Readmissions in HIV-Infected Inpatients: A Large Cohort Analysis

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Objective: Hospital readmissions impose considerable physical and psychological hardships on patients and represent a high, but possibly preventable, cost for insurers and hospitals alike. The objective of this study was to identify patient characteristics associated with 30-day readmission among persons living with HIV/AIDS (PLWH) using a statewide administrative database and to characterize the movement of patients between facilities.

Design: Retrospective cohort analysis of HIV-infected individuals in New York State using a comprehensive, all-payer database.

Setting: All hospitals in New York State.

Participants: HIV-infected adults admitted to a medical service in 2012. PLWH identified using International Classification of Disease (ICD)-9 diagnosis codes 042 and V08.

Results: Of 23,544 index hospitalizations, 21.8% (5121) resulted in readmission. Multivariable predictors of readmission included insurance status, housing instability, psychoses, multiple comorbid chronic conditions, substance use, and past inpatient and emergency department visits. Over 30% of readmissions occurred at a different facility than that of the initial hospitalization.

Conclusion: A number of patient characteristics were independently associated with hospital readmission within 30 days. Behavioral health disorders and comorbid conditions may be the strongest predictors of readmission in PLWH. Readmissions, especially those in urban areas, often result in fragmented care which may compromise the quality of care and result in harmful discontinuity of medical treatment.

Key Words: quality care, HIV, AIDS, readmission, fragmented hospital use

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INTRODUCTION

The nonvoluntary hospitalization of a patient within 30 days of a recent hospital discharge has become a key quality indicator and its reduction a prime objective of health care reform efforts, including the Affordable Care Act.[1] Readmissions are costly, often potentially avoidable, and place substantial physical and psychological stress on patients. A number of chronic medical conditions have been associated with high 30-day hospital readmission rates, including HIV.

Previous research has established that people living with HIV (PLWH) have higher rates of readmission than members of the general population.[2,3] Early in the AIDS epidemic, high rates of hospitalization and readmissions were principally driven by the progressive nature of the disease and lack of effective treatment, however, in the era of highly active antiretroviral therapy (ART) other factors also likely contribute.[4] Recent studies on readmission in PLWH suggest that the prevention of advanced HIV disease and improved management of chronic comorbid conditions may reduce readmission rates.[3,5,6] Because strategies aimed at reducing readmission rely on the identification of patients with the highest likelihood of readmission, a more thorough understanding of risk factors leading to readmission in PLWH is needed.[7,8]

Given the considerable frequency of readmissions among PLWH, their impact on the well-being of individuals, high cost to society, and the evolving risk of financial penalties for hospitals with excess readmissions,[9] a thorough understanding of the readmission of PLWH is timely. We sought to define previously unexamined patient characteristics associated with hospital readmission among a large, diverse cohort.

Because many HIV-infected individuals in New York State reside in urban areas with multiple hospitals, readmissions may entail a harmful discontinuity of care. Such variability in recurrent inpatient hospital use is highly inefficient and may pose a threat to the quality of inpatient care.[10,11] Because little is known about care fragmentation among PLWH, we examined multiple hospital use among HIV-infected individuals in New York State.

METHODS

Study Setting and Data Collection

We performed a retrospective cohort analysis of HIV-infected inpatients admitted to hospitals in New York State in 2012. This study used the Statewide Planning and Research

Cooperative System (SPARCS) database from the New York State Department of Health, which is a comprehensive all-payer data reporting system.[12] Since 1982, SPARCS has maintained discharge records for all hospital emergency visits and inpatient hospitalizations submitted by trained personnel in each hospital. The database includes all New York State hospitals and collects patient characteristics, diagnoses, treatments, services, and charges associated with each hospital inpatient admission.[13] Each patient is assigned a unique, encrypted identifier that combines each patient's first and last names and their social security number. Duplicated records may have resulted only from transcriptional errors such as misspellings or patient usage of multiple names and constitute a limitation of this identifier.

Because the database also captures information on outpatient services delivered at hospitals, we used SPARCS to examine Emergency Department (ED) utilization as a predictor of readmission. Because of the paucity of information on HIV primary care in SPARCS, we could not assess the relationship between engagement in HIV primary care and hospital readmission.

Derivation of the Cohort

Individuals in SPARCS were characterized as HIV+ if any of their hospital claims were accompanied by an HIV/AIDS-specific ICD-9 code (V08, 042). Previous studies have derived and validated case-finding algorithms using a single ICD-9 code.[14]

Determining 30-Day Readmissions

Hospital revenue codes were used to identify admissions to a medical service and 4844 admissions to psychiatric and detoxification units were excluded from consideration. All hospital admissions associated with HIV-infected individuals were analyzed, regardless of whether the hospitalization was accompanied by HIV-specific ICD-9 codes V08 or 042. Four hundred twenty-seven planned admissions for maintenance chemotherapy (ICD-9 V581) were also excluded.

Index hospitalizations were defined using the Centers for Medicare and Medicaid Services' methodology as hospitalizations that resulted in a live discharge and were the patient's first recorded hospitalization of the review period or occurred more than 30 days after a previous hospitalization. Nine hundred eighty index hospitalizations resulting in death were excluded from the analysis. Readmissions were hospitalizations that occurred within 30 days of a previous index hospitalization. If a patient was readmitted within 30 days and died during that hospitalization, the hospitalization was considered a readmission. When a readmission was itself followed by subsequent hospitalizations within 30 days, such events were designated as "readmission chains." Each readm ission in the chain was excluded from being an index hospitalization and was not designated as a unique readmission. Transfer admissions were considered a continuation of a preceding hospitalization and not considered readmissions. Same day readmissions were considered readmissions.

Because of the need to observe 30 days before and after a potential index hospitalization, we obtained data from December 2011 and January 2013. Hospital admissions before January 1, 2012 were excluded, as were index hospitalizations with discharges after January 1, 2013. Excluded from the analysis were hospitalizations in January 2012 preceded by hospitalizations in December 2011 by fewer than 30 days.

The population wide readmission rate was calculated by dividing the number of index admissions that resulted in readmission within 30 days by the total number of index admissions.

Independent Variables

Demographic, socio-demographic, geographic, and clinical factors were derived from administrative data. Patients associated with the ICD-9 code V60.0 ("Lack of Housing") or who were assigned the SPARCS homelessness indicator (evidence of homelessness in the patient medical record) were designated as being unstably housed.

To determine the number of comorbid chronic conditions, the Elixhauser index was computed using diagnosis codes present on patient discharge.[15] All available diagnostic ICD-9 codes were evaluated for the presence of 24 chronic conditions including diabetes, cardiovascular disease, and obesity. Because we sought to understand the independent relationship between substance abuse, psychosis, depression, and readmission, we withheld these conditions from the derivation of the Elixhauser index. Chronic kidney disease (ICD-9585) was also withheld from the index and treated as an independent variable because expert opinion identified the diagnosis as a unique cause of potentially avoidable readmission.

Up to 25 ICD-9 fields were queried for diagnoses identified a priori as being predictive of readmission. Patients were listed as having dementia if they were assigned an ICD-9 code that began with 290 or 294. Patients were designated as suffering from mental illness if they were diagnosed with schizophrenic disorder (295), manic disorder (296.0-1, 296.4, and 296.7-9), paranoid states (297), other nonorganic psychoses (298), psychosis with onset during childhood (299), or a personality disorder (301). Patients were designated as suffering from an anxiety disorder if they were diagnosed with an anxiety, dissociative, or somatoform disorder (300) and from depression if from a depressive disorder (296.2, 296.3, and 311). Illicit substance use was captured using ICD-9 codes 292, 304, and 305. Alcoholism was defined as having an alcoholic psychosis (291) or alcohol dependence syndrome (303). We did not distinguish dependent from nondependent substance abuse.

Patients were designated as presenting with an AIDS-defining illness at the time of hospitalization if their admission was accompanied by an ICD-9 code representing an AIDS-defining illnesses as defined by the Centers for Disease Control and Prevention.[16]

Within the SPARCS file, patients were characterized as having left against medical advice (AMA) if they voluntary left the hospital before the completion of medical treatment.

Patients were noted as having been discharged against medical advice if they were voluntarily discharged AMA at any time during the study period.

Missing Data

All available variables were examined for missing values. Because the SPARCS system requires certain data fields to be populated before submission, missing demographic information was rare. Patients were characterized as having no past ED or inpatient encounters if they were not associated with any 2011 records in the SPARCS system. This does not preclude the possibility that patients received care in adjacent states or territories.

Statistical Analyses

We sought to characterize the patients at highest risk of readmission. For each patient, a dichotomous response variable indicated whether they were readmitted during 2012 and a continuous variable summarized the total number of readmissions in 2012. Logistic and Negative Binominal regressions were used to examine independent predictors of readmission. Negative binomial regression was used because the data showed evidence of overdispersion ($P < 0.01$). Recursive partitioning and variable transformations were used to determine whether continuous variables (eg, number of inpatient admissions, age, and number of comorbidities) displayed nonlinear effects. To fit the final models, variables were included based on statistical significance.

Patient-level predictors of multiple hospital use were examined using Poisson regression, wherein number of hospitalizations was included as an exposure term.

In all analyses, the significance level was set as $P < 0.05$. All analyses were performed using R Version 3.0.3 (The R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

During 2012, HIV-infected individuals were hospitalized 31,565 times in New York State. 21.8% (5121) of 23,544 index admissions resulted in readmission within 30 days. A total of 2900 additional hospitalizations occurred within 1419 readmission chains. 44.0% of readmission chains entailed 3 or more discrete readmissions within a single chain.

27.5% (3925) of 16,558 hospitalized PLWH were readmitted at least once in 2012. Among 3925 readmitted patients, 58.6% had 1 index hospitalization that resulted in readmission, 18.8% had 2, 8.1% had 3, and 14.5% had 4 or more. The characteristics of the study cohort are shown in Table 1. The mean age of the cohort was 49.1 (SD = 11.9). 95.4% of patients lived in urban areas. 60.5% were male and 50.6% were African American.

Several demographic, behavioral, and clinical patient characteristics were predictive of hospital readmission. Having unstable housing or Medicaid insurance was independently associated with readmission, as was recurrent ED and inpatient utilization (Table 2). Depression, psychosis, illicit drug use, and alcoholism were also predictors. Having multiple chronic comorbid conditions conferred risk, as did AIDS-defining illnesses and chronic kidney disease.

33.1% of readmissions occurred at hospitals different than that of the index hospitalization. More readmissions occurring in New York City were to a hospital different than that of the index hospitalization (36%) than Upstate or on Long

TABLE 1. Characteristics of the Study Cohort

	Hospitalized PLWH	PLWH Not Readmitted (%)	PLWH Readmitted (%)
N	16,558	12,632	3925
Utilization history (2011)			
Inpatient admissions; mean (SD)	1.53 (2.3)	1.14 (1.8)	2.4 (3.0)
ED admissions; mean (SD)	3.16 (5.3)	2.74 (3.7)	4.2 (7.7)
Age, mean (IQR)	49.1 (11.9)	48.8 (11.9)	50.3 (11.2)
Gender			
Male	10,017 (60.5)	7624 (60.3)	2392 (60.9)
Female	6541 (39.5)	5008 (39.6)	1533 (39.1)
Insurance status			
Private	6702 (40.5)	5303 (41.9)	1399 (35.6)
Medicaid	4001 (24.1)	2862 (22.7)	1139 (29.0)
Medicare	4095 (24.7)	2991 (23.7)	1103 (28.1)
Uninsured	572 (3.4)	480 (3.6)	104 (2.6)
Other/unknown	1188 (7.2)	996 (7.9)	180 (4.5)
Race/ethnicity			
African American	8381 (50.6)	6268 (49.6)	2112 (53.8)
Caucasian	3079 (18.6)	2394 (18.9)	685 (17.4)
Hispanic	4922 (29.7)	3829 (30.3)	1093 (27.8)
Other/unknown	176 (1.1)	141 (1.1)	35 (0.9)
Geographic region			
Urban	15,799 (95.4)	12,051 (95.5)	3747 (95.5)
Rural	737 (4.6)	561 (4.5)	176 (4.5)
Location			
New York City	13,085 (79.0)	9886 (78.3)	3198 (81.5)
Rest of state	3473 (21.0)	2746 (21.7)	727 (18.5)
Unstably housed	3147 (19.0)	2094 (16.6)	1053 (26.8)
Substance use			
None	9053 (54.7)	7482 (59.2)	1571 (40.0)
Illicit drug use	7120 (43.0)	4861 (38.5)	2258 (57.5)
Alcoholism	1442 (8.7)	827 (6.5)	615 (15.7)
Mental health			
Psychosis	1872 (11.3)	1130 (9.0)	742 (18.9)
Dementia	668 (4.0)	332 (2.6)	336 (8.5)
Depression	2846 (17.2)	1790 (14.2)	1056 (26.9)
AIDS-defining illness in 2012	2319 (14.0)	1213 (9.6)	1106 (28.2)
Chronic kidney disease			
Chronic conditions			
0	2089 (12.6)	2002 (15.8)	87 (2.2)
1–2	7170 (43.3)	6111 (48.3)	1058 (26.9)
3–4	5416 (32.7)	3647 (28.8)	1769 (45.1)
5+	1883 (11.3)	872 (6.9)	1011 (25.8)
Ever left AMA	2208 (12.8)	1178 (9.0)	1029 (25.1)

IQR, interquartile range.

TABLE 2. Patient Characteristics Associated With Readmission

	Logistic Regression	Negative Binomial Regression		
	Adjusted OR (95% CI)	Coefficient	SE	*P*
Demographic				
Male	Reference	Reference	—	—
Female	0.88 (0.81 to 0.96)	−0.022	0.03	—
Race/ethnicity				
African American	0.92 (0.82 to 1.03)	−0.011	0.05	—
Caucasian	Reference	Reference	—	—
Hispanic	0.78 (0.68 to 0.89)	−0.050	0.05	—
Other/unknown	0.74 (0.39 to 1.50)	−0.21	0.25	—
Location				
New York City	1.05 (0.97 to 1.19)	0.024	0.04	—
Rest of state	Reference	Reference	—	—
Clinical				
Diagnosed ADI*	2.73 (2.45 to 3.02)	0.58	0.04	<0.01
Kidney disease	1.87 (1.65 to 2.11)	0.35	0.04	<0.01
# Comorbidities*				
None	Reference	Reference	—	—
1–2	2.8 (2.25 to 3.56)	0.95	0.10	<0.01
3–4	5.78 (4.60 to 7.27)	1.63	0.10	<0.01
>5	11.54 (9.0 to 14.7)	1.95	0.11	<0.01
Ever left AMA	2.28 (1.99 to 2.61)	0.47	0.04	<0.01
Behavioral health				
Alcoholism	1.40 (1.22 to 1.60)	0.29	0.04	<0.01
Illicit drug use	1.07 (0.96 to 1.19)	0.07	0.03	<0.05
Depression	1.61 (1.50 to 1.83)	0.01	0.03	—
Psychosis	1.43 (1.27 to 1.62)	0.39	0.05	<0.01
Utilization history				
Inpatient visits, 2011				
None	Reference	Reference	—	—
0–2	1.39 (1.29 to 1.57)	0.21	0.04	<0.01
2–4	2.19 (1.89 to 2.51)	0.51	0.05	<0.01
5+	2.77 (2.24 to 3.43)	0.79	0.06	<0.01
ED visits, 2011				
None	Reference	Reference	—	—
0–2	1.11 (0.9 to 1.19)	0.12	0.04	<0.05
2–4	1.17 (1.02 to 1.39)	0.05	0.05	
5+	1.50 (1.25 to 1.79)	0.14	0.06	<0.05
Socio-demographic				
Medicaid beneficiary	1.23 (1.12 to 1.35)	0.086	0.03	<0.05
Unstably housed	1.51 (1.37 to 1.68)	0.14	0.04	<0.01

N = 16,558 patients.
*Based on the Elixhauser Comorbidity Index.
ADI, AIDS-defining illness.

TABLE 3. Patient Characteristics Associated With Fragmented Hospital Use

	Estimate	SE	*P*
Illicit drug use	0.64	0.03	<0.05
Ever left AMA	0.081	0.03	<0.05
Kidney disease	−0.11	0.03	<0.01
Diagnosed ADI	−0.07	0.02	<0.05
Unstably housed	0.23	0.02	<0.001
Inpatient visits, 2011			
None	Reference	—	—
0–2	0.03	0.02	—
2–4	0.10	0.03	<0.05
5+	0.26	0.06	<0.01

N = 6323; Poisson Regression (# hospitalizations as exposure).

Island (24%, $P < 0.01$). 38.1% of the cohort was admitted to multiple facilities and several patient characteristics were independently associated with multiple hospital use (Table 3).

DISCUSSION

We provide strong evidence that PLWH are at high risk of readmission and that a sizeable fraction of readmissions in the population are driven by conditions comorbid with HIV. Because behavioral health diagnoses were common among readmitted PLWH, hospitals should consider targeted interventions among this subset of the population as part of comprehensive care and discharge planning. The study also demonstrates that many readmissions, especially those in urban areas, occur at different health care facilities than that of the initial hospitalization and represent a fragmentation of care that has significant implications for care coordination and quality of care.

Our findings suggest that social factors are important elements in the readmission of PLWH. We found housing instability, having Medicaid insurance, and past utilization of inpatient facilities and emergency rooms to be predictive of readmission. These findings corroborate recent studies that elucidate the association between low socioeconomic status, the underutilization of primary care, and high readmission rates among uninfected individuals.[17,18] Two studies in the general Medicaid population have revealed an association between high readmission rates and socioeconomic and educational disadvantages, which can impede effective post-discharge care.[19,20] In addition, other studies suggest that patients with low socioeconomic status perceive hospital care to be less expensive, more accessible, and of higher quality than outpatient care and that poor patients may use EDs in lieu of primary care.[18,21,22] Housing instability and homelessness are also well-documented predictors of readmission and were similarly noted in our study to be associated with readmission.[23,24] Investing in supportive housing for unstably housed, high-risk patients may therefore be a cost-effective way to reduce unnecessary hospitalizations.[25,26]

Independent associations between drug and alcohol abuse and readmission suggest that unmanaged substance abuse disorders impede the delivery and efficacy of medical care. Substance abuse may result in nonadherence to medications and physical illness, both of which may exacerbate an existing condition enough to elicit an unplanned hospitalization.[27,28]

This study also provides indirect corroborating evidence that the treatment of HIV is a critical element in the reduction of readmissions in PLWH. Although our dataset did not contain important CD4 and viral load values, the

diagnosis of an AIDS-defining illness during the study period increased the likelihood of readmission (aOR = 2.7, 95% CI: 2.4 to 3.0) and was seen in 28.2% of readmitted patients. Previous studies in the HIV+ population have observed an independent association between readmission, AIDS-defining illnesses, and low $CD4^+$ counts.[3,5,6] Nosyk et al demonstrated that ART significantly reduced a patient's risk of readmission. Efforts to promote care engagement, especially on hospital discharge, may reduce AIDS-defining illness-related readmissions, resulting in lower hospitalization expenditures that could offset the cost of antiretroviral drugs.[29]

Discharge AMA increased the likelihood of readmission.[30] Perceived discrimination by providers and the failure to adequately manage dependency disorders in an acute care setting can lead to discharge AMA.[31,32]

We demonstrate that PLWH with multiple chronic conditions are at an elevated risk of readmission. Although the Elixhauser comorbidity index is not a precise assessment of morbidity, the considerable frequency of chronic conditions and their strong association with readmission suggests that the successful management of chronic conditions is essential to reduce readmissions.[33] Inadequate management of chronic conditions during inpatient care has been identified as a preventable cause of readmission among PLWH.[34] Postdischarge care should be arranged to assure that all comorbidities are addressed through ongoing coordinated care.[35] The importance of adequate postdischarge care may be especially important for patients with chronic kidney disease, who are at an increased risk of readmission [aOR 1.87 (95% CI: 1.65 to 2.11)].

This study is the first to demonstrate that care fragmentation results from recurrent inpatient hospital use in PLWH. In New York City hospitals, 36% of readmission events occurred at a health care facility different from the one at which the preceding hospitalization occurred. This phenomenon was observed less frequently in other areas of New York State (24%, $P < 0.01$), where there are fewer hospitals within a geographic area. The incomplete transmittance of clinical information that results from care fragmentation may compromise the provision of effective and efficient care.[36] The potential harms of care fragmentation are underscored by recent work implicating poor quality of inpatient care as a cause of preventable readmissions among PLWH.[34]

PLWH who use illicit drugs, are unstably housed, and experience frequent hospital admission may be more likely to use multiple hospitals (Table 3). These patient groups would likely benefit from augmented health information exchange, which represents an important opportunity to improve patient safety, reduce duplicative test ordering, and improve overall care quality.[37] The failure to examine readmissions on a regional basis may lead to the underestimation of readmission rates and exclude an important cluster of patients who are readmitted across multiple facilities.

In contrast to many previously published studies of hospital readmission,[38] our study sought to characterize inpatients at highest risk of readmission. Published models for the prediction of individual readmissions generally show relatively poor discriminatory ability.[39] Modeling attempts are challenged by the inherent limitations of administrative data, which lack the precise clinical information needed to predict which hospitalizations ultimately result in readmission.[5,38,40] In addition, little evidence suggests that rehospitalization before and after the 30-day threshold are categorically different.[38,41]

Other limitations of our study should be considered. First, diagnostic coding in administrative data was used to identify HIV-infection status. Although some individuals may have been misclassified as HIV-positive, previous studies found inpatient claims with HIV-specific ICD-9 codes to be reliable indicators of HIV infection.[14] Second, our analysis lacked HIV laboratory data, which previous studies found predictive of readmissions among PLWH.[5] Third, neither the SPARCS homelessness indicator nor the ICD-9 code V60.00 are formally validated measures of housing instability and should be interpreted with caution. Fourth, heterogeneity in coding practices among clinicians and hospitals may have also affected our results.[40]

Although we found AIDS-defining illness predictive of readmission, our study cannot provide direct evidence that engagement in HIV medical care is protective against readmission. Engagement in HIV primary care is necessary for the provision of ART and the successful management of comorbid chronic conditions.[42] Future studies should examine whether interventions aimed at improving engagement in HIV primary care exist as a cost-effective solution to reducing hospital readmission.[29] Studies examining the use, dose, and type of supportive services in comprehensive care models, including those funded by the Ryan White HIV/AIDS Program are needed to determine how to best reduce possibly preventable hospitalizations in PLWH. Our findings support the premise that comprehensive care addressing clinical problems, comorbidities, and the social determinants of health is important to prevent readmissions among persons living with HIV. Finally, we demonstrate that readmissions often entail multiple hospital use. Future studies may underestimate readmission rates by as much as 30% if admissions to neighboring hospitals are not considered.

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