Original Study

Patient and Social Environment Factors Associated With Self Blood Pressure Monitoring by Male Veterans With Hypertension

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Self blood pressure monitoring (SBPM) can facilitate hypertension management, but determinants of SBPM are understudied. The authors examined the relationship of patient and social environment characteristics to monitor possession and frequency of SBPM in 578 male hypertensive veterans. Measures included possession of a monitor; SBPM frequency; concurrent blood pressure control; and patient demographic, clinical, and psychosocial factors. In logistic regression analyses, older age, diabetes, unemployment, and better mental health status were related to greater likelihood of monitor possession. Ordinal logistic regression showed that among patients with a monitor, having diabetes, being unemployed, and having a shorter duration of hypertension were independently related to greater frequency of SBPM. Monitor possession, but not frequency of SBPM, was related to a decreased likelihood of blood pressure control in adjusted analyses. Our results suggest that patient characteristics may influence SBPM and may represent points of leverage for intervening to increase self-monitoring. J Clin Hypertens (Greenwich). *2008;10:692–699.*

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Hypertension affects 65 million Americans[1] and is a major risk factor for cardiovascular and renal disease.[2] Two recent studies suggest that while rates of blood pressure (BP) control among individuals with hypertension have improved in recent years, fewer than half of all patients with hypertension have achieved target BP levels.[3,4] There remains a strong incentive to understand how to improve BP control.

Self blood pressure monitoring (SBPM) at home is increasingly recognized as an important tool in hypertension management; this is noted in the latest hypertension guidelines.[5] Growing enthusiasm for SBPM follows evidence that it may facilitate BP control,[6–8] reduce the need for frequent office visits,[7] and decrease costs of hypertension care.[7] SBPM may result in improved hypertension

outcomes in several ways. First, it provides documentation of the effects of medications and other lifestyle changes, which may improve patient adherence and subsequent BP control,[5,9–11] particularly among patients who have difficulty remembering to take their medications.[9,10] Positive results (ie, seeing BP decrease) encourage the patient to continue treatment, whereas continued high BP readings may lead to appropriate alterations in lifestyle or therapy.[12] Furthermore, when therapies are unsuccessful in reducing BP, patients are more inclined to work with their physicians to alter their medical regimen sooner.[13] Finally, home BP measurements may also help avoid unnecessary medication treatment due to higher office measurements resulting from the white-coat effect[5] or, alternatively, may prevent providers from disregarding high clinic readings due to an assumed white-coat effect.

Despite evidence of its beneficial effects and acceptance as an important aspect of clinical care for hypertension,[14,15] the factors that influence patients' possession of a home BP monitor, and particularly the frequency with which they use monitors, are largely unknown. Some research suggests that women,[16] older patients,[16] and those with higher levels of education[16,17] and who see physicians who involve them more in treatment decisions[18] are more likely to have a monitor, although psychosocial and clinical factors remain unexamined. Furthermore, among patients who have home monitors, few studies have identified factors associated with the frequency with which they use them. Identifying possible influences on possession of a home monitor and frequency of its use could be useful in implementing interventions to increase SBPM and ultimately improve hypertension outcomes.

The goal of this study was to examine, in patients with hypertension receiving primary care through the Department of Veterans Affairs (VA) health care system, individual and social environment characteristics that were related to SBPM, including (1) possession of a home BP monitor and (2) frequency of home BP recordings among patients with a monitor. A secondary aim was to examine whether possession of a monitor or SBPM frequency was related to BP control.

METHODS

Sample and Procedures

We analyzed data collected from baseline interviews and clinic records for the Veterans' Study to Improve the Control of Hypertension (V-STITCH), a randomized controlled trial[19] testing 2 interventions designed to improve BP control. The study population consisted of individuals with diagnosed hypertension (ICD-9-CM codes 401.0, 401.1, or 401.9) at a Durham VA primary care clinic who had filled a prescription for antihypertensive medication in the year before enrollment. Of the 816 patients who were approached, 588 (72%) enrolled, 190 (23%) refused participation, and 38 were excluded because of a cardiovascular-related hospitalization or a diagnosis of metastatic cancer in the past 3 months, a dementia diagnosis, residence in a nursing home, current receipt of home health care, or severely impaired hearing or speech (5%). We also excluded female patients from this analysis due to small numbers (n=10); our final sample consisted of 578 male veterans with hypertension. The study was completed in compliance with the requirements of the Durham VA Medical Center's institutional review board/human subjects research committee.

MEASURES

Self Blood Pressure Monitoring

We measured possession of a home BP monitor and frequency of SBPM. Patients were first asked, "Do you have a home blood pressure monitor?" (1=yes, 0=no). Those responding yes were also asked how often they used the monitor (monthly, weekly, daily, or don't know). Responses of "don't know" (n=65) were considered missing data, and we excluded individuals with unknown frequency from related analyses.

Patient and Social Environment Characteristics

We assessed a number of characteristics of patients and their social environments as described in the expanded Health Decision Model, which has been used to characterize determinants of hypertension self-management and BP control.[20,21] Patient demographics were assessed in interviews and included age (in years), race (white vs nonwhite), education level (high school degree or less, some college or vocational school, or college degree or more), and employment status (working full- or part-time, retired, or not currently working). Perceived financial status was also assessed by asking participants whether they would characterize their household's financial status as having enough money for bills and for special things, having enough for bills but little extra for special things, having enough for bills but only because of cutting back, or not having enough for bills no matter what.

Clinical characteristics included diabetes status (as per medical charts), patient-reported of length of time with hypertension (≤5 years, 6–10 years,

>10 years), and patients' experience of medication side effects, which was assessed by asking patients whether they had experienced each of 13 side effects that might be related to BP medication and summing affirmative responses.

We also gathered information on patient cognitive and emotional factors in baseline interviews. Hypertension knowledge was assessed by summing correct responses to 10 multiple-choice items inquiring about hypertension symptoms, prognosis, and risks.[22] Perceived seriousness of hypertension was measured with an item adapted from a health beliefs questionnaire[22]: "How serious do you think having high blood pressure is?" (4=very serious, 3=serious, 2=a little serious, 1=not at all serious). To assess perceived control over hypertension, patients reported how much they agreed or disagreed with 4 statements about whether their BP is within or outside of their own control[23]; higher scores represent higher levels of perceived control (α=.65). Health-related literacy was measured with the Rapid Estimate of Adult Literacy in Medicine (REALM)[24]; the total number of correctly read words constituted the patient's score. To measure medical regimen–specific memory, patients repeated a short passage explaining a hypertension self-management regimen; the number of correctly repeated phrases (range, 0–11) represented the patients' score. We measured perceived stress by asking patients how often in the past month they have felt nervous or stressed (1=never to 5=very often).[25] To assess mental health status, we used the Mental Component Score (MCS-12V) from the Veterans' SF-12[26] (range, 0–100). We divided MCS-12V scores by 10 to increase interpretability of odds ratios.

Social environment characteristics were assessed via patient report and included marital status (married or unmarried), household living status (alone or not), availability of emotional support, and availability of instrumental support. The latter were assessed by asking patients whether they have enough contact with someone they feel close to, trust, and can confide in (yes=1, no=0) and, if needed, whether there was someone available to help the participant with tasks (1=yes, 0=no), respectively.

BP Control

Systolic BP and diastolic BP values measured at office visits within a 14-day window around the patient's baseline interview were abstracted from patients' medical charts. The minimum, rather than the mean, of all available office readings was used to minimize the impact of the white-coat effect. Participants were then classified as in (1) or out (0) of BP control based on guidelines in effect during the time of the study: systolic BP <140 mm Hg and diastolic BP <90 mm Hg for individuals without diabetes and systolic BP <130 mm Hg and diastolic BP <85 mm Hg for individuals with diabetes.[27]

Analysis Approach

We used Stata Intercooled version 8.2 (StataCorp, College Station, TX) for analyses. To characterize the patient sample and check for missing data, we examined univariate statistics for all variables. To prevent loss of observations in multivariate models, we imputed values for independent variables with missing data using single regression imputation and used the imputed values in subsequent analyses.

We conducted logistic regression analyses to characterize the relationship between patient and social environment characteristics and possession of a home BP monitor. We first calculated crude odds ratios (ORs) and 95% confidence intervals (CIs) for the unadjusted relationships between all variables and monitor possession, followed by a multiple logistic regression model that included all variables simultaneously to determine their independent relationships to monitor possession. We used ordered logistic regression to estimate crude and fully adjusted ORs and 95% CIs for the relationship of patient and social environment characteristics to frequency of SBPM, using data from the subsample of 288 patients who had a monitor and reported frequency data. In this latter analysis, we checked for violations of the proportional odds assumption by conducting an omnibus likelihood ratio test for proportionality of odds across the response categories[28]; results of this test were nonsignificant in all cases. Finally, we conducted logistic regression analyses with BP control as the outcome to explore the relationship of monitor possession and frequency of SBPM to concurrent BP control, before and after adjusting for all patient and social environment characteristics. In all analyses, we adjusted standard errors and confidence intervals for non-independence of patients within provider clusters. For multivariate models, we examined variance inflation factors for all independent variables and determined that multicollinearity was not excessive (maximum variance inflation factor, 4.12).

RESULTS

Sample Characteristics

Approximately 61% (n=353) of the 578 participants in our sample possessed a home BP monitor. Among these individuals, 24% (n=84) used it daily,

Table I. Characteristics of the Patient Sample

	% or Mean (SD)
Patient characteristics	
Age, y	63.5 (11.3)
White race	56.9
Education: college or more	23.9
Education: some college or vocational school	24.4
Education: high school degree or less	51.7
Employment status: work part-time or full-time	28.9
Employment status: retired	54.0
Employment status: not currently working	17.0
Financial status: enough for special things	37.0
Financial status: enough for bills, little for special things	40.7
Financial status: enough for bills if cut back	11.8
Financial status: difficulty paying bills	9.7
Has diabetes	37.4
Hypertension for >10 y	46.2
Hypertension for 6–10 y	16.6
Hypertension for ≤5 y	28.6
No. of medication side effects (range, 0–13)	5.0 (3.1)
Hypertension knowledge (range, 0–10)	8.6 (1.2)
Perceived seriousness (range, 1–4)	3.5 (0.7)
Perceived control (range, 1–4)	3.1 (0.4)
Literacy (range, 0–66)	57.5 (12.6)
Medical regimen–specific recall (range, 0–11)	7.9 (2.6)
Perceived stress (range, 1–5)	2.9 (1.3)
Mental health status (range, 0–100)	51.9 (12.4)
Social environment characteristics	
Married	68.5
Lives alone	21.1
Emotional support is available	80.5
Instrumental support is available	91.2
Blood pressure	
Systolic blood pressure	138.4 (17.6)
Diastolic blood pressure	75.4 (11.3)
Blood pressure control	43.6

42% (n=148) weekly, 16% (n=56) monthly, and 18% (n=65) reported unknown use.

Table I shows characteristics of the patient sample. Patients were, on average, 63.5±11.3 years old. Approximately 57% of the sample was white, 52% had a high school degree or less, and 29% were currently working full- or part-time. More than one-third had diabetes, and almost half had been living with hypertension for more than 10 years. Approximately 56% of participants had inadequate BP control according to office measurements.

Factors Associated With Monitor Possession

In the unadjusted models, having diabetes (OR, 1.61; 95% CI, 1.19–2.18) and being married (OR, 1.50; 95% CI, 1.08–2.09) were associated with a greater likelihood of having a monitor. In adjusted analyses (Table II), having diabetes remained significantly associated with a greater likelihood of monitor possession (OR, 1.55; 95% CI, 1.16–2.07), and the relationships of age, employment status, and mental health status to monitor possession became statistically significant. Older age was associated with a higher likelihood of having a monitor (OR, 1.02; 95% CI, 1.00–1.04); each additional year of age was related to a 2% increase in the odds of having a monitor. Also, the odds of having a monitor among those who were retired were approximately 50% less than the odds of having a monitor among unemployed individuals (OR, 0.49; 95% CI, 0.25–0.96). Finally, patients with higher mental health status were more likely to have a monitor (OR, 1.15; 95% CI, 1.01–1.32).

Factors Associated With SBPM Frequency

Unadjusted ordered logistic regression results for the 288 patients who had a monitor and reported frequency data showed that employment status was related to frequency of SBPM; those who worked (OR, 0.36; 95% CI, 0.21–0.64) and those who were retired (OR, 0.48; 95% CI, 0.29–0.78) were less likely to report more frequent monitoring than those who were currently unemployed. Several clinical factors were also related to SBPM frequency in unadjusted analyses: individuals with diabetes (OR, 1.60; 95% CI, 1.09–2.36) and more medication side effects (OR, 1.10; 95% CI, 1.02–1.19) were more likely to report more frequent monitoring, and those who had been living with hypertension for 6 to 10 years were less likely to report more frequent monitoring compared with individuals who had hypertension diagnosed in the past 5 years (OR, 0.60; 95% CI, 0.36–0.99). In addition, married individuals were less likely to report more frequent monitoring (OR, 0.57; 95% CI, 0.39–0.83), and those who lived alone reported more frequent monitoring (OR, 1.59; 95% CI, 1.03–2.46). In the fully adjusted model (Table II), employment status, diabetes status, and duration of hypertension diagnosis remained significantly related to frequency of SBPM.

Relationship of SBPM to BP Control

Individuals who reported having a monitor were more likely to have uncontrolled office BP levels, before (OR, 0.55; 95% CI, 0.42–0.73) and after (OR, 0.62; 95% CI, 0.48–0.81) controlling for

Table II. Adjusted OR and 95% CIs for Possession of a Home BP Monitor and Frequency of SBPM, by Patient and Social Environment Characteristics

	Monitor Possession (n=578)		Frequency of SBPM (n=288)	
	OR	95% CI	OR	95% CI
Patient characteristics				
Age, y	1.02[a]	1.00–1.04	1.01	0.97–1.04
Race: white	0.99	0.71–1.39	0.80	0.46–1.40
Race: nonwhite (ref)	–	–	–	–
Education: college or more	0.73	0.45–1.19	1.32	0.67–2.61
Education: some college or vocational school	1.19	0.69–2.05	0.79	0.39–1.58
Education: high school degree or less (ref)	–	–	–	–
Employment status: work part or full-time	0.58	0.31–1.10	0.41[a]	0.20–0.87
Employment status: retired	0.49[a]	0.25–0.96	0.50	0.24–1.01
Employment status: not employed (ref)	–	–	–	–
Financial status: enough for special things	1.38	0.69–2.74	0.55	0.19–1.61
Financial status: enough for bills, little for special things	0.93	0.47–1.86	0.36	0.10–1.32
Financial status: enough for bills if cut back	1.08	0.44–2.69	0.44	0.15–1.27
Financial status: difficulty paying bills (ref)	–	–	–	–
Has diabetes: yes	1.55[b]	1.16–2.07	1.56[a]	1.00–2.44
Has diabetes: no (ref)	–	–	–	–
Duration of diagnosis: >10 y	1.38	0.85–2.22	0.68	0.40–1.13
Duration of diagnosis: 6–10 y	1.30	0.83–2.03	0.52[a]	0.30–0.93
Duration of diagnosis: ≤5 y (ref)	–	–	–	–
Medication side effects	1.03	0.95–1.10	1.07	0.98–1.17
Hypertension knowledge	1.07	0.89–1.28	1.01	0.82–1.23
Perceived seriousness	1.10	0.86–1.41	0.82	0.59–1.14
Perceived control	0.97	0.60–1.56	0.89	0.42–1.87
Literacy	1.01	1.00–1.03	1.00	0.98–1.02
Medical regimen–specific recall	0.99	0.92–1.06	1.00	0.91–1.10
Perceived stress	1.15	0.98–1.34	1.00	0.78–1.29
Mental health status	1.15[a]	1.01–1.32	1.20	0.93–1.54
Social environment characteristics				
Marital status: married	1.45	0.85–2.46	0.71	0.33–1.53
Marital status: not married (ref)	–	–	–	–
Household living situation: alone	1.00	0.57–1.76	1.19	0.52–2.75
Household living situation: with others (ref)	–	–	–	–
Availability of emotional support: yes	1.15	0.66–2.03	0.88	0.46–1.66
Availability of emotional support: no (ref)	–	–	–	–
Availability of instrumental support: yes	1.37	0.77–2.43	0.73	0.34–1.55
Availability of instrumental support: no (ref)	–	–	–	–

Abbreviations: BP, blood pressure; CI, confidence interval; OR, odds ratio; SBPM, self blood pressure monitoring.
[a] $P<.05$; [b] $P<.01$.

patient and social environment characteristics. In the adjusted model, the predicted probability of having adequate BP control was 39.8% for individuals who had a home BP monitor compared with 51.6% for those who did not have a monitor. Frequency of SBPM was related to inadequate BP control in the unadjusted model, in that those who monitored weekly were less likely than those who monitored monthly to have controlled BP (OR, 0.49; 95% CI, 0.29–0.85), although daily compared with monthly monitoring was not significantly associated with BP control (OR, 0.62; 95% CI, 0.30–1.26). After adjusting for patient and social environment characteristics, individuals who monitored daily (OR, 0.67; 95% CI, 0.29–1.56) or weekly (OR, 0.52; 95% CI, 0.27–1.01) rather than monthly were no more or less likely to have adequate BP control.

DISCUSSION

SBPM is being increasingly advocated for individuals with hypertension, yet little is known about patients' SBPM in practice. Our investigation of

male veterans with hypertension is one of few existing studies to examine the overall frequency and potential determinants of patients' SBPM.

We found that 61% of our patient sample reported having a BP monitor at home. This is similar to the rate of 60% reported in a recent national Internet survey of patients with hypertension[4] and considerably higher than the rates of 16% and 44% reported in two British clinic-based studies.[17,29] Although it was unknown how participants in our study obtained their monitors, the relatively high proportion of patients with a monitor may reflect good access to monitors in the VA health system and/or encouragement from their health providers to engage in SBPM. More research is needed on the source from which patients obtain their monitors and whether health system differences and insurance coverage affect patients' access to monitors.

We found that older age and having diabetes increased patients' likelihood of having a home BP monitor and that individuals who had a monitor were more likely to have inadequate concurrent BP control. In other words, patients with greater risk of negative cardiovascular outcomes were more likely to have a home monitor. Our finding that unemployed individuals were more likely to have a monitor compared with employed or retired individuals is also consistent with this pattern of results, in that unemployment may be a proxy for worse functional status. Our results suggest that providers may tend to recommend SBPM for patients with risk factors for worse health outcomes, compared with patients at lower risk, or that such patients may be more likely to agree to home monitoring or initiate home monitoring on their own. In particular, patients with diabetes as well as hypertension may be more natural candidates for SBPM, in their own view as well as their providers', because of established skills and experience with self-monitoring blood glucose levels. Regardless of the reason for these findings, it is encouraging that home monitor possession was more common among patients with greater risk, given the possible beneficial effect of SBPM on BP levels and cardiovascular outcomes. However, future interventions to increase the use of SBPM might emphasize benefits for lower-risk patients, including possible reduced need for office visits.

We also found that individuals with better mental health status were more likely to have a monitor. These results are consistent with recent findings that physicians may hesitate to intensify hypertension treatment for patients experiencing high levels of stress or psychological comorbidity.[30] Such patients might also be less receptive to adding another component to their hypertension self-management regimen. More research is needed on the impact of SBPM on patients' psychological outcomes, especially for those with preexisting psychological comorbidity.

In addition to elucidating potential influences on the likelihood that patients have a home monitor, this research fills a gap regarding the frequency with which patients who have monitors engage in SBPM. In the absence of clear guidelines as to how frequently SBPM should be performed and the absence of a significant relationship of more frequent SBPM to BP control in this sample, we are limited in our ability to make firm judgments regarding the frequency data collected in our study. However, our data suggest that among those with a home monitor, many engage in SBPM only sporadically, with 16% reporting only monthly use and 18% reporting unknown use. Furthermore, the meta-analysis showing the beneficial effect of SBPM on BP control was based on studies in which patients performed SBPM multiple times a week.[6] SBPM is likely to yield fewer benefits when performed on a sporadic basis, although more research is needed on the optimal schedule of SBPM.

As with possession of a monitor, having diabetes and being unemployed were associated with greater frequency of SBPM, again suggesting that patients with greater cardiovascular risk and/or worse functional status may have greater motivation to perform SBPM consistently. In addition, having diabetes and being unemployed may facilitate more frequent SBPM from a practical standpoint. That is, those with diabetes may already engage in other disease self-monitoring tasks and may incorporate SBPM into their routine more easily, while unemployed individuals may simply experience fewer barriers related to time and competing responsibilities when trying to incorporate SBPM into their lives. We also found that patients who had been living with hypertension for a longer time were less likely to monitor more frequently, suggesting that patients who have a home monitor may become more complacent about using it regularly the longer they have the condition.

Despite a solid base of evidence that SBPM can lead to better BP control, we found that patients who had a home monitor actually had worse BP control at office visits, and among those with a monitor, more frequent SBPM was not related to BP control. These findings are likely due to limitations of our study design, namely, the cross-sectional, observational nature of our data, and

should not necessarily be taken as evidence that SBPM is not effective or an important part of hypertension self-management. A more likely interpretation, as discussed above, is that physicians and patients may use SBPM more when BP is poorly controlled, as another tool to achieve BP control. Further, our reliance on BP measurements taken at office visits may have obscured the true relationship between home monitor possession and BP control. Office BP measurements might be reduced in patients without a monitor because in the absence of home BP measurements to the contrary, providers may classify patients with controlled BP as having uncontrolled BP on the basis of office assessment and perhaps (unnecessarily) intensify treatment until office measurements show that BP is controlled. However, the same treatment intensification might not occur for patients with a monitor who appear to have uncontrolled BP via office measurements but controlled BP via home measurements. Thus, the higher proportion of office BP control among those with a monitor in this study may be a result of using office measurements as our indicator of BP control, rather than a reflection of differences in rates of control among those with and without monitors.

Another limitation of our study includes an inability to generalize our findings to female patients, individuals residing in other geographic areas, or those receiving care outside of the VA health system, where cost and availability of monitors may serve as greater barriers. Also, patients who choose to participate in a randomized controlled trial relating to BP control may be more motivated to perform hypertension self-management behaviors such as SBPM or differ in other systematic ways from patients who refuse participation. More studies on the frequency and correlates of SBPM are needed, including different patient groups from different health systems. Finally, our study did not examine provider-level factors that might influence possession of a home BP monitor. A recent survey showed that 50% of patients were advised by their physicians to monitor their BP at home,[4] but prior studies have also suggested that provider attitudes toward the utility of SBPM are variable.[31] Future studies should examine whether these attitudes and other provider attributes influence physicians' tendency to suggest SBPM and subsequent monitoring by patients.

Despite these limitations, this study provides some important information on the frequency with which hypertensive patients in the VA system engage in SBPM. Findings from this study suggest some patient clinical and psychosocial characteristics that may influence whether patients have access to a home monitor and use it regularly, which may prove useful to target in future interventions to increase SBPM.

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