Two Self-management Interventions to Improve Hypertension Control
A Randomized Trial
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Background: Fewer than 40% of persons with hypertension in the United States have adequate blood pressure (BP) control.

Objective: To compare 2 self-management interventions for improving BP control among hypertensive patients.

Design: A 2 × 2 randomized trial, stratified by enrollment site and patient health literacy status, with 2-year follow-up. (ClinicalTrials.gov registration number: NCT00123058)

Setting: 2 university-affiliated primary care clinics.

Patients: 636 hypertensive patients.

Intervention: A centralized, blinded, and stratified randomization algorithm was used to randomly assign eligible patients to receive usual care, a behavioral intervention (bimonthly tailored, nurse-administered telephone intervention targeting hypertension-related behaviors), home BP monitoring 3 times weekly, or the behavioral intervention plus home BP monitoring.

Measurements: The primary outcome was BP control at 6-month intervals over 24 months.

Results: 475 patients (75%) completed the 24-month BP follow-up. At 24 months, improvements in the proportion of patients with BP control relative to the usual care group were 4.3% (95% CI, 1.9% to 6.7%) in the behavioral intervention group, 4.5% to 12.9%) in the behavioral intervention group, and 11.0% (CI, 1.9%, 19.8%) in the combined intervention group. Relative to usual care, the 24-month difference in systolic BP was 0.6 mm Hg (CI, −2.2 to 3.4 mm Hg) for the behavioral intervention group, −0.6 mm Hg (CI, −3.6 to 2.3 mm Hg) for the BP monitoring group, and −3.9 mm Hg (CI, −6.9 to −0.9 mm Hg) for the combined intervention group; patterns were similar for diastolic BP.

Limitation: Changes in medication use and diet were monitored only in intervention participants; 24-month outcome data were missing for 25% of participants, BP control was adequate at baseline in 73% of participants, and the study setting was an academic health center.

Conclusion: Combined home BP monitoring and tailored behavioral telephone intervention improved BP control, systolic BP, and diastolic BP at 24 months relative to usual care.

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Although multiple treatment options are available for hypertension, only one third of U.S. patients with hypertension have their blood pressure (BP) under effective control (1). Home BP monitoring is a potentially important aspect of successful hypertension management (2). Adopting a healthy lifestyle and adhering to provider recommendations are also important in managing hypertension. Few educational and BP monitoring studies have provided long-term follow-up (>12 months) or implemented a multidimensional intervention that is tailored to patients’ needs and delivered by telephone (3). A tailored telephone behavioral intervention and home BP monitoring may be a cost-effective method for improving BP outcomes (4).

We compared the effectiveness of BP self-monitoring, a tailored, nurse-administered behavior self-management intervention, and a combination of the 2 interventions with that of usual care.

Methods

The study was approved by the Duke University Institutional Review Board, and all patients provided written informed consent.

Setting and Participants

Recruitment occurred from May 2004 to December 2005, with follow-up from November 2004 to January 2008. Potentially eligible study patients were identified through weekly data extractions from the billing and appointment database for 2 Duke University Health System primary care clinics. Patients were cared for by 7 faculty general internists in 1 clinic and 85 residents under the supervision of faculty at the other clinic.

Initial inclusion criteria were hypertension diagnosed at least 12 months before the data extraction date (International Classification of Diseases, 9th revision, codes 401.0, 401.1, or 401.9), enrollment with a primary care physician at the included clinic for at least 12 months before data extraction, self-report of current antihypertension medication use, and adherence for at least 6 months with a provider review of BP, medication adherence, and lifestyle recommendations.

Exclusion criteria were patients with a history of renal disease or diabetes, or those receiving treatment for diabetes.

A total of 636 patients were enrolled, of whom 16% had diabetes, 95% were Caucasian, 13% were non-Hispanic black, and 40% were male. The mean age was 66 years, and the mean baseline diastolic blood pressure was 95 mm Hg. The study was approved by the Duke University Institutional Review Board, and all patients provided written informed consent.

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Can self-management interventions help improve blood pressure control in hypertensive patients?

In this trial, 636 patients with hypertension were randomly assigned to receive usual care; a telephone-delivered, nurse-administered behavioral self-management intervention; home blood pressure self-monitoring; or both of the latter 2 interventions. Compared with usual care, the adjusted improvement in the proportion of patients with blood pressure control at 24 months was 4.3% for the behavioral intervention group, 7.6% for the blood pressure monitoring group, and 11.0% for the combined intervention group.

Caution

Patients were recruited from 2 university-affiliated clinics, and most (73%) already had reasonable blood pressure control at trial entry.

—The Editors

Figure 1 shows the flow of participants in the study. Overall, 2060 invitation letters were mailed to patients. Research assistants attempted to contact 1728 potential participants by telephone. Six hundred fifty-six patients were enrolled and consented to participate; the remaining 1072 were not enrolled for various reasons. Twenty additional patients were excluded at the time of the baseline interview.

Randomization and Intervention

The 636 eligible patients were randomly assigned to receive usual care, a tailored behavioral telephone intervention, home BP monitoring, or the behavioral intervention plus BP monitoring. In a 2 × 2 design, randomization was stratified at baseline by enrollment site (2 primary care clinics) and health literacy status, as determined by using the Rapid Estimate of Adult Literacy in Medicine (5) (low literacy, score of 0 to 60 [9th-grade level or less] [6], vs. adequate literacy, score of 61 to 66 [greater than 9th-grade level] [7]). Consecutively numbered envelopes were used to randomly assign patients in each stratum. Randomization blocks of 16 were computer generated by the study statistician and used to ensure ongoing balanced enrollment across the 4 groups. The research assistants were blinded to block size, and patient randomization sequences were maintained by the study statistician in a separate office from the clinics. At completion of the baseline interview, a research assistant opened an envelope and disclosed the patient’s randomization status. Participants were reimbursed $25 for the baseline visit and for each of the 4 subsequent 6-month BP measurement visits ($125 total).

Usual Care

Patients assigned to usual care received hypertension care from their primary care provider. They were not provided home BP monitors and did not have access to the nurse-administered behavioral intervention. They underwent the same 6-month outcome assessment measurements as the other groups.

Tailored Behavioral Self-management Intervention

Patient factors targeted in the behavioral intervention included perceived risk for hypertension, memory, literacy, social support, patients’ relationships with their health care providers, and side effects of antihypertension medication. In addition, the intervention focused on improving adherence to the Dietary Approaches to Stop Hypertension (DASH) dietary pattern (8–11), weight loss (12, 13), reduced sodium intake (13, 14), regular moderate-intensity physical activity (15, 16), smoking cessation, and moderation of alcohol intake (17).

The intervention was delivered by 1 nurse during bimonthly telephone calls. All information was presented in an easily understood format with a Flesch–Kincaid readability score of less than 9th grade (18). Each encounter...
included a core group of modules potentially implemented during each call (for example, medication and side effects) plus additional modules activated at specific intervals (for example, diet and social support) (19).

### Home BP Monitoring Intervention

Patients assigned to home BP monitoring received an Omron HEM 773AC arm monitor (OMRON Healthcare, Bannockburn, Illinois) if arm circumference was 17 inches or less or an Omron HEM 637 wrist monitor if arm circumference was greater than 17 inches and wrist circumference was less than 8.5 inches. Two research assistants trained patients in proper use of the home BP devices. At each 6-month assessment, patients were retrained if their BP assessment procedure was incorrect. Patients were asked to measure their BP 3 times weekly on 3 separate days, at the same time of day, and record their values in a log. Patients were asked to mail their logs in every 2 months by using study-provided, preaddressed, stamped envelopes.

### Combined Intervention

Patients assigned to the combined intervention received a home BP monitor, training on its use, and the behavioral self-management intervention. The nurse did
not examine home BP values and did not use the home BP values to adjust the intervention.

Outcomes and Measurements

Baseline Measurement

Patient demographic information and diagnosis of diabetes were obtained from patients during a face-to-face baseline interview. Inadequate income was assessed by asking patients to report whether they had enough money to pay bills only by cutting back on things or had difficulty paying bills (20). Health literacy was evaluated as a dichotomous variable (7). Body weight abstracted from the medical record and self-reported height were used to calculate body mass index.

Study Outcomes: BP Control and Systolic and Diastolic BP

The primary outcome was the proportion of participants with adequate BP control at each study time point (baseline and 6, 12, 18, and 24 months). Blood pressure control was defined as systolic BP less than 140 mm Hg and diastolic BP less than 90 mm Hg for patients without diabetes, and systolic BP less than 130 mm Hg and diastolic BP less than 80 mm Hg for patients with diabetes (21). Secondary outcomes were systolic and diastolic BP at each time point over 24 months. At each time point, a research assistant who was blinded to the patient’s group assignment obtained 2 BP measurements with a digital sphygmomanometer (BPTRU Automated Non-invasive BP monitor, Model BPM-100, BpTRU Medical Devices Headquarters, Coquitlam, British Columbia, Canada); the first was obtained after patients were seated and had rested for at least 5 minutes, and the second was obtained 30 seconds after the first. The mean of the 2 values was used as the outcome for that time point.

We collected data on secondary outcomes, including hypertension knowledge and self-efficacy; however, these results are not reported here.

Health Care Utilization and Cost

Electronic data on medical resource use in the Duke University Health System were obtained for all enrolled patients from randomization through 24 months. These data included the cost estimates for all health care services.

The cost of each patient intervention encounter was based on an estimate of annual fixed costs (for example, office space and telephone) and the nurse’s salary and assumed that 7 encounters were completed per 6-hour day. This estimate was assigned to each completed patient encounter. Our cost estimates also included variable costs, which covered a relatively small amount for patient education materials (for example, paper and toner). Variable costs for home BP monitoring costs included the cost of the BP monitor and batteries.

Follow-up Procedures and Monitoring

We did not anticipate any specific adverse effects of the intervention. We monitored for cardiovascular adverse events, such as myocardial infarction, death, and hospitalizations, through medical record and patient report. A data safety and monitoring board met annually to review all adverse events.

Statistical Analysis

Sample size estimation was based on the primary hypothesis that patients assigned to an intervention group would have improved BP control at 24 months compared with the usual care group. A linear change in BP control was assumed, so the comparison was a difference in slopes (the treatment-by-time interaction in a logistic mixed-effects regression model [22]). Sample size and power estimates were generated empirically in a simulation study by using PROC NLMIXED in SAS, version 9.1 (SAS Institute, Cary, North Carolina). On the basis of previous studies (23, 24), we estimated baseline BP control as 40% and the 24-month dropout rate as 15%. The random intercept variance component was assumed to be 0.7 (equivalent to a patient interclass correlation of 0.18) (22). To detect a difference in slopes resulting in 10% improvement in BP control at 24 months with 80% power and a type I error rate of 5%, 570 patients were needed; however, to account for dropout, we enrolled 636 individuals.

Primary Analysis

A logistic mixed-effects regression model (22) was used to estimate change in BP control over time for each intervention group relative to usual care (that is, a difference in slopes). Observed means and exploratory analyses indicated that, on average, BP control improved in a linear trend over time and there were equal correlations between patients’ repeated measurements. The fixed effects for the model were coded to reflect the $2 \times 2$ factorial design and included a common intercept (25), the 2 stratification variables, time (in months), and the following interaction terms: behavioral intervention by month, home BP monitoring by month, and behavioral intervention by home BP monitoring by month. A random effect was included to account for the correlation of patients’ repeated measurements over time. Estimates for the proportion of patients with BP control for each intervention group and the usual care group at 12 and 24 months were converted to marginalized probabilities (22). One thousand bootstrap samples were used to derive CIs around the estimated differences of the marginalized probabilities between each intervention group and the usual care group at 12 and 24 months (26).

Secondary Analyses

For systolic and diastolic BPs, general linear models (PROC MIXED in SAS, version 9.1) were used to estimate changes in BP over time and to test for BP differences.
in the intervention groups relative to usual care at 12 and 24 months. Exploratory analyses indicated that both systolic and diastolic BPs had quadratic shapes in which improvements in BPs were greatest during the first half of the study. Predictors in the model were coded to reflect the 2 × 2 factorial design. The final model included a common intercept, the 2 stratification variables, and the following interaction terms: behavioral intervention by month, home BP monitoring by month, behavioral intervention by home BP monitoring by month, behavioral intervention by month squared, home BP monitoring by month squared, and behavioral intervention by home monitoring by month squared.

Patients were analyzed on the basis of initial randomization group (intention to treat); 634 patients were included in the analyses (Figure 1). All available data, including data from participants who subsequently discontinued the study, were used for analyses. Our analysis techniques assumed ignorable dropout, meaning that the probability of dropout may depend on covariates in the model or participants’ previous responses but not on current or future responses (22).

### Role of the Funding Source

The study was funded by the National Heart, Lung, and Blood Institute; a Pfizer Foundation Health Communication Initiative Award; and an Established Investigator Award from the American Heart Association to Dr. Bosworth. The funding sources had no role in the study design; data collection; administration of the interventions; analysis, interpretation, or reporting of data; or decision to submit the findings for publication.

### Results

#### Patients

Of the 636 study patients, 49% were African American, 66% were female, and 19% reported having inadequate income; the mean age was 61 years (Table 1). At baseline, mean systolic BP was 125 mm Hg (SD, 18) and mean diastolic BP was 71 mm Hg (SD, 11). Seventy-three percent of participants had their BP under control at baseline. Baseline characteristics did not differ meaningfully by treatment group.

### Table 1. Patient Characteristics at Baseline

<table>
<thead>
<tr>
<th>Characteristic*</th>
<th>All Patients (n = 636)</th>
<th>Usual Care Group (n = 159)</th>
<th>Behavioral Intervention Group (n = 160)</th>
<th>Home BP Monitoring Group (n = 158)</th>
<th>Combined Intervention Group (n = 159)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mean age (SD), y</td>
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<td>62 (12)</td>
<td>60 (13)</td>
<td>62 (12)</td>
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<tr>
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<td></td>
</tr>
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<td>48</td>
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<td>52</td>
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<tr>
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<td>Completed ≤12 y of school</td>
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<td>Low health literacy†</td>
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<td>No weekly aerobic exercise lasting ≥20 min</td>
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<td>20</td>
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<td>Current smoker</td>
<td>16</td>
<td>18</td>
<td>18</td>
<td>14</td>
<td>16</td>
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<tr>
<td>Mean BMI (SD), kg/m²</td>
<td>32.09 (8.2)</td>
<td>32.6 (8.5)</td>
<td>32.2 (8.8)</td>
<td>31.4 (7.6)</td>
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<td>Medication nonadherence§</td>
<td>36</td>
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<td>41</td>
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<td><strong>Medical history</strong></td>
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<td>Started taking BP medication &gt;5 y ago</td>
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<td>59</td>
<td>62</td>
<td>56</td>
<td>63</td>
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<tr>
<td>Parent or sibling has hypertension</td>
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<td>72</td>
<td>79</td>
<td>80</td>
<td>77</td>
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<tr>
<td><strong>BP¶</strong></td>
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<td></td>
</tr>
<tr>
<td>Controlled‡</td>
<td>73</td>
<td>72</td>
<td>72</td>
<td>77</td>
<td>70</td>
</tr>
<tr>
<td>Mean systolic BP (SD), mm Hg</td>
<td>125 (18)</td>
<td>124 (18)</td>
<td>124 (18)</td>
<td>126 (15)</td>
<td>126 (20)</td>
</tr>
<tr>
<td>Mean diastolic BP (SD), mm Hg</td>
<td>71 (11)</td>
<td>70 (10)</td>
<td>71 (10)</td>
<td>72 (11)</td>
<td>72 (12)</td>
</tr>
</tbody>
</table>

BMI = body mass index; BP = blood pressure.
* Unless otherwise indicated, data are the percentage of patients. All data except BP and weight used in the calculation of BMI were patient-reported. Missing values were included in the calculation of percentages.
† Less than 9th grade, as indicated by a Rapid Estimate of Adult Literacy in Medicine score ≤60.
‡ Defined as reporting difficulty paying bills no matter what was done or having money to pay bills only if the patient cut back on spending on other things.
§ Assessed by using a 4-item measure based on the Morisky scale (33). Response options ranged from strongly agree (1) to strongly disagree (4). A summary binary variable was created by coding those who responded “strongly agree,” “agree,” “don’t know,” or “refused” to any of the 4 questions as 1 (nonadherent); otherwise, patients received a value of 0 (adherent).
¶ When patients had multiple BP readings during their baseline visit, mean systolic and mean diastolic readings were used as the baseline BP values.
† According to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure guidelines: <140/90 mm Hg for nondiabetic patients and <130/80 mm Hg for diabetic patients.
Figure 2. Changes in study outcomes from baseline to 24 months, by intervention group.

Bars represent 95% CIs. BP = blood pressure. **Top.** Estimated proportion of patients with BP control. Estimates are marginalized probabilities from a logistic mixed-effects regression model (22). The model-estimated intrapatient correlation was 0.56. The 95% CIs at 12 and 24 months were derived from 1000 bootstrap samples. **Middle.** Estimated mean systolic BP. Estimates are based on a general linear model with an unstructured covariance matrix. The model-estimated correlation between time points ranged from 0.41 (baseline and 24 months) to 0.58 (months 6 and 12). **Bottom.** Estimated mean diastolic BP. Estimates are based on a general linear model with an unstructured covariance matrix. The model-estimated correlation between time points ranged from 0.54 (baseline and 24 months) to 0.66 (baseline and 6 months).

The 1424 persons who were excluded before random allocation were similar to study participants in sex (64% female) and diagnosis of diabetes but were slightly older (mean age, 63 years) and were more likely to be African American (57%). No crossover among study groups occurred; however, individuals not assigned to the home BP monitoring groups may have used their own BP monitors. No study-related adverse events occurred in any intervention group.

Overall, BP measurements were available for 475 (75%) patients at 24 months of follow-up (Figure 1): 81%, 78%, 72%, and 69% of patients in the usual care, behavioral intervention, home BP monitoring, and combined intervention groups, respectively (P = 0.075). Sixty-three percent of patients with lower health literacy and 79% of those with higher health literacy (P < 0.001) and 57% of patients at one of the clinics versus 82% at the other clinic (P < 0.001) had BP readings at 24 months.

**Primary Outcome: BP Control**

The combined intervention had the greatest increase in the proportion of patients with BP control (Figure 2). At 24 months, the adjusted improvement compared with usual care was 11.0% (95% CI, 1.9% to 19.8%; P = 0.012) for the combined intervention group, 4.3% (CI, −4.5% to 12.9%; P = 0.34) in the behavioral intervention group, and 7.6% (CI, −1.9% to 17.0%; P = 0.096) for the home BP monitoring group. The 3-way interaction of behavioral intervention by home BP monitoring by month squared was significant (P = 0.041 for the systolic BP model; P = 0.004 for the diastolic BP model), indicating that the main effects of home BP monitoring and the behavioral interventions on BP over time enhanced one another (Table 2).

**Secondary Outcomes**

**Systolic and Diastolic BP**

The largest sustained improvement for systolic and diastolic BP was observed in the combined intervention group (Figure 2). The 3-way interaction of behavioral intervention by home monitoring by month squared was significant (P = 0.041 for the systolic BP model; P = 0.004 for the diastolic BP model), indicating that the main effects of home BP monitoring and the behavioral interventions on BP over time enhanced one another (Table 2).

Figure 2 shows the changes in BP over time. At 12 months, the mean systolic BP was lower by 1.6 mm Hg (CI, −3.9 to 0.7 mm Hg; P = 0.174) in the behavioral intervention group, 3.7 mm Hg (CI, −6.1 to −1.2 mm Hg; P = 0.004) in the home BP monitoring group, and 3.3 mm Hg (CI, −5.7 to −0.8 mm Hg; P = 0.009) in the combined intervention group than the usual care group. However, by 24 months, the mean systolic BP was statistically significantly lower only in the combined intervention group than in the usual care group, indicating the synergistic effect of the 2 interventions on improving BP over time. Compared with the usual care group, the adjusted 24-month difference in systolic BP was 0.6 mm Hg (CI, −2.2 to 3.4 mm Hg; P = 0.67) in the behavioral...
intervention group, −0.6 mm Hg (CI, −3.6 to 2.3 mm Hg; \( P = 0.69 \)) in the home BP monitoring group, and −3.9 mm Hg (CI, −6.9 to −0.9 mm Hg; \( P = 0.010 \)) in the combined intervention group.

Compared with the usual care group at 12 months, the mean diastolic BP was lower by 1.4 mm Hg (CI, −2.6 to −0.1 mm Hg; \( P = 0.030 \)) in the behavioral intervention group, 3.1 mm Hg (CI, −4.4 to −1.8 mm Hg; \( P < 0.001 \)) in the home BP monitoring group, and 2.2 mm Hg (CI, −3.5 to −0.8 mm Hg; \( P = 0.001 \)) in the combined intervention group (Figure 2). Similarly to systolic BP, the synergistic effect of the combined intervention on diastolic BP was evident by the end of follow-up. Compared with that in the usual care group, the adjusted 24-month difference in diastolic BP was 0.4 mm Hg (CI, −1.1 to 1.9 mm Hg; \( P = 0.61 \)) in the behavioral intervention group, −1.2 mm Hg (CI, −2.9 to 0.4 mm Hg; \( P = 0.132 \)) in the home BP monitoring group, and −2.2 mm Hg (CI, −3.8 to −0.6 mm Hg; \( P = 0.009 \)) in the combined intervention group.

Adherence

Behavioral Self-management Intervention. The nurse completed 1682 telephone calls to the 160 patients assigned to the behavioral intervention. The mean number of completed calls per patient was 11 (SD, 2) of a possible 12, and the mean call length was 16 minutes (SD, 7).

Home BP Monitoring. Of the 158 patients assigned to the home BP monitoring intervention, 91% of patients in the first 2 months of the study and 64% of patients in the last 2 months turned in BP logs with at least 1 recorded BP reading. The percentage of patients who turned in their logs was higher among patients who completed the study.

Combined Intervention. Of the 159 patients assigned to the combined intervention group, 89% and 59% turned in BP logs with at least 1 recorded BP reading for the first and last 2 months of the study, respectively; these proportions were 99% and 81%, respectively, for the 110 patients with a BP measurement at 24 months. Nurses completed 1589 telephone calls to 156 patients; the mean number of completed calls per patient was 10 (SD, 3) of a possible 12, and the mean call length was 16 minutes (SD, 7).

Medical Resource Use and Costs

The number of outpatient encounters over 24 months was similar for the 4 groups; medians ranged from 13 to 15 (\( P = 0.73 \)). The proportion of hospitalized individuals did not differ (range, 19.5% to 22.6%; \( P = 0.91 \)). The mean 2-year medical cost across the groups was $15 641 (SD, $25 769; median, $6698).

Intervention Cost Analysis

Intervention costs over 2 years were estimated to be $345 for the behavioral intervention, $90 for home BP monitoring, and $416 for the combined intervention (not including patient time costs). In sensitivity analyses, the mean cost to implement the combined intervention ranged from $208 to $811 per patient, depending on assumptions regarding the mean time between successful encounters and various direct costs of implementing the intervention.

Additional Analyses

We examined self-reported medication adherence and exercise at 6 and 24 months of follow-up; however, although there were trends indicating improvement over time, changes in the intervention groups compared with the usual care group were not generally statistically significant.
DISCUSSION

We examined the effects of a patient behavioral intervention delivered by telephone, home BP monitoring, and a combination of these interventions in improving BP among hypertensive adults treated in primary care. Neither intervention alone improved BP control at 24 months; however, the combination intervention resulted in a clinically significant improvement in BP control of 11% compared with usual care. Patients in the combined intervention group also had a clinically meaningful decrease in systolic BP of 3.9 mm Hg compared with the usual care group. These effects were observed with a brief telephone intervention that was implemented bimonthly and the use of home BP monitors, which required minimal patient training (<5 minutes every 6 months).

Home BP monitoring alone has been well studied as a method to improve BP control. Its main effect is thought to be on BP recognition, which may lead to improved adherence and better control. Our results regarding home BP monitoring are consistent with those of a meta-analysis of 18 randomized, controlled trials that compared home BP monitoring with usual care and found that home BP monitoring resulted in small improvements in BP (reduction of 2.2/1.9 mm Hg) (27). A decrease in BP may encourage the patient to continue treatment, whereas continued high BP readings may encourage appropriate changes in lifestyle or therapy (28) and faster changes to medical regimens (29).

A literature search through June 2009 using the terms self-management and behavior intervention yielded 7 randomized, controlled trials. These trials reported mean differences in systolic BP ranging from −15.7 to 0.6 mm Hg (30) and had an average follow-up of less than 12 months. However, the trials involved in-person contact, which potentially reduces scalability and increases intervention costs. In a review of 10 studies testing mostly in-person behavioral interventions, results favored counseling over usual care, with improvements of 11.1 mm Hg in systolic BP and 3.5 mm Hg in diastolic BP (31). Few studies have implemented a multidimensional intervention that is tailored to patients’ needs and delivered by telephone, yet based in primary care practices. Furthermore, few studies have examined changes in BP for longer than 12 months, which was particularly relevant in our study; the effects of using home BP monitors at 12 months indicated an almost 4–mm Hg decrease in systolic BP, but these findings dissipated by 24 months for all but the combined intervention group. The combined intervention did not increase health care use, and its cost was approximately $400 for 2 years.

The patient self-management intervention was effective only when combined with home BP monitoring. One proposed explanation is that self-management may be most effective when it includes ongoing disease monitoring by patients that creates the opportunity to respond to new information (32).

Our study had limitations, 2 of which were the high rate of BP control (73%) in the study population at baseline and the academic health center setting. The relationship between BP and cardiovascular risk is continuous, and BP reductions translate to reductions in clinical events, even with observed relatively low baseline BP (21). Changes in process measures, such as medication use and salt intake during the trial, were measured only in the intervention groups. Finally, 25% of the sample was not available at 24 months; however, we used mixed-effects models as our primary analysis tool, which includes all patients with any BP measurements and leads to valid inferences.

In conclusion, the combination of home BP monitoring and a tailored brief behavioral intervention resulted in a clinically and statistically significant improvement in BP control and decreased systolic and diastolic BP at 24 months, at minimal cost. This combination may be a valuable tool for improving BP control rates.

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