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TRENDS IN REASONS FOR HOSPITALIZATION IN A MULTISITE UNITED STATES COHORT OF PERSONS LIVING WITH HIV, 2001 - 2008

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Abstract

Introduction—Hospitalization rates for comorbid conditions among persons living with HIV in the current HAART era are unknown.

Methods—Hospitalization data from 2001 – 2008 were obtained on 11,645 adults receiving longitudinal HIV care at 4 geographically diverse U.S. HIV clinics within the HIV Research Network. Modified clinical classification software from the Agency for Healthcare Research and Quality assigned primary ICD-9 codes into diagnostic categories. Analysis was performed with repeated measures negative binomial regression.

Results—During 2001 – 2008, the rate of AIDS defining illness (ADI) hospitalizations declined from 6.7 to 2.7 per 100 person years (PY), incidence rate ratio per year, 0.89 [0.87, 0.91]. Among the other diagnostic categories with average rates > 2 per 100 PY, cardiovascular hospitalizations increased over time (1.07 [1.03, 1.11]), while non-AIDS defining infection (0.98 [0.96, 1.00]), psychiatric (0.96 [0.93, 1.00]), and gastrointestinal/liver (0.96 [0.92, 1.00]) were slightly decreasing or stable. While less frequent overall, renal and pulmonary admissions also increased over time in univariate and multivariate analyses. Of all diagnostic categories, ADI admissions had the longest mean length of stay, 10.5 days.

Discussion—ADI hospitalizations have continued to decline in recent years but are still relatively frequent and potentially costly given long lengths of stay. Increases or stability in the rates of chronic end-organ disease admissions imply a need for broader medical knowledge among individual clinicians and/or teams who care for persons living with HIV and a need for long-term access to medications for these conditions.

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INTRODUCTION

Persons living with HIV (PLWH) continue to be hospitalized at high rates.¹⁻⁶ HIV clinicians may use knowledge of the current rates of illnesses in their efforts at prevention and early identification, and for planning management of patients with organ-specific specialists. Policy-makers and healthcare payers may use present trends to project future areas of clinical need and associated costs.

No clear pattern of trends in illness rates among U.S. PLWH in the current ART era has yet emerged. An examination of reasons for hospitalization in 2001 in the geographically diverse, multisite HIV Research Network (HIVRN) revealed that AIDS defining illnesses (ADI) were the most frequent reason for admission, followed by gastrointestinal/liver, psychiatric, and cardiovascular.⁷ Recent longitudinal analyses from two other U.S. cohorts, the HIV Outpatient Study (HOPS) and the military HIV Natural History Study (NHS), concurred in finding non-AIDS defining infections, ADI, gastrointestinal/liver, cardiovascular, and pulmonary among the leading categories.^{4, 5} However, these two studies did not show agreement on time trends within these categories. Factors which may be changing the pattern of morbidities since the early ART era include longer cumulative exposure to antiretrovirals and the aging of PLWH.⁸

This study evaluates time trends in hospitalization rates and associated lengths of stay (LOS) among diagnostic categories from 2001–2008 in the HIVRN. We include more recent years than were included in the HOPS analysis, and we examine a non-military population which may be more generally representative of U.S. PLWH than is the NHS. We have previously described a decline in the all-cause hospitalization rate in the HIVRN from 35 to 27 / 100 person years (PY) from 2002 to 2007.³

METHODS

Study Population and Data Collection

The HIVRN is a consortium of 12 sites providing longitudinal adult HIV care in 11 U.S. cities.^{3, 9} Sites abstract comprehensive demographic, laboratory, and inpatient and outpatient utilization data from clinical records, then strip these data of identifying characteristics and submit them to a data coordinating center where they are reviewed and combined. Institutional review boards at each site and at the data coordinating center at Johns Hopkins University have approved the collection and use of these data.

Four HIVRN sites were chosen for this analysis because of complete collection of reasons for hospitalization in the form of International Classification of Diseases, Ninth Revision (ICD-9) codes. These codes are assigned by trained clinical abstractors in the generation of billing claims with the first-listed code generally required to be the primary reason for hospitalization. The four HIVRN sites are academically affiliated and are located in the West (2), the South (1), and the Northeast (1). All patients ≥ 18 years old receiving longitudinal HIV care at these sites 2001–2008 were included in this analysis.

Years of active outpatient care were defined by having at least one HIV clinician visit and one measured CD4 cell count (either of which could have been routinely scheduled or generated by an acute complaint). Loss to follow-up was defined as becoming inactive from outpatient care for any reason other than death. Subjects returned to observation if and when they returned to active care. Although sometimes available, hospitalization data from inactive years were excluded because some subjects who were lost to follow-up probably received care, including hospitalizations, at outside institutions.

Outcome Variables

Several steps were taken in assigning each hospitalization to a single diagnostic category. The first step was determining the primary ICD-9 code. Using a method similar to one we have previously employed,^{10, 11} the first listed code referring to neither HIV (042, V08, 795.71, V01.79) nor chronic Hepatitis C (070.44, 070.54, 070.70, 070.71) was defined as the primary code for the hospitalization. Hospitalizations (173 total) with a first-listed code for “chemotherapy encounter” (V58.11 and V58.12) were assigned to the first subsequent code for a type of cancer.

Secondly, Clinical Classification Software (CCS) developed by the Agency for Healthcare Research and Quality¹² was used to assign the primary ICD-9 code into one of 18 first-level categories, e.g. infection, cardiovascular. Hospitalizations (42 total, or 0.3%) for which the only ICD-9 code referred to HIV or to chronic Hepatitis C were classified as missing.

Lastly, we modified the CCS classification in several ways. First, the CCS assigns many infections to an organ system category rather than to the infection category. We reassigned ICD-9 codes falling into the following CCS sub-levels to the infection category: central nervous system infection; infection of the eye; otitis media; endocarditis; respiratory infection; intestinal infection; anal and rectal conditions; peritonitis and intestinal abscess; urinary tract infections; inflammatory conditions of the genitals; skin and subcutaneous tissue infections; infective arthritis and osteomyelitis; infection and inflammation of an internal prosthesis; postoperative infection. We also reassigned unspecified sepsis (995.91 and 995.92) from the injury/poisoning category to the infectious category, alcoholic cirrhosis (571.2) from psychiatric to gastrointestinal/liver, and hypertensive chronic kidney disease (403.00–403.91) from cardiovascular to renal/genitourinary (“renal”). Next, we constructed a separate category for ADI by reassigning appropriate admissions according to individual ICD-9 codes (Supplementary Table) as per the 1993 Centers for Disease Control and Prevention Revised Classification.¹³ Recurrent bacterial pneumonia was defined as any bacterial pneumonia admission occurring within > 30 but ≤ 365 days of a previous such admission.

In order to determine the most frequent individual diagnoses within each category, frequently-appearing individual ICD-9 codes were explored using an online ICD-9 description tool.¹⁴ Where appropriate, we grouped highly-similar codes into individual diagnosis groups. For example, within the cardiovascular category, unspecified chest pain (786.50); precordial pain (786.51); and discomfort, pressure, or tightness in the chest (786.59) were grouped together as ‘chest pain’. The Supplementary Table describes all such groupings.

For each diagnostic category, two LOS outcomes were examined. The first was the PY-specific mean LOS, and the second was the patient-specific mean LOS aggregated across all years. In creating these variables, the LOS for an individual admission was determined by subtracting the admission date from the discharge date and adding one. Hence, same-day admission and discharges counted as one day. PY with no admissions were not included in LOS analyses.

Independent Variables

We analyzed several covariates thought to be associated with hospitalization rate. We categorized race as non-Hispanic Black (“Black”), non-Hispanic White (“White”), Hispanic, and other. The racial groups Asian / Pacific Islander and American Indian comprised too few subjects (117 and 44, respectively) to perform meaningful statistical tests. For purposes of analysis, these groups were combined into the “other” category. Subjects reporting an HIV risk factor of injection drug use (IDU) in conjunction with another risk factor, e.g. same

sex male contact (MSM), were coded as IDU. Age, CD4 count, and HIV-1 RNA level were time varying according to calendar year. Age was categorized as 18–35, 36–49, and ≥ 50 years old. For CD4 and HIV-1 RNA, the first measurements of each year were used.

Analysis

Rates of hospitalizations due to all causes and within each diagnostic category were calculated as the number of hospitalizations per 100 PY. We conducted comparative cross-sectional analyses. After graphic exploration of rates over time, calendar year was coded as a linear trend. Assessments of time trends in hospitalization rates and in yearly mean LOS were performed with repeated-measures negative binomial regression, separately by diagnostic category. Differences in time-aggregated mean LOS between diagnostic categories were assessed in a negative binomial regression model with dummy variables for each diagnostic category (with ADI as the reference). All models used generalized estimating equations and robust variance estimators. A two-sided type I error of 5% was considered statistically significant. All analyses were performed using Stata 11.0 (StataCorp LP, College Station, TX, USA).¹⁵

RESULTS

During 2001–2008, 11,645 subjects were observed in 40,499 PY of active outpatient care. The median number of active years was 3 (interquartile range (IQR), 1–5). At least one instance of drop out from active care occurred for 6,975 subjects (60%) with 1,482 subjects (21% of those who dropped out) returning to observation at least once and 1,128 (16% of those who dropped out) having their only instance of drop out due to death. In 2001, the cohort was 72% male, 43% Black, 39% White, 15% Hispanic, 28% IDU, and had a median age of 40 years (Table 1). By 2008, relative decreases in the percentages of Blacks (41%) and Whites (36%) were accompanied by an increase among Hispanics (19%) (chi-square $P < 0.01$ for each comparison); IDU decreased to 20% (chi-square $P < 0.001$); and median age increased to 45 years (rank sum $P < 0.001$). The median CD4 count on first measurement of the year increased steadily from 341 (177–550) to 416 (240–613) cells / μl between 2001 and 2008 (rank sum $P < 0.001$). The percentage of subjects with HIV RNA < 400 copies increased from 35% in 2001 to 59% in 2008 (OR per year [95% confidence interval], 1.19 [1.18, 1.20]).

During active care, 4,423 subjects (38% of all subjects) were hospitalized at least once, resulting in a total of 13,323 hospitalizations. Among those hospitalized, the median number of admissions was 2 (1–4). The unadjusted all-cause hospitalization rate showed a decline from 37.1 / 100 PY in 2001 to 28.9 / 100 PY in 2008 (incidence rate ratio (IRR) per year 0.98 [0.97, 0.99], Figure 1).

Non-AIDS defining infection was the most frequent diagnostic category, totaling 26% of all admissions and having a mean rate across the study period of 8.6 / 100 PY. For all years combined, the three most frequent individual non-AIDS defining infection diagnoses were bacterial pneumonia, cellulitis, and septicemia (Table 2). Together, these three diagnoses were responsible for 13% of all admissions. The unadjusted hospitalization rate for non-AIDS defining infections showed a borderline significant decline over time, IRR per year 0.98 [0.96, 1.00] (Figure 1).

ADI was the second most frequent diagnostic category, at 15% of all-cause hospitalizations over the study period. The ADI hospitalization rate declined from 6.7 in 2001 to 2.7 in 2008 (IRR per year 0.89 [0.87, 0.91]). This was the largest degree of change among all diagnostic categories.

Cardiovascular, psychiatric, and gastrointestinal/liver, were, respectively, the next most frequent diagnostic categories and had average rates across the study interval between 2 and 3 / 100 PY. In unadjusted analyses, cardiovascular hospitalizations became more frequent over time (IRR per year 1.07 [1.03, 1.11]) while gastrointestinal/liver and psychiatric admissions had declines of borderline significance (Figure 1).

Renal; non-AIDS defining cancer; pulmonary; and endocrine, nutritional, metabolic, immune ("endocrine/metabolic") were next in frequency and had average rates across the study interval between 1 and 2 / 100 PY. In unadjusted analyses, renal admissions and pulmonary admissions increased in frequency while the other categories did not show significant changes.

Diagnostic categories with average rates less than 1 / 100 PY included injury/poisoning, symptomatic, hematologic, neurologic, orthopedic, obstetric/gynecologic, dermatologic, unclassified, congenital, perinatal, and missing (comprising 1% of all admissions).

For frequent diagnostic categories, Table 3 shows multivariate analyses of hospitalization rates. As in univariate analysis, ADI hospitalizations were associated with a declining time trend; gastrointestinal/liver with a borderline declining time trend; and cardiovascular, renal, and pulmonary hospitalizations with increasing time trends. In multivariate analysis, all-cause, non-AIDS defining infections, and psychiatric were no longer associated with declines over time. Categories with stable time trends in univariate analyses (non-AIDS defining cancer, endocrine/metabolic, and injury/poisoning) continued to show stability in multivariate analyses.

In multivariate analyses, several patient characteristics were associated with higher hospitalization rates among the most frequent diagnostic categories (Table 3). Age ≥ 50 years was associated with a higher hospitalization rate than age ≤ 35 in all categories except ADI. The association for age ≥ 50 was particularly strong for cardiovascular (IRR vs. ≤ 35 years old, 5.01 [3.41, 7.38]). Among subjects ≥ 50 , cardiovascular surpassed ADI to become the second most frequent category and accounted for 13% of all admissions. Blacks, women, and IDUs tended to have higher hospitalization rates across most diagnostic categories. Black race was strongly associated with renal admissions (IRR vs. White race, 3.45 [2.63, 4.52]). Lower CD4 count strata were associated with hospitalization within every frequent diagnostic category.

For cardiovascular hospitalizations, we evaluated whether codifying age as a categorical variable might have failed to capture the full effect of this potential strong confounder of the relationship with calendar time. In alternate models, we codified age as both a linear and a quadratic variable. In both cases, the multivariate calendar time trends (IRR 1.05 per year [1.01, 1.09]) were similar to the trend produced by the categorical age variable (1.06 [1.02, 1.10]).

Because of the known association of IDU with viral hepatitis, the rate of GI hospitalizations was investigated by IDU and non-IDU subgroups. Among 2775 IDU, the univariate (IRR per year 0.94 [0.88, 1.00]) and multivariate (0.93 [0.88, 0.99]) time trends were declining. Among 8870 non-IDU, the univariate (0.98 [0.93, 1.03]) and multivariate (0.99 [0.94, 1.04]) time trends were not significantly changing. There was no statistically significant interaction between IDU and calendar time ($P > 0.20$ for each interaction term in a model containing the interactions between IDU and year codified categorically 2001–2008).

The yearly mean LOS did not change significantly over time within diagnostic categories (either in univariate or multivariate analyses, results not shown). For the most frequent diagnostic categories, Table 4 shows the mean LOS, calculated across all years. The result

for ADI was 10.5 days, significantly longer than for any other category. The result for cardiovascular was 5.9 days, which ranked near the lowest. The mean time-aggregated LOS across all categories was 7.2 days.

DISCUSSION

Our study has several important findings. The ADI hospitalization rate declined sharply, with the 2008 rate being less than half of the 2001 rate and the category decreasing from 18% of all admissions in 2001 to 8% of all admissions in 2008. Non-AIDS defining infection was the most frequent category across all years and was not significantly changing over time in multivariate analysis. Cardiovascular, renal, and pulmonary hospitalization rates increased significantly. Other relatively frequent categories; psychiatric, gastrointestinal/liver, non-AIDS defining cancer, and endocrine/metabolic; did not have clear trends. Finally, LOS differed substantially across diagnostic categories and was longest for ADI.

The strong decline in ADIs represents continued progress. The trend coincided with substantial immunologic and virologic improvements in the cohort. Shorter duration with low CD4 count because of more timely and/or more tolerable ART may have been an important unmeasured contributor. This decline resembles the decline apparent for ADIs during 2000–2005 in the HOPS and contrasts with the relative stability of ADIs in the NHS 1999–2007.^{4, 5} In the latter study, the average annual CD4 count was higher (554 cells / mm³) and stable across time. From a public health perspective, most ADIs are theoretically preventable through early HIV case finding, engagement in care, and use of ART. The long LOS associated with ADI admissions likely increases the cost of ADI admissions compared with other categories. Despite the decline, as of 2008, ADIs remain relatively frequent, and persistent efforts to further reduce incidence are needed.

The frequency and relative stability of non-AIDS defining infection admissions indicates that despite the decline in ADIs, management of infections remains a large component of HIV healthcare. Our finding of a stable multivariate time trend was distinct from the moderate declines seen in the HOPS and NHS. Non-AIDS defining infections comprised a relatively larger proportion of hospitalizations than in the HOPS, the NHS, or in our prior HIVRN study. These three studies classified many infections with organ system categories (e.g. pneumonia classified with pulmonary). In the present study, we made non-AIDS defining infection the more inclusive category because antimicrobials are the primary therapy and because many cases require infectious diseases specialist involvement.

The frequency and the increasing time trends in cardiovascular, renal, and pulmonary hospitalizations are notable findings but ultimately require confirmation in other studies. Most recent studies among PLWH have not found similar increases. In one instance of similarity, cardiovascular hospitalizations among PLWH in Denmark increased from 2.5 to 4.4 / 100 PY during 1995–2007.¹⁶ In contrast, renal and pulmonary hospitalization rates did not increase in this cohort, and no statistically significant increases were seen in any of these three diagnostic categories in either the HOPS or NHS.^{4, 5} With approximately 5000 patients under observation annually, our analytic sample was larger than the other cohorts (1500–3000 patients annually). It is also possible that the increases we have identified in cardiovascular, renal, and pulmonary admissions may simply reflect trends in the general population rather than any effect specific to PLWH. To the contrary, reports of nationwide data through 2008 suggest decreases in hospitalizations for myocardial infarctions and heart failure and uncertainty surrounding obstructive pulmonary disease hospitalization trends.^{17–19} However, a slight increase in general population renal hospitalizations has been described.²⁰

Assuming increases in one or more of these three categories do represent effects particular to PLWH, then identification of underlying causes and consideration of the implications for HIV healthcare are warranted. Although our cohort was aging over the study interval, our multivariate analyses support the conclusion that age was not the sole factor underlying the increasing rates. Cumulative exposure to certain antiretrovirals (e.g. protease inhibitors and tenofovir) and/or to uncontrolled HIV disease has previously been associated with cardiovascular and renal illnesses²¹⁻²⁸. A limitation of our dataset is that we could not evaluate medication exposures, cumulative HIV exposure, nor smoking in the case of pulmonary disease. Presently in the U.S., there may be substantial variation in whether primary care for PLWH is provided by HIV specialists (some of whom have infectious diseases training) or by separate primary care practitioners.^{29, 30} The growing breadth of complications may signify need to emphasize the latter model or to reconsider what training components are needed to make an HIV specialist. Finally, increases in admissions in these end-organ disease categories may forecast increasing chronic medication costs (e.g. anti-platelet and lipid-lowering agents in the case of cardiovascular disease.)

Unlike a rise noted in the first five years after ART in several cohorts,^{6, 10, 31} gastrointestinal/liver admissions did not increase during 2001–2008. Unexpectedly, gastrointestinal/liver rates declined among the subgroup of IDU. We have previously speculated that with longer survival from ADIs, PLWH coinfecting with Hepatitis C (HCV) would have had a persistent increase in hepatic illness over time.¹¹ Similar to our results, no increase occurred in the HOPS, the NHS, nor Spanish, Danish and Australian studies.^{4, 5, 16, 31, 32} While not increasing, gastrointestinal/liver still represents a leading category of illness in all of these cohorts. Given the strong etiologic role for HCV, access to HCV medicines will be important for the foreseeable future.

The overall frequency of psychiatric admissions and their relatively long LOS highlights persistent need for access to outpatient psychiatric care and coverage of psychotropic medicines.

We did not detect an increase in hospitalizations for non-AIDS defining cancers 2001–2008. This is generally consistent with recent studies of cancer incidence which have noted increases in specific cancers (e.g. anal cancer, Hodgkin's Disease) but no clear increase in overall non-AIDS defining cancer incidence since 2001.³³⁻³⁷

A possible limitation of our study is the use of ICD-9 codes. This may be less accurate than physician chart review, although two validation studies using similar methodology at one site found > 95% concurrence with chart review.^{10, 11} Another limitation of this study is that we are not certain of data collection from hospitalizations occurring outside the HIVRN site hospitals. While each site makes attempts to capture utilization data from neighboring clinicians, this may be incomplete. At one site, an analysis of statewide insurance claims revealed that 91% of all admissions occurred at the home hospital.¹⁰ We expect that this lack of data from outside institutions generates a slight underestimation of hospitalization rates; however we do not expect that it substantially affects the relative pattern across diagnostic categories.

A final limitation is that our data come from only four sites and may not be widely generalizable. Compared to the 26,929 subjects who received care during 2001–2008 at the 8 non-selected HIVRN sites, the 11,645 subjects included in this analysis were comparable with respect to age, gender, median CD4 count and HIV RNA and number of years in care but were less likely to be Black (38% vs. 53%) or Hispanic (19% vs. 23%), and were more likely to be MSM (41% vs. 36%) or IDU (24% vs. 18%). Our multivariate analyses accounting for the effects of demographic and clinical variables may help to increase the

generalizability of our findings. Nevertheless, we believe further studies will be needed to confirm if the trends we have seen are widely representative among PLWH.

In summary, we have found that a strong decline in ADI hospitalizations has been coupled with relative stability or increases in non-AIDS defining infection, cardiovascular, psychiatric, gastrointestinal/liver, renal, non-AIDS defining cancer, pulmonary, and endocrine/metabolic admissions in our large, mostly inner-city cohort. Further improvements in access to care and use of ART may help ensure a continued decline in ADIs. However, there is also an increasing need for preventing, managing, and paying for general medical conditions among PLWH.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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APPENDIX – HIVRN Details

Participating Sites

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

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Sponsoring Agencies

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

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

Data Coordinating Center

Johns Hopkins University (Richard Moore, M.D., Jeanne Keruly, C.R.N.P., Kelly Gebo, M.D., Cindy Voss, M.S., Bonnie Cameron, M.S.)

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Figure. Unadjusted hospitalization rates by diagnostic categories

* GI / Liver, 0.96 [0.92, 1.00]

† Psych, 0.96 [0.93, 1.00]

Note: NAD, non-AIDS defining; ADI, AIDS defining illness; GI, gastrointestinal; Psych, psychiatric; Cardiovasc, cardiovascular; Endo/Met, endocrine/metabolic/nutritional/immune; GU, genitourinary

Table 1

Patient characteristics

	2001	2005	2008
N in care	4833	4958	5604
Gender			
Male	3480 (72)	3604 (73)	4058 (72)
Female	1353 (28)	1354 (27)	1546 (28)
Age, years			
Median (IQR)	40 (35 – 46)	43 (38 – 49)	45 (39 – 51)
18 – 35	1309 (27)	899 (18)	868 (16)
36 – 49	2814 (58)	2860 (58)	2949 (53)
≥ 50	710 (15)	1199 (24)	1787 (32)
Race / Ethnicity			
Non-Hispanic Black (“Black”)	2085 (43)	1939 (39)	2274 (41)
Non-Hispanic White (“White”)	1885 (39)	1930 (39)	2020 (36)
Hispanic	703 (15)	887 (18)	1059 (19)
Asian / Pacific Islander	42 (1)	54 (1)	59 (1)
American Indian	14 (0)	14 (0)	9 (0)
Unknown / Other	104 (2)	134 (3)	183 (3)
HIV Risk Factors			
MSM	1929 (40)	2130 (43)	2297 (41)
Heterosexual	1257 (26)	1361 (27)	1587 (28)
IDU	1363 (28)	1123 (23)	1139 (20)
Unknown / Other	283 (6)	343 (7)	581 (10)
CD4 Count* (cells/mm³)			
Median (IQR)	341 (177-550)	389 (225-576)	416 (240-613)
≤ 50	473 (10)	349 (7)	309 (6)
51 – 200	899 (19)	716 (14)	801 (14)
201 – 350	1114 (23)	1099 (22)	1151 (21)
> 350	2347 (49)	2794 (56)	3343 (60)
HIV RNA* (copies/mL)			
< 400	1674 (35)	2341 (47)	3299 (59)
400 – 49,999	1926 (40)	1653 (33)	1448 (26)
≥ 50,000	1178 (24)	853 (17)	629 (11)
Missing	55 (1)	111 (2)	228 (4)

Values are number (percent) unless specified. Percentages may exceed 100 due to rounding. Each patient can contribute multiple observations (for multiple years in care).

* CD4 count and HIV-1 RNA are the first available values of the calendar year.

Table 2

Frequencies of diagnostic categories and of the three most frequent individual diagnoses within each category among 13,323 total admissions

Category	Frequency	% All Cause
Non-AIDS Defining Infection	3,486	26.2
Bacterial pneumonia	935	7.0
Cellulitis	505	3.8
Sepsis	267	2.0
AIDS Defining Illness *	2,035	15.3
<i>Pneumocystosis</i>	538	4.0
Recurrent bacterial pneumonia	199	1.5
<i>Cryptococcosis</i>	185	1.4
Cardiovascular	998	7.5
Congestive heart failure	194	1.5
Chest pain	148	1.1
Confirmed coronary event	145	1.1
Psychiatric	949	7.1
Major depressive disorder, single or recurrent episode	211	1.6
Depressive disorder not elsewhere classified	153	1.2
Unspecified psychosis	45	0.3
Gastrointestinal / Liver	945	7.1
Pancreatitis (acute or chronic)	178	1.3
Gastrointestinal bleed (upper or lower tract)	96	0.7
Liver cirrhosis (due to any cause)	92	0.7
Renal / Genitourinary	687	5.2
Unspecified acute renal failure	309	2.3
Hypertensive chronic kidney disease	88	0.7
Kidney / ureteral stone	47	0.4
Non-AIDS Defining Cancer	602	4.5
Lymphoma not elsewhere classified	183	1.4
Primary lung cancer	44	0.3
Primary liver cancer	35	0.3
Pulmonary	581	4.4
Chronic obstructive lung disease exacerbation	135	1.0
Asthma exacerbation	132	1.0
Acute respiratory failure not otherwise specified	58	0.4
Endocrine / Metabolic / Nutritional / Immune	578	4.3
Hypovolemia	120	0.9
Diabetic ketoacidosis or hyperosmolar state	54	0.4
Cachexia	45	0.3

* This category included 176 (1.3% of total admissions) AIDS defining cancer admissions comprised of 102 admissions for Non-Hodgkin's Lymphoma, 72 for Kaposi's sarcoma, and 2 for cervical cancer.

Table 3

Multivariate analysis of factors associated with hospitalization rate by diagnostic category

	All Cause	Non-AIDS Defining Infection	AIDS Defining Illness	Cardiovascular	Psychiatric	Gastrointestinal / Liver	Renal / Genitourinary	Non-AIDS Defining Cancer	Pulmonary	Endocrine / Nutritional / Metabolic / Immune
Calendar Time										
per year, 2001-2008	1.01 (0.99, 1.02)	1.02 (1.00, 1.04)	0.94 (0.92, 0.97)	1.06 (1.02, 1.10)	1.01 (0.97, 1.05)	0.96 (0.92, 1.00)	1.09 (1.05, 1.14)	1.01 (0.96, 1.06)	1.09 (1.04, 1.15)	1.04 (1.00, 1.09)
Age (years)										
18-35	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
36-49	1.10 (1.01, 1.19)	1.10 (0.97, 1.24)	0.98 (0.84, 1.15)	2.01 (1.40, 2.90)	1.06 (0.82, 1.38)	1.15 (0.88, 1.50)	1.44 (1.02, 2.02)	2.20 (1.35, 3.60)	1.87 (1.34, 2.60)	1.55 (1.15, 2.09)
≥50	1.44 (1.30, 1.59)	1.19 (1.03, 1.38)	0.83 (0.67, 1.02)	5.01 (3.41, 7.38)	0.82 (0.59, 1.14)	1.58 (1.19, 2.09)	2.16 (1.51, 3.09)	3.86 (2.32, 6.44)	3.00 (2.08, 4.35)	2.38 (1.70, 3.32)
Gender										
Male	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Female	1.34 (1.24, 1.44)	1.20 (1.08, 1.33)	1.26 (1.09, 1.45)	1.33 (1.07, 1.65)	1.18 (0.95, 1.46)	1.16 (0.95, 1.42)	1.31 (1.06, 1.63)	1.09 (0.83, 1.42)	2.01 (1.48, 2.73)	1.41 (1.11, 1.79)
Race / Ethnicity										
Black	1.38 (1.28, 1.50)	1.35 (1.20, 1.52)	1.31 (1.11, 1.54)	1.76 (1.38, 2.24)	1.80 (1.44, 2.25)	1.03 (0.83, 1.27)	3.45 (2.63, 4.52)	0.87 (0.64, 1.19)	1.27 (0.95, 1.69)	2.01 (1.56, 2.59)
White	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Hispanic	1.20 (1.08, 1.33)	1.02 (0.87, 1.19)	1.57 (1.31, 1.89)	1.12 (0.81, 1.56)	0.67 (0.47, 0.97)	1.50 (1.15, 1.95)	1.12 (0.74, 1.70)	1.09 (0.74, 1.62)	1.16 (0.77, 1.75)	1.29 (0.92, 1.79)
Other	0.86 (0.67, 1.11)	0.78 (0.56, 1.08)	1.23 (0.77, 1.93)	0.55 (0.25, 1.21)	0.61 (0.34, 1.11)	0.60 (0.27, 1.33)	0.46 (0.10, 2.22)	0.90 (0.42, 1.92)	0.49 (0.20, 1.16)	0.84 (0.42, 1.69)
HIV risk										
IDU	1.61 (1.49, 1.73)	1.75 (1.58, 1.93)	1.09 (0.94, 1.26)	1.50 (1.22, 1.84)	2.83 (2.31, 3.47)	1.62 (1.33, 1.97)	1.82 (1.47, 2.25)	1.11 (0.82, 1.50)	2.37 (1.77, 3.16)	1.34 (1.06, 1.68)
Non-IDU	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
CD4 count[*] (cells / mm³)										
≤ 50	4.83 (4.42, 5.27)	4.39 (3.81, 5.05)	34.8 (26.6, 45.5)	2.24 (1.66, 3.01)	2.05 (1.54, 2.73)	2.73 (2.05, 3.63)	4.77 (3.54, 6.42)	2.55 (1.67, 3.89)	4.21 (2.80, 6.31)	5.87 (4.27, 8.06)
51-200	2.53 (2.33, 2.75)	2.57 (2.27, 2.90)	10.3 (7.93, 13.4)	1.58 (1.25, 2.01)	1.78 (1.40, 2.27)	2.76 (2.20, 3.47)	2.66 (2.05, 3.45)	2.96 (2.13, 4.11)	3.05 (2.21, 4.21)	3.13 (2.37, 4.13)
201-350	1.45 (1.35, 1.57)	1.57 (1.40, 1.77)	3.06 (2.26, 4.13)	1.31 (1.05, 1.64)	1.19 (0.95, 1.49)	1.25 (0.99, 1.57)	1.39 (1.07, 1.82)	1.66 (1.24, 2.23)	1.88 (1.42, 2.49)	1.44 (1.08, 1.91)
> 350	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
HIV RNA[*] (copies / mL)										
< 400	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
400-49,999	1.19 (1.11, 1.28)	1.51 (1.35, 1.69)	1.39 (1.12, 1.73)	1.23 (1.01, 1.48)	1.47 (1.18, 1.83)	0.94 (0.76, 1.16)	0.99 (0.78, 1.26)	1.20 (0.90, 1.60)	1.05 (0.79, 1.39)	1.01 (0.78, 1.32)
≥ 50,000 or missing	1.46 (1.35, 1.58)	2.03 (1.79, 2.29)	2.29 (1.85, 2.85)	1.34 (1.05, 1.70)	1.68 (1.31, 2.17)	1.11 (0.89, 1.39)	0.97 (0.75, 1.26)	1.15 (0.83, 1.59)	1.23 (0.88, 1.72)	1.15 (0.88, 1.50)

^{*} CD4 count and HIV-1 RNA are the first available values of the calendar year.

Table 4

Length of Stay (LOS) by Diagnostic Category

	Mean [*] LOS (SD) in Days	Median [*] LOS (IQR) in Days	Adjusted [†] Relative Change in LOS vs. ADI Category (95% CI)
AIDS Defining Illnesses[‡]	10.5 (10.6)	7 (5 – 12)	1.00 (REF)
Pulmonary	8.3 (12.5)	5 (3 – 9)	0.85 (0.72, 1.00)
Psychiatric	7.9 (7.9)	6 (4 – 10)	0.83 (0.75, 0.91)
Non-AIDS Defining Cancer	7.7 (8.3)	5 (3 – 8)	0.81 (0.71, 0.92)
Non-AIDS Defining Infection	7.3 (7.7)	5 (4 – 8)	0.74 (0.69, 0.80)
Renal / Genitourinary	6.9 (8.3)	5 (3 – 8)	0.69 (0.61, 0.77)
Gastrointestinal / Liver	6.8 (9.3)	5 (3 – 7)	0.70 (0.62, 0.79)
Cardiovascular	5.9 (5.8)	4 (3 – 7)	0.61 (0.56, 0.68)
Endocrine / nutritional / metabolic / immune	5.5 (7.8)	4 (3 – 6)	0.56 (0.48, 0.65)
All Cause	7.2 (8.1)	5 (3 – 8)	<i>Not compared</i>

^{*} Values are means (or medians) of patient-specific means calculated across all years in which a patient had relevant admissions.

[†] Adjusted for age in 2003, sex, race, IDU, median CD4 across all years, and median HIV RNA across all years

[‡] AIDS defining cancers, a subset of the ADI category, had mean LOS 9.3 (9.3) days and median 6 (5 – 10) days