AIDS CARE (2002), VOL. 14, NO. 5, pp. 607–617

Taylor & Francis
healthsciences

Patient-perceived barriers to antiretroviral adherence: associations with race

T. F. FERGUSON,[1,2] K. E. STEWART,[2,3] E. FUNKHOUSER,[1]
J. TOLSON,[4] A. O. WESTFALL[5] & M. S. SAAG[3,6]

[1]*Department of Epidemiology, School of Public Health, University of Alabama at Birmingham (UAB),* [2]*Division of Preventive Medicine, Department of Medicine, UAB,* [3]*Center for AIDS Research, UAB,* [4]*Glaxo-Wellcome, Inc.,* [5]*Comprehensive Cancer Center, UAB &* [6]*Division of Infectious Diseases, Department of Medicine, UAB, USA*

Abstract *New antiretroviral (ARV) regimens require strict adherence if optimal suppression of HIV is to be maintained. This study is a theory-based examination of racial differences in patient-perceived barriers and reported ARV adherence. Participants (*$N = 149$*) completed the Patient Medication Adherence Questionnaire (PMAQ), measuring adherence and perceived barriers to adherence. Adherence was defined as a self-report of 100% adherence in the past four weeks. Odds ratios were calculated to determine the relation of reported barriers to adherence for race and gender groups, and for the sample overall. For every ten-point increase in barrier score, there was an 86% increased risk of being non-adherent (OR = 1.86; 95% CI: 1.19, 2.91). Adherence was not different between racial and gender groups, nor was total barrier score. However, individual barriers were differentially endorsed across groups. Rather than relying on demographic predictors, which may be only an indirect marker of adherence, evaluations of adherence should examine the psychological and social barriers to positive adherence outcomes in individual patients. Our findings support the use of theory-based behavioural interventions that address perceived barriers to adherence and other health promotion activities.*

Introduction

It is well established that HIV-positive persons with high levels of HIV RNA in plasma ('viral load') progress much faster to illness and death (Mellors *et al.*, 1996). Recent advances in drug development such as the advent of protease inhibitors and the ability to closely monitor viral load have provided a new arsenal of weapons against HIV. Potent new antiretroviral (ARV) drugs and the assessment of viral load allow health care providers to maintain tighter control of viral replication, resulting in longer, healthier lives for HIV-positive individuals (Havlir *et al.*, 1996; Ho *et al.*, 1995; Wei *et al.*, 1995). Continuous viral suppression is, as a result, now the primary goal in the medical management of HIV (Havlir *et al.*, 1996; Katzenstein *et al.*, 1997). Because viral replication dramatically increases within days after withdrawing or missing ARV doses (Haubrich *et al.*, 1995; Piatak *et al.*, 1993), strict

Address for correspondence: T. Freeman Ferguson, MPH, MSPH, 1717 11th Avenue South, Medical Towers Suite 401, Birmingham, AL 35205–4410, USA. Tel: + 1 (205) 934 7723; Fax: + 1 (205) 034 0777; E-mail: tferguson@dopm.uab.edu

ISSN 0954-0121 print/ISSN 1360-0451 online/02/050607-12 © Taylor & Francis Ltd
DOI: 10.1080/0954012021000005434

adherence to a prescribed ARV regimen is critical (Katzenstein, 1997; Ungvarski, 1997; Williams, 1997) and presents one of the most crucial behavioural challenges in the treatment of HIV (Kelly *et al.*, 1998).

In addition to its role in maintaining suppression of viral load, adherence may be related to the development of viral resistance, another critical aspect of HIV viral dynamics (Deeks *et al.*, 1997; Havlir *et al.*, 1996; Katzenstein *et al.*, 1997). The increased viral replication after missed ARV doses increases the probability of resistance-conferring mutations that could render these drugs useless (Vanhove *et al.*, 1996). Because the development of drug resistance eliminates that drug from the relatively small number of available treatment regimens, clinicians have been advised to vigorously promote strict adherence to recommended dosing parameters (Deeks *et al.*, 1997).

Achieving adequate adherence to ARV regimens is a remarkably difficult task. The regimens are often complicated, including several different medications with varying dosing schedules, dietary restrictions and adverse effects. Because investigations of other populations suggest that adherence can be difficult to achieve even on single-drug regimens (Luscher *et al.*, 1985; Turk *et al.*, 1991), adherence to multi-drug regimens is likely to be even more problematic. Early approaches to classifying HIV patients as adherent to ARV regimens if 80% of prescribed doses were taken correctly (Besch *et al.*, 1997; Cortese *et al.*, 1993; Samet *et al.*, 1992; Singh *et al.*, 1996; Vogel *et al.*, 1993) do not reflect the higher clinical and behavioural threshold that is necessary in HIV disease management to avoid viral failure and development of resistance. Recent evidence suggests that over 90% adherence may still be only marginally sufficient for long-term suppression of viral replication (Bangsberg *et al.*, 1998; Paterson *et al.*, 1999). Because of these high behavioural thresholds and serious consequences of non-adherence, some authors have called for early identification of potentially non-adherent patients (Paterson *et al.*, 1999; Stewart *et al.*, 1998).

Early investigations that evaluated adherence to ARV regimens were primarily descriptive in their approach and attempted to identify factors that were predictive of adherence. Although some investigations have described associations between adherence and demographic factors such as race and age (Muma *et al.*, 1995; Singh *et al.*, 1996), others have concluded that such associations are not robust (Holzemer *et al.*, 1999; Williams, 1995). Other investigators have focused on psychosocial variables, including access to treatment, perceptions of the efficacy of ARV treatment, depressive symptomatology and HIV-related social support, as more important predictors (Broers *et al.*, 1994; Catt *et al.*, 1995; Geletko *et al.*, 1995; Kissinger *et al.*, 1995; Morse *et al.*, 1991; Nannis *et al.*, 1993).

The fact that associations between demographic factors and adherence are observed inconsistently indicates that demographics may be only moderately correlated with other more directly influential psychosocial variables. However, understanding the relationships among demographics, especially race and gender, and such psychosocial variables is critical in HIV-related behaviour research. Because women and people of colour are increasingly disproportionately represented in the HIV epidemic (Bowler *et al.*, 1992; DiClemente, 1992), such an understanding will aid in the development of adherence enhancing interventions that are targeted to psychosocial variables of particular importance to these groups.

In addition, a clearer understanding of the relationships among demographics and psychosocial variables may help reduce stereotyping about persons at risk of poor ARV adherence. This stereotyping phenomenon is suggested by the finding that clinicians often err in their judgement of their patients' adherence levels (Morin *et al.*, 1996; van Ryn & Burke, 2000).

The psychosocial variables most often found to be associated with ARV adherence are consistent with a major theory of health behaviour: the Health Belief Model (HBM; Becker,

1974; Kirscht, 1974). The HBM states that individuals will engage in health-promoting behaviours if they (1) perceive themselves to be susceptible to the disease or condition, (2) believe the condition has serious consequences, (3) believe that the behaviours will result in avoiding the condition (or reducing its severity), and (4) believe that the barriers to (or costs of) the health-promoting behaviours are outweighed by the benefits. Variables such as access to ARV treatment, perceptions of the efficacy of treatment, and perceived personal or social barriers to treatment are all consistent with HBM's approach.

An examination of variables based in the HBM and their association with demographic variables may confirm that demographics are, indeed, a poor marker for overall non-adherence. However, the same investigation may also help clinicians identify psychosocial barriers to adherence that will be important to consider in the assessment of individual patients' adherence and help inform the development of interventions that are culturally appropriate, especially for people of colour and women.

Presented is a cross-sectional study of HIV-positive patients currently receiving ARV therapy. These patients at a large university-based HIV outpatient clinic are part of an ongoing prospective clinical cohort study of the effects of potent antiretroviral therapy on clinical, virologic, functional and financial outcomes (Williams, 1997). The study was designed to test three primary hypotheses: (1) racial groups do not differ significantly in their overall level of self-reported adherence to ARV regimens or total number of perceived psychosocial barriers to adherence, (2) racial and gender groups would demonstrate differences in the types of perceived psychosocial barriers to ARV adherence that were endorsed, and (3) that perceived barriers would be significantly associated with reported adherence.

Methods

Participants for the prospective study were recruited from HIV- positive individuals receiving care at the university-based HIV outpatient clinic. Entry criteria included initiating or changing to a new ARV regimen, HIV RNA viral load greater than 5000 copies/ml and a reading level of at least sixth grade. A total of 158 participants were enrolled in the overall prospective study. At the time of analysis, a total of 149 participants met the inclusion criteria of actively receiving ARV and completing an adherence questionnaire at the time point of interest (three months post-baseline). The nine participants excluded from the current analysis were not significantly different in regard to race or age from the 149 participants included. All participants completed an informed consent form approved by the Institutional Review Board of the University of Alabama at Birmingham.

Procedure and measures

Participants enrolled in the study provided demographic data at enrollment. They returned at three-month intervals after enrollment to complete an adherence interview with a clinical pharmacist, provide blood samples for measurement of viral load, and complete questionnaires measuring health status, patient satisfaction, self-reported ARV adherence and perceived barriers to adherence. Questionnaires were administered using a touch-screen computer program located in a private room, allowing the participant to complete the questionnaires with a high degree of privacy. Participants were given the option to complete the questionnaires using an identical paper version of the instruments. At the time point of interest, approximately 5% of the participants provided data via paper questionnaires rather than using the computer. Scores on the measures of interest in this investigation did not differ between the two modalities.

The specific aim of this investigation was to evaluate the prediction of self-reported barriers and difference in odds of self-reported adherence according to the Patient Medication Adherence Questionnaire (PMAQ; Jhingran, 1997). The PMAQ is composed of two parts. The first part assesses self-reported ARV adherence by asking participants to indicate on a five-point Likert scale how often they have missed doses of each class of ARV medications (e.g. nucleoside and non-nucleoside reverse transcriptase inhibitors, protease inhibitors) over the past four weeks. A 'missed dose' is characterized as omitting an entire scheduled dose. Higher scores indicate poorer adherence. The second part is a questionnaire listing 25 potential barriers to ARV adherence, encompassing five psychosocial domains: knowledge and attitudes about medicines, social support, qualities of the medicines themselves, scheduling issues and memory issues. Each item is scored on a five-point Likert scale. A total barrier score is computed by adding all items (after reversing the scoring of several items for consistency). Higher scores indicate more perceived barriers. A barrier intensity score is computed by dividing the total score by 25. Higher scores indicate a greater tendency to strongly endorse barriers. The 25 potential barriers were created to cover each of the five domains; however, each barrier is not exclusive to one barrier domain.

Statistical analyses

Adherence was defined as a score of zero on the adherence questions, indicating a self-report of perfect adherence. This high threshold was selected to reflect the higher requisite threshold of adherence for ARV medications and because prior analyses with this population suggest that self-reported adherence scores above zero are associated with less viral suppression.

Distributions of the population's characteristics were estimated overall and by race and gender. Chi-square tests were performed to assess the statistical significance of differences by race and gender in perceived barriers. *T*-tests were performed to evaluate the presence of an overall difference by race and gender in mean total barrier scores and barrier intensity scores both, which were normally distributed. Logistic regression was used to examine the association of reported adherence and patient perceived barriers, both individually and by domains. The dependent variable was adherence, and the independent variable was barrier domain score or total barrier score. We estimated odds ratios (ORs) as the measure of association of barrier domains and perceived barriers with non-adherence. Logistic regression was used to obtain ORs and 95% confidence intervals (CIs). The potential for confounding of the associations of non-adherence by race and sex was assessed by adding race and sex into the models and comparing adjusted estimates with crude estimates. All statistical analyses were conducted using the SAS statistical analysis package (SAS System, Cary, NC: SAS Institute Incorporated). For all tests of statistical significance, the alpha level was 0.05.

Results

Study population

Demographic characteristics of the sample population are presented in Table 1. Participants had a mean age of 39 $\pm$ 8.6 years and were primarily Caucasian males. Participants reported a variety of HIV risk factors, including sexual and drug-using behaviours.

Table 1. *Demographics and characteristics of population*

	All $n=149$ %	Caucasian $n=98$ %	African American $n=51$ %	Male $n=130$ %	Female $n=19$ %
Gender					
Male	87.2	92.9	76.5	—	—
Female	12.8	7.1	23.5	—	—
		$p=0.004$			
Adherence	34.8	31.3	43.8	34.3	38.5
		$p=0.213$		$p=0.772$	
Sexual orientation					
Heterosexual	24.1	13.0	44.9	12.3	100
Bisexual	39.7	47.8	24.5	45.9	—
Homosexual	36.2	39.1	30.6	41.8	—
		$p=0.003$		$p<0.001$	
Injection drug users	8.3	11.6	2.0	8.7	5.26
		$p=0.047$		$p=0.612$	
Total barrier score					
Mean ± SD	48.7 ± 11.0	48.3 ± 10.8	49.5 ± 11.5	47.9 ± 10.8	53.9 ± 11.6
		$p=0.700$		$p=0.600$	
Score per question					
Mean ± SD	1.95 ± 0.44	1.93 ± 0.43	1.98 ± 0.46	1.92 ± 0.43	2.16 ± 0.46
		$p=0.609$		$p=0.056$	

Adherence and barrier score differences by race and gender

The mean total adherence scores, total barrier scores and barrier intensity score are reported in Table 1, stratified by race and gender. No significant differences were found on any of the three variables between men and women or between Caucasians and African Americans (all p values >0.05). Power calculations reveled that there was not adequate power to detect differences by gender. Power to detect difference by race was greater than 80%. Therefore, these findings suggest that overall adherence and overall barriers were not different among Caucasians and African Americans.

Specific barrier item differences

The following were the five most frequently reported perceived barriers, in order of most frequently reported: (a) individuals were taking more medicines than they wanted; (b) taking medicines was a reminder of HIV status; (c) participants were uncomfortable for other people to know that medicines were for HIV/AIDS; (d) participants did not want to be seen taking medications; and (e) medicines were hard to swallow.

The individual barriers were categorized according to the barrier domains: Knowledge and Attitudes about Medications (KAMED), Social Support, Qualities of Medicine, Schedule, and Memory. There was a difference in mean score by race for six barriers, and a difference in mean score by gender for two barriers (Table 2). These differences were not

Table 2. *The mean with standard deviation (SD) for perceived barriers with non-adherence*

Barriers*	All Mean ± SD	Caucasian Mean ± SD	African American Mean ± SD
Knowledge and attitudes about medicines			
Take more medicines than desired	4.08 ± 1.30	4.28 ± 1.13	3.65 ± 1.55†
Taking medicines is a reminder of HIV status	3.82 ± 1.40	3.88 ± 1.36	3.68 ± 1.51
Too busy to take medications	1.98 ± 1.11	2.06 ± 1.15	1.78 ± 1.00
Not understanding how to take medicines	1.10 ± 0.30	1.08 ± 0.28	1.14 ± 0.48‡
Social support			
Not wanting people to see them taking medications	3.08 ± 1.46	3.07 ± 1.41	3.11 ± 1.58
Uncomfortable for people to know medicines are for HIV/AIDS	3.20 ± 1.62	3.05 ± 1.57	3.56 ± 1.70
Embarrassed to have medicines filled at a drug store	2.28 ± 1.48	2.07 ± 1.38	2.77 ± 1.61†
No support from family and friends	1.19 ± 0.51	1.20 ± 0.51	1.14 ± 0.48
It's easy to talk to doctor about medicines	1.21 ± 0.48	1.20 ± 0.51	1.22 ± 0.42
Qualities of medicine			
Medicines are hard to swallow	2.56 ± 1.34	2.58 ± 1.33	2.51 ± 1.37
When medicines cause side effects, they are sometimes not taken	1.40 ± 0.88	1.35 ± 0.79	1.51 ± 1.04
Ceasing medications when feeling better	1.09 ± 0.43	1.04 ± 0.19	1.22 ± 0.71†
Deny medicines are helping	1.61 ± 0.84	1.64 ± 0.84	1.54 ± 0.87
Sometimes do not take medicines because of bad taste	1.20 ± 0.53	1.17 ± 0.49	1.27 ± 0.61
Schedule			
Medicines are inconvenient to take	2.26 ± 1.25	2.44 ± 1.26	1.87 ± 1.13†
Not easy to take medicines when scheduled	2.04 ± 1.19	2.11 ± 1.22	1.89 ± 1.13
Always carry medicines when away from home	1.69 ± 1.02	1.53 ± 0.84	2.03 ± 1.28†
Medicines are taken on time	1.66 ± 0.63	1.64 ± 0.57	1.70 ± 0.74
Sometimes too tired to take medicines	1.45 ± 0.73	1.43 ± 0.72	1.51 ± 0.77
No place to store medicines	1.36 ± 0.66	1.27 ± 0.52	1.57 ± 0.87†
Memory			
Forget to bring medicines	2.10 ± 1.32	2.02 ± 1.27	2.27 ± 1.47
The more medicines to take, the more likely to forget	1.66 ± 0.95	1.66 ± 0.95	1.68 ± 0.97
Sometimes forget to take medicines	1.61 ± 0.68	1.66 ± 0.69	1.49 ± 0.65
Sometimes forget to refill medicines	1.31 ± 0.75	1.26 ± 0.70	1.41 ± 0.87‡
Sometimes refills are not gotten because of cost	1.73 ± 1.19	1.66 ± 1.10	1.89 ± 1.39

* Possible scores per question ranged from one for definitely true to five for definitely false; † there was a statistically significant ($p \leq 0.050$) difference between means by race; ‡ there was a statistically significant ($p \leq 0.050$) difference between means by gender, data not shown. Mean higher in women.

limited to a single barrier domain. Caucasian participants were more likely than African Americans to report that ARV medications were not convenient to take (Schedule) and that they were taking more ARV medication than they desired (KAMED). African American participants were more likely than Caucasians to report that they had no place to store ARV medications (Schedule). African Americans also reported that they did not take ARV medications when they felt well (Qualities of Medicine) and that they were embarrassed to get their ARV medications refilled (Social Support) more frequently than Caucasians. Women were more likely than men to report not understanding how to take their medications (KAMED) and forgetting to refill medications (Memory) (all $p < 0.05$).

Table 3. *Odds ratio (OR) of patient medication adherence questionnaire (PMAQ) barrier domains, by one mean incremental increase, with non-adherence*

	All		Caucasian		African American	
	OR	95% CI	OR	95% CI	OR	95% CI
KAMED	2.18†	(1.08, 4.42)	1.74	(0.75, 4.07)	3.36	(0.87, 13.02)
Social support	1.55	(0.93, 2.59)	1.58	(0.83, 2.98)	1.82	(0.73, 4.59)
Qualities of medicine	2.66†	(1.04, 6.83)	5.64†	(1.37, 23.27)	1.19	(0.28, 4.97)
Schedule	2.42†	(1.10, 5.34)	2.56	(0.93, 7.06)	2.48	(0.66, 9.36)
Memory	3.41†	(1.53, 7.59)	3.82†	(1.35, 10.80)	3.30	(0.82, 13.31)

† Statistically significant ($p \leq 0.050$).

Association of barrier score and adherence

Each barrier domain was positively associated with non-adherence (Table 3). Of the five domains, Memory had the strongest association with non-adherence. Individuals were 3.4 times as likely to be non-adherent with every point increase of their Memory barrier domain score (OR = 3.41; 95% CI: 1.53, 7.59). The mean score for the barrier domains ranged from 1–4.25; therefore, a one-point increase represents approximately 30% of the total range. The second most predictive barrier domain was Qualities of Medicine (OR = 2.66; 95% CI: 1.04, 6.83). The barrier domain that was the least predictive of non-adherence was Social (OR = 1.55; 95% CI: 0.93, 2.59).

Overall, KAMED, Qualities of Medicine, Schedule and Memory reached statistical significance. The associations of the barrier domains with non-adherence differed by race. For the Medicine barrier domain, the association with non-adherence was much stronger in Caucasians (OR = 5.64; 95% CI: 1.37, 23.27) than African Americans (OR = 1.19; 95% CI: 0.28, 4.97). Because of the small number of women and lack of variance of answers among women, a number of ORs were undefined; therefore, associations are not reported. Among African Americans, the most predictive barrier domain was KAMED (OR = 3.36; 95% CI: 0.87, 13.02), which indicated a trend toward significance, although none of the barrier domain associations reached statistical significance among African Americans. Both Qualities of Medicine and Memory were of statistical significance among Caucasians.

When combining the barriers from the domains and looking at the barriers overall, the total barrier score was positively associated with non-adherence. As shown in Table 4, a ten-point increase in barrier score overall resulted in an 86% increased risk of being non-adherent (OR = 1.86; 95% CI: 1.19, 2.91). The total barrier score masked differences in race that became evident when barrier domains were examined. The association of total barrier score with non-adherence was similar for African Americans and Caucasians but was stronger among females than males. Adjustment by race and sex had small effects.

Analyses were also conducted using a less stringent adherence criterion, 90–85% instead of 100%, allowing more of the participants to be considered adherent. These data are not shown. These results revealed an overall twofold increase in the odds of total barrier score and non-adherence.

Discussion

The goal of this study was to evaluate the associations of self-reported barriers with self-reported adherence. Overall, the study hypotheses were confirmed. Race was not associ-

Table 4. *The association of a total barrier score (incremental increases of ten) and non-adherence*

	Non-adherence		
	n	OR	95% CI
All	112	1.86†	(1.19, 2.91)
Race adjusted		1.92†	(1.22, 3.03)
Sex adjusted		1.90†	(1.20, 2.99)
Race and sex adjusted		1.94†	(1.22, 3.08)
Race			
Caucasians	72	2.02†	(1.14, 3.66)
African Americans	40	1.77	(0.86, 3.64)
Gender			
Males	99	1.71†	(1.07, 2.73)
Females	15	4.98	(0.81, 30.53)

† Statistically significant ($p \leq 0.050$).

ated with either adherence or total perceived barriers to adherence. However, race and gender groups did differ in reporting perceived barriers.

In particular, Caucasian participants were more likely to report that they were taking more medications than desired and that medication was inconvenient. African American participants were more likely to report problems with storing medications, not taking medications when they felt well, and being more embarrassed about refilling and taking medications. Women were more likely to report forgetting to refill medications and not understanding how to take medications properly. Finally, we confirmed that level of adherence was associated with perceived barriers. Overall, the study population demonstrated an 86% increased risk of non-adherence with a ten-point increase in barrier score. Each of the psychosocial domains of the PMAQ questionnaire predicted non-adherence. Memory and Qualities of Medicine were the domains most strongly associated with non-adherence, particularly for Caucasian participants.

The results of this study are consistent with findings that demographic characteristics are generally poor predictors of antiretroviral adherence; however, it does emphasize that demographic groups may face somewhat different challenges and barriers to adherence. Thus, the results of the study may be used to inform the development of interventions to improve adherence. For example, interventions that focus on women with HIV may benefit from special attention to the multiple life demands that may interfere with remembering to refill medications or recall specific instructions from the physician, and then may provide techniques or skills for improving memory for refills and medication instructions.

The current study benefits from the use of a reliable valid assessment that is grounded in the Health Belief Model, the PMAQ. The PMAQ questions along with its correlation between self-reported, ART adherence and virologic outcome have been validated in previous studies (Demasi *et al.*, 1999). The PMAQ covers perceived barriers pertaining to a patient's social support network, knowledge, attitudes and perceived qualities of the antiretroviral medicines, a patient's schedule, and memory. We are aware that the PMAQ does not exhaust all possible patient perceived barriers to adherence. However, the specific aim of this study was to evaluate the predictability of the PMAQ captured barriers, not to maximize the predictability of non-adherence.

The associations of the barriers with non-adherence seen in this study can be considered conservative. The adherence criterion was 100%. Non-adherence was based on missing an entire dose of antiretroviral medication 'during the past four weeks'. Because self-reported adherence tends to err towards overestimation of adherence, we would expect that replication of this study with measures of adherence that are more direct, such as pill counts or medication event monitoring, would confirm that the association of barriers and adherence is stronger than the current study results suggest. Because self-reported adherence is the most commonly used measure of adherence in clinical practice, it is a highly generalizable measure.

It is also important to replicate this study in other geographic areas and with other demographic sub-groups, as this investigation was limited to African American and Caucasian participants in the southern USA. This analysis was also limited by a relatively small proportion of female participants. Future investigations should evaluate barriers among women more comprehensively. We would anticipate that some of the observed differences are unique to the demographic composition of this study population. However, we would also anticipate that the assessment of specific perceived barriers would continue to be a useful way to understand the reasons underlying non-adherence, regardless of the findings in a particular geographic region or among a particular sub-group.

Adherence will continue to be a significant behavioural challenge in HIV medical care. A comprehensive assessment of the multiple factors that affect adherence which includes psychological, social and cognitive barriers such as those assessed by the PMAQ will continue to be important if appropriate interventions are to be developed and if adherence in specific sub-groups affected by the epidemic is to be maximized. The results of this study encourage a theory-based approach to both assessment and intervention with adherence issues.

Acknowledgements

This study was supported by grant number RESA 2014–02 from Glaxo-Wellcome, Inc. and a fellowship from the Congressional Black Caucus Foundation. Portions of this manuscript were presented at the 1999 HIV Prevention Conference. The authors wish to acknowledge the contributions of the participants, who gave generously of their time and energy for this project.

References

Bangsberg, D.R., Zolopa, A.R., Charlebois, E., Tulsky, J., Hecht, F.M., Robertson, M. *et al.* (1998) HIV-infected homeless and marginally housed (H/M) patients adhere to and receive early virologic benefit from protease inhibitors. Fifth Conference on Retroviruses and Opportunistic Infections (abstract no. 152).

Becker, M.H., (1974) The Health Belief Model and personal health behavior. *Health Education Monograph*, *2*, 324–473.

Besch, C.L., Morse, E., Simon, P., Hodges, J. & Franchino, B. (1997). Preliminary results of a compliance study within CPCRA 007 combination nucleoside study (NuCombo). *4th Conference on Retroviral and Opportunist Infection*, *111*, 254.

Bowler, S., Sheon, A.R., D'Angelo, L.J. & Vermund, S.H. (1992). HIV and AIDS among adolescents in the United States: increasing risk in the 1990s. *Journal of Adolescence*, *15*, 345–371.

Broers, B., Morabia, A. & Hirschel, B. (1994). A cohort study of drug users' compliance with zidovudine treatment [see comments]. *Archives of Internal Medicine*, *154*, 1121–1127.

Catt, S., Stygall, J. & Catalan, J. (1995). Acceptance of zidovudine (AZT) in early HIV disease: the role of health beliefs. *AIDS Care*, *7*, 229–335.

Cortese, L., Chung, R., Stoute, J., Oster, C., Mansfield, J. & Ledsky, R. (1993). Zidovudine usage: patient compliance and factors. *International Conference on AIDS* (abstract PO-B32–2233), *9*, 507.

Deeks, S.G., Smith, M., Holodny, M. & Kahn, J.O. (1997). HIV-1 protease inhibitors: a review for clinicians. *Journal of the American Medical Association*, *277*, 145–153.

DEMASI, R., TOLSON, J., PHAM, S., CAPUANO, G., GRAHAM, N., FISHER, R., SHAEFER, M. & ERON, J. (1999). Self-reported adherence to HAART and correlation with HIV RNA: initial results with the patient medication adherence questionnaire. *6th Conference Retroviruses Opportunistic Infections*, *85* (abstract 94).

DICLEMENTE, R.J. (1992). Epidemiology of AIDS, HIV prevalence, and HIV incidence among adolescents. *Journal of School Health*, *62*(7), 325–330.

GELETKO, S.M., BALLARD, C.R. & MATTHEWS, W.X. (1995). Health beliefs and discontinuation of zidovudine therapy. *American Journal of Health System Pharmacy*, *52*, 505–507.

HAUBRICH, R.H., HIRSCH, M., FLEXNER, C., LEDERMAN, M., GINSBERG, R. & RICHMAN, D.D. (1995). Effect of antiretoviral discontinuation (AD) and reintroduction on markers of HIV infection. *2nd Annual National Conference on Human Retroviruses and Related Infections*, 124 (abstract 381).

HAVLIR, D. & RICHMAN, D.D. (1996). Viral dynamics of HIV: implications for drug development and therapeutic strategies. *Annals of Internal Medicine*, *124*, 984–994.

HO, D.D., NEUMANN, A.U., PERELSON, A.S., CHEN, W. & LEONARD, J.M. (1995). Rapid turnover of plasma virions and CD4 lymphocytes in HIV-1 infection. *Nature*, *373*, 123–126.

HOLZEMER, W.L., CORLESS, I.B., NOKES, K.M., TURNER, J.G., BROWN, M.A., POWELL-COPE, G.M., INOUYE, J., HENRY, S.B., NICHOLAS, P.K. & PORTILLO, C.J. (1999). Predictors of self-reported adherence in persons living with HIV disease. *AIDS Patient Care & STDs*, *13*, 185–197.

JHINGRAN, P., TOLSON, J., SCOTT-LENNOX, J, JORDAN, J. & PHAM, S. (1997). Development and content validation of an HIV-specific Patient Medication Adherence Questionnaire (PMAQ). 37th Interscience Conference on Antimicrobial Agents and Chemotherapy.

KATZENSTEIN, D.A. (1997). Adherence as a particular issue with protease inhibitors. *Journal of the Association of Nurses in AIDS Care*, *8*, 10–17.

KATZENSTEIN, D.A., LYONS, C., MOLAGHAN, J.P., UNGVARSKI, P., WOLFE, G.S. & WILLIAMS, A. (1997). HIV therapeutics: confronting adherence. *Journal of the Association of Nurses in AIDS Care*, *8*, 46–58.

KELLY, J.A., OTTO-SALAJ, L.L., SIKKEMA, K.J., PINKERTON, S.D. & BLOOM, F.R. (1998). Implications of HIV treatment advances for behavioral research on AIDS: protease inhibitors and new challenges in HIV secondary prevention. *Health Psychology*, *17*, 310–319.

KISSINGER, P., COHEN, D., BRANDON, W., RICE, J., MORSE, A. & CLARK, R. (1995). Compliance with public sector HIV medical care. *Journal of the National Medical Association*, *87*, 19–24.

LUSCHER, T.F., VETTER, H., SIEGENGHALER, W. & VETTER, W. (1985). Compliance in hypertension: facts and concepts. *Journal of Hypertension*, (Suppl.), *3*, 3–10.

MELLORS, J.W., RINNALDO, C.R., GUPTA, P., WHITE, R.M., TODD, J.A. & KINGSELY, L.A. (1996). Prognosis in HIV-1 infection predicted by the quantity of virus in plasma. *Science*, *272*, 1167–1170.

MORIN, M., MUNZENBERGER, N., SOUVILLE, M., MOATTI, J.P. & GASTAUT, J.A. (1996). Biases in recruitment and non-compliance in AIDS clinical trials. *International Conference on AIDS* (abstract no Th.B. 4145), *11*, 276.

MORSE, E.V., SIMON, P.M., COBURN, M., HYSLOP, N., GREENSPAN, D. & BALSON, P.M. (1991). Determinants of subject compliance within an experimental anti-HIV drug protocol. *Social Science & Medicine*, *32*, 1161–1167.

MUMA, R.D., ROSS, M.W., PARCEL, G.S. & POLLARD, R.B. (1995). Zidovudine adherence among individuals with HIV infection. *AIDS Care*, *7*, 439–447.

NANNIS, E.D., TEMESHOK, L.R., SMITH, M. & JENKINS, R. (1993). Perceptions of AZT: implications for adherence to medical regimiens. *Journal of Applied Biobehavioral Research*, *1*, 39–54.

PATERSON, D., SWINDELLS, S., MOHR, J., BRESTER, M., VERGIS, E., SQUIER, C., *ET AL.* (1999). How much adherence is enough? A prospective study of adherence to protease inhibitor therapy using MEMSCaps. Program and abstracts of the Sixth Conference on Retroviruses and Opportunistic Infections (abstract 92).

PIATAK, M., SAAG, M.S., YANG, L.C., CLARK, S.J., KAPPES, J.C., LUK, K.C., HAHN, B.H., SHAW, G.M. & LIFSON, J.D. (1993). High levels of HIV-1 plasma during all stages of infection determined by competitive PCR. *Science*, *259*, 1749–1754.

SAMET, J.H., LIBMAN, H., STEGER, K.A., DHAWAN, R.K., CHEN, J., SHEVITZ, A.H., DEWEES-DUNK, R., LEVENSON, S., KUFE, D. & CRAVEN, D.E. (1992). Compliance with zidovudine therapy in patients infected with human immunodeficiency virus, type 1: a cross-sectional study in a municipal hospital clinic. *American Journal of Medicine*, *92*, 495–502.

SINGH, N., SQUIER, C., SIVEK, C., WAGENER, M., NGUYEN, M.H. & YU, V.L. (1996). Determinants of compliance with antiretroviral therapy in patients with human immunodeficiency virus: prospective assessment with implications for enhancing compliance. *AIDS Care*, *8*, 261–269.

STEWART, K.E., GREENE, P., CALL, S., WESTFALL, A., CHATWOOD, A., SAAG, M.S. *ET AL.* (1998). Patterns of self-reported adherence to ART in a prospective clinical cohort. Program and abstracts of the 38th ICAAC September 24–27, San Diego (abstract I-176).

VAN RYN, M. & BURKE, J. (2000). The effect of patient race and socio-economic status on physicians' perceptions of patients. *Social Science & Medicine*, *50*, 813–828.

TURK, D.C. & MEICHENBAUM, D. (1991). Adherence to self-care regimens: the patient's perspective. In: J. J SWEET, R. H. ROZENSKY & S. M. TOVIAN (Eds), *Handbook of clinical psychology in medical settings* (pp. 249–265). New York: Plenum Press.

UNGVARSKI, P. (1997). Adherence to prescribed HIV-1 protease inhibitors in the home setting. *Journal of the Association of Nurses in AIDS Care*, *8*, 37–45.

VANHOVE, G.F., SCHAPIRO, J.M., WINTERS, M.A., MERIGAN, T.C. & BLASCHKE, T.F. (1996). Patient compliance and drug failure in protease inhibitor monotherapy (letter). *Journal of the American Medical Association*, *276*, 1955–1956.

VOGEL, S., GRADY, C. & ROPKA, M. (1993). Factors affecting investigational medication compliance in healthy HIV-infected participants of a randomized controlled trial (RCT) comparing AZT & interferon-alpha (IFN-alpha). *International Conference on AIDS* (abstract no. PO-B44–2544), *9*, 559.

WEI, X., GHOSH, S.K., TAYLOR, M.E., JOHNSON, V.A., EMINI, E.A., DEUTSCH, P., LIFSON, J.D., BONHOEFFER, S., NOWAK, M.A., HAHN, B.H., SAAG, M.S. & SHAW, G.M. (1995). Viral dynamics in human immunodeficiency virus type 1 infection. *Nature*, *373*, 117–122.

WILLIAMS, A. (1997) Antiretroviral therapy: factors associated with adherence. *Journal Association Nurses AIDS Care*, *8*(Suppl.), 18–23.

WILLIAMS, A. & FRIEDLAND, G. (1997). Adherence, compliance, and HAART. *AIDS Clinical Care*, *9*, 51–54, 58.