

Hospital and Outpatient Health Services Utilization Among HIV-Infected Adults in Care 2000–2002

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Background: Rapid changes in HIV epidemiology and antiretroviral therapy may have resulted in recent changes in patterns of healthcare utilization.

Objective: The objective of this study was to examine sociodemographic and clinical correlates of inpatient and outpatient HIV-related health service utilization in a multistate sample of patients with HIV.

Design: Demographic, clinical, and resource utilization data were collected from medical records for 2000, 2001, and 2002.

Setting: This study was conducted at 11 U.S. HIV primary and specialty care sites in different geographic regions.

Patients: In each year, HIV-positive patients with at least one CD4 count and any use of inpatient, outpatient, or emergency room services. Sample sizes were 13,392 in 2000, 15,211 in 2001, and 14,403 in 2002.

Main Outcome Measures: Main outcome measures were number of hospital admissions, total days in hospital, and number of outpatient clinic/office visits per year. Inpatient and outpatient costs were estimated by applying unit costs to numbers of inpatient days and outpatient visits.

Results: Mean numbers of admissions per person per year decreased from 2000 (0.40) to 2002 (0.35), but this difference was not significant in multivariate analyses. Hospitalization rates were significantly higher among patients with greater immunosuppression, women, blacks, patients who acquired HIV through drug use, those 50 years of age and over, and those with Medicaid or Medicare.

Mean annual outpatient visits decreased significantly between 2000 and 2002, from 6.06 to 5.66 visits per person per year. Whites, Hispanics, those 30 years of age and over, those on highly active antiretroviral therapy (HAART), and those with Medicaid or Medicare had significantly higher outpatient utilization. Inpatient costs per patient per month (PPPM) were estimated to be \$514 in 2000, \$472 in 2001, and \$424 in 2002; outpatient costs PPPM were estimated at \$108 in 2000, \$100 in 2001, and \$101 in 2002.

Conclusion: Changes in utilization over this 3-year period, although statistically significant in some cases, were not substantial. Hospitalization rates remain relatively high among minority or disadvantaged groups, suggesting persistent disparities in care. Combined inpatient and outpatient costs for patients on HAART were not significantly lower than for patients not on HAART.

Key Words: resource use, health services, cost of care, hospital admission, antiretroviral therapy, gender, race, disparities, female, injection drug use, black

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The treatment and epidemiology of HIV disease have shown marked changes in recent years. The advent of highly active antiretroviral therapy (HAART) dramatically altered the clinical course of HIV infection. Well-documented declines in opportunistic illness and mortality occurred in the United States and other developed countries where these drugs have been widely available.^{1–3} Declines in hospitalization rates have also been reported.^{4,5} Over time, treatment indications have changed, with thresholds for initiation of HAART dropping from 500 to 350 CD4 cells/mm³, and new antiretroviral medications such as Trizivir and Kaletra have become available.

In addition to changes in HIV therapy, the epidemiology of HIV infection in the United States has changed in a manner that could affect healthcare resource utilization and associated costs. HIV is affecting greater numbers of women, those of minority race/ethnicity, and those with a history of substance abuse than in previous years.⁶ Other comorbidities found in patients with HIV such as hepatitis C and complications of antiretroviral therapy—particularly diabetes, car-

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diovascular, cerebrovascular, and peripheral vascular disease—may be becoming more prevalent.^{7–15}

These changes may affect patterns of healthcare utilization among persons with HIV infection and may have potentially important implications for healthcare financing. Inpatient care has historically been a prominent component of healthcare resource utilization in HIV.^{16,17} In 1996, inpatient care accounted for almost half of medical resource utilization in patients with HIV/AIDS,¹⁸ and by 1998, it had declined to approximately one third of average monthly medical expenditures.¹⁹ Further declines in inpatient utilization could potentially result in additional cost savings.

Service use data from the HIV Cost and Service Utilization Study (HCSUS), a large representative sample of persons in care for HIV infection, were collected in 1996 to 1998, early in the HAART era.¹⁸ More recent U.S. estimates of HIV-related service utilization are based on data collected in 1999 from a nonrepresentative sample.²⁰ However, given the changes in epidemiology, antiretroviral treatments available, and treatment indications between 1999 and 2002, there is a need for more timely data on trends in HIV-related service utilization. This study presents data from 2000, 2001, and 2002 documenting inpatient and outpatient utilization during these years and investigating differences in utilization by demographic and clinical characteristics, including the use of HAART.

METHODS

Site Selection

The HIV Research Network (HIVRN) is a consortium of 17 sites that provide primary and subspecialty care to adult patients with HIV. To be included, a site had to have a minimum dataset available in electronic format or through paper abstraction. The minimum data required were the patients' age, sex, race, HIV transmission risk factors, AIDS-defining illnesses, CD4 level, HIV-1 RNA, and use of antiretroviral medication. Eleven sites also collected data on resource utilization, including hospital admissions, length of stay, and outpatient clinic and office visits. Data from these 11 sites, located in the eastern (6), midwestern (3), southern (1), and western United States (1), were included in this analysis. Eight of these sites have academic affiliations; 3 are community-based. In each year, the analysis was limited to adult patients (≥ 18 years old) who were in longitudinal HIV primary care, as defined by 1) at least one instance of outpatient, emergency room, or inpatient use during the year; and 2) one recorded CD4 test result within a calendar year. Patients who did not meet both criteria were excluded from analyses. The sample size per site ranged from 88 to 2759 patients in 2000, from 233 to 3364 in 2001, and from 254 to 3632 in 2002.

Data Collection

The data elements described here were abstracted from electronic or paper records at each site. Abstracted data were sent in electronic format to a data coordinating center after personal identifying information was removed. For this analysis, data collection encompassed 3 time periods: calendar years 2000, 2001, and 2002. The date of the encounter (not the date of billing or payment of claim) was used.

Electronic data received by the coordinating center were reviewed to ensure that each data element was correctly formatted and that all elements were captured. Data elements with incorrect formatting, unknown or incomplete information, or other inaccuracies were reviewed with the site and corrected. After this verification process, the data were combined across sites to achieve a uniformly constructed multi-site database. A variable identifying the site was included in the database.

Definitions of Variables

HIV transmission risk factors included injection drug use (IDU), men who had sex with men (MSM), and heterosexual transmission (HET), defined as heterosexual activity with a partner at high risk for HIV or with an HIV-infected individual. Persons with both IDU and MSM risk factors were identified as MSM-IDU, and those with IDU and HET were identified as HET-IDU. Patients recorded as acquiring HIV from blood products or from "other" routes were classified as "other." Age was categorized as 18 to 30, 31 to 49, and 50 or older. Race/ethnicity was categorized as white, black, Hispanic, and other.

Insurance was categorized into private, Medicaid, Medicare, and Ryan White/uninsured. Patients with dual Medicare/Medicaid insurance ($n = 687$ across all years) were classified as Medicare, because Medicare is the primary payer for these patients. Patients recorded as self-pay and those covered by local governmental programs (eg, county relief) were considered to be uninsured.

HAART was defined as use of 3 or more nucleosides; any use of one or more protease inhibitors (PI) in conjunction with a nucleoside; a nonnucleoside reverse transcription inhibitor (RTI) in combination with a nucleoside RTI; or a PI, nonnucleoside RTI, or nucleoside RTI combination. Patients were considered to be on HAART if they received any of these combinations during a calendar year. The CD4 and HIV-1 RNA laboratory values used in this analysis were the first values recorded in each calendar year.

For each patient, the number of hospital admissions, the length of stay for each admission, and the number of outpatient clinic/office visits were determined for each 12-month time period. Hospitalization rates were calculated using the total number of admissions per person per year; for tabular display, the mean numbers of admissions were multiplied by 100. Length of stay (LOS) for each admission was calculated

by subtracting the admission date from the discharge date and adding one; same-day admissions and discharges thus count as 1 day. We calculated total inpatient days by summing LOS for each admission during the year. The mean LOS was calculated for each patient with at least one inpatient admission by dividing total inpatient days by number of admissions for that patient; mean LOS was not calculated for patients with no inpatient admissions. Outpatient utilization was measured by the number of visits per person per year. Outpatient encounters were limited to nonemergency department visits to a healthcare provider and did not include administrative visits, laboratory testing, or other visits in which a healthcare provider was not seen.

Cost Estimation

We converted resource use into estimated expenditures by assigning costs in 2001 U.S. dollars to inpatient and outpatient services. These cost estimates were based on the method used in the HIV Cost and Services Utilization Study (HCSUS) for purposes of comparison. HCSUS estimates were \$1657 per hospital day and \$178 for a nonemergency department outpatient visit using 1996 dollars.¹⁹ These estimates were adjusted to 2001 dollars using the annual U.S. medical care inflation rate of the Consumer Price Index, yielding \$1988 per hospital day and \$214 per nonemergency outpatient visit. Monthly inpatient and outpatient costs were calculated by multiplying the inflated HCSUS cost estimates by the number of hospital days or outpatient visits in a year and dividing by 12. Patients with no hospitalizations were assigned zero inpatient costs. Because detailed pharmacy data were not available, outpatient cost estimates do not include the costs of medications.

Data Analysis

We first conducted descriptive analyses of variations in inpatient and outpatient use by patients' demographic and clinical characteristics, including age, gender, race/ethnicity, HIV transmission risk factor, use of HAART, CD4 count (≤ 50 , 51–200, 201–500, > 500 cells/mm³), HIV-1 RNA ($\leq 10,000$, 10,001–100,000, $> 100,000$ copies/mL), and insurance. To retain patients with missing data in the analyses, categories of "missing" were included for race, risk factor, HAART use, insurance, and HIV-1 RNA. A small number of patients missing data on age ($n = 38$) or gender ($n = 111$) were removed from the analyses.

In multivariate analyses of number of inpatient admissions, number of outpatient visits, and total inpatient days, we used negative binomial regression to estimate effects (adjusted rate ratios) for calendar year, and the other demographic and clinical variables. For analyses of count data, negative binomial regression is more robust than Poisson regression when the variance is not equivalent to the mean of the distribution.²¹ Analyses of any hospitalization in a year

were conducted using logistic regression. Multivariate analyses of mean length of stay (ALOS) were conducted using linear regression on the logarithm of ALOS to reduce the skewness in the distribution. The analyses of total inpatient days and mean LOS were restricted to patients with a hospitalization ($n = 2967$ in 2000, 3111 in 2001, and 2842 in 2002). All multivariate analyses included binary indicators for each care site (not shown in the tables) to capture site-specific variation in utilization patterns.

Because a goal of the analysis is to compare resource utilization across 3 years, we adopted a comparative cross-sectional approach to the analysis in which we compare aggregate utilization across years. Data from all available patients were included for each year. Multivariate analyses pooled data for the 2000, 2001, and 2002 cohorts. Data were obtained for 13,392 patients in 2000, 15,211 in 2001, and 14,403 in 2002. A total of 7464 patients provided data in all 3 years, and 6500 had data for 2 years. Because the same patient can appear in multiple years, data from different years are not fully independent. In multivariate analyses, we therefore used generalized estimating equations, with each patient as a cluster and robust standard errors, to deal with the correlation across years for a subset of patients.²²

RESULTS

Table 1 shows the demographic and clinical characteristics of the study sample in each year. The sample was predominantly male and of minority race/ethnicity. The modes of HIV transmission were predominantly MSM and heterosexual, with over 20% having an IDU risk factor in each year. The median age was 40 in 2000 and 41 in 2001 and 2002. Most of the sample had Medicaid or were uninsured.

Across time, there was little change in the distribution of demographic characteristics. The proportion with Medicaid declined (42% to 34%) and the proportion aged 50 and older rose by 4 percentage points. The median initial CD4 levels were 325, 329, and 355 cells/mm³ in each respective year. The median initial HIV-1 RNA in 2000 was 2405 copies/mL and dropped to 1897 and 1641 copies/mL in 2001 and 2002; in all years, 60% of the sample had initial viral loads less than 10,000 copies/mL. The overall proportion receiving HAART increased slightly between 2000 and 2001 but declined slightly in 2002 (71% to 77% to 74%). (If patients missing HAART data—5.8% across all 3 years—are excluded from the computation, 77% received HAART in 2000, 81% in 2001, and 76% in 2002.)

Inpatient Resource Use

Table 2 presents descriptive results for inpatient resource utilization. In 2000, 22.2% of patients had at least one hospital admission, with a mean LOS of 7.44 days. Of the full sample, 13.2% had one hospitalization, 4.9% had 2, and 4.2% had 3 or more. In 2001, 20.4% had at least one hospitaliza-

TABLE 1. Demographic and Clinical Characteristics of Sample by Calendar Year

Characteristic	Year		
	2000 (n = 13,392)	2001 (n = 15,211)	2002 (n = 14,403)
Gender			
Male	69.9%	69.8%	71.2%
Female	30.1	30.2	28.8
Age (years)			
18–30	8.9	8.1	8.2
31–49	75.6	74.7	72.9
50+	15.5	17.2	19.0
Race/ethnicity			
White	27.4	28.4	28.9
Black	47.5	47.3	48.8
Hispanic	22.9	22.2	8.10
Other	1.4	1.5	1.7
Missing	0.8	0.7	2.7
HIV transmission			
MSM	36.2	35.3	38.3
Heterosexual	32.4	33.0	32.3
IDU	15.2	14.6	12.2
MSM-IDU	2.6	2.5	2.6
Heterosexual-IDU	5.4	5.2	5.6
Other	3.2	3.9	2.6
Missing	5.0	5.4	6.4
Initial CD4 (cells/mm³)			
<51	11.3	10.3	9.5
51–200	19.8	19.5	17.2
201–500	40.5	41.9	41.5
>500	28.5	28.3	31.7
Initial HIV-1 RNA (copies/mL)			
<10,000	60.6%	62.0%	62.8%
10,000–1000,000	22.8	22.9	23.1
>100,000	15.2	14.0	13.0
Missing	1.4	1.2	1.2
HAART receipt			
No	20.0	17.7	23.0
Yes	70.6	77.0	74.2
Missing	9.5	5.4	5.4
Insurance			
Private	14.7	14.2	15.6
Medicaid	41.9	35.8	34.3
Medicare	15.9	18.0	16.5
Ryan White/uninsured	25.3	29.3	28.4
Missing	2.3	2.6	5.2

MSM indicates men who have sex with men; IDU, injection drug user; HAART, highly active antiretroviral therapy.

tion, with a mean LOS of 7.62 days. Overall, 12.5% had one hospitalization, 4.2% had 2, and 3.7% had 3 or more in 2001. In 2002, 19.7% had at least one hospitalization, with a mean

LOS of 6.96 days; 12.1% had exactly one hospitalization, 3.9% had 2, and 3.8% had 3 or more. The unadjusted decrease between 2000 and 2001 in the overall proportion

TABLE 2. Inpatient Utilization, 2000–2002

	Any Hospitalization**			Admission Rate†		Total Inpatient Days‡			Mean Length of Stay			
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Overall	22.2	20.4	19.7	39.70	36.14	34.83	13.9	13.9	12.9	7.44	7.62	6.96
Gender												
Male	20.8	18.7	18.4	37.08	33.10	32.60	13.9	13.9	13.0	7.52	7.73	7.08
Female	25.3	24.4	23.1	45.81	43.19	40.36	13.9	13.7	12.6	7.28	7.41	6.74
Age (years)												
18–30	20.0	20.1	18.7	30.32	32.79	29.48	10.2	13.5	11.6	6.47	8.05	6.69
31–49	21.3	19.5	18.9	38.56	34.61	33.43	13.8	14.0	12.9	7.31	7.68	6.96
50+	27.5	24.6	23.5	50.67	44.34	42.53	15.9	13.4	13.4	8.33	7.23	7.05
Race/ethnicity												
White	17.6	16.0	16.4	30.63	26.20	25.53	11.8	11.8	10.8	6.39	7.04	6.62
Black	25.0	23.1	22.2	45.55	40.82	40.60	14.8	14.2	13.7	7.81	7.84	7.16
Hispanic	22.1	20.8	20.4	39.69	38.72	37.24	14.1	14.5	13.4	7.65	7.56	6.91
Other	18.2	15.4	16.4	27.27	33.33	26.23	9.6	17.2	9.6	6.06	6.89	5.93
Missing	16.9	18.2	9.1	25.00	47.47	19.43	11.2	28.4	14.4	7.62	12.53	6.81
HIV transmission												
MSM	17.9	15.2	15.0	29.74	26.40	24.33	11.7	13.0	11.2	6.70	7.27	6.55
Heterosexual	22.3	20.6	19.2	38.89	35.05	32.72	13.3	12.6	12.3	7.24	7.04	6.65
IDU	27.9	27.3	27.1	53.78	52.74	53.60	16.0	15.8	14.3	8.18	7.74	6.95
MSM-IDU	24.6	21.2	21.2	48.12	37.96	38.86	15.4	14.0	11.7	7.79	8.02	6.02
Heterosexual-IDU	31.5	27.2	25.8	67.13	50.51	50.93	18.1	16.9	16.0	8.50	9.24	7.57
Other	19.9	22.8	21.7	33.41	37.19	36.10	14.5	12.8	11.2	7.78	7.81	6.50
Missing	24.7	26.1	29.9	44.41	46.22	56.11	15.0	15.6	16.0	8.18	9.49	9.17
Initial CD4 (cells/mm ³)												
<51	53.2	52.5	49.4	113.14	107.23	103.21	18.4	19.1	18.4	8.80	9.56	8.77
51–200	29.5	28.2	27.8	54.03	49.78	50.42	14.3	14.3	13.4	7.46	8.06	7.34
201–500	16.5	15.2	16.0	27.14	25.76	26.56	11.9	11.4	10.8	6.92	6.47	6.12
>500	12.7	11.2	11.4	18.47	16.31	16.69	9.7	9.3	9.0	6.11	5.85	5.65
Initial HIV-1 RNA (copies/mL)												
<10,000	16.2	14.9	14.7	26.35	24.83	24.81	11.9	11.4	11.2	6.90	6.44	6.28
10,001–100,000	24.6	23.0	22.2	43.89	40.62	38.77	13.8	13.7	13.2	7.35	7.60	7.10
>100,000	41.1	39.3	38.8	83.34	77.50	75.48	16.8	17.9	15.8	8.20	9.42	8.03
Missing	33.0	34.8	28.1	74.87	53.59	43.27	20.4	16.5	11.7	9.79	10.14	7.73

(Continued)

TABLE 2. (Continued)

	Any Hospitalization*†			Admission Rate‡			Total Inpatient Days‡			Mean Length of Stay		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
HAART receipt												
No	22.4	20.2	20.5	40.07	33.18	32.31	14.3	13.9	11.9	7.84	8.26	7.41
Yes	22.4	20.6	19.4	40.15	36.92	34.96	13.7	13.8	13.0	7.28	7.46	6.82
Missing	19.4	18.9	22.0	35.62	34.60	52.23	15.2	14.1	18.4	7.88	7.83	6.80
Insurance												
Private	12.7	15.8	11.4	22.41	26.75	18.50	14.0	15.0	11.4	7.26	8.68	6.45
Medicaid	25.9	24.7	23.4	47.49	46.99	43.86	14.7	15.0	13.7	7.62	7.56	6.95
Medicare	25.4	22.9	24.5	46.73	42.38	47.42	12.7	13.3	13.2	6.68	6.90	6.50
Ryan White/uninsured	15.7	14.4	14.7	25.35	22.79	22.24	12.0	11.9	11.4	7.13	7.30	7.00
Missing	63.1	37.1	32.5	117.97	45.45	52.86	16.9	11.7	13.7	9.32	10.11	8.64

*Entries are percentages with at least one hospitalization.

†Entries are inpatient admission rates per 100 person-years.

‡Entries are calculated among patients with at least one hospitalization (n = 2967 in 2000, 3111 in 2001, and 2842 in 2002).

MSM indicates men who have sex with men; IDU, injection drug user; HAART, highly active antiretroviral therapy.

with any inpatient admission was significant ($P < 0.001$), as was the difference between 2000 and 2002; the difference between 2001 and 2002 was not significant.

In unadjusted comparisons across years, overall hospitalization rates were significantly lower in the 2001 and 2002 cohorts than in the 2000 cohort, dropping from 39.7 to 34.83 admissions per 100 persons across the 3 years. Mean LOS, among 7102 patients with an inpatient admission, did not differ significantly between 2000 and 2001, but it was significantly different between 2001 and 2002. Total inpatient days, however, did not change significantly over time.

Admission Rates

After adjustment for compositional differences using multivariate negative binomial regression (Table 3), the inpatient admission rate did not change significantly between years (adjusted rate ratio = 0.96 for 2001 and 0.95 for 2002). Pooling all 3 years together, admission rates were higher for women than men, for blacks compared with whites, for older patients, and for patients with any IDU HIV risk factor compared with those with an MSM risk factor. As would be expected, admission rates were higher for those with lower CD4 counts and for those with higher HIV-1 RNA levels. Admission rates were higher for patients with Medicare or Medicaid than for those with private coverage; admission rates for those with no insurance did not differ from rates for the privately insured. Receipt of HAART was not associated with admission rates.

The major distinction is between those with no inpatient hospitalizations and those with one or more. A logistic regression analysis of any hospitalization (Table 3) produced the same pattern of significant results as the analysis of number of hospitalizations, with the exception that the difference across years was significant. A negative binomial regression analysis of number of admissions, among patients with at least one admission (results not shown), revealed a generally similar pattern of effects to the analysis of number of admissions among the full sample, although the magnitudes of the coefficients tended to be smaller. In this analysis, however, admission rates were significantly ($P = 0.007$) higher for those receiving HAART compared with those not taking HAART (adjusted incidence rate ratio [IRR] = 1.05). In addition, the gender effect was not significant, whereas the effect for heterosexual HIV transmission was (adjusted IRR = 1.05, $P = 0.04$).

Number of Inpatient Days

A negative binomial regression of number of inpatient days (Table 4) was based on 8916 observations from 7102 patients who had an inpatient admission in one of the 3 years. Adjusting for other variables, there were no significant differences across time. The pattern of effects for age, HIV risk group, CD4 count, and viral load was similar to the analysis

TABLE 3. Multivariate Analysis of Number of Inpatient Admissions and Any Inpatient Admission

Characteristic	No. Inpatient Hospitalizations*	Any Inpatient Hospitalization [†]
Year		
2000	1.0 (Ref)	1.0 (Ref)
2001	0.96 (0.91–1.01)	0.93 (0.88–0.98) [§]
2002	0.95 (0.90–1.01)	0.89 (0.84–0.95) [‡]
Gender		
Male	1.0 (Ref)	1.0 (Ref)
Female	1.25 (1.17–1.34) [‡]	1.40 (1.30–1.50) [‡]
Age (years)		
18–30	1.0 (Ref)	1.0 (Ref)
31–49	0.99 (0.91–1.09)	0.91 (0.82–1.00)
50+	1.36 (1.22–1.51) [‡]	1.33 (1.19–1.50) [‡]
Race/ethnicity		
White	1.0 (Ref)	1.0 (Ref)
Black	1.21 (1.12–1.30) [‡]	1.18 (1.09–1.28) [‡]
Hispanic	1.08 (0.99–1.18)	1.03 (0.94–1.13)
Other	0.97 (0.77–1.23)	0.90 (0.70–1.15)
Missing	0.86 (0.64–1.16)	0.65 (0.50–0.84) [‡]
HIV transmission		
MSM	1.0 (Ref)	1.0 (Ref)
Heterosexual	1.08 (0.99–1.17)	1.08 (1.00–1.18)
IDU	1.61 (1.47–1.76) [‡]	1.60 (1.46–1.76) [‡]
MSM-IDU	1.54 (1.36–1.75) [‡]	1.44 (1.26–1.65) [‡]
Heterosexual-IDU	1.43 (1.19–1.73) [‡]	1.37 (1.14–1.64) [‡]
Other	1.22 (1.05–1.42) [§]	1.22 (1.04–1.43) [‡]
Missing	1.32 (1.17–1.48) [‡]	1.41 (1.25–1.59) [‡]
Initial CD4 (cells/mm ³)		
<51	4.59 (4.19–5.02) [‡]	5.94 (5.38–6.56) [‡]
51–200	2.34 (2.15–2.55) [‡]	2.42 (2.22–2.63) [‡]
201–500	1.38 (1.28–1.48) [‡]	1.30 (1.21–1.40) [‡]
>500	1.0 (Ref)	1.0 (Ref)
Initial HIV-1 RNA (copies/mL)		
<10,000	0.64 (0.59–0.68) [‡]	0.57 (0.53–0.62) [‡]
10,001–100,000	0.73 (0.68–0.77) [‡]	0.67 (0.62–0.72) [‡]
>100,000	1.0 (Ref)	1.0 (Ref)
Missing	0.79 (0.67–0.94) [¶]	0.87 (0.71–1.06)
HAART receipt		
No	1.0 (Ref)	1.0 (Ref)
Yes	1.03 (0.96–1.10)	0.94 (0.88–1.01)
Missing	0.96 (0.83–1.11)	0.82 (0.71–0.96) [¶]
Insurance		
Private	1.0 (Ref)	1.0 (Ref)
Medicaid	1.63 (1.47–1.80) [‡]	1.68 (1.51–1.87) [‡]
Medicare	1.66 (1.49–1.85) [‡]	1.66 (1.49–1.86) [‡]
Ryan White/uninsured	0.98 (0.88–1.09)	0.98 (0.87–1.09)
Missing	2.39 (2.07–2.77) [‡]	4.74 (4.05–5.54) [‡]

*Entries are adjusted incidence rate ratios from negative binomial regression, with 95% confidence intervals in parentheses. Analysis based on 43,003 observations from 21,806 patients.

[†]Entries are adjusted odds ratios from logistic regression, with 95% confidence intervals in parentheses. Analysis based on 43,003 observations from 21,806 patients.

[‡] $P < 0.001$.

[§] $P < 0.01$.

[¶] $P = 0.05$.

of number of hospitalizations. In contrast, effects for gender and for insurance were not significant for total inpatient days. Receipt of HAART was not related to total days in the hospital.

Mean Length of Stay

A linear regression of logged mean LOS (results not shown), based on patients who had at least one inpatient episode, produced results similar to those for number of inpatient days. However, the difference between 2000 and 2002 was significant ($-0.07, P = 0.001$) in this analysis, as was the difference between those who received HAART and those who did not ($-0.07, P = 0.001$). Log mean LOS was longer at lower CD4 levels, for patients not receiving HAART and among patients who were older (versus younger), black or Hispanic (vs. white), with HIV-1 RNA above 100,000 copies/mL (vs. <10,000 copies/mL), and with any IDU HIV risk factor (vs. MSM).

Outpatient Resource Use

Outpatient visits are shown in Table 5. The unadjusted annual mean outpatient visit rate decreased significantly between 2000 and 2001, from 6.06 to 5.58 visits per person ($P < 0.001$). The unadjusted rate increased significantly between 2001 and 2002, to 5.66 mean visits per person, although the magnitude of the change was small. The proportion of patients with no recorded outpatient visit was low: 1.2% in 2000, 3.8% in 2001, and 2.3% in 2002.

A multivariate negative binomial regression of number of outpatient visits (Table 6), combining data from all 3 years, revealed significantly lower outpatient utilization rates in 2001 and 2002 compared with 2000 (IRRs = 0.87 and 0.97, respectively). Patients with lower CD4 counts and those who received HAART had higher numbers of visits. Women and older patients had significantly more visits than men and younger patients, respectively. Hispanic patients had higher numbers of outpatient visits than whites, but the difference between blacks and whites was not significant. Patients with an IDU-only risk factor had significantly fewer outpatient visits than MSM, as did those with a heterosexual-only HIV risk factor. Surprisingly, the outpatient visit rate for patients with private insurance was significantly lower than the rates for Medicare or Medicaid patients, but it was significantly higher than the rate for patients with no insurance.

Inpatient and Outpatient Expenditures per Person per Month

Estimated expenditures for inpatient care are proportional to the number of inpatient days but include zero cost for persons with zero inpatient days, who comprised the majority of patients. Overall monthly inpatient costs per patient were estimated at \$514 in 2000, \$472 in 2001, and \$424 in 2002. This decrease primarily reflects a drop in the

TABLE 4. Negative Binomial Regression for Number of Inpatient Days

Characteristic	Adjusted Rate Ratio (95% CI)
Calendar Year	
2000	1.0
2001	1.01 (0.95–1.07)
2002	0.97 (0.91–1.03)
Age (years)	
18–30	1.0
31–49	1.07 (0.97–1.18)
50+	1.19 (1.07–1.33)*
Sex	
Male	1.0 (Ref)
Female	0.96 (0.90–1.03)
Race/ethnicity	
White	1.0 (Ref)
Black	1.17 (1.09–1.26)*
Hispanic	1.10 (1.01–1.19)†
Other	1.01 (0.79–1.29)
Missing	1.41 (1.09–1.84)†
HIV transmission	
MSM only	1.0 (Ref)
Heterosexual only	1.01 (0.93–1.09)
IDU only	1.23 (1.14–1.34)*
Heterosexual–IDU	1.34 (1.19–1.52)*
MSM/IDU	1.20 (1.02–1.41)*
Other	1.14 (0.98–1.33)
Missing	1.17 (1.06–1.30)†
Initial CD4 (cells/mm ³)	
<50	1.88 (1.71–2.06)*
51–200	1.40 (1.28–1.53)**
201–500	1.15 (1.06–1.25)*
>500	1.0 (Ref)
Initial HIV-1 RNA (copies/mL)	
<10,000	0.82 (0.77–0.88)*
10,001–100,000	0.86 (0.80–0.92)*
>100,000	1.0 (Ref)
Missing	0.94 (0.78–1.12)
Antiretroviral therapy	
No HAART	1.0 (Ref)
HAART	0.99 (0.93–1.05)
Missing	1.04 (0.90–1.21)
Insurance	
Private	1.0 (Ref)
Medicaid	1.02 (0.92–1.12)
Medicare	0.99 (0.90–1.10)
Ryan White/uninsured	0.91 (0.82–1.01)
Other/missing	1.04 (0.91–1.20)

Note: Entries are incidence rate ratios, with 95% confidence intervals in parentheses. Analysis included indicators for treatment site (not shown). Analysis based on 8916 observations from 7102 patients with at least one inpatient admission.

* $P < 0.001$.

† $P < 0.01$.

CI indicates confidence interval; MSM, men who have sex with men; IDU, injection drug user; HAART, highly active antiretroviral therapy.

TABLE 5. Mean Number of Outpatient Visits by Calendar Year

Characteristic	Year		
	2000 (n = 13,392)	2001 (n = 15,211)	2002 (n = 14,403)
Overall	6.06	5.58	5.66
Gender			
Male	5.90	5.46	5.54
Female	6.44	5.86	5.93
Age (years)			
18–30	4.87	4.12	4.53
31–49	6.04	5.55	5.59
50+	6.86	6.42	6.39
Race/ethnicity			
White	6.02	5.28	5.43
Black	5.68	5.10	5.34
Hispanic	7.01	7.02	6.74
Other	6.00	5.93	6.17
Missing	3.59	4.26	6.27
HIV transmission			
MSM	5.89	5.36	5.34
Heterosexual	6.12	5.60	5.70
IDU	6.16	6.07	6.38
MSM-IDU	6.69	6.79	6.62
Heterosexual-IDU	6.10	5.77	6.02
Other	5.42	4.35	5.40
Missing	6.65	5.79	5.35
Initial CD4 (cells/mm ³)			
<51	7.37	6.36	6.52
51–200	6.68	6.13	6.20
201–500	5.92	5.48	5.69
>500	5.33	5.07	5.07
Initial HIV-1 RNA (copies/mL)			
<10,000	5.94	5.50	5.65
10,001–100,000	6.04	5.72	5.58
>100,000	6.92	5.99	6.11
Missing	2.66	2.32	2.37
HAART receipt			
No	4.58	3.77	4.06
Yes	6.36	5.99	6.12
Missing	6.95	5.70	6.67
Insurance			
Private	4.53	4.95	4.74
Medicaid	6.76	6.36	6.68
Medicare	7.38	7.17	6.25
Ryan White/uninsured	5.32	4.28	4.81
Missing	2.27	2.04	4.42

Note: Entries are mean numbers of visits within each category and year.

MSM indicates men who have sex with men; IDU, injection drug user; HAART, highly active antiretroviral therapy.

TABLE 6. Negative Binomial Regression for Number of Outpatient Visits

Characteristic	Adjusted Rate Ratio (95% CI)
Calendar year	
2000	1.0
2001	0.87 (0.86–0.89)*
2002	0.97 (0.95–0.99)*
Age (years)	
18–30	1.0
31–49	1.13 (1.10–1.16)*
50+	1.27 (1.22–1.31)*
Sex	
Male	1.0 (Ref)
Female	1.12 (1.09–1.14)*
Race/ethnicity	
White	1.0 (Ref)
Black	1.02 (0.99–1.04)
Hispanic	1.11 (1.08–1.14)†
Other	1.04 (0.97–1.12)
Missing	0.93 (0.87–1.00)‡
HIV transmission	
MSM only	1.0 (Ref)
Heterosexual only	0.95 (0.93–0.98)*
IDU only	0.96 (0.93–0.99)‡
Heterosexual–IDU	1.06 (1.00–1.12)‡
MSM/IDU	1.04 (0.99–1.09)
Other	0.87 (0.83–0.92)*
Missing	0.84 (0.81–0.88)†
Initial CD4 (cells/mm ³)	
<50	1.26 (1.21–1.31)*
51–200	1.15 (1.12–1.18)*
201–500	1.05 (1.04–1.07)*
>500	1.0 (Ref)
Initial HIV-1 RNA (copies/mL)	
<10,000	0.97 (0.94–0.99)‡
10,001–100,000	0.98 (0.95–1.01)
>100,000	1.0 (Ref)
Missing	0.49 (0.44–0.54)*
Antiretroviral therapy	
No HAART	1.0 (Ref)
HAART	1.39 (1.36–1.42)*
Missing	1.02 (0.98–1.07)
Insurance	
Private	1.0 (Ref)
Medicaid	1.12 (1.09–1.15)*
Medicare	1.22 (1.19–1.26)*
Ryan White/uninsured	0.97 (0.94–0.99)‡
Other/missing	0.59 (0.55–0.62)*

Note: Entries are incidence rate ratios, with 95% confidence intervals in parentheses. Analysis included indicators for treatment site (not shown). Analysis based on 43,003 observations from 21,806 patients.

**P* < 0.001.

†*P* < 0.01.

‡*P* = 0.05.

CI indicates confidence interval; MSM, men who have sex with men; IDU, injection drug user; HAART, highly active antiretroviral therapy.

proportion with any admission and not changes in inpatient days among those hospitalized. Estimated expenditures for outpatient care are proportional to the number of outpatient visits. Mean outpatient costs per month were estimated to be \$108 in 2000, \$100 in 2001, and \$101 in 2002. Combined inpatient and outpatient costs per patient per month were \$622 in 2000, \$571 in 2001, and \$525 in 2002. The unadjusted differences in (logged) combined inpatient and outpatient costs in 2001 and 2002, compared with 2000, were both significant (*P* < 0.001).

In 2000, HAART use was associated with lower mean monthly inpatient costs (\$512) than nonuse of HAART (\$533). However, monthly inpatient costs were slightly higher for patients receiving HAART in 2001 (\$474 vs. \$468) and in 2002 (\$420 vs. \$407). In all years, mean monthly outpatient costs were greater for those on HAART than for those not on HAART (\$113 vs. \$82 in 2000; \$107 vs. \$67 in 2001; \$109 vs. \$72 in 2002). Median outpatient costs were also lower for those not on HAART than for those on HAART in each year (results not shown).

Combining all 3 years, estimated (unadjusted) mean monthly outpatient costs were \$110 for persons receiving HAART and \$74 for those not receiving HAART; mean monthly inpatient costs (unadjusted) were \$465 for patients receiving HAART and \$467 for those not receiving HAART. In analyses pooling data from all years, the effect of HAART on logged combined inpatient and outpatient costs was statistically significant, with costs being higher for those on HAART.

DISCUSSION

In this large, multistate sample of HIV patients from 11 different care sites, outpatient utilization rates decreased significantly between 2000 and 2002 for the overall population by roughly half a visit on the average. Although the proportion of patients with any inpatient episode declined over time, the number of inpatient admissions and the number of inpatient days per person did not change significantly over time in multivariate analyses. Mean length of stay per admission also did not change appreciably. Overall, changes in inpatient and outpatient utilization across time were not substantial.

Some studies have suggested that HIV-related hospitalization rates may be increasing as a result of complications of liver disease secondary to hepatitis C^{9,12} or to complications of HAART, including diabetes or cardiovascular or cerebrovascular disease.^{7,8,10,11,13,23–27} We did not see this trend, but additional studies of hospitalization rates across a longer timespan may reveal an increase in these diagnoses.

Studies early in the HAART era reported lower hospitalization rates among those on HAART compared with those not on HAART,^{4,28–30} but other studies have demonstrated the opposite result.^{7,20} Our multivariate analyses show no

significant difference in the probability of any hospitalization, number of admissions, or inpatient days as a function of HAART receipt, although mean LOS among those with an admission was slightly shorter for those receiving HAART. Outpatient utilization and costs were higher among those on HAART than among those not on HAART, which is consistent with the need for periodic monitoring of drug effectiveness and toxicity.

One factor affecting the obtained nonsignificant effects of HAART on inpatient use is the fact that we also controlled for CD4 cell count and HIV-1 RNA in the multivariate analyses. It could be argued that these laboratory values are influenced by receipt of HAART and thus mediate the impact of HAART on inpatient service use. To examine this possibility, we reestimated the regression models, removing CD4 and HIV-1 RNA. In these revised models, receiving HAART did significantly affect the odds of any hospitalization (adjusted odds ratio = 1.07, $P = 0.04$), as well as the number of hospitalizations (IRR = 1.14, $P = 0.001$), but not the total number of inpatient days (IRR = 1.03, $P = 0.8$). The effect of HAART was positive in these revised models, presumably reflecting the fact that patients on HAART have more advanced HIV disease than those not on HAART.

Over all 3 years, mean combined inpatient and outpatient costs were slightly higher for patients on HAART (\$577 vs. \$538). It has been suggested that the advent of HAART might lead to lower overall costs of treating HIV as a result of a reduction in costly inpatient utilization.³¹ The current estimates, which do not include drug costs, imply that clinical advances brought by HAART have not been associated with substantially lower costs of care.

Similar to past studies,^{20,28,32} higher hospitalization rates were found in patients with the greatest levels of immunosuppression, as evidenced by lower CD4 levels. As would be expected, patients with high HIV-1 RNA (greater than 10,000 copies/mL) also had significantly higher inpatient utilization than those with HIV-1 RNA less than 10,000 copies/mL. More frequent monitoring of more immunosuppressed patients also may underlie the associations of CD4 count and HIV-1 RNA with number of outpatient visits.

Persons with HIV transmission resulting from IDU, either alone or in conjunction with other risk factors, had higher hospitalization rates and more inpatient days than those with other HIV risk factors. This is consistent with prior studies.^{28,32,33} Because we were unable to differentiate active from past drug use, we do not know whether this overall greater use of inpatient healthcare resources results from ongoing illicit drug use or other related factors. Other studies have suggested that patients with a history of IDU are less likely to engage in care.^{34,35} Unlike the patients in those studies, our patients with a history of drug use are already in care and appear to be using inpatient settings at a higher rate than those who do not have a history of drug use. Numbers of

outpatient visits among patients with a history of IDU, however, either did not differ from or were less than the outpatient visit rate among patients with MSM HIV transmission.

Demographic differences in service use are generally consistent with prior research.^{12,28,32,33} Women had significantly higher hospitalization rates and outpatient visits than men. Blacks also had significantly higher inpatient utilization than whites. In contrast to HCSUS findings,³³ blacks did not differ significantly from whites in outpatient utilization.

Patients with Medicare or Medicaid insurance had significantly more inpatient admissions and outpatient visits than those with private insurance. HCSUS also reported a higher likelihood of inpatient admission among persons with Medicaid or Medicare coverage, although the differences were not significant in multivariate analyses.³³ Unmeasured variation in disease severity may partially explain the association between Medicare/Medicaid and higher utilization, because persons with Medicare or Medicaid coverage may be at more advanced disease stages than those with private coverage. Persons with private coverage did not differ significantly from the uninsured in inpatient admission rates in multivariate analyses. These findings differ from other studies, which typically show higher inpatient rates among the uninsured compared with the privately insured.³³ This unexpected finding requires replication with additional data. The outpatient visit rate for the privately insured was higher than that for the uninsured, consistent with HCSUS.³³

HCSUS estimated mean monthly inpatient expenditures in 1998 of \$420 (or \$473 in inflation-adjusted 2001 dollars), and 1999 HIVRN data estimated inpatient expenditures at \$423 (adjusted to \$466 in 2001 dollars). In the current study, monthly inpatient expenditures were \$514 in 2000, \$472 in 2001, and \$424 in 2002, showing a decline over time. Estimates of monthly inpatient costs in 2001, adjusted for inflation, were very similar in the 3 studies. Mean monthly outpatient expenditures of \$108, \$100, and \$101 were lower than the HCSUS estimate of \$201 and the 1999 HIVRN estimate of \$183 (both adjusted to 2001 dollars). Compared with data from HCSUS and 1999 HIVRN data, current data suggest resource utilization costs decreased from 1998 through 2001.

This study has several limitations. First, sites in our sample were not selected by a statistically derived algorithm. The data thus cannot be considered as nationally representative. Nevertheless, the sample includes a large number of patients with broad demographic and geographic distribution. Second, we included all hospitalizations and all visits to primary care providers, but did not include laboratory or administration visits, which could underestimate utilization.²⁰ Third, we did not collect data on home or domiciliary care, or pharmacy utilization. Previous data suggest that home care and chronic facility care comprise 4% to 5% of the cost of HIV care.^{36,37} However, medication costs are a significant

proportion of the overall costs of HIV care. Fourth, a 3-year time interval is a relatively short period in which to observe changes in utilization patterns. Although this time period was not so short as to preclude any statistically significant change, a longer time period might have resulted in observing more change in utilization. Fifth, we relied on sites with experienced HIV providers, who have high rates of HAART and opportunistic infection prophylaxis use compared with other studies.^{38,39} Previous data suggest that providers with HIV experience have lower patient mortality rates and higher use of antiretroviral therapy.^{40,41} Therefore, our results may not generalize to HIV-infected persons who are cared for by non-HIV specialist providers or in rural sites. Nevertheless, we believe that the growing complexity of HIV care will continue to direct most HIV-infected persons to experienced HIV primary care providers, and that data from such providers will capture a substantial proportion of HIV-related care.

Finally, the utilization data obtained in this study will underestimate true utilization rates to the extent that patients received services from multiple providers in addition to those participating in the HIVRN. All HIVRN sites attempt to collect comprehensive utilization data, including utilization from other care providers. A recent unpublished analysis of Medicaid claims of patients at one study site documented that 96% of all admissions occurred at that site's hospital. However, it is not clear if other sites have a comparable proportion of utilization, and we cannot be certain that we have captured all service use for each patient. Hypothetically, it is not clear how existing demographic and clinical differences in inpatient or outpatient utilization would be altered if data on utilization from non-HIVRN providers were included in the analyses.

In summary, in this multistate, multisite cohort of patients with HIV, overall outpatient utilization decreased significantly between 2000 and 2002, whereas inpatient utilization remained relatively unchanged. HAART receipt is not strongly related to reduced inpatient costs, however, and is related to higher outpatient utilization and costs. Sociodemographic disparities in utilization persist, including relatively high inpatient utilization by blacks and IDUs.

REFERENCES

1. Palella FJ Jr, Delaney KM, Moorman AC, et al. Declining morbidity and mortality among patients with advanced human immunodeficiency virus infection. HIV Outpatient Study Investigators. *N Engl J Med.* 1998;338:853–860.
2. Ledergerber B, Egger M, Erard V, et al. AIDS-related opportunistic illnesses occurring after initiation of potent antiretroviral therapy: the Swiss HIV Cohort Study. *JAMA.* 1999;282:2220–2226.
3. Moore RD, Chaisson RE. Natural history of HIV infection in the era of combination antiretroviral therapy. *AIDS.* 1999;13:1933–1942.
4. Mouton Y, Alfandari S, Valette M, et al. Impact of protease inhibitors on AIDS-defining events and hospitalizations in 10 French AIDS reference centres. Federation National des Centres de Lutte contre le SIDA. *AIDS.* 1997;11:F101–F105.
5. Torres RA, Barr M. Impact of combination therapy for HIV infection on inpatient census. *N Engl J Med.* 1997;336:1531–1532.
6. Centers for Disease Control and Prevention. *HIV/AIDS Surveillance Supplemental Report.* 2001;7.
7. Bozzette SA, Ake CF, Tam HK, et al. Cardiovascular and cerebrovascular events in patients treated for human immunodeficiency virus infection. *N Engl J Med.* 2003;348:702.
8. Moore RD, Keruly JC, Lucas GM. Increasing incidence of cardiovascular disease in HIV-infected persons in care. Abstract, 10th Conference on Retroviruses and Opportunistic Infections; Boston, MA; February 2003.
9. Soriano V, Martin-Carbonero L, Garcia-Samaniego J, et al. Mortality due to chronic viral liver disease among patients infected with human immunodeficiency virus. *Clin Infect Dis.* 2001;33:1793–1795.
10. Henry K, Melroe H, Huebsch J, et al. Severe premature coronary artery disease with protease inhibitors. *Lancet.* 1998;351:1328.
11. Carr A, Samaras K, Burton S, et al. A syndrome of peripheral lipodystrophy, hyperlipidaemia and insulin resistance in patients receiving HIV protease inhibitors. *AIDS.* 1998;12:F51–F58.
12. Gebo KA, Diener-West M, Moore RD. Hospitalization rates differ by hepatitis C status in an urban HIV cohort. *J Acquir Immun Defic Syndr.* 2003;34:165–173.
13. The Data Collection on Adverse Events of Anti-HIV Drugs (DAD) Study Group. Combination antiretroviral therapy and the risk of myocardial infarction. *N Engl J Med.* 2003;349:1993–2003.
14. Klein D, Hurley LB, Quesenberry CP, et al. Do protease inhibitors increase the risk for coronary heart disease in patients with HIV-1 infection? *J Acquir Immun Defic Syndr.* 2002;30:471–477.
15. Holmberg SD, Moorman AC, Williamson JM, et al. Protease inhibitors and cardiovascular outcomes in patients with HIV-1. *Lancet.* 2002;360:1747–1748.
16. Scitovsky AA, Cline M, Lee PR. Medical care costs of patients with AIDS in San Francisco. *JAMA.* 1986;256:3103–3106.
17. Hellinger FJ. The lifetime cost of treating a person with HIV. *JAMA.* 1993;270:474–478.
18. Bozzette SA, et al. The care of HIV-infected adults in the United States. HIV Cost and Services Utilization Study Consortium. *N Engl J Med.* 1998;339:1897–1904.
19. Bozzette SA, Joyce G, McCaffrey DF, et al. Expenditures for the care of HIV-infected patients in the era of highly active antiretroviral therapy. *N Engl J Med.* 2001;344:817–823.
20. The HIV Research Network. Hospital and outpatient health services utilization among HIV-infected patients in care in 1999. *J Acquir Immun Defic Syndr.* 2002;30:21–26.
21. Long JS. *Regression Models for Categorical and Limited Dependent Variables.* Thousand Oaks, CA: Sage Publications; 1997.
22. Liang KY, Zeger S. Longitudinal data analysis using generalized linear models. *Biometrika.* 1986;1986:13–22.
23. Fisher A, Stenzel M, Fisher AE. Increased prevalence of diabetes mellitus in patients with HIV infection. In: Abstracts of the 12th World AIDS Conference; Geneva; June 28–July 3, 1998:575.
24. Heath KV, Hogg RS, Chan KJ, et al. Lipodystrophy-associated morphological, cholesterol and triglyceride abnormalities in a population-based HIV/AIDS treatment database. *AIDS.* 2001;15:231–239.
25. Behrens G, Schmidt H, Meyer D, et al. Vascular complications associated with use of HIV protease inhibitors. *Lancet.* 1998;351:1958.
26. Gallet B, Pulik M, Genet P, et al. Vascular complications associated with use of HIV protease inhibitors. *Lancet.* 1998;351:1958–1959.
27. Vittecoq D, Escaut L, Monsuez JJ. Vascular complications associated with use of HIV protease inhibitors. *Lancet.* 1998;351:1959.
28. Gebo KA, Diener-West M, Moore RD. Hospitalization rates in an urban cohort after the introduction of highly active antiretroviral therapy. *J Acquir Immun Defic Syndr.* 2001;27:143–152.
29. Weber AE, Yip B, O'Shaughnessy MV, et al. Determinants of hospital admission among HIV-positive people in British Columbia. *CMAJ.* 2000;162:783–786.
30. Tashima KT, Hogan JW, Gardner LI, et al. A longitudinal analysis of hospitalization and emergency department use among human immunodeficiency virus-infected women reporting protease inhibitor use. *Clin Infect Dis.* 2001;33:2055–2060.
31. Freedberg KA, Losina E, Weinstein MC, et al. The cost effectiveness of combination antiretroviral therapy for HIV disease. *N Engl J Med.*

- 2001;344:824–831.
32. Schoenbaum EE, Lo Y, Floris-Moore M. Predictors of hospitalization for HIV-positive women and men drug users, 1996–2000. *Public Health Rep.* 2002;117(suppl 1):S60–S66.
 33. Shapiro MF, Morton SC, McCaffrey DF, et al. Variations in the care of HIV-infected adults in the United States: results from the HIV Cost and Services Utilization Study. *JAMA.* 1999;281:2305–2315.
 34. Strathdee SA, Palepu A, Cornelisse PG, et al. Barriers to use of free antiretroviral therapy in injection drug users. *JAMA.* 1998;280:547–549.
 35. Celentano DD, Vlahov D, Cohn S, et al. Self-reported antiretroviral therapy in injection drug users. *JAMA.* 1998;280:544–546.
 36. Gebo KA, Chaisson RE, Folkemer JG, et al. Costs of HIV medical care in the era of highly active antiretroviral therapy. *AIDS.* 1999;13:963–969.
 37. Moore RD, Chaisson RE. Costs to Medicaid of advancing immunosuppression in an urban HIV-infected patient population in Maryland. *J Acquir Immun Defic Syndr Hum Retrovirol.* 1997;14:223–231.
 38. McNaghten AD, Hanson DL, Dworkin MS, et al. Differences in prescription of antiretroviral therapy in a large cohort of HIV-infected patients. *J Acquir Immun Defic Syndr.* 2003;32:499–505.
 39. Gebo KA, Fleishman JA, Reilly ED, et al. High rates of primary *Mycobacterium avium* complex and *Pneumocystis jirovecii* prophylaxis in the United States. *Med Care.* In press.
 40. Kitahata MM, Koepsell TD, Deyo RA, et al. Physicians' experience with the acquired immunodeficiency syndrome as a factor in patients' survival. *N Engl J Med.* 1996;334:701–706.
 41. Kitahata MM, Van Rompaey SE, Shields AW. Physician experience in the care of HIV-infected persons is associated with earlier adoption of new antiretroviral therapy. *J Acquir Immun Defic Syndr.* 2000;24:106–114.

APPENDIX

Participating Sites

- Montefiore Medical Group, Bronx, New York (Robert Beil, MD)
- Alameda County Medical Center, Oakland, California (Kathleen Clanon, MD)
- Wayne State University, Detroit, Michigan (Lawrence Crane, MD)
- Community Health Network, Rochester, New York (Steven Fine, MD)
- St. Jude's Children's Hospital, Memphis, Tennessee (Patricia Flynn, MD)
- Johns Hopkins University, Baltimore, Maryland (Kelly Gebo, MD, MPH)
- Montefiore Medical Group, Bronx, New York (Marc Gourevitch, MD)
- Montefiore Medical Center, Bronx, New York (Lawrence Hanau, MD)
- Community Medical Alliance, Boston, Massachusetts (James A. Hellinger, MD)

- Henry Ford Hospital, Detroit, Michigan (John Jovanovich, MD)
- Parkland Health and Hospital System, Dallas, Texas (Philip Keiser, MD)
- Oregon Health and Science University, Portland, Oregon (P. Todd Korthuis, MD, MPH)
- University of California, San Diego, California (W. Christopher Mathews, MD, MSPH)
- Johns Hopkins University, Baltimore, Maryland (Richard D. Moore, MD, MHS)
- Tampa General Health Care, Tampa, Florida (Jeffrey Nadler, MD)
- Nemechek Health Renewal, Kansas City, Missouri (Patrick Nemechek, DO)
- Children's Hospital of Philadelphia, Philadelphia, Pennsylvania (Richard Rutstein, MD)
- St. Luke's Roosevelt Hospital Center, New York, New York (Victoria Sharp, MD)
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- Health Resources and Services Administration, Rockville, Maryland (Richard Conviser, PhD)
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