350	0.14 (0.08, 0.21)**	19,019	0.22 (0.18, 0.27)**	15,020
51–200	0.44 (0.35, 0.52)**	25,460	0.57 (0.52, 0.63)**	21,367
≤ 50	0.94 (0.76, 1.12)**	42,255	1.02 (0.94, 1.11)**	33,606
Constant	9.13	---	9.00	---

[a] Entries in columns 2 and 4 are coefficients from generalized linear regression models with log link and gamma-distributed errors. The 95% confidence intervals are in parentheses. Entries in columns 3 and 5 are mean expenditures predicted from the model.

[b] Analyses based on 4,258 observations from 3 sites.

[c] Analyses based on 14,691 observations from 10 sites.

Table 5

Mean Annualized 2006 Major Costs (and 95% Confidence Interval) of HIV Care by CD4 Stratum and Decedent Status – 10 Sites

	CD4 Stratum (cells/mm^3)				
	≤ 50	**51–200**	**201–350**	**351–500**	**>500**
Non-decedents	$27,524 (24,507 – 30,541)*	$20,626 (19,584 – 21,668)*	$15,132 (14,580– 15,683)*	$12,804 (12,370 – 13,238)	$12,361 (12,069– 12,653)
Died in 2006	$60,129 (48,739 – 71,519)	$43,032 (27,932 – 58,133)	$41,188 (24,498 – 57,878)	$22,254 [a] (9,998 – 34,510)	$18,394 (10,315– 26,473)
Died in 2007	$40,395 (28,083– 52,707)	$38,300 (26,159– 50,441)	$25,658 (18,715 – 32,601)	$20,725 (11,228 – 30,221)	$22,163 [a] (14,950 –29,377)

A – mean based on < 30 observations.