Hospital and Outpatient Health Services Utilization Among HIV-Infected Children in Care 2000–2001

Richard M. Rutstein, MD, Kelly A. Gebo, MD, MPH,† George K. Siberry, MD, MPH,† Patricia M. Flynn, MD,‡ Stephen A. Spector, MD,§ Victoria L. Sharp, MD,¶ and John A. Fleishman, PhD‖*

Background: The aging of the pediatric HIV cohort and advances in antiretroviral therapy for children may have resulted in recent changes in patterns of healthcare utilization.

Objectives: The objectives of this study were to examine inpatient and outpatient HIV-related health service utilization in a multistate sample of HIV-infected children, and to assess sociodemographic and clinical correlates of utilization.

Design: Cohort study of pediatric patients with HIV. Demographic, clinical, and resource utilization data were collected from medical records for 2000 and 2001.

Setting: This study was conducted at 4 U.S. HIV primary pediatric and specialty care sites in different geographic regions.

Patients: Three hundred three HIV-positive children with at least one outpatient visit or CD4 test in either 2000 or 2001 were studied.

Main Outcome Measures: Mean outcome measures were number of hospital admissions, mean length of hospital stay, and number of outpatient clinic/office visits.

Results: Hospitalization rates decreased significantly from 39.2 (95% confidence interval [CI], 28.4–50.1) to 25.3 (95% CI, 16.4–34.3) admissions per 100 patients between 2000 and 2001. Hospitalizations were higher among patients with greater immunosuppression, those 2 years and under, and those with AIDS, but were not significantly related to receipt of highly active antiretroviral therapy. Mean outpatient visits did not change significantly between 2000 and 2001 from 9.09 (95% CI, 8.3–9.9) to 9.06 (95% CI, 8.4–9.7) visits per child per year. Children 2 years and under, those on highly active antiretroviral therapy, those with AIDS, and those with Medicaid had significantly higher outpatient utilization. Those with higher HIV-1 RNA had higher outpatient utilization than those with less advanced disease.

Conclusion: Inpatient utilization significantly decreased between 2000 and 2001, but outpatient utilization did not change over time. Compared with prior studies, utilization rates appear to be declining over time. Unlike adults, racial/ethnic or gender disparities in healthcare utilization are less pronounced for HIV-infected children.

Key Words: resource use, HIV, children, hospital admission, antiretroviral therapy

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The advent of highly active antiretroviral therapy (HAART) has led to dramatic changes in the clinical course of HIV infection. Well-documented declines in opportunistic illness and mortality have occurred among children and adults in the United States and other developed countries where these drugs have been widely available.[1–6] Declines in hospitalization rates in adults have been reported,[7,8] and similar declines, if observed among children, would have significant implications for financing HIV care.

Utilization data for pediatric patients with HIV, especially data reflecting advances in therapy since the mid-1990s, are not as readily available as for adults. In the pediatric population, the clinical course of HIV infection may differ from that found in adult HIV infection, including, historically, a more rapid progression.[9,10] In addition, children on HAART are less likely to achieve viral suppression than adults on HAART.[11] This may reflect immunologic differences between children and adults, as well as the fact that many antiretroviral agents approved for adult use are difficult to take or poorly tolerated among children, resulting in greater challenges to adherence in the pediatric population.

From the *Division of General Pediatrics, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania; †Johns Hopkins University School of Medicine, Baltimore, Maryland; the ‡Department of Infectious Diseases, St. Jude Children's Research Hospital, Memphis, Tennessee; the §Department of Pediatrics, University of California, San Diego, La Jolla, California; the ¶Center for Comprehensive Care, St. Luke's Roosevelt Hospital Center, New York, New York; and the ‖Center for Financing, Access, and Cost Trends, Agency for Healthcare Research and Quality, Rockville, Maryland.

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Drs. Rutstein and Gebo contributed equally to this article.

Reprints: Kelly Gebo, MD, MPH, Johns Hopkins University School of Medicine, 1830 E. Monument St., Room 442, Baltimore, MD 21287. E-mail: kgebo@jhmi.edu.

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In the context of an aging pediatric cohort, rapidly changing clinical treatment, and absence of recent data from relatively large samples, there is a need for accurate data on current trends in HIV-related service utilization for infected children. In addition, it is not clear if service utilization data based on children in clinical trials generalize to the broader population of HIV-infected children in care. This article describes patterns of healthcare utilization in a relatively large sample of HIV-infected children followed at 4 sites specializing in primary care for these patients. This analysis describes the use of inpatient and outpatient services in 2000 and 2001 by perinatally infected children and adolescents. In addition, we report the associations of various demographic and clinical characteristics, including the use of HAART, with health services utilization.

METHODS

Site Selection

HIV Research Network (HIVRN) sites were selected from members of the HIV Quality Care Network of the Infectious Diseases Society of America. The HIVRN is a consortium of 17 sites that provide primary and subspecialty care to 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 factor, AIDS-defining illnesses, absolute CD4 count, CD4 percent, HIV-1 RNA, and use of antiretroviral medication. Participating sites also collected data on resource utilization, including hospital admission with length of stay, and outpatient clinic and office visits. Data from 4 sites specializing in the care of pediatric HIV-infected patients were included in this analysis; other HIVRN sites had no pediatric patients. Geographically, 2 sites are located in the eastern United States, one in the southern United States, and one in the western United States. All of these sites have academic affiliations. Sample sizes per site ranged from 46 to 120 patients in 2001. This analysis was limited to vertically infected children (≤17 years old) who were in longitudinal HIV primary care, as defined by at least one visit to a primary care provider at one of these sites and one recorded CD4 count within a calendar year.

Data Collection

The data elements described here were abstracted from electronic or paper records at each individual 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 the time period of January 1, 2000, through December 31, 2001. The date of the encounter (not the date of billing or payment of claim) was used. Electronic data received by the coordinating center were assessed to ensure that each data element was correctly formatted and that all elements were captured. Data elements with incorrect formatting, with 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 multisite database. A variable identifying the site was included in this database.

Definition of Variables

Insurance was categorized into private, Medicaid, self-pay/Ryan White, and other/missing. Patients classified as self-pay/Ryan White are considered to be uninsured. HAART was defined as: 1) 3 or more nucleosides; 2) any use of one or more protease inhibitors (PI) or a nonnucleoside reverse transcription inhibitor (RTI) in combination with 2 or more nucleoside RTI; or 3) 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 absolute CD4 count, CD4 percent, and HIV-1 RNA laboratory values used were the first values recorded in each calendar year.

For each patient, the number of hospital admissions and the length of stay for each admission, and the number of outpatient clinic/office visits were determined for each 12-month time period from January 1 to December 31, 2000 and January 1 to December 31, 2001. 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. Hospitalization rates were calculated for each patient using the total number of admissions per year; for tabular display, mean numbers of admissions were multiplied by 100. The mean length of stay (LOS) was calculated for each patient with at least one inpatient admission by dividing total inpatient days by number of admissions. Outpatient utilization was measured by the number of visits per person per year.

Data Analysis

We first conducted descriptive analyses of variations in inpatient and outpatient use by patients' demographic and clinical characteristics, including age (>2 years vs. ≤2 years), gender, race/ethnicity (white, Hispanic, and black), presence of AIDS, use of HAART, CD4 count (≤200, 201–500, >500 cells/mm^3), CD4% (≤14, 15–24, ≥25%), HIV-1 RNA (≤400, 401–10,000, 10,001–100,000, >100,000 copies/mL), and insurance (private, Medicaid, self-pay/Ryan White, or other/missing). As a result of the large number of observations with missing data for insurance and for CD4 percent, we included categories of "missing" in the analyses for these variables.

In bivariate analyses, we examined the relationship between each demographic and clinical factor and each dependent variable within each calendar year. Results of biva-

riate statistical tests appear in Tables 2 and 5, although we do not comment on them explicitly.

In multivariate analyses of number of inpatient admissions and number of outpatient visits, we used negative binomial regression to estimate effects (adjusted rate ratios) for calendar year, age, gender, race/ethnicity, HIV risk factor, CD4 count, HIV-1 RNA, AIDS, HAART, and insurance. 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.[12] Analyses of any hospitalization in a year were conducted using logistic regression. Multivariate analyses of mean LOS costs were conducted using linear regression on the logarithm of this variable to reduce the skewness in the distribution. The analysis of mean length of stay was restricted to patients with a hospitalization. All multivariate analyses included binary indicators for each care site to capture site-specific variation in utilization patterns.

Because a goal of the analysis is to compare resource utilization in 2000 and 2001, we adopted a comparative cross-sectional approach to the analysis. Multivariate analyses pooled data for the 2000 and 2001 cohorts. Data from all available patients were included for each year. Utilization data were obtained for 283 patients in 2000 and 288 in 2001, comprising 303 unique patients over both years. Overall, 268 patients provided data for both years, 15 had data for 2000 only, and 20 had data only for 2001. In multivariate analyses of admissions and outpatient visits, a small number of observations with missing data for race, HIV-1 RNA, or HAART were deleted, resulting in an analytic sample of 534 observations from 284 children, of whom 250 provided data in both years. Because of this overlap, data from the 2 years are not fully independent. 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.[13]

Absolute CD4 count had lower rates of missing data than CD4 percent. Therefore, in multivariate models, we used the absolute CD4 count instead of CD4 percentage. Analyses using CD4 percent, augmented with a "missing" category instead of CD4 count produced nearly equivalent results. CD4 percent was not significantly associated with inpatient visits, mean LOS, or outpatient visits.

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

Characteristic	2000 (n = 283)	2001 (n = 288)
Age (years)		
Median	8	8
Range	0–17	0–17
Sex		
Male	132 (46.8%)	131 (45.6%)
Female	150 (53.2%)	156 (54.4%)
Race		
White	33 (11.7%)	33 (11.5%)
Black	191 (68.0%)	199 (69.3%)
Hispanic	57 (20.3%)	55 (19.2%)
Initial CD4 (cells/mm^3)		
Median	798	788
≤50	7 (2.5%)	9 (3.1%)
51–200	9 (3.2%)	14 (4.9%)
201–500	53 (18.7%)	60 (20.8%)
>500	214 (75.6%)	205 (71.2%)
CD4%	n = 239	n = 192
≤14	30 (12.6%)	20 (10.4%)
15–24	50 (20.9%)	40 (20.8%)
≥25	159 (66.5%)	132 (68.8%)
Initial HIV-1 RNA (copies/mL)	n = 268	n = 278
Median	1653	1471
≤400	112 (41.8%)	118 (42.5%)
401–10,000	76 (28.4%)	80 (28.8%)
10,001–100,000	41 (15.3%)	55 (19.8%)
>100,000	39 (14.6%)	25 (9.0%)
Antiretroviral therapy	n = 266	n = 275
No HAART	29 (10.9%)	15 (5.5%)
HAART	237 (89.1%)	260 (94.6%)
AIDS	85 (30.0%)	80 (27.8%)
No AIDS	198 (70.0%)	208 (72.2%)
Insurance		
Private	19 (6.7%)	15 (5.2%)
Medicaid	198 (70.0%)	200 (69.4%)
Ryan White	18 (6.4%)	19 (6.6%)
Missing	48 (17.0%)	54 (18.8%)

HAART indicates highly active antiretroviral therapy.

RESULTS

The demographic and clinical characteristics of the study sample for each year are shown in Table 1. The sample had a slight female predominance. The majority was black; 19% were Hispanic and 12% were white. Between 2000 and 2001, the median age remained at 8 years, with a range of less than 1 to 17 years. For both years, the median CD4 level was near 800 cells/mm^3, and over 70% had CD4 counts greater than 500 cells/mm^3. The median HIV-1 RNA was 1653 and 1471 copies/mL in 2000 and 2001, respectively, with over 40% of patients being virally suppressed at less than 400 copies/mL. Over 85% were on HAART in each year; 30% had AIDS; and 70% were covered by Medicaid.

Inpatient Resource Use

Hospital admission-associated resource utilization is shown in Table 2. In 2000, 22.3% of patients had at least one

TABLE 2. Inpatient Utilization 2000–2001

Characteristic	2000			2001		
	Percent With Any Inpatient Stay	Mean Length of Stay in Those Hospitalized (n = 63)	Inpatient Admission Rate per 100 Person-Years	Percent With Any Inpatient Stay	Mean Length of Stay in Those Hospitalized (n = 43)	Inpatient Admission Rate per 100 Person-Years
Total	22.3	4.25	39.2	14.9	3.15	25.3¶
Age						
>2 yr*	18.9	4.29	32.5	13.4	3.24	22.1
≤2 yr	47.1	4.13	88.2‡	30.8	2.77	57.7
Sex						
Male	22.7	3.72	36.4	11.5	3.23	20.6
Female*	22.0	4.73	41.7	18.0	3.11	29.5
Race/ethnicity						
White*	6.1	2.25	9.1	3.0	1.00	3.0
Black	27.8	4.45	50.3‡	19.6	2.97	33.7§
Hispanic	14.0	3.47	21.1	5.5	6.22	9.1
Initial CD4 (cells/mm^3)						
≤200	43.8	9.39	93.8§	47.8	4.45	95.7†
201–500	28.3	3.22	56.6	11.7	2.98	20.0
≥500*	19.2	3.75	30.8	12.2	2.63	19.0
Initial CD4%						
≤14*	30.0	8.67	46.7	55.0	3.71	115.0‡
15–24	40.0	3.24	76.0	15.0	2.89	27.5†
≥25	18.2	3.87	30.8	13.6	2.79	19.7
HIV-1 RNA (copies/mL)						
<400*	15.2	3.32	21.4	6.8	2.25	7.6
401–10,000	17.1	3.51	32.9	11.3	2.33	12.5
10,000–100,000	19.5	2.50	34.1	21.8	4.02	40.0†
≥100,000	56.4	6.17†	115.4	52.0	3.56	124.0†
AIDS	34.1	5.37	74.1†	28.8	2.61	57.5†
No AIDS	17.2	3.30	24.3	9.6	3.62	13.0
Antiretroviral therapy						
No HAART*	27.6	3.63	31.0	26.7	2.25	40.0
HAART	21.9	3.57	40.9	13.9	3.00	23.8
Insurance						
Private*	21.1	2.94	36.8	20.0	3.33	26.6
Medicaid	27.3	4.44	49.0	18.5	3.09	31.0
Self-pay/Ryan White	11.1	4.00	16.7	0	—	0
Missing	6.3	2.83	8.3	5.6	3.75	13.0

*Reference category.
†<.001 within a year, compared with reference category.
‡<0.01 within a year, compared with reference category.
§<0.05 within a year, compared with reference category.
¶<0.05 between years, within category of independent variable.
HAART indicates highly active antiretroviral therapy.

hospital admission, with a mean LOS of 4.25 days. Overall, 13.1% of patients had one hospitalization, 5.0% had 2, and 4.2% had 3 or more. In 2001, only 14.9% of patients were hospitalized with a mean LOS of 3.15 days. Overall, 9.7% had one hospitalization, 2.8% had 2, and 2.4% had 3 or more. The unadjusted annual hospitalization rate decreased significantly between 2000 and 2001, from 39.2 to 25.3 hospitalizations per 100 persons ($P < 0.05$).

After adjustment for other factors using multivariate negative binomial regression (Table 3), the inpatient admission rate was significantly lower in 2001. Younger children and those with AIDS had more admissions than older children or those without AIDS, respectively. In addition, the number of admissions was higher for those with CD4 counts <200 cells/mm^3 and for those with higher levels of HIV-1 RNA (>10,000 copies/mL). Inpatient utilization did not vary by gender, race/ethnicity, or HAART use. Logistic regression analyses of any hospitalization produced the same pattern of results, with the adjusted odds of hospitalization in 2001 being 0.58 of the odds in 2000 (results not shown).

Length of Stay

The linear regression of logged length of stay based on 79 patients (Table 4) revealed only one significant effect: black children had longer LOS than whites. LOS was not significantly different in 2001 compared with 2000. Length of stay did not vary significantly by gender, HAART use, age, insurance, AIDS status, CD4 cell count, or HIV-1 RNA.

TABLE 3. Negative Binominal Regression for Number of Inpatient Hospitalizations

Characteristic	Adjusted Rate Ratio (95% CI)
Calendar year	
2000	1.0 (Ref)
2001	0.59 (0.38–0.91)
Age	
>2 yr	1.0 (Ref)
≤2 yr	3.68 (2.16–6.29)
Sex	
Male	0.93 (0.62–1.34)
Female	1.0 (Ref)
Race/ethnicity	
White	1.0 (Ref)
Black	3.32 (0.61–18.20)
Hispanic	2.89 (0.53–15.78)
Initial CD4 count	
≤200	3.45 (1.56–7.62)
201–500	1.76 (0.98–3.19)
>500	1.0 (Ref)
HIV-1 RNA (copies/mL)	
≤400	1.0 (Ref)
401–10,000	1.24 (0.68–2.28)
10,001–100,000	2.15 (1.22–3.82)
>100,000	3.00 (1.50–5.99)
Antiretroviral therapy	
HAART	0.71 (0.38–1.36)
No HAART	1.0 (Ref)
AIDS	3.04 (1.89–4.88)
No AIDS	1.0 (Ref)
Insurance	
Private	1.0 (Ref)
Medicaid	0.60 (0.24–1.53)
Self-pay/Ryan White	0.33 (0.08–1.25)
Missing	0.30 (0.09–1.03)

Note: Entries are incidence rate ratios, with 95% confidence intervals in parentheses. Analysis included indicators for treatment site (not shown).

n = 534 observations from 284 patients.

CI indicates confidence interval; HAART, highly active antiretroviral therapy.

TABLE 4. Linear Regression of Logarithm of Mean Inpatient Length of Stay (n = 79 Patients)

Characteristic	Estimate (95% CI)
Calendar year	
2000	(Ref)
2001	−0.18 (−0.43–0.07)
Age	
>2 yr	(Ref)
≤2 yr	0.19 (−0.21–0.58)
Sex	
Male	−0.01 (−0.31–0.29)
Female	(Ref)
Race/ethnicity	
White	(Ref)
Black	0.51 (0.03–0.98)
Hispanic	0.57 (−0.12–1.26)
Initial CD4 (cells/mm^3)	
≤200	0.19 (−0.37–0.75)
201–500	0.15 (−0.22–0.52)
≥500	(Ref)
HIV-1 RNA (copies/mL)	
≤400	(Ref)
401–10,000	0.07 (−0.31–0.44)
10,001–100,000	−0.10 (−0.51–0.30)
>100,000	0.12 (−0.31–0.55)
Antiretroviral therapy	
HAART	0.10 (−0.46–0.26)
No HAART	(Ref)
AIDS	0.13 (−0.21–0.46)
No AIDS	(Ref)
Insurance	
Private	(Ref)
Medicaid	−0.07 (−0.78–0.64)
Self-pay/Ryan White	−0.04 (−1.45–1.37)
Missing	−0.15 (−1.11–0.81)

Note: Entries are regression coefficients, with 95% confidence intervals in parentheses.

CI indicates confidence interval; HAART, highly active antiretroviral therapy.

Outpatient Resource Use

Descriptive statistics for outpatient resource utilization are shown in Table 5. The annual mean outpatient visit rate did not change significantly over time, with 9.09 visits per child in 2000 and 9.06 visits per child in 2001. A multivariate negative binomial regression of number of outpatient visits (Table 6) revealed no difference in outpatient utilization between 2000 and 2001. Younger patients had more visits than older ones, and those with AIDS had more visits than those with less advanced disease. Patients with HIV-1 RNA between 401 and 100,000 copies/mL had higher outpatient visit rates than those with HIV-1 RNA less than or equal to 400 copies/mL, but the effects of CD4 count were not significant. After adjustment for other variables, black and Hispanic patients did not have more frequent outpatient visits

TABLE 5. Outpatient Utilization in 2000–2001

Characteristic	2000 Mean Outpatient Visits per Person per Year	2001 Mean Outpatient Visits per Person per Year
Total	9.09	9.06
Age		
>2 yr*	8.56	8.81
≤2 yr	12.97†	11.62§
Sex		
Male	9.55	9.31
Female*	8.69	8.81
Race/ethnicity		
White*	6.52	7.03
Black	9.54†	9.39†
Hispanic	9.26‡	9.18‡
Initial CD4 (cells/mm^3)		
≤200	9.25	12.78†
201–500	8.91	8.37
>500*	9.12	8.84
CD4%		
≤14	10.83	13.00§
15–24	8.48	9.20†
≥25*	8.86	8.48
HIV-1 RNA (copies/mL)		
≤400*	8.21	7.58
401–10,000	8.43	9.96†
10,001–100,000	9.83	9.22§
>100,000	13.31†	13.48†
AIDS	9.87	10.38‡
No AIDS*	8.75	8.55
Antiretroviral therapy		
No HAART*	6.58‡	7.73
HAART	9.65	9.13
Insurance		
Private*	8.16	6.47
Medicaid	9.02	9.11§
Self-pay/Ryan White	6.78	6.05
Missing	10.63	10.65‡

*Reference category.
†<0.001 within a year, compared with reference category.
‡<0.01 within a year, compared with reference category.
§<0.05 within a year, compared with reference category.
HAART indicates highly active antiretroviral therapy.

TABLE 6. Negative Binominal Regression for Number of Outpatient Visits

Characteristic	Adjusted Rate Ratio (95% CI)
Calendar year	
2000	1.0
2001	0.99 (0.93–1.06)
Age	
>2 yr	(Ref)
≤2 yr	1.41 (1.19–1.68)
Sex	
Male	1.05 (0.94–1.16)
Female	1.0 (Ref)
Race/ethnicity	
White	1.0 (Ref)
Black	1.13 (0.96–1.33)
Hispanic	1.14 (0.92–1.42)
CD4	
≤200	1.05 (0.85–1.30)
201–500	0.96 (0.85–1.08)
>500	1.0 (Ref)
HIV-1 RNA (copies/mL)	
≤400	1.0 (Ref)
401–10,000	1.11 (1.01–1.22)
10,001–100,000	1.15 (1.02–1.29)
>100,000	1.23 (0.98–1.53)
Antiretroviral therapy	
HAART	1.16 (0.96–1.40)
No HAART	1.0 (Ref)
AIDS	1.27 (1.12–1.44)
No AIDS	1.0 (Ref)
Insurance	
Private	1.0 (Ref)
Medicaid	1.23 (1.03–1.47)
Self-pay/Ryan White	0.85 (0.66–1.09)
Missing	0.87 (0.68–1.10)

Note: Entries are incidence rate ratios, with 95% confidence intervals in parentheses. Analysis included indicators for treatment site (not shown). Analysis included indicators for treatment site (not shown). n = 534 observations from 284 patients.
CI indicates confidence interval; HAART, highly active antiretroviral therapy.

compared with whites, and gender differences were not significant. Children with Medicaid had more outpatient visits than either those with private coverage or those with no insurance.

DISCUSSION

The widespread use of HAART for HIV-infected adults and children has resulted in a significant decrease in morbidity and mortality.[1,4–6] Although several studies have documented associated changes in utilization for adults while on HAART, no such data have been reported from the United States for the pediatric population.[7,8,14–18] Previously reported pediatric utilization data have been confined, for the most part, to the pre-HAART era.[19,20]

The data reported from this unique observational cohort were collected from 4 geographically diverse sites providing comprehensive primary and specialty care to HIV-infected children. Each site captured all encounters at their institution, including outpatient visits and hospital admissions. Studies of adults have shown that patients followed in observational cohort studies differ in clinical disease progression and virologic suppression compared with patients followed in clinical trials.[21] The generalizability of the findings from this study is thus enhanced because data were not restricted to children selected to participate in clinical trials.

HIV-infected children have higher rates of hospital and outpatient utilization than HIV-negative children. Dovey et al reported a mean hospitalization rate of 3.6 per 100 child years, with 1.98 outpatient physician visits per child per year, and the National Ambulatory Medical Care survey in 2001 reported an outpatient utilization rate of 2.43 visits per year for HIV-negative children less than 15 years old.[22,23] Inpatient and outpatient utilization rates in the current study are substantially higher.

Previous data on HIV-infected children were collected in the pre-HAART era and demonstrated significantly higher inpatient utilization rates and longer LOS than we have observed. Using New Jersey hospital discharge data, Conviser et al reported a hospitalization rate of 436 per 100 patient years (PY) with a mean LOS of 14.1 days for children with AIDS.[19] Based on data from 1991 to 1992, Hsia et al reported a hospitalization rate of 140 per 100 PY for those with AIDS.[20] In addition, the European Collaborative Study demonstrated a rate of 48 per 100 child years between 1986 and 1997.[20,24] Our admission rates of 39.2 and 25.3 per 100 children in 2000 and 2001, respectively, are considerably lower. A recent study, based on data from the United Kingdom and Ireland, confirms this trend. Gibb et al noted a decreased hospitalization rate from 1997 through 2002.[25]

Outpatient utilization estimates from the pre-HAART era were also higher than in our study. Hsia et al reported 18.2 ambulatory visits per child per year for those with AIDS and 15 visits per year for HIV-infected children.[20] Our rates in 2001 of approximately 10.4 visits per year for those with AIDS and 8.6 per year for those without AIDS are significantly lower. Our rates do suggest a higher utilization than the quarterly visits recommended by International AIDS Society (IAS) guidelines for well-controlled HIV-infected children over the age of 2 years.[11]

In summary, our observed lower inpatient utilization and outpatient utilization rates are lower than those of previously published HIV-infected pediatric cohorts from pre-HAART studies. Although it seems most plausible that the dramatically lowered utilization rates reported here are the result of newer antiretroviral therapies, part of the difference might be a result of the general aging of the pediatric HIV-infected population. In the AIDS Costs and Services Utilization Study (ACSUS) sample, from 1991 to 1992, 6% were less than 1 year with no child older than 12 years. In our cohort, the median age was 8 years, with an age range of birth through 17 years, and less than 7% were under 2 years. Consistent with prior studies,[23,24] younger age was associated with increased physician visits and risk of hospitalization. In the study presented here, children less than 2 years of age had 50% more outpatient visits than older children. Part of this increased outpatient utilization reflects pediatric well-child care standards, which recommend 10 well-child visits in the first 24 months of life.[26] As children age, they require less well-child care and are typically hospitalized less often with fevers.[22,23] Therefore, some of the decrease in inpatient and outpatient utilization reported here may be the result of the increasing age of the cohort.

Although the majority of patients had CD4 counts above 500/mm^3, only 40% had HIV-1 RNA less than or equal to 400 copies/mL, suggesting lower than desirable rates of virologic suppression. Most HIV-infected children are started on HAART at, or soon after, the diagnosis, most frequently in the first year of life. Many HIV-infected children therefore have developed antiretroviral resistance by adolescence. As these HIV-infected children age and develop more extensive resistance, it is possible healthcare utilization will increase.

In contrast to studies of HIV infected adults,[14,18] after adjustment for other clinical factors, we did not find any differences in outpatient visits by race. This suggests that other clinical factors such as HIV-1 RNA, AIDS status, and HAART use are stronger predictors of utilization than race. Unlike studies of adults, we found no difference in utilization by gender.

An important difference between this pediatric sample and adult cohorts is the nearly universal insurance coverage for children, primarily through Medicaid. Nearly 85% of the sample was covered by Medicaid. Public insurance plays a key role for this population.

Similar to past studies,[14,17,27] higher hospitalization rates were found in patients with the greatest levels of

immunosuppression, as evidenced by the lower CD4 levels and CD4 percent. As would be expected, children who had detectable HIV-1 RNA, greater than 400 copies/mL, also had higher inpatient and outpatient utilization than those with HIV-1 RNA less than 400 copies/mL. It is possible that the effects of HAART on service utilization may be indirect by fostering virologic suppression, which in turn leads to lower utilization rates. However, estimating such an indirect causal effect of HAART on utilization is difficult in observational data, because HAART use also depends on measures of immunosuppression such as HIV-1 RNA and CD4 levels or percent, creating the possibility of reciprocal causation.

This study has several potential limitations. First, sites in our sample were not selected by a statistically derived algorithm. 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 potentially underestimate utilization.[14] Third, there were elements of resource use that we did not collect, including home care or domiciliary care and pharmacy utilization. Data from adult studies indicate that pharmacy costs account for an increasingly large portion of total healthcare costs of HIV-infected individuals. Previous adult data suggest that home care and chronic facility care may comprise only 4% to 5% of the cost of HIV care.[28,29] Fourth, although our sample of children with HIV infection is larger than other studies, it is still small. Statistical tests may have low power, especially for analyses of LOS, which were based on 79 individuals across both years. Also, a 1-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 outpatient utilization. Our analyses may have missed admissions that occurred at other hospitals. However, all of our sites attempt to comprehensively collect all patient hospitalizations, including those at outside hospitals. In fact, a recent analysis of Medicaid claims of patients at one study site documented that 96% of all admissions occur at that site's hospital and that there were no differences in outside hospitalizations by any demographic group. Our results, however, would be underestimates of utilization if hospitalizations were missed. Finally, we relied on sites with experienced HIV providers who have high rates of HAART and opportunistic infection prophylaxis use compared with other studies.[30,31] Previous data suggest that providers with HIV experience have lower patient mortality rates and higher use of antiretroviral therapy.[32,33] This may lower the costs of HIV care compared with sites in which HIV-infected persons are cared for by non-HIV specialist providers. 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 this network will be valuable.

In conclusion, for this multisite cohort of HIV-infected children and adolescents, we observe the lowest inpatient and outpatient utilization yet reported from the United States. Overall inpatient admissions decreased significantly between 2000 and 2001. In contrast to data from HIV-infected adults, racial and gender disparities in utilization appear to be minimal. Further timely data from cohorts such as the one described here will be important in tracking national trends in health care utilization in pediatric HIV infection.

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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)

Alameda County Medical Center, Oakland, California (Silver Sisneros, MD)

Drexel University, Philadelphia, Pennsylvania (Peter Sklar, MD)

University of San Diego, Owen Clinic, San Diego, California (Stephen Spector, MD)

Drexel University, Philadelphia, Pennsylvania (James Witek, MD)

Sponsoring Agencies

Agency for Healthcare Research and Quality, Rockville, Maryland (Fred Hellinger, PhD, John Fleishman, PhD, Irene Fraser, PhD)

Health Resources and Services Administration, Rockville, Maryland (Richard Conviser, PhD)

Substance Abuse and Mental Health Services Administration, Rockville, Maryland (Joan Dilonardo, PhD)

Substance Abuse and Mental Health Services Administration, Rockville, Maryland (Laura House, PhD)

Office of AIDS Research, NIH, Bethesda, Maryland (Paul Gaist, PhD)

Data Coordinating Center

Johns Hopkins University (Richard Moore, MD, Principal Investigator, Jeanne Keruly, CRNP, Kelly Gebo, MD, Erin Reilly, MPH, Liming Zhou)