

Association of Social Stress, Illicit Drug Use, and Health Beliefs with Nonadherence to Antiretroviral Therapy

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OBJECTIVE: To assess the roles of socioeconomic status, social stability, social stress, health beliefs, and illicit drug use with nonadherence to antiretroviral therapy.

DESIGN: Cross-sectional study.

SETTING: Urban hospital clinic.

PARTICIPANTS: One hundred ninety-six consecutive HIV-infected patients taking at least 1 antiretroviral medication, awaiting a visit with their primary care provider.

METHODS: Patients were interviewed while waiting for a clinic appointment and were asked to fill out a 4-part survey with questions regarding antiretroviral adherence, illicit drug use, health beliefs, and social situation. Adherence was defined as the percentage of doses taken, i.e., the number of doses taken divided by the number of doses prescribed over a 2-week interval. Univariate and multivariate logistic regressions were performed to identify factors associated with nonadherence in different patient subgroups.

MAIN RESULTS: Nonadherence to antiretroviral therapy was associated with active illicit drug use (adjusted odds ratio [AOR], 2.31; 95% confidence interval [95% CI], 1.17 to 4.58), eating fewer than 2 meals per day (AOR, 3.31; 95% CI, 1.11 to 9.92), and feeling as though pressures outside of the clinic affected patient's ability to take antiretroviral medications as prescribed (AOR, 2.22; 95% CI, 0.99 to 4.97). In patients with a history of injection drug use, nonadherence to antiretroviral therapy was independently associated with eating fewer than 2 meals per day (AOR, 17.54; 95% CI, 1.92 to 160.4) and active illicit drug use (AOR, 4.18; 95% CI, 1.68 to 10.75). In patients without any injection drug use, nonadherence was only associated with feeling as though pressures outside of clinic affected patient's ability to take antiretroviral medications as prescribed (AOR, 3.55; 95% CI, 1.07 to 11.76). Male-to-male sexual contact was associated with lower nonadherence in patients with an HIV risk factor other than injection drug use (AOR, 0.35; 95% CI, 0.13 to 0.95). A history of drug use but no illicit drug use within 6 months of the interview was not associated with an increased rate of nonadherence.

CONCLUSIONS: Although our sample size was limited and variables that are not significant in subgroup analysis may still be associated with adherence, our results suggest that correlates of nonadherence are HIV risk factor specific.

Strategies to increase antiretroviral adherence in HIV-infected patients should include social support interventions targeted at different risk factors for different patient groups.

KEY WORDS: adherence; antiretroviral therapy; drug use; HIV; socioeconomic status.

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Highly active antiretroviral therapy has been shown to reduce morbidity and mortality in HIV patients and has transformed HIV from a progressive, terminal illness into a chronic, treatable disease.^{1,2} Successful treatment with these medications can result in undetectable viral loads; however, strict adherence to complicated antiretroviral regimens is critical to maintaining durable viral suppression and clinical well-being. The beneficial effects of these regimens can quickly be offset by even short-term nonadherence and the development of resistant HIV. Resistant virus generates both individual and public health concerns as transmission of multi-drug-resistant strains of HIV have been reported.³

Self-reported adherence to HIV therapy has been shown to range from 56% to 88%.^{4–6} With some regimens requiring up to a dozen pills 2 to 3 times per day and multiple side-effects, long-term adherence can be difficult for even the most compliant patient. Therefore, greater attention is now being placed on identifying risk factors for nonadherence in HIV-infected patients.

Many biomedical barriers have been linked to nonadherence to antiretroviral regimens, including depression and side-effect severity.^{7–9} Although some work has been done in evaluating the interaction of nonadherence with self-efficacy, lack of social support, illiteracy, and educational level, little research has looked at the effects of social and psychosocial factors and their potential interactions with nonadherence.^{7,8} In most studies in which socioeconomic status (SES) has been evaluated, the commonly used measures of education and current income have not fully encompassed the multiple dimensions of SES. Available resources may differ in persons with equivalent education and income because of previous debts or owning other assets, and standard measures may fail to capture variability in SES. Therefore, in this study, we attempted to evaluate material hardship and deprivation to more fully understand the effects of SES and its association with adherence to antiretroviral medication.

The changing epidemiology of HIV has resulted in more female patients and more indigent patients, and these patients are often living under great social stress and in conditions of considerable social instability. We hypothesized that social stresses differed by gender as well as HIV risk factor category. Therefore, we chose to evaluate the

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impact of social stresses and social stability on nonadherence to antiretroviral medication, with stratification by gender and HIV risk factor.

METHODS

We performed a cross-sectional study of 196 consecutive patients enrolled in the Johns Hopkins University HIV Clinic between June 1, 1999 and January 15, 2000 who were taking at least 1 antiretroviral medication. No patient who was approached refused to participate in the study. Patients were approached about the study in the clinic waiting room while waiting for a visit with their primary care provider. Patients were administered a previously validated questionnaire with 3 sections regarding antiretroviral adherence, health beliefs, and alcohol, tobacco, and substance abuse.^{10,11} In addition, 12 questions regarding SES, social situation, and perception of social stress were administered. Finally, demographic and clinical information was also collected including age, gender, race/ethnicity, HIV risk factor, CD4 cell count, and antiretroviral drug(s) prescribed.

After obtaining informed consent, a research assistant administered the survey in a private room adjacent to the main clinical area. To increase the validity of self-report, an introduction to the survey gave "permission" to admit to nonadherence.^{12,13} Patients were instructed that we were investigating reasons why patients may not be able to adhere to their antiretroviral regimen, because we understood that many patients are not able to take all of their pills as prescribed. The entire survey took approximately 15 minutes and patients were compensated \$5 for participating.

The research assistant interviewed patients 5 days per week, at an average of 2 patients per half-day session. This represents every clinical session in the clinic. In addition, she interviewed all new enrollees to the clinic on the day of their appointment (approximately 400 per year). Only 50% of the patients interviewed were on antiretroviral therapy at the time of the interview. Our sample comprised 196 consecutively interviewed patients who were taking at least 1 antiretroviral medication and who were longitudinally followed in our clinic, and represents a continuous effort.

For our analysis, HIV transmission risk factor was self-defined and included injection drug use (IDU), male-to-male sexual contact, and heterosexual transmission, which was defined as heterosexual activity with a known HIV-positive individual. CD4 count was defined as the CD4 count on enrollment into the clinic. Illicit drug use was defined as use of any illicit drug, injected or inhaled, and current drug use was defined as use of any illicit drug, injected or inhaled, within 6 months of the interview.

Material deprivation was evaluated with questions assessing the adequacy of resources for necessities including housing, meals, medications, or transportation in the past 90 days. The resources variable was dichotomized into

having or not having adequate resources for essentials. Material deprivation was further analyzed by another variable, having access to a telephone. In addition, social stability was evaluated by the number of planned meals per day, the number of places slept in the past 90 days, the number of people residing in the household, and the length of time at that residence. Social stress was evaluated by recent incarceration, recent court appearance, responsibility for children or elders, and the patient's perception of their outside stress.

Many of our patients live in transient housing arrangements, often in unstable living situations with extended families or with other substance abusers. Many of these patients have suggested that living with more people than a dwelling is designed to hold can increase the likelihood of nonadherence due to privacy issues with medications as well as a lack of safe place to leave their medicines; therefore, we chose to assess this factor by asking patients about the number of people living in their household.

Health beliefs were measured using 4 questions, each with a 5-point Likert scale, on the depth of belief that antiretrovirals would prevent hospitalization and HIV symptoms and would increase longevity, and that sickness would result if medications were not taken as prescribed.

Adherence rates were calculated as the percentage of doses taken—the total number of doses taken divided by the total number of doses prescribed—for each antiretroviral medication for the 2-week period prior to the interview. Adherence rates were then dichotomized into adherent ($\geq 90\%$ adherence for all antiretroviral medications) or nonadherent ($< 90\%$ adherence with any antiretroviral medication). Adherence was defined as 90% adherent because this level of adherence has been shown to delay progression to AIDS.¹⁴

Statistical analysis was performed using Stata 6.0 (Stata Corp., College Station, Tex). Univariate analyses to evaluate the relationship of each factor with overall adherence were done using the χ^2 test for categorical variables and *t* tests for continuous variables (age, CD4 count). All significant factors were then tested in multivariate analysis using stepwise logistic regression. Possible interaction effects between pairs of significant variables were tested by combining variables in a logistic regression analysis. Variables reaching statistical significance at the .05 level were included in the final multivariate regressions.

RESULTS

Our clinic population is predominately African American (77%) and male (69%), and the mean age at enrollment is 37 years. Injection drug use is the predominant HIV risk factor (48%). Overall demographic and clinical characteristics of the study population were very similar to those of our clinic population (Table 1). The population was predominately African American and male, with a mean age at enrollment in the clinic of 37 years. Injection drug

Table 1. Demographic and Clinical Characteristics of 196 HIV-infected Patients*

	<90% Adherent (N = 57)	≥90% Adherent (N = 139)	Total (N = 196)
Mean age, y	37.9	37.3	37.5
Male (%)	34 (60)	99 (71)	133 (68)
Female (%)	23 (40)	40 (29)	63 (32)
Race/ethnicity			
African American (%)	48 (84)	104 (75)	152 (78)
White (%)	9 (16)	35 (24)	43 (22)
Other (%)	0 (0)	1 (1)	1 (1)
HIV risk factor [†] (%)			
Injection drug use	32 (56)	69 (50)	101 (51)
Male-to-male sexual contact	15 (26)	50 (35)	65 (33)
High-risk heterosexual sex	19 (33)	38 (27)	57 (29)
CD4 count at enrollment, cells/mm ³			
<50 (%)	12 (21)	28 (20)	40 (20)
50–99 (%)	4 (7)	17 (12)	21 (11)
100–199 (%)	10 (18)	16 (12)	26 (13)
200–499 (%)	17 (30)	55 (40)	72 (37)
>500 (%)	14 (25)	23 (17)	37 (19)
Mean (SD)	317 (301)	280 (255)	291 (268)
Drugs prescribed (%)			
Nucleoside analogues	53 (93)	133 (96)	186 (95)
Protease inhibitors	32 (56)	80 (58)	112 (57)
Non-nucleoside reverse transcriptase	22 (39)	53 (38)	75 (38)
Alcohol use within 6 mo of interview (%)	30 (53)	64 (46)	94 (48)
Tobacco use within 6 mo of interview (%)	41 (72)	94 (68)	135 (69)
Mean 2-week compliance, % (SD)	41.3 (39)	97.9 (2.8)	81.4 (33.4)
Any illicit drug use within 6 mo of interview (%)	29 (51)	38 (57)	67 (34)
Cocaine use within 6 mo of interview (%)	18 (32)	21 (54)	39 (20)
Heroin use within 6 mo of interview (%)	19 (33)	14 (10)	33 (17)
Binge drug use within 6 mo of interview (%)	11 (19)	8 (6)	19 (10)
Eating 2 or more meals/d (%)	10 (18)	7 (5)	7 (9)
Running out of money in the past 90 d (%)	38 (67)	66 (47)	104 (53)
Pressures outside of clinic affect ability to take medications as prescribed (%)	19 (33)	18 (13)	37 (19)
Strongly believe will live longer if take medications (%)	22 (39)	76 (55)	98 (50)
Strongly believe will get sick if don't take meds (%)	23 (40)	77 (55)	100 (51)
Strongly believe meds will prevent admission (%)	17 (29)	62 (45)	79 (40)
Strongly believe meds prevent symptoms (%)	20 (35)	73 (52)	93 (47)

* No clinical or demographic feature was statistically different between those who adhered and those who did not ($P < .05$).

[†] More than 1 HIV risk factor could be reported.

use was the principal risk factor for HIV transmission, although nearly one third of the population had an HIV risk factor of male-to-male sexual contact. The mean CD4 count at enrollment was 291 cells/mm³. There was a mean overall 2-week adherence of 80%, and 71% of patients reported ≥90% adherence with all prescribed antiretroviral therapy. There were no statistically significant differences in demographic or clinical factors between those who adhered and those who did not.

Results of univariate and multivariate regression for adherence for the total sample are shown in Table 2. In univariate regression, any illicit drug use (odds ratio [OR], 2.75; 95% confidence interval [95% CI], 1.45 to 5.22), cocaine use (OR, 2.59; 95% CI, 1.25 to 5.36), heroin use (OR, 4.46; 95% CI, 2.05 to 9.74), and binge drug use (OR, 3.92; 95% CI, 1.48 to 10.34) within 6 months of the interview were all significantly associated with nonadherence. Social stability, socioeconomic factors, and social

stress factors that significantly correlated with nonadherence were eating fewer than 2 meals per day (OR, 4.01; 95% CI, 1.44 to 11.14), running out of money within the past 90 days for life essentials (OR, 2.21; 95% CI, 1.60 to 7.05), and feeling as though pressures outside of the clinic affected the patient's ability to take their medication as prescribed (OR, 3.37; 95% CI, 1.60 to 7.05). Health beliefs associated with adherence were strongly believing medications would increase longevity (OR, 0.52; 95% CI, 0.28 to 0.98), strongly believing that sickness would result if medications were not taken (OR, 0.55; 95% CI, 0.29 to 1.02), strongly believing medications prevented hospitalization (OR, 0.53; 95% CI, 0.27 to 1.02), and strongly believing medication prevented HIV symptoms (OR, 0.49; 95% CI, 0.15 to 0.93). In multivariate regression, any illicit drug use within 6 months of the interview (adjusted odds ratio [AOR], 2.31; 95% CI, 1.17 to 4.58), eating fewer than 2 meals per day (AOR, 3.31; 95% CI, 1.11 to 9.92), and feeling as though

Table 2. Factors Associated with Antiretroviral Nonadherence by Univariate and Multivariate Adjusted Analyses*

	Univariate Odds Ratio [†] (95% CI)	P Value	Multivariate Odds Ratio [†] (95% CI)	P Value
Any illicit drug use within 6 mo of interview	2.75 (1.45 to 5.22)	.002	2.31 (1.17 to 4.58)	.016
Cocaine use within 6 mo of interview	2.59 (1.25 to 5.36)	.01		NI
Heroin use within 6 mo of interview	4.46 (2.05 to 9.74)	<.001		NI
Binge drug use within 6 mo of interview	3.92 (1.48 to 10.34)	.006		NI
Eating <2 meals/d	4.01 (1.44 to 11.14)	.008	3.31 (1.11 to 9.92)	.032
Running out of money in the past 90 d	2.21 (1.16 to 4.21)	.016		NI
Pressures outside of clinic affect ability to take medications as prescribed	3.37 (1.60 to 7.05)	.001	2.22 (0.99 to 4.97)	.05
Strongly believe will live longer if take medications	0.52 (0.28 to 0.98)	.04		NI
Strongly believe will get sick if don't take meds	0.55 (0.29 to 1.02)	.05		NI
Strongly believe meds will prevent admission	0.53 (0.27 to 1.02)	.05		NI
Strongly believe meds prevent symptoms	0.49 (0.26 to 0.93)	.028		NI

* Non-significant factors analyzed in both univariate and multivariate analysis included age, gender, race/ethnicity, HIV risk factor, CD4 count at enrollment, and tobacco or alcohol use within 6 months of interview.

[†] An odds ratio >1.0 indicates an increased odds of nonadherence; an odds ratio <1.0 indicates a decreased odds of nonadherence, or an increased odds of adherence.

CI, confidence interval; NI, not included in multivariate analysis due to collinearity with other variables in the model.

pressures outside of the clinic affected the patient's ability to take their medication as prescribed (AOR, 2.22; 95% CI, 0.99 to 4.97) were significantly associated with nonadherence. No statistically significant interactions were found among significant variables in the multivariate model.

Significant interactions were found between male-to-male sexual contact and IDU ($P < .05$); therefore, analyses were stratified by HIV risk factor (Table 3).

Results of univariate and multivariate analyses performed for patients with an HIV risk factor of IDU are shown in Table 3. In multivariate analysis, significant factors for nonadherence were any illicit drug use within 6 months of the interview (AOR, 4.18; 95% CI, 1.68 to 10.75) and eating fewer than 2 meals per day (AOR, 17.54; 95% CI, 1.92 to 160.4). In multivariate analysis, the factor significantly associated with nonadherence in patients without a history of IDU was social pressures outside of

clinic affecting ability to take medications as prescribed (AOR, 3.55; 95% CI, 1.07 to 11.76) (Table 3). Male-to-male sexual contact was associated significantly with adherence (AOR, 0.35; 95% CI, 0.13 to 0.95). No statistically significant interactions were found among significant variables in either of these models.

Although gender was not a significant variable in multivariate analysis and we did not find interactions between variables because of the small number of women, we performed descriptive analysis of risk factors between men and women separately because of the potential clinical implications (Table 4). Table 4 demonstrates results of univariate and multivariate analysis for adherence in men and women. The factors significantly associated with nonadherence in women were active heroin use within 6 months of the interview (AOR, 8.26; 95% CI, 1.66 to 41.7), eating fewer than 2 meals per day (OR, 8.32; 95% CI, 1.31

Table 3. Factors Associated with Antiretroviral Nonadherence in Patients with an HIV Risk Factor Other Than IDU (N = 95) and in Patients with an HIV Risk Factor of IDU (N = 101) in Multivariate Adjusted Analyses

	HIV Risk Factor Other Than IDU,* Multivariate Odds Ratio (95% CI)	P Value	HIV Risk Factor of IDU, [†] Multivariate Odds Ratio (95% CI)	P Value
Any illicit drug use within 6 mo of interview			4.18 (1.68 to 10.75)	.003
Eating <2 meals/d			17.54 (1.92 to 160.4)	.011
Male-to-male sexual contact	0.35 (0.13 to 0.95)	.038		
Pressures outside of clinic affect ability to take medications as prescribed	3.55 (1.07 to 11.76)	.039		

* Nonsignificant factors for non-IDU analyzed in both univariate and multivariate analysis included gender, race/ethnicity, age, CD4 count at enrollment, and tobacco, alcohol, or illicit drug use within 6 months of interview and health beliefs.

[†] Nonsignificant factors for IDU analyzed in both univariate and multivariate analysis included gender, race/ethnicity, CD4 count at enrollment, and tobacco or alcohol use within 6 months of interview.

CI, confidence interval.

Table 4. Factors Associated with Antiretroviral Nonadherence in Men (N = 133) and Women (N = 63) in Multivariate Adjusted Analyses

	Men* Multivariate Odds Ratio (95% CI)	P Value	Women† Multivariate Odds Ratio (95% CI)	P Value
Any illicit drug use within 6 mo of interview	3.62 (1.60 to 8.15)	.002		
Heroin use within 6 mo of interview			8.26 (1.66 to 41.7)	.01
Eating <2 meals/d			8.32 (1.31 to 52.8)	.025
Pressures outside of clinic affect ability to take medications as prescribed			5.14 (1.21 to 24.3)	.027

* Nonsignificant factors for men analyzed in both univariate and multivariate analysis included age, race/ethnicity, HIV risk factor, tobacco use or alcohol use.

† Nonsignificant factors for women analyzed in both univariate and multivariate analysis included age, race/ethnicity, HIV risk factor, any illicit drug use, tobacco use or alcohol use.

CI, confidence interval.

to 52.8), and believing that pressures outside of the clinic affected ability to take antiretroviral medication as prescribed (AOR, 5.14; 95% CI, 1.21 to 24.3). Factors significantly associated with nonadherence in men (Table 4) were current illicit drug use (OR, 3.62; $P = .002$), cocaine use within 6 months of the interview (OR, 3.06; $P = .014$), heroin use within 6 months of the interview (OR, 4.37; $P = .002$), binge drug use within 6 months of the interview (OR, 4.77; $P = .007$), running out of money for life essentials in the 90 days prior to the interview (OR, 2.77; $P = .017$), and feeling as though pressures outside of the clinic affected their ability to take their antiretroviral medications as prescribed (OR, 2.91; $P = .022$). In multivariate analysis, however, only current drug use remained a statistically significant variable (AOR, 3.62; 95% CI, 1.60 to 8.15).

We found no association with homelessness, incarceration within 1 year, being in court within a year, having a telephone, the number of people sleeping in the home, or the number of children or elders for whom patient was primarily responsible, with overall adherence in any sample that was evaluated.

DISCUSSION

New antiretroviral treatments for HIV have produced dramatic improvements in clinical and immunologic measures in patients who are adherent. In our sample of 196 patients, there was a mean overall 2-week adherence of 80%, which is consistent with other studies.^{7,8,10} In many chronic illnesses, such as hypertension, taking 80% of doses has been used as the threshold for defining adherence. Early HIV adherence studies used this same threshold.^{10,15,16} With combination antiretroviral therapy, however, this level of nonadherence has been associated with poor treatment outcomes.¹⁷ The more stringent definition of 90% adherence used in this study is associated with a sustained suppression of HIV-1 RNA and delayed progression to AIDS,^{14,17} and has been used in other HIV studies assessing adherence.¹⁴

Our study demonstrates that IDU as the mode of HIV transmission is not associated with adherence, a result

consistent with data from other studies.^{8,17} We found, however, that the active use of any illicit drugs within 6 months of the interview was a strong and independent risk factor for nonadherence. In a Swiss cohort study, injection drug users tended to access the system later in the course of their disease and receive less preventive care than other groups; however, once injection drug users did accept antiviral treatment, they were as compliant as patients from other risk groups.¹⁸ This suggests that if patients discontinue substance abuse, they can be as adherent as other patients.

Notably, we found that there are potentially different factors associated with nonadherence in patients with IDU as the risk factor for HIV transmission and those with other HIV transmission risk factors. Social pressures outside of the clinic affecting ability to take medications as prescribed was a strong and independent predictor of nonadherence in both groups; but after multivariate adjustment, it remained statistically significant only in patients without a history of injection drug use. Eating fewer than 2 meals per day was also associated with a high risk of nonadherence in patients with a history of IDU, indicating perhaps a high level of chaos in their lives that does not allow them to plan for meals or medications. In addition, males who had sex with males were much more likely to adhere to their antiretroviral regimen than were patients with an HIV risk factor of high-risk heterosexual activity. One potential hypothesis is that this group of men has more social support to take antiretroviral medication as prescribed and that these patients feel less social stigma attached to taking the medications in public; however the association of social support and HIV progression in this group of men is controversial.¹⁹

Many social and behavioral factors have been associated with adherence, although few studies have evaluated specific aspects of the social situation at home when evaluating adherence. Unlike other studies that have found an association with self-perceived social support²⁰ or housing instability and nonadherence,²¹ we found no association with homelessness, incarceration within 1 year, being in court within a year, having a telephone, the

number of people sleeping in the home, or the number of children or elders for whom the patient was responsible with overall adherence. Eating fewer than 2 meals per day and running out of money for life essentials within the past 90 days were strong and independent predictors of nonadherence. A possible explanation could have been the association of meals with the taking of certain medications; however, we found no correlation between this variable and any particular antiretroviral medication in our population. Although running out of money for life essentials could perhaps be a surrogate for homelessness or drug binges, we could find no association in our data. We did not have data regarding current overall income for each patient to further evaluate this association.

Although our analysis was not designed to specifically address the controversial association of gender and adherence, we felt it was clinically important and performed descriptive analyses. Some studies have shown that men are less likely to adhere, especially when associated with mental illness²²; others have shown that women miss more clinic visits than men:⁹ and some have found no correlation between gender and adherence.¹⁷ It has been hypothesized that women face different pressures than men, such as child and elder care and lack of financial independence, which could affect their ability to adhere to antiretroviral medication. One study showed that when free on-site childcare was provided, adherence with scheduled visits increased immediately.²³ In our study, women had potentially different risk factors for nonadherence than men. In particular, social stability and social stress, as reflected by eating fewer than 2 meals per day and believing that social stress outside of the clinic affected the patient's ability to take medications, were strong predictors of nonadherence in women but not in men.

The association between race/ethnicity and adherence is complicated. Nonwhite ethnicity has been a risk factor for nonadherence to antiretroviral medication in some studies,²⁴ although satisfaction with social support and coping style partially accounted for the racial differences in adherence. Neither our study nor a study by Catz et al. was able to demonstrate an association between race/ethnicity and adherence.⁷

The relationship between number of medications and adherence is not clear-cut. Studies by Eldred et al. and Stone et al. showed a significant relationship between number of medications and antiretroviral adherence.^{10,25} However, we found, as did other studies,^{6,17,24,26} no statistically significant association between number of antiretroviral medications and overall adherence. Nevertheless, we did find a nonsignificant trend toward nonadherence with 3-times-daily dosing ($P = .09$).

Although directly observed therapy for antiretrovirals has been more difficult than for anti-tuberculosis drugs because of the dosing of antiretroviral medications, creative programs to increase adherence in marginalized populations have worked in the urban poor and homeless in San Francisco^{27,28} and Connecticut.^{29,30} Our results suggest

that soup kitchens or other places where patients could receive a regularly scheduled meal could be combined with dispensing medication to potentially increase overall adherence. Although running out of money for life essentials was found to be a strong predictor of nonadherence, this does not mean that patients were unable to afford medication. Many of these patients had access to antiretroviral therapy through Ryan White CARE Act funds and Medicaid. Instead, running out of money for life essentials and eating fewer than 2 meals a day are most likely representative of a life of poverty and social instability that need to be addressed in order to potentially increase overall antiretroviral adherence.

The factors we found to be associated with nonadherence are not necessarily predictive of which patients should receive antiretroviral therapy. Instead, they may be useful in identifying which patients may be at high risk for nonadherence and may need added instruction and intervention from the physician and others to increase adherence. A team approach between the provider, patient, and family to provide information, promote trust, and motivate the patient has been encouraged.³¹ Each patient may require a tailored intervention program, depending on his or her individual risk factors for nonadherence. Interventions that address social stresses, such as running out of money and food, and that treat substance abuse are those that would most likely increase adherence in our population. In addition, strategies to improve adherence include carefully reviewing the patient's understanding of the regimen at each visit, as well as assessing adherence at each visit.³²

In our study, we measured self-reported adherence to antiretroviral therapy, and not actual adherence. Although there are several different measures for adherence, including health care provider estimates, electronic monitoring systems such as the Medication Event Monitoring System (MEMS), pharmacy and administrative records, pill count, and self-reported adherence, a "gold-standard" for measuring adherence to antiretroviral therapy has not been established. Although patients' self-reported adherence has been shown to overestimate adherence,^{26,33-35} it has been used extensively in both trials and community settings.^{10,36-38} In addition, self-reported nonadherence has been shown to correlate with virologic outcomes.^{26,37} Finally, our sample size was limited, and variables that are not significant in subgroup analysis may still be associated with nonadherence. Further studies will need to be done to validate our results.

In summary, eating fewer than 2 meals per day, active illicit use of any drugs, and feeling as though pressures outside of the clinic affected the ability to take medications as directed were found to be strong, independent predictors of nonadherence in all patients. Patients with a history of IDU had different risk factors for nonadherence compared to those with a history of other HIV transmission risk factors. Further analyses by gender will need to be completed. Strategies to increase adherence to antiretroviral

medications in HIV-infected patients should include social support interventions targeted at different risk factors for different patient populations.

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