PREDICTORS OF MEDICATION ADHERENCE FOR AFRICAN AMERICAN PATIENTS DIAGNOSED WITH HYPERTENSION

Julia Braverman, PhD; Julien Dedier, MD, MPH

Background: The prevalence, morbidity and mortality of hypertension are strikingly higher for African Americans than for Whites. Poor adherence to the antihypertensive medication regimen is a major cause of inadequate blood pressure control. In this study, we assess the relationship of antihypertensive medication adherence to sociodemographic, clinical and cognitive characteristics of urban African American adults.

Method: Data were drawn from a larger randomized controlled trial assessing the effect of a behavioral intervention to improve medication adherence and blood pressure control among hypertensive African American patients followed in an urban primary care network. Medication adherence was assessed at baseline using the Medication Event Monitoring System (MEMS) – a method regarded as the gold standard for assessing medication adherence in clinical research. Information on potential correlates of medication adherence (sociodemographic, clinical and cognitive) was obtained at baseline by computer-assisted interview. We assessed the cross sectional association of these factors to medication adherence in baseline data.

Results: Medication adherence was significantly associated with systolic blood pressure ($r=.253$, $P<.04$) and self-reported medication adherence ($r=.285$, $P<.03$). The relationship of education to medication adherence varied significantly by sex ($P<.05$ for interaction). Specifically, lower educational attainment was related to higher adherence among men, but lower adherence among women.

Conclusion: Identifying correlates of low antihypertensive medication adherence and their interactions, as in this study, will help health providers to better recognize patients at higher risk for worse hypertension-related outcomes. This knowledge can also inform interventions which target a higher-risk subset of hypertensive patients. (*Ethn Dis.* 2009;19:396–400)

Key Words: Hypertension, Medication Adherence, African Americans, Urban Population

From Division of Clinical Informatics, Beth Israel Deaconess Medical Center (JB), Medical Information Systems Unit, Boston Medical Center (JD).

Address correspondence and reprints request to Julia Braverman; Beth Israel Deaconess Medical Center; Division of Clinical Informatics; 1330 Beacon St., Suite 400; Boston, MA 02215; 617-278-8166; 617-278-8188 (fax); 617-278-8166; braverju@gmail.com

INTRODUCTION

In the United States, hypertension is 30%–50% more prevalent in African Americans than Whites[1] and accounts for half of the excess cardiovascular mortality observed in African Americans vs Whites.[2] Of those diagnosed with hypertension, African Americans have lower rates of blood pressure (BP) control than Whites, and this disparity has increased over time.[3] Poor adherence to prescribed antihypertensive medications contributes significantly to lower rates of BP control and, among modifiable risk factors, increasing such adherence is considered to have the greatest potential to improve BP control.[4] Further, studies suggest that as a group African Americans may have lower adherence to the antihypertensive medication regimen than Whites[5–6] and may benefit substantially from interventions to promote adherence to the BP medication regimen.

Unfortunately, physicians are generally not good at identifying poor medication adherence among their African American patients. In a study of young, urban, hypertensive, African Americans, primary care providers were unable to identify poor medication adherence 60% of the time.[7] Knowledge of the correlates of poor medication adherence would help physicians and health educators to identify patients at risk for poorer BP-related health outcomes. This knowledge is also a first step toward developing interventions to improve antihypertensive medication adherence among African Americans.

In this study, we assess the relationship of antihypertensive medication adherence to sociodemographic, clinical and cognitive characteristics of urban African American adults.

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METHOD

Participants

This study was part of a larger randomized control trial of a telephone-based behavioral intervention to improve medication adherence, physical activity and dietary behaviors among hypertensive, urban, African American adults of low socioeconomic status. We present results of a cross sectional analysis using baseline data.

Participants were drawn from the primary care practices of a large urban teaching hospital, and four of its affiliated neighborhood health centers. Eligibility criteria were as follows: 1) a physician diagnosis of hypertension; 2) being at least 35 years old; 3) being non-adherent to dietary recommendations for hypertension; 4) having an active prescription for at least one antihypertensive medication; 5) having two elevated clinic blood pressure

readings ($\geq$140/90 or $\geq$135/85 if diabetic) within the proceeding 6 months; 6) non-adherence to physical activity recommendations; 7) non-adherence to dietary recommendations for hypertension; 8) the ability to understand spoken English; 9) regular access to a telephone; and 10) self-reported African American race/ethnicity.

Procedure

The electronic health record (EHR) was used to identify individuals who satisfied the first four eligibility criteria. Apparent race/ethnicity, also captured in the EHR, was used as an initial proxy for African American race/ethnicity. Next, each participating primary care provider was shown a list of potentially eligible patients and asked to remove anyone who did not meet eligibility criteria. Study personnel then contacted the remaining patients by telephone to establish eligibility. Five weeks later, a research assistant went to the subject's home to confirm eligibility, obtain written informed consent, and to place Medication Event Monitoring System (MEMS) caps on up to 3 antihypertensive medication pill bottles. MEMS caps contain a microprocessor that records the time and date that a patient opens the pill bottle to obtain a dose of medication. Such electronic monitoring devices are considered the gold standard for assessing rates of medication adherence in clinical research.[8] During the next home visit 6 weeks to one year later, a research assistant downloaded MEMS caps adherence data and collected baseline data on all other variables used in this analysis. The Boston Medical Center institutional review board approved the study.

Measures

Medication adherence

Medication adherence was viewed as the dependent variable in these analyses, and was measured using MEMS caps applied to up to 3 BP medication bottles as described above. Because the duration between placing the caps and uploading data varied, by patient, from 6 weeks to 1 year, we used data from a middle 30-day period in the analyses. Powerview communication software (Aardex Corporation, Union City, CA) was used to read and download adherence data from each MEMS cap. For each medication, we calculated the percentage of prescribed doses taken each day during the 30-day period. We then averaged this number over all 30 days to determine the average percentage of prescribed doses taken per day. For participants who had more than one monitored medication, we averaged this value across all medications. As a second measure of medication adherence, we calculated the average percentage of days the monitored medication was taken as prescribed. Therefore, we had two summary measures of medication adherence for each subject.

Candidate correlating variables

A list of potential correlates of poor medication adherence was derived from the literature[9] and supplemented by clinical opinion. As noted above, information on each of these factors was obtained by trained research assistants at the second home visit via computer-assisted personal interviews.

The participants' subjective financial status was assessed by asking them to classify their current financial situation as: 1) comfortable, with enough money for extras; 2) enough to pay the necessary bills without cutting back, but not extras; 3) enough to pay the bills, but have had to cut back; or 4) cannot pay some bills no matter how hard I try.

Household income was assessed by asking participants to approximate their household income in the previous year as: <$10,000; $10,000 to $20,000; $20,001 to $30,000; $30,001 to $40,000; $40,001 to $50,000; or >$50,000.

Employment type was assessed by asking the participants to indicate if they were employed and, if so, whether full- or part-time. If unemployed, participants could indicate if they were disabled, retired, a student or a homemaker.

Insurance type was assessed using the question, "How do you cover your health care costs?" Possible responses were: Medicare/Medicaid, self-insured, employer-paid, veteran's benefits, free care, or other.

Self-efficacy for taking medication was assessed using a 51-item measure consisting of all 43 candidate items tested by Ogedegbe et al,[10] and 8 additional experimental items. On a scale from 1 to 5, participants rated how confident they were that they could take their blood pressure medication as prescribed under certain adverse conditions, such as: when you are busy at home, when you are tired, or in the presence of people other than relatives or friends. Individual item scores were summed to create an overall score for each subject ranging from 51 (low self-efficacy) to 255 (maximal self-efficacy).

We assessed self-reported medication adherence using the 7-item version of the Morisky survey, a validated measure of adherence to medication regimens.[11] Each response tail contained 2 to 5 possible options and was scored from 1 to 5. Individual item scores were summed to create an overall score for each subject ranging from 7 (poor adherence) to 17 (maximum adherence). This total score was used in the analyses.

Physician support was assessed using the single item, "How much encouragement for taking your hypertension medication as prescribed do you get from your doctor?" scored on a 5-point Likert scale.

Family support was assessed using a similar item, "How much encouragement for taking your hypertension medication as prescribed do you get from your friends and family?"

In addition, every subject was asked to select 3 values of personal importance from a list of 12 including responsibil-

Table 1. Baseline characteristics of study participants

	Current sample (N=70)	Sample for the larger RCT (N=337)
Age in years (mean±SE)	58±11	56.5
Males	21 (30%)	100 (30%)
Full-time or part-time employment	27 (39%)	132 (39%)
Education (years)	12.2	12.1
History of stroke	6 (8%)	25 (7.5%)
Diabetic	31 (44%)	129 (38%)
Systolic BP	131±17	131.2
Diastolic BP	80±10	80.6
Mean annual household income		
<10 K	9 (27%)	122 (36%)
10–20 K	21 (30%)	85 (25%)
21–30 K	10 (14%)	48 (14%)
31–40 K	4 (6%)	23 (7%)
41–50 K	3 (4%)	9 (3%)
>50 K	3 (4%)	17 (5%)
Non reporters	10 (14%)	33 (10%)
# with medication insurance benefit	68 (97%)	333 (99%)
Number of BP medications		
1	39%	36%
2	30%	37%
3	31%	27%

ity, independence, God's will, physical strength, etc.

Statistical Analysis

The following were coded as categorical variables in the analyses: sex, financial status (4 groups, as above), living alone or not, insurance and employment types, diabetes status (Y/N), history of stroke (Y/N), medication class (beta blocker, diuretic or calcium channel blocker), and personal values. The following were coded as continuous variables in the analyses: education, self-reported income, blood pressure, number of prescribed medications, weight, self-efficacy for taking medication, and level of physician and family support. Frequencies were calculated for categorical variables, and means and standard errors for continuous variables. We conducted a Pearson correlation and a curve analysis for all continuous variables with MEMS-derived medication adherence to identify possible linear and non-linear correlates of medication adherence. For binary categorical variables, we conducted t tests to assess their relation to medication adherence. For those with 3 or more categories we performed a one-way ANOVA. We used a two-way ANOVA to test for interaction effects of 2 or more categorical variables on medication adherence.

RESULTS

MEMS data were collected for all 337 randomized participants in the larger clinical trial as described above. However, we report findings on the 70 participants' baseline MEMS data available for analysis. Table 1 shows the baseline characteristics of these 70 participants and of all participants enrolled in the larger clinical trial. The

2 groups are comparable across the variables shown and, therefore, are also likely to have had similar baseline levels of medication adherence. Twenty-seven (39%) participants took one antihypertensive medicine, 21 (30%) took two, and 22 (31%) participants took three. The two MEMS-derived measures of overall adherence were highly correlated with each other (ie, the mean percentage of prescribed doses taken per day and the mean percentage of days taken as prescribed, $r=.94$, $P<.001$). For this reason, we used only the latter measure as the dependent variable in subsequent analyses. Mean medication adherence was 71.6%, median=82.3%, sd=26%.

Table 2 shows the correlation between MEMS-derived medication adherence and selected study variables. Medication adherence was significantly correlated with systolic blood pressure ($r=.253$, $P<.04$) and self-reported medication adherence ($r=.285$, $P<.03$). It was marginally correlated with self-efficacy for medication adherence ($r=.198$, $P<.09$). No curve fit analysis resulted in significant results.

There was no significant difference in adherence between males and females, however, there were strong interactions between: 1) sex and education (Figure 1), and 2) sex and whether or not the individual lived alone (Figure 2). With respect to education, when education was coded as high school and above or below high school, females with a less than high school education were less adherent (61%) than females with more formal education (74%). The opposite pattern was observed for males as those with lower education were more adherent than

Table 2. Significant and marginally significant correlations between MEMS-derived medication adherence and other variables

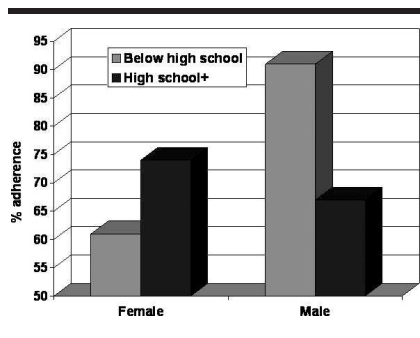| Variable	r	Significance level
Systolic blood pressure	.253	$P<.04$
Self-efficacy	.285	$P<.03$
Self-reported medication adherence	.198	$P<.09$

Figure 1. Effects of sex and education level on medication adherence.

those with higher education (91% vs. 72%, respectively; F [1, 47]=4.244; $P<.05$). (Figure 1).

The interaction between sex and whether or not the individual lived alone approached marginal statistical significance (F [1,66]=3.38, $P<.08$). Of the 70 subjects, 31 lived alone and 39 lived with someone else. Females who lived alone were more adherent (74%) than females who lived with someone else (65%); whereas, males who lived alone were less adherent (69%) than males who lived with someone else (86%) (Figure 2).

We assessed for confounding of the interaction effects described above. We were particularly interested in the effects of per capita income and age as these two variables are intuitively related to education, sex and to whether or not one lives alone.

Correlation analysis did not demonstrate any relation between age and medication adherence. However, it was found that people who lived alone were
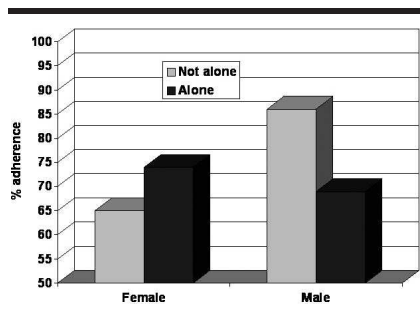

Figure 2. Effects of sex and living alone or not on medication adherence.

older (65 vs 54, $P<.01$). No significant interactions between age, sex and living alone were found.

The per capita income was obtained by dividing the upper limit of the houshold income category by the number of people in the houshold. Not surprisingly, females' self-reported income was lower than males' ($10.6 K vs $18.4 K, $P<.001$). No effect of income on medication adherence was found, either by itself or in an interaction with other variables.

A separate one-way ANOVA test and a single multiway ANOVA were conducted to determine if adherence was related to insurance type, actual income or participants' perceived financial status. No test reached statistical significance or showed a promising trend. This may be explained by the fact that all but 2 subjects reported that their insurance covered the cost of medications.

DISCUSSION

The purpose of this study was to identify correlates of medication adherence among urban, hypertensive, African American adults of low socioeconomic status. Unlike most other studies of medication adherence in this population, we assessed adherence using MEMS technology which is considered a more objective and rigorous assessment approach than self-report alone. We observed a mean adherence rate of 71.6% in our sample, which is similar to that of other studies in similar socio-demographic populations. We also observed a trend between self-efficacy for medication taking and actual medication adherence which is consistent with prior research.[9,10]

A novel finding is the interaction observed between education and medication adherence by sex. While the least educated females tended to demonstrate the lowest adherence, the least educated males demonstrated the highest adherence, on average. Similarly, high school

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and above education was associated with relatively high adherence among women, but only moderate to low adherence among men. A potential explanation for this finding is that women with lower education are more likely than more educated women to be preoccupied with children and families. Indeed, the literature does suggest that caring for dependents is associated with lower medication adherence.[9] This being the case, one might expect to find a direct correlation between education and employment status, and between employment status and medication adherence. No such relation was found.

The moderating effect of education on medication adherence observed in our study may also parallel the effect of general IQ on behavior change described in McGuire's Informational Processing Theory.[12] This model states two factors must be present in order for someone to comply with a request or agree with a message: 1) reception (ie, understanding of the message), and 2) yielding (ie, accepting of the message). People with a higher IQ or level of education typically understand the message better than those with a lower IQ or educational level. However, they are also more likely to mount counterarguments and to display resistance to the request or message. This tendency toward resistance is also higher among people with higher self-esteem.[13] In our study sample, one can argue that the males with higher educational attainment possessed higher self-esteem[14] and were, therefore, less adherent to their

medication regimen on that basis. On the other hand, educational attainment has less influence on women's level of self-esteem. This is because women's self-esteem is shown to be more influenced by emotional factors (eg, relational harmony) rather than by achievement.[14,15] Therefore, for the women in our sample higher educational attainment may have increased understanding of the message about improving medication adherence without increasing resistance to that message.

We also noted a marginal interaction of sex, and whether one lived alone, on medication adherence. Specifically, women who lived alone were more adherent than women who lived with someone else (presumably, a family member), whereas, men who lived alone were less adherent than men who lived with someone else. As argued above, females who live with others may invest in meeting the needs of their dependents such that their own medication adherence suffers. Conversely, medication adherence among men who have a live-in partner would be expected to improve, as was observed in this study.

Although electronic monitoring systems such as the one used in this study are considered to be the most reliable measure of drug adherence, their use may potentially increase adherence by the so-called Hawthorne effect.[16] This effect is strongest during the initial period of monitoring, but wanes over time.[17] In this study we used a middle 30-day period of MEMS data, rather than an earlier period, to calculate medication adherence. We believe this approach mitigates the influence of MEMS monitoring on actual medication adherence. Moreover, the adherence rate reported in our study is similar to rates reported in studies of medication adherence that did not use electronic monitoring systems.[9] In addition, the 70 participants in our study were similar to those in the larger randomized trial across a range of characteristics. These facts argue against the presence of significant monitoring or selection bias in the medication adherence rates we observed.

Multiple factors that influence patient adherence to prescribed therapies have been described. These include quality of life, complexity and side effects of medications, health care system issues, demographic, behavioral, treatment and clinical variables, lack of knowledge regarding hypertension, to name only a few.[9] Although these factors are variably important when considered in isolation, our findings highlight the need to consider how individual risk factors for poor medication adherence interact to increase or reduce the likelihood of medication non-adherence. Identifying correlates of low antihypertensive medication adherence will help healthcare providers to better recognize patients at higher risk for poor adherence and worse hypertension-related outcomes. A knowledge of these risk factors will also inform the development of interventions which target a higher-risk subset of hypertensive patients.

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AUTHOR CONTRIBUTIONS

Design concept of study: Braverman, Dedier
Acquisition of data: Braverman, Dedier
Data analysis and interpretation: Braverman, Dedier
Manuscript draft: Braverman, Dedier
Statistical expertise: Braverman, Dedier
Acquisition of funding: Braverman, Dedier
Administrative, technical, or material assistance: Braverman, Dedier
Supervision: Braverman, Dedier