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Medication Routines and Adherence Among Hypertensive African Americans

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Abstract

Poor adherence to prescribed medication regimens remains an important challenge preventing successful treatment of cardiovascular diseases such as hypertension. While studies have documented differences in the time of day or weekday vs weekend on medication adherence, no study has examined whether having a medication-taking routine contributes to increased medication adherence. The purpose of this study was to: (1) identify patients' sociodemographic factors associated with consistent medication-taking routine; (2) examine associations between medication-taking consistency, medication adherence, and blood pressure (BP) control. The study included black patients with hypertension (n = 190; 22 men and 168 women; age, mean±standard deviation 54 ± 12.08 years) who completed a practice-based randomized controlled trial. Findings showed that medication-taking consistency was significantly associated with better medication adherence ($F = 9.54$, $P = .002$). Associations with the consistency index were not statistically significant for diastolic BP control (odds ratio, 1.319; 95% confidence interval, 0.410–4.246; $P = .642$) and systolic BP control (odds ratio, 0.621; 95% confidence interval, 0.195–1.974; $P = .419$).

Hypertension (HTN) affects 29% of the adult population and contributes to atherosclerosis and cardiovascular disease morbidity and mortality.[1] Despite numerous effective treatments, only 53% of patients with HTN are at goal blood pressure (BP).[1] Lowering of high BP reduces the risk of stroke by approximately 38%, congestive heart failure by 42%, and coronary heart disease by 28%.[1,2] On average, patients with severe HTN (>200/120 mm Hg) live 2.7 years less than those with normal BP (<140/90 mm Hg).[3] African Americans have a disproportionately large burden of cardiovascular disease (CVD) morbidity and mortality in the United States compared with white patients.[3,4] Despite several studies demonstrating the impact of antihypertensive medications in achieving optimal BP control,[5–8] nonadherence to prescribed antihypertensive medications has been identified as one of the main reasons for poorly controlled BP among African Americans.[9–14] Nonadherence and poor BP control has been reported as a possible explanation for the disparity in CVD morbidity and mortality in

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African American and white patients.[15,16] Thus, there is a need for different strategies aimed at improving medication adherence and BP control among African Americans.

To enhance medication adherence and BP control, patients are often encouraged to establish a consistent medication routine based on their daily lives (eg, place medication next to their toothbrush) as a means to increase adherence behaviors. However, empirical evidence supporting this notion is lacking. More importantly, no study has examined whether consistency in medication-taking is associated with better BP control. Therefore, the purpose of this study was to: (1) identify patient sociodemographic factors that are associated with having a consistent medication-taking routine; (2) examine the association between medication-taking consistency and medication adherence over a 9-month monitoring period; and (3) examine the association between medication-taking consistency and BP control.

METHODS

Study Design and Population

This study was embedded within a larger clinical trial, designed to evaluate the effect of motivational interviewing on medication adherence among hypertensive African Americans receiving care from two primary-care facilities affiliated with New York Presbyterian Hospital's Ambulatory Care Network (ACN). Details of the methods are described elsewhere.[17] Eligible patients were identified and provided written informed consent approved by the institutional review board of Columbia University Medical Center. In brief, trained research assistants conducted baseline assessments and collected information on sociodemographic characteristics, number and doses of prescribed antihypertensive medications, medical comorbidity, and clinic BP readings obtained through medical records. After baseline assessments, patients were randomly assigned to either the usual care control group or motivational interviewing group. Those in the intervention group received standard care plus four sessions of behavioral counseling about medication adherence using motivational interviewing at 3-month intervals. The Medication Event Monitoring System (MEMS; AARDEX Group Ltd, Sion, Switzerland) is a pill bottle with an electronic chip in the cap that records a temporal history of the date, time, and interval between each dosing. These data allow for real-time tracking of adherence behaviors, which is not captured by more traditional methods such as the pill count, and enables an evaluation of the consistency of medication-taking behavior over a long period.[18] Powerview (Aprex, a division of Aardex Corporation, Union City, CA) was the communication software used to download the adherence data downloaded from the MEMS cap. The daily pattern of medication ingestion was one antihypertensive medication taken once daily. In the event that patients were prescribed multiple antihypertensive medications, their providers were asked to choose one medication taken once daily to be placed in the bottle. Patients were given a MEMS with instructions on the general purpose of the device and how to use it and they were informed to bring the MEMS to all follow-up appointments. This was necessary to facilitate acquisition of adherence data using the Powerview communication software.

Measures

Sociodemographic Characteristics—The baseline questionnaire included information on sociodemographic variables including patient sex, age, marital status, employment, education, and income.

Blood Pressure—Clinic BP readings were extracted from the patients' medical records at baseline and at the 9-month visit. BP control was calculated as a mean BP <140/90 mm/Hg.

Medication Adherence—Medication adherence was assessed as the proportion of days in which patients took their antihypertensive medication as prescribed (range: 0%–100%) according to MEMS electronic monitoring devices over a 9-month monitoring period. To avoid erroneously penalizing patients for missing values for those days during the study when their MEMS was not in use (ie, "drug holidays") as a result of medical emergencies, we kept detailed records of all patient hospitalizations and emergency room visits. Such days were then removed from the denominator of the adherence formula in estimating the adherence rates for those patients. The mean percentage adherence was calculated for the entire 9-month period.

Measure of Consistency—An index of the variation (inconsistency) in patient daily medication-taking was created by calculating a within-person standard deviation across each time-stamped MEMS cap opening. Lower values indicated more consistency in medication-taking (eg, always taken the same time of day), whereas higher values indicated a more variable pattern.[19]

Statistical Analysis—Data analysis was performed with SPSS version 20.0 for windows (SPSS Inc, Chicago, IL) and SAS version 9.3 for windows (SAS Institute, Cary, NC). For all statistical analyses, the significance level was set at $P < .05$. Bivariate associations between sociodemographic factors (eg, age, sex, income level, marital status, insurance status, and employment) and index of medication-taking were analyzed using two sample *t* test and one-way analysis of variance. In addition, two-sample *t* test and chi-square test were also used in assessing the differences of baseline continuous and categorical characteristics between patients with two or fewer prescriptions and more than two prescriptions, respectively.

General linear regression models (analysis of covariance) were also used to evaluate the association between medication adherence and medication-taking consistency at the 9-month period, controlling for age, sex, income, employment, insurance, and effect of the intervention. Logistic regression was used to evaluate the association between control of systolic BP (SBP) and diastolic BP (DBP) and medication-taking consistency over the 9-month period, controlling for age, sex, income, employment, insurance, and effect of the intervention. The indicator variable for successful control of SBP (<140 mm Hg) was defined as 1 and 0 otherwise. In the same way, we defined an indicator variable for controlling DBP (<90 mm Hg).

To evaluate the association between number of medication prescriptions and BP, we conducted a stratified statistical analysis for patients receiving two or fewer prescriptions as well as for patients receiving more than two prescriptions. In logistic regression, we decided not to adjust covariates since the dataset was too small to produce valid results for stratified or nonstratified analysis.

RESULTS

A total of 190 African American patients with hypertension were eligible for the study. Table I describes the baseline characteristics of the study participants. A total of 88% of the patients were women, with a mean age of 54 years. Approximately three quarters of patients had Medicaid (74%), one quarter reported less than a high school education (23%), half were unemployed (54%), half reported being single (44%), and most reported a household income <$20,000. A total of 48% of the patients were adherent to the single MEMS antihypertensive medication at the 9-month monitoring period as determined by MEMS. The scores range from 0 (0% adherent) to 1.00 (100% adherent) and nonadherence was defined as mean adherence score <80%. Younger patients were significantly more likely to have a variable (inconsistent) medication-taking routine than older patients ($F = 4.79$, $P = .01$). This relationship became stronger after adjusting for sex, income, employment, insurance, and intervention ($F = 13.41$, $P < .0001$).

Results of the regression analyses showed that medication adherence was significantly negatively associated with medication-taking inconsistency with higher inconsistency indicating lower medication adherence at the 9-month monitoring period ($F = 4.93$, $P = .01$). This association also became stronger after adjusting for age, sex, income, employment, insurance, and intervention ($F = 9.54$, $P = .002$).

For a stratified analysis, the relationship between age difference in various medication inconsistency categories was statistically significantly different, with older patients having a lower inconsistency index for patients with two or fewer prescriptions ($F = 4.02$, $P = .021$). The relationship between higher age and lower inconsistency index remained, but it was not statistically significant for patients with more than two prescriptions ($F = 1.33$, $P = .278$). A similar relationship was observed for medication adherence and medication-taking inconsistency. The significant association remained for patients with one or two prescriptions ($F = 4.86$, $P = .009$) and disappeared for patients with more than two prescriptions ($F = 0.27$, $P = .766$).

To evaluate BP control in association with medication-taking consistency, we conducted logistic regression with the indicator variables for SBP and DBP control. For DBP control, we found that the odds of successful control was higher in the more consistent medication-taking group vs the less consistent group, although the results were not statistically significant (odds ratio [OR], 1.319; 95% confidence interval [CI], 0.410–4.246; $P = .642$). For systolic pressure control, the association was reversed, but again the results were not statistically significant (OR, 0.621; 95% CI, 0.195–1.974; $P = .419$). However, if the stratified variable with two or fewer prescriptions was used as a covariate, we found that probability of successful SBP control was significantly higher in favor of more prescriptions (OR, 3.992; 95% CI, 1.523–10.464; $P = .005$). This observation remained when more covariates were adjusted (OR, 6.325; 95% CI, 1.920–20.838; $P = .002$). We did not observe a similar pattern for DBP on the number of prescriptions (OR, 1.386; 95% CI, 0.548–3.504; *P* = .490). The details are presented in Table II.

DISCUSSION

The goal of this study was to investigate the associations between medication-taking consistency, medication adherence, and BP control. The results show that patients with consistent medication-taking routines were more likely to be adherent to their medications over time compared with patients with variable (inconsistent) medication routines. The results suggest that younger patients were significantly more likely to have a variable medication-taking routine than older patients and with lower rate of medication adherence. These results confirm the findings of previous studies[7,20,21] that examined the association between increasing age and higher patient medication adherence, suggested that older patients made fewer adherence errors and were more consistent in taking their prescribed medications as a result of having more regular daily routines. Furthermore, the study found statistically significant results for older patients with two or fewer antihypertensive prescriptions to be more consistent and adherent in taking their medication. The relationship of higher age with lower inconsistency index was not statistically significant for patients with more than two prescriptions.

With respect to the association between medication-taking consistency and BP control, the study results suggest that patients with consistent medication-taking routines are more likely to have DBP control compared with patients with variable medication routines, although the results were not statistically significant. For SBP, we observed a reverse finding, but also not statistically significant. However, SBP control seemed strongly positively associated with the number of prescriptions. This finding was statistically significant, suggesting that the probability of successful SBP control was significantly higher in favor of more prescriptions. We did not observe a similar pattern for DBP on the number of prescriptions. These findings confirm the reports of previous studies that examined patient adherence and medication intensification.[22,23] However; more research is needed on the number and type of antihypertensive prescriptions per patient and optimal BP control.

In line with other studies, our findings show that most sociodemographic characteristics were not associated with adherence and better BP control.[24,25] The findings of this study attest to the multifactorial nature of BP control.

This study used MEMS, an objective measure of adherence, which makes it possible to observe each single intake and missed dose from the prescribed regimen.[26,27] Examining the impact of consistency in medication taking on adherence and BP control provides some insight on how behavior can affect patient outcomes. Thus, this study should shed light on the importance of helping younger patients to establish daily medication-taking routines for better medication adherence and BP control.

Study Limitations

The findings of this study should be interpreted with caution because of several limitations. First, it should be noted that our findings may not be generalizable to a broader population because of the predominantly low-income African American women in the study. This study used adherence data from the MEMS electronic monitoring devices, which makes it possible to observe medication adherence; however, electronic monitoring devices are still limited in that they do not provide confirmation that a dose is actually taken.[28]

BP control is a multifactorial challenge. Thus, the better SBP control noted in favor of more prescriptions for patients may be attributed to other factors such as type of medications, lifestyle factors, and greater treatment intensity, which is often noted among hypertensive African Americans.[29,30]

Clinical Implications

Health professionals, especially clinicians who are involved in patient care, should discuss with their patients potential problems associated with interruptions in their daily routines and develop alternate medication-dosing plans such as using cues to remind patients to take their medications and pillboxes to organize daily doses to promote medication adherence. It has been shown that providing individualized recommendations via cues helps patients remember to take their medication and consequently improve adherence.[31–33] Since individualized medication plans may be difficult to develop within time-constrained office visits with providers, innovative strategies that utilize clinic support staff or technology will need to be developed for practical use in health care settings.

CONCLUSIONS

African American hypertensive patients with consistent medication-taking routines are more likely to be adherent to their medications over time and have better SBP control. These findings support intervention efforts to help patients establish consistent medication routines that fit within their daily lives in order to improve adherence behaviors. Future interventions should use this approach among younger patients.

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All authors contributed to the design, analysis, and interpretation of the results and to drafting the critical review of the manuscript. All authors reviewed and approved the final version of the manuscript.

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References

1. Crim MT, Yoon SS, Ortiz E, et al. National surveillance definitions for hypertension prevalence and control among adults. Circ Cardiovasc Qual Outcomes. 2012; 5:343–351. [PubMed: 22550130]
2. Roberie DR, Elliott WJ. What is the prevalence of resistant hypertension in the United States? Curr Opin Cardiol. 2012; 27:386–391. [PubMed: 22596184]
3. Roger VL, Go AS, Lloyd-Jones DM, et al. Heart disease and stroke statistics - 2011 update: a report from the American Heart Association. Circulation. 2011; 123:e18–e209. [PubMed: 21160056]

4. Kressin NR, Orner MB, Manze M, et al. Understanding contributors to racial disparities in BP control. Circ Cardiovasc Qual Outcomes. 2010; 3:173–180. [PubMed: 20233981]

5. Wetzels GEC, Nelemans P, Schouten JS, et al. Facts and fiction of poor compliance as a cause of inadequate BP control: a systematic review. J Hypertens. 2004; 22:1849–1855. [PubMed: 15361751]

6. Morris AB, Li J, Kroenke K, et al. Factors associated with drug adherence and BP control in patients with hypertension. Pharmacotherapy. 2006; 26:483–492. [PubMed: 16553506]

7. Elliott WJ, Plauschinat CA, Skrepnek GH, et al. Persistence, adherence, and risk of discontinuation associated with commonly prescribed antihypertensive drug monotherapies. J Am Board Fam Med. 2007; 20:72–80. [PubMed: 17204738]

8. Ogedegbe GO, Boutin-Foster C, Wells MT, et al. A randomized controlled trial of positive-affect intervention and medication adherence in hypertensive African Americans. Arch Intern Med. 2012; 172:322–326. [PubMed: 22269592]

9. Svarstad BL, Kotchen JM, Shireman TI, et al. Improving refill adherence and hypertension control in black patients: Wisconsin TEAM trial. J Am Pharm Assoc. 2013; 53:520–529.

10. Shaw R, Bosworth HB. Baseline medication adherence and BP in a 24-month longitudinal hypertension study. J Clin Nurs. 2012; 21:1401–1406. [PubMed: 22107599]

11. Lewis LM, Ogedegbe C, Ogedegbe G. Enhancing adherence of antihypertensive regimens in hypertensive African-Americans: current and future prospects. Expert Rev Cardiovasc Ther. 2012; 10:1375–1380. [PubMed: 23244358]

12. De Simoni A, Hardeman W, Mant J, et al. Trials to improve BP through adherence to antihypertensives in stroke/TIA: systematic review and meta-analysis. J Am Heart Assoc. 2013; 2:e000251. [PubMed: 23963756]

13. Brinker S, Pandey A, Ayers C, et al. Therapeutic drug monitoring facilitates BP control in resistant hypertension. J Am Coll Cardiol. 2014; 63:834–835. [PubMed: 24315901]

14. Panjabi S, Lacey M, Bancroft T, et al. Treatment adherence, clinical outcomes, and economics of triple-drug therapy in hypertensive patients. J Am Soc Hypertens. 2013; 7:46–60. [PubMed: 23321404]

15. Poon I, Lal LS, Ford ME, et al. Racial/ethnic disparities in medication use among veterans with hypertension and dementia: a national cohort study. Ann Pharmacother. 2009; 43:185–193. [PubMed: 19193586]

16. Bosworth HB, Powers B, Grubber JM, et al. Racial differences in BP control: potential explanatory factors. J Gen Intern Med. 2008; 23:692–698. [PubMed: 18288540]

17. Ogedegbe GO, Schoenthaler A, Richardson T, et al. An RCT of the effect of motivational interviewing on medication adherence in hypertensive African Americans: rationale and design. Contemp Clin Trials. 2007; 28:169–181. [PubMed: 16765100]

18. Cramer JA, Mattson RH, Prevey ML, et al. How often is medication taken as prescribed? A novel assessment technique. JAMA. 1989; 261:3273–3277. [PubMed: 2716163]

19. Knafl GJ, Schoenthaler A, Ogedegbe G. Secondary analysis of electronically monitored medication adherence data for a cohort of hypertensive African Americans. Patient Prefer Adherence. 2012; 6:207–219. [PubMed: 22536057]

20. Demonceau J, Ruppar T, Kristanto P, et al. Identification and assessment of adherence-enhancing interventions in studies assessing medication adherence through electronically compiled drug dosing histories: a systematic literature review and meta-analysis. Drugs. 2013; 73:545–562. [PubMed: 23588595]

21. Lee GKY, Wang HHX, Liu KQL, et al. Determinants of medication adherence to antihypertensive medications among a Chinese population using Morisky medication adherence scale. PLoS One. 2013; 8:e62775. [PubMed: 23638143]

22. Rodondi N, Peng T, Karter AJ, et al. Therapy modifications in response to poorly controlled hypertension, dyslipidemia, and diabetes mellitus. Ann Intern Med. 2006; 144:475–484. [PubMed: 16585661]

23. Heisler M, Hogan MM, Hofer PT, et al. When more is not better: treatment intensification among hypertensive patients with poor medication adherence. Circulation. 2008; 117:2884–2892. [PubMed: 18506011]

24. van Dijk L, Heerdink ER, Somai D, et al. Patient risk profiles and practice variation in nonadherence to antidepressants, antihypertensives and oral hypoglymics. BMC Health Serv Res. 2007; 7:51. [PubMed: 17425792]

25. Osterberg L, Blaschke T. Adherence to medication. N Engl J Med. 2005; 353:487–497. [PubMed: 16079372]

26. Savic RM, Barrail-Tran A, Duval X, et al. Effect of adherence as measured by MEMS, ritonavir boosting, and CYP3A5 genotype on atazanavir pharmacokinetics in treatment-naive HIV-infected patients. Clin Pharmacol Ther. 2012; 92:575–583. [PubMed: 23033116]

27. Vrijens B, Goetghehur E. The impact of compliance in pharmacokinetic studies. Stat Methods Med Res. 1999; 8:247–262. [PubMed: 10636337]

28. Girard P, Sheiner LB, Kastrissios H, et al. Do we need full compliance data for population pharmacokinetic analysis? J Pharmacokinet Biopharm. 1996; 24:265–282. [PubMed: 8970015]

29. Philips LS, Twombly JG. It's time to overcome clinical inertia. Ann Intern Med. 2008; 148:783–785. [PubMed: 18490691]

30. Turner BJ, Hollenbeak CS, Weiner M, et al. Effect of unrelated comorbid conditions on hypertension management. Ann Intern Med. 2008; 148:578–586. [PubMed: 18413619]

31. Rosen MI, Rigsby MO, Salabi JT, et al. Electronic monitoring and couseling to improve medication adherence. Behav Res Ther. 2004; 42:409–422. [PubMed: 14998735]

32. Russell CL, Ruppar TM, Matteson M. Improving medication adherence: moving from intention and motivation to a personal systems approach. Nurs Clin North Am. 2011; 46:271. [PubMed: 21791262]

33. Aoka Y1, Hagiwara N, Kasanuki H. Heterogeneity of hemodynamic parameters in untreated primary hypertension, and individualization of antihypertensive therapy based on noninvasive hemodynamic measurements. Clin Exp Hypertens. 2013; 35:61–66. [PubMed: 22681554]

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TABLE I

Characteristics of Study Participants on Medication-Taking Consistency in Hypertensive African Americans (N = 190)

Characteristics	Total	Two or More Medications	More than Two Medications	*P* Value or χ^2
Age, mean (SD), y	54 (12.08)	52 (11.92)	59 (11.16)	.001
Sex, No. (%)				
Female	168 (88)	131 (69)	37 (19)	.158
Male	22 (12)	19 (10)	3 (2)	
Marital status, No. (%)				
Single	84 (44)	72 (38)	12 (6)	.009
Married	33 (17)	29 (15)	4 (2)	
Separated	58 (31)	42 (22)	16 (8)	
Widower	15 (8)	8 (4)	7 (4)	
Education, No. (%)				
Elementary	44 (23)	33 (17)	11 (6)	.698
High school/GED	85 (45)	69 (36)	16 (8)	
Some college	61 (32)	49 (26)	12 (6)	
Employment, No. (%)				
Full-time	29 (15)	26 (14)	3 (2)	.412
Part-time	13 (7)	11 (6)	2 (1)	
Retired	20 (11)	14 (7)	6 (3)	
Not working	103 (54)	79 (42)	24 (13)	
On disability	25 (13)	21 (11)	4 (2)	
Type of insurance, No. (%)				
HMO	13 (7)	11 (6)	2 (1)	.061
Medicare	22 (12)	13 (7)	9 (5)	
Medicaid	140 (74)	112 (59)	28 (15)	
Self	15 (8)	15 (8)	0 (0)	
Annual income, No. (%)				
Unknown	29 (15)	25 (13)	4 (2)	.177
<$20,000	122 (64)	92 (48)	30 (16)	
≥20$20,000	39 (21)	34 (18)	5 (3)	
BP at baseline, mean (SD)				
Diastolic BP	86.6 (11.4)	86.2 (10.88)	88.4 (13.19)	.289
Systolic BP	144.4 (19.1)	141.9 (17.85)	154.2 (20.77)	.001
BP at 9 months, mean (SD)				
Diastolic BP	82.9 (10.4)	82.2 (10.15)	85.8 (11.03)	.116
Systolic BP	136.4 (15.8)	134.3 (15.19)	144.4 (15.99)	.004

Abbreviations: BP, blood pressure; HMO, health maintenance organization; SD, standard deviation

TABLE II

Blood Pressure Control <140/90 mm Hg by Inconsistency Index

	Inconsistent Index	Number of Prescriptions
Controlled SBP <140 mm Hg		
Unadjusted	0.621 (0.195–1.974)	3.992 (1.523–10.464)
Adjusted	0.774 (0.210–2.843)[a]	6.325 (1.920–20.838)[b]
Controlled DBP <90 mm Hg		
Unadjusted	1.319 (0.410– 4.246)	1.386 (0.548–3.504)
Adjusted	3.135 (0.762–12.906)[a]	1.691 (0.470–6.078)[b]

Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure. Values are expressed as odds ratios (95% confidence intervals).

[a]Adjusted for age, sex, income, education, marital status, employment status, educational status, and effect of intervention.

[b]Adjusted for inconsistency, age, sex, income, education, marital status, employment status, and effect of intervention.