Original Paper

Use of Home Blood Pressure Monitoring by Hypertensive Patients in Primary Care: Survey of a Practice-Based Research Network Cohort

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Using a survey of a cohort of primary care patients, the authors determined the proportion currently using home blood pressure monitoring (HBPM) and calculated odds ratios (ORs) of factors associated with such use. Overall, 530 questionnaires were received (80% response rate); 35.2% of respondents reported that their doctor had recommended HBPM (95% confidence interval [CI], 31.1–39.3), and 43.1% reported currently using HBPM (95% CI, 38.8–47.3). Compared with patients younger than 45 years, hypertensive patients older than 65 years were more likely to be using HBPM (OR, 2.53; 95% CI, 1.20–5.33). Those with a history of stroke/transient ischemic attack were also more likely to use HBPM (OR, 2.06; 95% CI, 1.00–4.24). Compared with patients with a level of hypertension knowledge <10th percentile, those with a knowledge level >90th percentile were more likely to use HBPM (OR, 1.96; 95% CI, 1.08–3.56). The factor most strongly associated with use of HBPM was recalling a doctor's recommendation to do so (OR, 7.93; 95% CI, 4.96–12.7). J Clin Hypertens (Greenwich). *2008;10:280–286.* ©*2008 Le Jacq*

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Hypertension is one of the most important contributors to premature deaths in developed countries.[1] A large body of clinical trial evidence demonstrates that treatment of hypertension reduces cardiovascular events.[2,3] Unfortunately, many patients who would benefit from treatment do not receive it, and in many who receive treatment, goal blood pressure (BP) is not attained for various reasons, including undertreatment by physicians and poor adherence on the part of patients.[4] Self-management, as a component of collaborative care between patients and clinicians, may be one strategy to improve BP control in patients.[5,6]

Home blood pressure monitoring (HBPM) is a self-management tool that patients can use to become more involved in their hypertension care. Evidence of the utility and benefits of HBPM is accumulating.[7,8] HBPM may improve BP control, inform treatment decisions, and provide diagnostic as well as prognostic information.[8–11] HBPM has also been shown to be cost-effective, resulting in fewer needed physician visits to achieve BP control.[12] While HBPM is not considered part of the standard of care for hypertension management, US guidelines note that HBPM may improve patients' adherence to antihypertensive medication regimens.[13] HBPM is less expensive and provides numerous recordings over time compared with 24- or even 48-hour ambulatory monitoring.

Numerous devices for performing HBPM are available, and a Web site maintains an up-to-date list of devices that have been independently validated.[14] The automatic devices are easy to use and continue to become more affordable. Judging by the number of devices available, there is clearly a market for home BP monitors. Indeed, sales of home BP monitors have increased roughly 10% per year, creating an industry-estimated $330 million market.[15] However, the extent to which patients utilize HBPM, either with or without the recommendation of or oversight by a physician, is largely unknown. The purpose of this study was to determine the prevalence of the use of HBPM and factors associated with its use by hypertensive patients in a primary care population.

METHODS

Overall Design

This study was a cross-sectional survey of adult patients seen in practices within the North Carolina Family Medicine Research Network. The 24 practices in the network were selected to represent the geographic regions and ethnic diversity of the state of North Carolina. Through this practice-based research network (PBRN), a cohort of patients was developed for the purpose of facilitating research on health care problems commonly addressed in primary care settings.[16] A complete description of the network's scope and design is presented elsewhere.[16]

For initial enrollment, all patients 18 years and older who presented for a scheduled office visit during a 4-week period were approached for participation. Of those, 64% agreed to participate.[16] Patients who agreed to participate were given a 4-page enrollment questionnaire containing standardized questions on self-reported chronic conditions and health habits as well as demographic items. Patients were asked whether they were willing to be contacted for future studies, and 81.9% granted such permission.[16] The current study surveyed a sample of those individuals who completed the enrollment survey. This study was approved by the Biomedical Institutional Review Board of the University of North Carolina at Chapel Hill School of Medicine.

Sample

In the updated year 2004 to 2005 cohort of patients enrolled in the PBRN (n=2720), 1088 patients indicated on their enrollment questionnaire that they had high BP. From these 1088 potential participants, we drew a computer-generated random sample stratified by race (446 whites and 254 blacks). We anticipated a 60% response rate, or 420 returned questionnaires, which would allow precision within 5%, assuming the proportion who used HBPM was 10%.

Survey Instrument and Variables

The survey instrument was developed by the project investigators through an iterative process. After an initial drafting and revisions of the HBPM questionnaire, the final product was guided by a focus group in which clinic nurses and medical assistants were queried regarding their perceptions of patients' performance of HBPM, gleaned from their interactions with patients. The questions were also assessed for clarity and readability during this focus group. Six knowledge questions were drawn from a 12-item questionnaire designed by the National Institutes of Health for assessment of high BP knowledge among nonmedical persons.[17] The final questionnaire contained 20 items.

We considered respondents to be using HBPM if they answered "yes" to the question, "Do you currently use a home blood pressure monitoring device to check your blood pressure?" While many patients may believe that measuring their BP in a pharmacy is equivalent to HBPM, the two are not equivalent. Therefore, other methods of out-of-office self BP measurement (eg, using an automated device stationed in a pharmacy) were not considered HBPM. The survey instrument also included the question, "Has your doctor ever recommended that you use a home blood pressure monitoring device to check your blood pressure?" We created a variable representing the number of the 6 knowledge questions answered correctly and divided respondents into percentiles of hypertension knowledge. The 90th percentile corresponded to answering all 6 questions correctly. The 10th percentile corresponded to answering ≤4 items correctly.

For incorporating the remaining independent variables, the home BP monitoring questionnaire data were linked to the variables already maintained on respondents (eg, demographics, other cardiovascular conditions, health behaviors). From these variables, we included several characteristics that have either been shown or that we hypothesized to be associated with use of HBPM. Age, self-reported health status, and education level were each divided into 3 categories. Body mass index (BMI) was computed based on self-reported height and weight and divided into 3 categories.

Survey Administration

The survey was mailed with a cover letter and postage-paid return envelope to the 700 potential

respondents using the most recent address in the PBRN database. As a small token of appreciation, a $1 bill was attached to the questionnaire. A reminder/thank you postcard was mailed to all 700 potential respondents 1 week later. A second questionnaire was mailed to nonrespondents 3 weeks later. Six weeks after the second mailing, attempts were made to contact remaining nonrespondents by telephone. Patients who were contacted were offered completion of the questionnaire via telephone or a third mailing. Upon receipt of completed surveys, the data were double-entered into a database. Once all survey data were entered, the data were imported into standard statistical software, compared for accuracy, checked for logical errors, and cleaned and compiled.

Analysis

After performing a series of exploratory analyses to ensure the integrity of the data, we determined percentages of respondents and nonrespondents within categories of the independent variables; these are reported as means with standard deviations or percentages with 95% confidence intervals (CIs). We then determined bivariate associations of the independent variables with reports of current use of HBPM and tested for significance using Pearson chi-square. Those characteristics with a *P* value <.10 were placed into a multivariate logistic regression model to determine their independent associations with current use of a HBPM device.

Refusals to answer questions and missing values were handled by exclusion from analysis. As a result, 79 observations were excluded from the regression model. We considered *P* values of ≥.05 and 95% CIs not containing the null value to be statistically significant. All analyses were performed using Stata 8.1 statistical software (StataCorp, College Station, TX).

RESULTS

Of the 700 questionnaires mailed, 25 were undeliverable. There were 15 mail refusals, and 11 recipients were ineligible (9 were deceased; 1 was incarcerated; 1 did not have hypertension). Following the first mailing, 433 questionnaires were returned completed. An additional 31 questionnaires were returned completed after the second mailing. During the period of telephone follow-up, an additional 66 questionnaires were completed for a conservative, unadjusted response rate of 76% (530 of 700). After excluding ineligibles (n=11) and undeliverables (n=25), the response rate was 80% (530 of 664).

Respondents had a mean age of 59.6±13.7 years. The majority were female (68.5%), white (67.5%), and overweight or obese (86.1%); did not smoke (79.2%); and had at least a high school education (74.4%) (Table I). More than one-fourth (26.0%) reported having heart disease, one-third had diabetes, and 10.3% reported a history of a stroke or mini-stroke (transient ischemic attack [TIA]). Nonrespondents were disproportionately younger, black, and male.

Knowledge of hypertension was relatively high, with approximately 44% of respondents having a knowledge level in the 90th percentile. Slightly more than 35% reported that a doctor had recommended using a home BP monitor. Overall, 43.1% (95% CI, 38.8–47.3) of respondents reported currently using a HBPM device (Table I).

In bivariate analyses (Table II), older individuals were more likely to use HBPM (47.0% for those older than 65 years vs 29.3% for those younger than 45 years; *P*=.03); whites were more likely than blacks to use HBPM (47.0% vs 34.7%; *P*=.008); overweight (BMI, 25–30 kg/m^2) and normal/underweight (BMI <25 kg/m^2) hypertensives were more likely to use HBPM than obese (BMI >30 kg/m^2) hypertensives; and those with known heart disease were more likely to use HBPM (52.9% vs 40.8%; *P*=.02). Persons with greater hypertension knowledge were more likely to use HBPM (47.1% of those with a knowledge level in greater than the 90th percentile vs 33.3% of those with a knowledge level in less than the 10th percentile; *P*=.05). Recalling a recommendation by one's doctor had the strongest bivariate relationship with current use of HBPM (71.4% vs 27.8%; *P*<.001).

After adjustment for the other variables in the model, older age remained a factor associated with use of HBPM. Compared with hypertensives younger than 45 years, individuals older than 65 years were more likely to use HBPM (odds ratio [OR], 2.53; 95% CI, 1.20–5.33) (Table III). The association with history of stroke or TIA was strengthened after adjustment (OR, 2.06; 95% CI, 1.00–4.24); hypertension knowledge remained associated with use of HBPM (OR, 1.96 for those with highest-percentile knowledge; 95% CI, 1.08–3.56). Recalling a recommendation by one's doctor remained the factor most strongly associated with use of HBPM (OR, 7.93; 95% CI, 4.96–12.7).

Sex, education level, self-reported exercise status, and smoking status were not associated with use of HBPM. Hypertensive patients with diabetes were no more likely to use HBPM than those without diabetes. Race, BMI, self-reported health status,

Table I. Characteristics of Survey Respondents (n=530) and Nonrespondents (n=170)

	Respondents		Nonrespondents	
	Mean (SD) or %	95% Confidence Interval	Mean (SD) or %	95% Confidence Interval
Age, y	59.6 (13.7)		54.2 (15.8)	
Age category, y				
<45	14.2	11.2–17.2	27.7	20.9–34.4
45–65	50.4	46.1–54.6	47.1	39.5–54.6
>65	35.5	31.4–39.6	25.3	18.7–31.9
Male	31.5	27.5–35.5	44.4	36.8–51.9
Race				
Black	32.5	28.5–36.5	48.2	40.6–55.8
White	67.5	63.5–71.5	51.8	44.2–59.4
Education level				
<High school graduate	25.6	21.9–29.4	29.9	22.9–37.0
High school graduate	32.5	28.5–36.5	32.3	25.2–39.5
Some college or more	41.9	37.6–46.1	37.7	30.3–45.2
Reports little/no exercise	42.3	38.0–46.6	45.7	37.9–53.4
Body mass index, kg/m^2				
<25	14.0	11.0–16.9	18.2	12.4–24.1
25–30	30.8	26.8–34.7	25.3	18.7–31.9
>30	55.3	51.0–59.5	56.5	48.9–64.0
Self-reported health				
Excellent or very good	21.2	17.7–24.7	15.9	10.3–21.4
Good	39.5	35.3–43.7	36.5	29.2–43.8
Fair or poor	39.3	35.1–43.5	47.6	40.1–55.2
Current smoker	20.8	17.3–24.3	30.2	23.2–37.2
Other cardiovascular conditions				
Heart disease	26.0	22.1–29.9	29.9	22.4–37.4
Diabetes	32.6	28.4–36.7	38.0	30.1–45.9
Stroke or mini-stroke	10.3	7.6–13.1	14.1	8.4–19.7
Hypertension knowledge				
<10th percentile	22.3	18.7–25.9		
10th–90th percentile	34.1	30.0–38.2		
>90th percentile	43.6	39.3–47.9		
Doctor ever recommended using home blood pressure monitor	35.2	31.1–39.3		
Currently use home blood pressure monitor	43.1	38.8–47.3		

and heart disease were not independently associated with use of HBPM in the multivariate model.

DISCUSSION

In this sample of hypertensive adults from a primary care population, we found a surprisingly high proportion (43.1%) currently using HBPM. There are few published primary care-based data on prevalence of use of HBPM with which to compare our results. A study of hypertensive patients in a primary care clinic in Singapore found that 24% of hypertensives used HBPM.[18] A study of use of HBPM by patients visiting a hospital hypertension clinic in Italy demonstrated that a much higher proportion (66%) were using HBPM.[19] Another study of patients calling a "cardiovascular hotline" in Germany found that 71% used HBPM.[20] It is not surprising that studies of patients visiting hypertension clinics or calling a cardiovascular telephone service would find higher rates of utilization of HBPM.

A population-based survey of residents in a metropolitan area of the United States conducted more than 20 years ago from 1981 to 1984 found that

Table II. Bivariate Associations With Current Use of Home Blood Pressure Monitoring

	No.	%	*P* Value
Age category, y			
<45	22	29.3	.03
45–65	117	44.2	
>65	87	47.0	
Sex			
Male	76	45.8	.39
Female	150	41.8	
Race			
Black	59	34.7	.008
White	167	47.0	
Education level			
<High school graduate	58	44.3	.27
High school graduate	64	38.1	
Some college or more	101	46.1	
Reports little/no exercise			
Yes	97	44.7	.52
No	123	41.8	
Body mass index, kg/m^2			
<25	36	49.3	.002
25–30	84	52.5	
>30	106	36.3	
Self-reported health			
Excellent or very good	57	50.9	.09
Good	90	43.5	
Fair or poor	78	38.1	
Current smoker			
Yes	48	43.6	.90
No	178	43.0	
Heart disease			
Yes	65	52.9	.02
No	147	40.8	
Diabetes			
Yes	63	39.6	.20
No	151	45.7	
Stroke or mini-stroke			
Yes	26	55.3	.08
No	178	42.0	
Hypertension knowledge			
<10th percentile	38	33.3	0.05
10th–90th percentile	74	42.5	
>90th percentile	105	47.1	
Doctor ever recommended using home BP monitor			
Yes	132	71.4	<.001
No	94	27.8	

only 7.5% of respondents reported having a device (sphygmomanometer) in their home for measuring BP.[21] Many of those having such a device were health care professionals, and while persons in the sample who indicated that they had hypertension were more likely to report owning a device, the devices were not necessarily being used by the owners to measure or track their BP.[21] The actual prevalence of use of HBPM devices by hypertensive patients in that study is unclear, but an increase in ownership and usage would be expected in the ensuing 2 decades given the improved automated technology, lower cost, advice by physicians, and wider availability of devices. Our study thus adds to a paucity of data on current utilization of HBPM by hypertensive patients in the primary care setting, where the vast majority of such patients are seen and managed.

The study conducted in Singapore was a relatively recent study that was similar in its intent to ours in that it sought to determine use of HBPM by hypertensive patients in a primary care setting.[18] In that study, persons with higher socioeconomic status were more likely to use HBPM, and age was not associated with use of HBPM.[18] In contrast, we found that—at least as measured by education level—socioeconomic status was not associated with use of HBPM. We found that older persons were more likely to use HBPM, a finding consistent with the fact that older persons generally take more interest in their health because they have more health problems. Our finding that persons with diabetes were no more likely to use HBPM than those without diabetes was similar to what was found in the Singapore study. Perhaps diabetic patients are not using HBPM because they are spending time performing home glucose monitoring. It is worth noting though that the BP goal for diabetic patients (<130/80 mm Hg) is lower than for nondiabetic patients (<140/90 mm Hg) and that good BP control may be more important than tight glucose control for reducing morbidity and mortality.[13,22]

We did find that hypertensive patients with a history of stroke or TIA were more likely to use a HBPM device. The importance of BP control in such patients may have been emphasized by those in charge of their care, and use of HBPM may be one way to achieve better control in such patients. In a meta-analysis of 18 randomized controlled trials, HBPM was shown to result in BP goals being achieved in a greater proportion of hypertensive patients compared with usual monitoring in the health care setting.[8]

Table III. Independent Associations[a] With Use of Home Blood Pressure Monitoring (N=451)

	Odds Ratio	95% Confidence Interval	*P* value
Age category, y			
<45		referent	
45–65	2.06	1.03–4.11	.04
>65	2.53	1.20–5.33	.02
Race			
Black		referent	
White	1.42	0.88–2.32	.15
Body mass index, kg/m^2			
<25		referent	
25–30	0.97	0.49–1.92	.94
>30	0.54	0.28–1.04	.07
Self-reported health			
Excellent or very good		referent	
Good	1.04	0.57–1.92	.89
Fair or poor	0.63	0.33–1.18	.15
Heart disease	1.52	0.89–2.61	.12
Stroke or mini-stroke	2.06	1.00–4.24	.05
Hypertension knowledge			
<10th percentile		referent	
10th–90th percentile	1.40	0.77–2.56	.27
>90th percentile	1.96	1.08–3.56	.03
Doctor recommendation	7.93	4.96–12.7	<.001

[a]Adjusted for all other characteristics in table.

Despite such evidence that HBPM can assist in improving BP control in hypertensive patients, we found that only about 35% of patients report that their primary care physician recommended it. One prior survey found that 52% of primary care physicians felt that HBPM could cause problems in treating hypertension, expressed mostly as an anticipated increase in patients contacting them due to concern about elevated readings.[23] Our study demonstrates that the factor most strongly associated with patients using HBPM is that their doctor recommended it. Because HBPM appears to be a cost-effective self-care adjunct in the management of hypertension, primary care physicians ought to consider making such a recommendation, particularly to those for whom getting to goal BP seems to be difficult. It is possible that one reason physicians have yet to fully endorse the use of HBPM is lack of clear guidance on how to best use it in the care of their patients. New evidence is helping to sort out this problem,[7,24] and future versions of hypertension guidelines may well include more information on use of HBPM.

A recent national survey study of hypertension management conducted for the Hypertension Education Foundation also included questions on use of HBPM.[25] In that study, slightly more than half of respondents reported that their physician had recommended they use HBPM, and 3 out of 5 respondents had a monitoring device at home. More than half of patients with monitors reported HBPM to be helpful, very helpful, or extremely helpful in controlling BP. Also noted was that persons with multiple health problems were more likely to use HBPM daily.

Limitations

For this study, we did not examine whether a doctor's recommendation for use of HBPM varied based on BP levels. It is possible that HBPM was suggested more often by physicians and initiated more often by patients when BP values were far above target levels. We also did not examine use of HBPM with control of BP. We asked respondents to indicate whether their last BP measurement was <140/90 mm Hg. Respondents currently using HBPM were more likely to report that that their last BP measurement was <140/90 mm Hg (77.4% vs 63.6%; *P*=.006). While suggestive, these self-reports cannot be used to affirm that office BP control is greater among those using HBPM.

This study relied on self-report to identify patients with hypertension. We also relied on self-report to determine whether a doctor had ever recommended using HBPM. The potential limitation

of recall bias must be considered. If persons not currently using an HBPM device recall being given the advice to use one by their doctor at a lower rate than those who are currently using a device, the result would be biased away from the null. However, such a bias is unlikely to fully explain the large effect size seen. We must also consider the possibility of nonresponse bias. If nonrespondents tended not to use HBPM, our results of associations with male sex, white race, and older age may have been biased. However, this bias would be toward the null for race and older age and away from the null only for male sex.

Perhaps the most important consideration is that the overall recruitment rate of participants visiting the network practices was only 64%. Taking into account that 81.9% of those recruited persons agreed to be contacted for future studies (such as this one), the general overall recruitment rate for the cohort from which this study's sample was drawn was approximately 52.4%. Thus, while our adjusted response rate to this particular study was 80%, the overall response rate was approximately 42%. It is probable that this selection bias resulted in a sample of persons generally more interested in their health. Therefore, caution must be used in generalizing our findings. The actual proportion of hypertensive adults in the primary care setting who currently use HBPM may be higher or lower than estimated, depending on the degree to which the sample may differ from the overall primary care population.

CONCLUSIONS

In this sample of hypertensive adults seen in the primary care setting, approximately 43% currently use HBPM. Persons more likely to use HBPM are older and have greater hypertension knowledge. Recommendation by one's doctor is the factor most strongly associated with use of HBPM. Because HBPM may be a valuable tool in hypertension self-management, clinicians should consider recommending it more widely.

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