Predictors of Early Hospital Readmission in HIV-infected Patients with Pneumonia

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OBJECTIVE: **Although hospitalization patterns have been studied, little is known about hospital readmission among HIV-infected patients in the era of highly active antiretroviral therapy. We explored the risk factors for early readmission to a tertiary care inner-city hospital among HIV-infected patients with pneumonia in Vancouver, Canada.**

DESIGN: **Case-control study.**

SETTING: **Tertiary care, university-affiliated, inner-city hospital.**

PARTICIPANTS: **All HIV-infected patients who were hospitalized with *Pneumocystis carinii* pneumonia (PCP) or bacterial pneumonia (BP) between January 1997 and December 2000. Case patients included those who had early readmissions, defined as being readmitted within 2 weeks of discharge (*N* = 131). Control patients were randomly selected HIV-infected patients admitted during the study period who were not readmitted within 2 weeks of discharge (*N* = 131), matched to the cases by proportion of PCP to BP.**

MEASUREMENTS: **Sociodemographic, HIV risk category, and clinical data were compared using χ^2 test for categorical variables, and the Wilcoxon rank-sum test was used for continuous variables. Multivariable logistic regression was performed to determine the factors independently associated with early readmission. We also reviewed the medical records of 132 patients admitted to the HIV/AIDS ward during the study period and collected more detailed clinical data for a subanalysis.**

MAIN RESULTS: **Patients were at significantly increased odds of early readmission if they left the hospital against medical advice (AMA) (adjusted odds ratio [OR], 4.26; 95% confidence interval [95% CI], 2.13 to 8.55), lived in the poorest urban neighborhood (OR, 2.03; 95% CI, 1.09 to 3.77), were hospitalized in summer season (May though October, OR, 2.36; 95% CI, 1.36 to 4.10), or had been admitted in the preceding 6 months (OR, 2.55; 95% CI, 1.46 to 4.47). Gender, age, history of AIDS-defining illness, and injection drug use status were not significantly associated with early readmission.**

CONCLUSIONS: **Predictors of early readmission of HIV-infected patients with pneumonia included: leaving hospital AMA, living in the poorest urban neighborhood, being hospitalized in the preceding 6 months and during the summer months. Interventions involving social work may address some of the underlying reasons why these patients leave hospital AMA and should be further studied.**

KEY WORDS: **case-control; hospital readmission; HIV; AIDS; bacterial pneumonia; PCP; antiretroviral therapy.**
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Many studies have indicated that hospital readmissions occur frequently, especially among patients with AIDS, renal disease, cancer, and congestive heart failure.[1–3] Rates of readmissions have ranged from 6.5% within 14 days of discharge among HIV-infected patients with bacterial pneumonia[4] to 23% within 12 months of discharge among lower-income patients with heart failure.[5] Repeated admissions for chronic medical problems are actually more costly for total days of stay than single, cost-intensive stays.[6] Factors shown to influence the likelihood of readmission include socioeconomic status,[5,7] receipt of welfare,[1] having AIDS,[2] prior admissions,[3,4,8] use of crack cocaine, leaving hospital unaccompanied by family or friend, and patient noncompliance.[1,4]

Grant et al. found that AIDS patients with pneumonia who left hospital alone, used crack cocaine, who had 1 or more coincident AIDS diagnosis, and who had been hospitalized in the preceding 6 months were more likely to be readmitted within 2 weeks of discharge.[4] However, this study was done prior to the widespread availability of highly active antiretroviral therapy (HAART), i.e., combination therapy with at least 3 antiretroviral agents. Since it is well known that HAART provided a therapeutic breakthrough that led to significant reductions in morbidity and mortality as well as enhanced quality of life for many HIV-positive individuals,[9–11] its impact on hospital readmission remains to be investigated.

Hospital admission for acute illness among HIV-infected patients may serve as an opportunity to review patients' medications and to optimize therapy prior to discharge. The uptake of HAART may be an important marker of quality of care among HIV-positive patients. We therefore explored the factors associated with early readmission to a tertiary care inner-city hospital among HIV-positive patients with pneumonia as well as the uptake of HAART at admission and discharge among a subgroup of these patients in Vancouver, Canada.

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METHODS

All admissions records, from January 1, 1997 to December 31, 2000, of HIV-infected patients with *Pneumocystis carinii* pneumonia (PCP) (International Classification of Diseases, Ninth Revision [ICD-9] code 136.3) or bacterial pneumonia (BP) (ICD-9 codes 481–483, 485, and 486) were retrieved from discharge abstracts. A discharge abstract, completed by the staff of the Medical Records Department, is a patient-specific administrative record from the start of admission to discharge or transfer to another institution or death. Patient demographics such as age, gender, and postal code, and clinical information on diagnosis, procedures, and patients' injection drug use were recorded in the discharge abstract. Case patients were defined as all HIV-infected patients with a diagnosis of PCP or BP for at least 1 hospitalization who were subsequently readmitted to St. Paul's Hospital within 14 days for any reason (early readmission). If a case patient had more than 1 admission for BP or PCP and was subsequently readmitted within 14 days during the study period, then 1 of these admissions was randomly selected for the study. The selected admission was defined as the index hospitalization of case patients. Control patients were randomly selected from patients who had hospitalizations for BP or PCP and who were not readmitted within 14 days. In patients hospitalized more than once for BP or PCP during the study period, only 1 (randomly selected) hospitalization was included and was defined as the index hospitalization for the controls. Case and control patients were matched by proportion of PCP and BP.

Based on the information from the index hospitalization, patients were classified as injection drug users or non–injection drug users. Patients with at least 1 diagnosis of AIDS or advanced HIV disease (ICD-9 codes 42.0–44.9) were identified. This classification was used as a marker of the HIV disease severity. According to patients' postal codes, they were classified as "Downtown Eastside" (the poorest urban neighborhood in Canada and subsequently referred to as the "poorest urban neighborhood"),[12] "no fixed address" if they did not report a fixed address at admission, and "other." We classified patients as leaving the hospital against medical advice (AMA) and not-AMA based on the manner in which they were discharged from the index hospitalization. Patients were also classified as having a previous admission if they were admitted in the 6 months preceding their index hospitalizations. To look at the effect of season on risk of readmission of HIV-positive patients with pneumonia, we classified the index hospitalization into 2 seasons, summer (May through October) and winter (November through April), hypothesizing that most of the admissions would be in the winter months.

To obtain more detailed clinical data, including ethnicity (Aboriginal versus other) and uptake of HAART at admission and discharge, we reviewed the medical records of 368 patients admitted with PCP or BP to the St. Paul's Hospital HIV/AIDS ward during the study period. We employed the same procedures as described earlier to identify case and control patients. Finally, we compared the coding of injection drug use in the hospital data set to the 30-day drug use history obtained from 132 patients in the HIV/AIDS ward and found the κ statistic for reliability was 0.68 (95% confidence interval [95% CI], 0.55 to 0.81). The St. Paul's Hospital Ethics Committee for Human Experimentation approved the data collection for this study.

Statistical Analysis

Both bivariable and multivariable analyses were used in the study. In the bivariable analysis, categorical variables were compared using χ^2 test, while continuous variables were compared using the Wilcoxon rank-sum test. Variables were checked for co-linearity prior to applying logistic regression to determine the factors associated with early readmissions. We also checked the effect of possible interaction terms, such as AMA and area of residence, AMA and injection drug use (IDU), and IDU and area of residence. The same procedure was repeated for the subanalysis using the HIV/AIDS ward data. All statistical analyses were performed using the SAS 8.2 software program (SAS Institute, Inc., Cary, NC).

RESULTS

Between January 1, 1997 and December 31, 2000, 724 HIV-infected patients accounted for 1,311 admissions to St. Paul's Hospital for PCP or BP. Of the 287 patients who were hospitalized for PCP, 60 (21%) had a subsequent readmission within 14 days; and of the 1,024 BP cases, 156 (15%) had a subsequent early readmission. Of the 724 patients admitted during the study time period, 140 (19%) incurred at least 1 early readmission. The median time to readmission for the case patients was 5 days (interquartile range [IQR], 2–9).

Case and control patients were matched by proportion of PCP and BP. There were 27 PCP and 104 BP case patients matched to 27 PCP and104 BP control patients. Table 1 presents patients' characteristics. We found that case patients were more likely to be injection drug users, live in the poorest urban neighborhood, leave the hospital AMA, be hospitalized in summer season, and have had an admission to hospital in the preceding 6 months. Length of stay (LOS) at the index hospitalization did not differ significantly between case and control patients (median LOS 7, days versus 6 days; $P = .14$). The median CD4 cell count for cases was lower than for the controls (65 versus 160 cells/mm^3; $P = .009$).

Table 2 lists the unadjusted and adjusted odds ratios (ORs) and corresponding 95% confidence intervals (95% CIs) of factors associated with early readmission. After adjusting for gender, history of an AIDS-defining illness, and IDU status, case patients were more likely to leave the hospital AMA (OR, 4.26; 95% CI, 2.13 to 8.55), to have a previous admission <6 months (OR, 2.55; 95%

Table 1. Characteristics of Case and Control Patients at the Index Hospitalization

Characteristics	Cases	Controls	*P* Value
Sample size, *n*	131	131	
Median age (Q1–Q3), y	38 (32–44)	38 (34–44)	.9
Female (%)	41 (31)	30 (23)	.13
Poorest urban neighborhood* (%)	61 (47)	37 (28)	<.002
No fixed address* (%)	13 (10)	8 (6)	
AIDS-defining illness (%)	78 (60)	67 (51)	.17
IDU (%)	77 (59)	61 (47)	.05
Median length of stay (Q1–Q3), d	7 (4–15)	6 (4–11)	.14
Hospitalized in summer (%)	77 (59)	50 (38)	<.001
Left hospital AMA (%)	56 (43)	17 (13)	<.001
Previous admission <6 mo (%)	91 (69)	56 (43)	<.001
Median CD4 cell count (cells/mm^3)	65 (20–210)	160 (20–330)	.009

* *Compared to living in other neighborhoods in Vancouver.*
IDU, injection drug use; AMA, against medical advice.

CI, 1.46 to 4.47), to live in the poorest urban neighborhood (OR, 2.03; 95% CI, 1.09 to 3.77), and to be hospitalized during the summer season (OR, 2.36; 95% CI, 1.36 to 4.10). Since none of the interaction terms were statistically significant, we did include them in the final logistic regression model.

Table 2. Factors Associated With Early Hospital Readmission: Unadjusted and Adjusted Odds Ratios Among HIV Patients Hospitalized With BP or PCP During Their Index Hospitalization

Factors	Crude (95% CI)	Adjusted* (95% CI)
Female	1.53 (0.88 to 2.66)	
Living in poorest urban neighborhood†	2.49 (1.47 to 4.22)	2.03 (1.09 to 3.77)
No fixed address†	2.45 (0.96 to 6.29)	
AIDS-defining illness	1.41 (0.86 to 2.29)	
IDU	1.64 (1.00 to 2.66)	
Hospitalized in summer	2.31 (1.41 to 3.79)	2.36 (1.36 to 4.10)
Left hospital AMA	5.01 (2.70 to 9.27)	4.26 (2.13 to 8.55)
Previous admission <6 mo	3.05 (1.83 to 5.06)	2.55 (1.46 to 4.47)

* *Adjusting for gender, history of an AIDS-defining illness, and IDU status, C-statistic = 0.77.*
† *Reference group: living in neighborhoods in Vancouver other than the poorest urban neighborhood (Downtown Eastside of Vancouver).*
BP, bacterial pneumonia; PCP, Pneumocystic carinii *pneumonia; IDU, injection drug use; CI, confidence interval; AMA, against medical advice.*

For the subanalysis, there were 368 HIV-infected patients who incurred 595 admissions to the HIV/AIDS ward at St. Paul's Hospital for PCP or BP between January 1, 1997 and December 31, 2000. Of the 152 hospital admissions for PCP, 31 (20%) had a subsequent readmission within 14 days; and of the 443 BP cases, 70 (16%) had a subsequent early readmission. Of the 368 patients admitted during the study time period, 69 (19%) required at least 1 early readmission. There were 19 PCP and 47 BP case patients matched to 19 PCP and 47 BP control patients. The median time to readmission for the case patients was 6 days (IQR, 3–10).

Table 3 depicts the characteristics of cases and controls who had admissions to the HIV/AIDS ward. Cases were more likely to be female, Aboriginal, live in the poorest urban neighborhood, be hospitalized during the summer months, leave hospital AMA, and have an admission in the previous 6 months. In terms of receipt of HAART, there was no significant difference between cases and controls in the proportion on HAART at admission (26% vs 14%; P = .08) and although a similar proportion were discharged on HAART, more controls were scheduled to see

Table 3. Characteristics of Case and Control Patients from the HIV/AIDS Ward at Their Index Hospitalization

Characteristics	Cases	Controls	*P* Value
Sample size, *n*	66	66	
Median age (Q1–Q3), y	38 (32–44)	37 (34–45)	.49
Female (%)	20 (30)	13 (20)	.16
Aboriginal ethnicity (%)	26 (39)	13 (20)	.01
Poorest urban neighborhood* (%)	28 (42)	14 (21)	.03
No fixed address* (%)	7 (11)	7 (11)	
Social support no/unknown (%)	14 (21)	14 (21)	1.0
AIDS-defining illness (%)	44 (67)	40 (61)	.47
IDU (%)	37 (56)	35 (53)	.73
Median length of stay (Q1–Q3), d	7 (4–17)	6 (4–12)	.38
Hospitalized in summer (%)	40 (61)	32 (48)	.16
Left hospital AMA (%)	30 (45)	6 (9)	<.001
Previous admission <6 mo (%)	50 (76)	24 (36)	<.001
HAART on admission	17 (26)	9 (14)	.08
HAART on discharge†			
Yes	14 (21)	14 (21)	.03
Scheduled	6 (9)	17 (26)	
No‡	46 (70)	35 (53)	
Median CD4 cell count (mm^3)	160 (10–210)	90 (30–230)	.08

* *Compared to living in other neighborhoods in Vancouver.*
† *The* P *value reflects a* χ^2 *test for 3 × 2 table.*
‡ *36 Patients left AMA (30 in the case group).*
IDU, injection drug use; AMA, against medical advice; HAART, highly active antiretroviral therapy.

a prescribing physician to start HAART in the community (26% vs 9%; $P = .03$). The median CD4 cell counts for cases and controls were similar (160 vs 90 cells/mm^3; $P = .08$). We also found that patients who left AMA were much more likely not to have HAART prescribed compared to those who were discharged formally (Table 4). Table 5 shows the unadjusted and adjusted odds ratios of factors associated with early hospital readmission. Similar to the main analysis, living in the poorest urban neighborhood, leaving hospital AMA, and having a hospital admission in the previous 6 months increased the odds of readmission.

DISCUSSION

Among HIV-positive patients who were hospitalized with PCP and bacterial pneumonia, we found the following risk factors for early readmission: leaving hospital AMA, living in the poorest neighborhood, the index admission occurring during the summer months and being hospitalized in the preceding 6 months. Our 2-week readmission rates were substantially higher than those reported by Grant et al.[4] (PCP: 21% vs 4.2%; BP: 15% vs 6.5%). Our patients had higher median CD4 cell counts than Grant's cohort (cases, 65 vs 19 cells/mm^3; controls, 160 vs 26 cells/mm^3), who appeared to be in more-advanced stages of AIDS. This large difference in readmission rates may be due to differences in population and health care systems. Furthermore, the difference in CD4 counts between cases and controls may reflect the possibilities that patients with readmissions were more likely to have had HIV for longer periods of time, that they had been less likely to take HAART, or that they had higher rates of nonadherence or drug therapy resistance or failure.

Leaving hospital against medical advice was the strongest predictor of readmission. In an earlier study, we found that leaving on welfare check day and a history of IDU were significant predictors of discharge AMA among hospitalized HIV-infected patients.[13] In addition, these patients leaving AMA, when compared to those formally discharged, were found to be readmitted more frequently (frequency ratio:95% C.I., 1.25:1.11 to 1.42), be more likely to be readmitted with a related diagnosis within 30 days (OR, 5.00; 95%CI, 3.04 to 8.24) and to have significantly longer length of stay in the follow-up period. Other studies have found that patients who leave AMA tend to be younger,[14,15] to be of a lower income level,[15] and to have no primary care physician.[14] As in our earlier study,[13] patients who leave AMA are more likely to be substance users,[14,16] and to use psychoactive drugs more frequently than patients discharged formally.[16] In addition, patients who are discharged AMA may have negative preconceptions about hospital stays and feel that hospital staff are not helpful.[17,18] Because leaving hospital AMA is an indicator of incomplete therapy, it may negatively affect the health outcomes of the patients,[14] leading to rapid rehospitalization.[16,17] Patients who leave AMA are up to 7 times more likely to be readmitted than those formally discharged.[14] In addition, Weingart et al. suggest that a patient who leaves AMA may not be able to remain in hospital for the duration of treatment for personal reasons, and would return after they have addressed other needs.[15] Low income is correlated with AMA discharges,[15] and among HIV-infected persons residing in the poorest neighborhood, welfare check issue day may influence their decision to leave the hospital prematurely.[13]

Table 4. Receipt of HAART at Discharge for Case and Control Patients from the HIV/AIDS Ward Stratified by AMA Status

Characteristics	Cases (*N* = 66)	Controls (*N* = 66)
AMA	30	6
HAART on discharge		
Yes	0	0
Scheduled	0	0
No	30	6
Not AMA	36	60
HAART on discharge		
Yes (%)	14 (39)	14 (23)
Scheduled (%)	6 (16)	17 (28)
No (%)	16 (44)	29 (44)

AMA, against medical advice; HAART, highly active antiretroviral therapy.

Table 5. Factors Associated With Early Hospital Readmission: Unadjusted and Adjusted Odds Ratios Among HIV Patients Hospitalized With BP and PCP During Their Index Hospitalization on the HIV/AIDS Ward

Factors	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)
Female	1.77 (0.79 to 3.95)	
Aboriginal ethnicity	2.65 (1.21 to 5.79)	
Living in poorest urban neighborhood†	2.90 (1.32 to 6.38)	2.96 (1.04 to 8.37)
No fixed address†	1.45 (0.46 to 4.55)	
No/unknown social support	1.00 (0.43 to 2.30)	
AIDS-defining illness	1.30 (0.64 to 2.65)	
IDU	1.13 (0.60 to 2.24)	
Hospitalized in summer	1.63 (0.82 to 3.26)	
Left hospital AMA	8.33 (3.16 to 21.96)	13.3 (3.49 to 50.6)
Previous admission <6 mo	5.47 (2.57 to 11.62)	3.51 (1.45 to 8.53)

* *Adjusting for gender, history of an AIDS-defining illness, and IDU status, C-statistic = 0.82.*

† *Reference group: living in neighborhoods in Vancouver other than the poorest urban neighborhood (Downtown Eastside of Vancouver). BP, bacterial pneumonia; PCP,* Pneumocystis carinii *pneumonia; CI, confidence interval; IDU, injection drug use; AMA, against medical advice.*

Grant et al. found that leaving the hospital unaccompanied by family or friend was independently associated with hospital readmission.[4] This factor may represent a sensitive measure of social isolation even better than living situation, because living situation (as well as other indicators of social isolation) was not different between cases and controls. Illicit drug use and poor social support also have been associated with higher rehospitalization rates.[1,4,19–21] Another study found that schizophrenic patients whose family members came to visit them were less likely to have early rehospitalizations.[19] They suggested that the social environment of the discharged individual might influence the course of recovery. The problems associated with lack of social support are important to examine in the context of our study population. In our cohort, we found that readmissions were significantly associated with living in the poorest urban neighborhood, where illicit drug use is alarmingly high.[22]

As Grant et al.[4] hypothesized, concomitant AIDS diagnoses were not predictive of early hospital readmission in the era of HAART; however, recent antecedent hospitalization continues to be associated with readmission and may reflect suboptimal management of HIV disease. There was a trend for the controls to be discharged on HAART or scheduled to see a prescribing physician regarding HAART as an outpatient compared to cases. Unfortunately, more case patients left hospital AMA, precluding arrangement for this complex therapeutic regimen.

Prior admission within the past 6 months was associated with early readmission, which has been confirmed elsewhere.[4] The number of prior admissions has been found to be a strong predictor of future rehospitalization.[23] One study showed that patients who were readmitted were significantly more likely than those who were not readmitted to have had 4 or more prior hospitalizations.[19] This may be explained by the notion that frequently hospitalized patients tend to be chronically ill and are often rehospitalized for the same illness.[20] In addition, we unexpectedly found that hospitalization in the summer months was associated with higher risk for readmission. The reason for this is unclear, because we controlled for leaving AMA that may occur more frequently in the summer months.

Limitations of our study include retrospective data collection and clinical data that were limited to the subsample of patients on the HIV/AIDS ward. As in the study by Grant et al.,[4] during the pre-HAART era, we limited our diagnoses to BP and PCP, because they are common and reliably diagnosed. Data on non-injection drug use were not specifically collected. We probably underestimated the number of readmissions, because we studied only 1 hospital, although the patients served by this hospital tend to come back for their medical care because it is a well-known AIDS tertiary care center with a specialized HIV/AIDS ward.[24,25] It is possible, however, that injection drug users are being readmitted elsewhere and this may explain why it was not significantly associated with hospital readmission. In addition, the patients from the poorest urban neighborhood who leave AMA may be the type of patient who would re-present to the same hospital. The sample size may have been too small in the subanalysis to identify other factors of interest that are associated with readmission. Finally, the odds ratios derived from case-control are somewhat inflated, and a longitudinal study would provide more precise estimates.

On the basis of our findings, we recommend identifying HIV-infected patients who are at risk for early readmission, such as those with recent hospitalizations and those who live in poorer urban neighborhoods. A social worker might be able to explore and address some of the underlying reasons that these patients leave hospital AMA; this could alleviate the health and economic burden of potentially avoidable readmissions in this vulnerable population.

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