Cluster-Randomized Trial of a Physician/Pharmacist Collaborative Model to Improve Blood Pressure Control

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Background—The purpose of this study was to evaluate if a physician/pharmacist collaborative model would be implemented as determined by improved blood pressure (BP) control in primary care medical offices with diverse geographic and patient characteristics and whether long-term BP control could be sustained.

Methods and Results—Prospective, cluster-randomized trial of 32 primary care offices stratified and randomized to control, 9-month intervention (brief), and 24-month intervention (sustained). We enrolled 625 subjects with uncontrolled hypertension; 54% from racial/ethnic minority groups and 50% with diabetes mellitus or chronic kidney disease. The primary outcome of BP control at 9 months was 43% in intervention offices (n=401) compared with 34% in the control group (n=224; adjusted odds ratio, 1.57 [95% confidence interval, 0.99–2.50]; P=0.059). The adjusted difference in mean systolic/diastolic BP between the intervention and control groups for all subjects at 9 months was −6.1/−2.9 mmHg (P=0.002 and P=0.005, respectively, and it was −6.4/−2.9 mmHg (P=0.009 and P=0.044, respectively) in subjects from racial or ethnic minorities. BP control and mean BP were significantly improved in subjects from racial minorities in intervention offices at 18 and 24 months (P=0.048 to P=0.001) compared with the control group.

Conclusions—Although the results of the primary outcome (BP control) were negative, the key secondary end point (mean BP) was significantly improved in the intervention group. Thus, the findings for secondary end points suggest that team-based care using clinical pharmacists was implemented in diverse primary care offices and BP was reduced in subjects from racial minority groups.

Clinical Trial Registration—URL: http://www.clinicaltrials.gov. Unique identifier: NCT00935077.

Key Words: hypertension ■ patient care team ■ pharmacists

Physician/pharmacist collaboration has been an effective strategy to improve blood pressure (BP) in primary care.1,2 Our team has developed an effective model of physician/pharmacist collaboration studied in carefully controlled efficacy studies.3–6 The most recent meta-analysis7 and systematic review8 have reconfirmed that pharmacist interventions can significantly improve BP. The authors of the meta-analysis evaluated 39 randomized controlled trials in 14,224 patients and found pharmacist interventions reduced systolic BP (SBP)−7.6 mmHg (95% confidence interval [CI], −9.0 to −6.3 mm Hg) compared with usual care. These authors concluded that pharmacist interventions were highly effective but that comparative effectiveness studies with longer duration of follow-up are still needed to determine the most efficient methods of implementation.7 Of note, most studies reported before 2008 when this study was designed, would be described as efficacy studies conducted under optimal conditions and often included only 1 or 2 offices with a small number of intervention pharmacists. It is not known if our intervention would be implemented in typical primary care offices when evaluated in an effectiveness trial under more routine care conditions. It is also unclear if pharmacist interventions are as effective in under-represented minority populations when compared with whites. Finally, it is not clear if there is a sustained effect after discontinuation of the intervention.9–11

The purpose of the Collaboration Among Pharmacists and Physicians To Improve Outcomes (CAPTION) study was to evaluate whether the intervention (1) could be implemented in a large number of medical offices, (2) had a sustained effect once it was discontinued, and (3) was effective in minority populations. CAPTION was an implementation trial designed...
WHAT IS KNOWN

• Involving pharmacists in team-based care has been shown to improve blood pressure when compared with usual care.
• Most studies were efficacy studies involving pharmacists and have been conducted in small numbers of clinics and included limited number of pharmacists.

WHAT THE STUDY ADDS

• The physician/pharmacist collaborative intervention was implemented in diverse medical offices and patient populations. In spite of a negative primary outcome, it provides insight to implementation issues.
• Reductions in mean blood pressure in the intervention group compared with usual care in this comparative trial were similar to reductions seen in other efficacy trials.
• Blood pressure reductions with the intervention were similar in under-represented minorities and whites and were sustained even after the intervention was discontinued.

Methods

The CAPTION study was a prospective, multicenter trial in 32 medical offices from 15 states. A main requirement of each office was that an onsite clinical pharmacist must have practiced in the office. The preplanned goal was to recruit ≥60% minority patients, particularly blacks and Hispanics. All subjects signed informed consent and were assigned to an intervention or control group by virtue of their medical office randomization. Offices were stratified based on the level of pharmacy services at baseline (low versus high) and percent minorities (<44% versus ≥44%) and then randomized to 1 of 3 groups, such as (1) a 9-month pharmacist intervention (brief intervention, [BI]), (2) a 24-month pharmacist intervention (sustained intervention, [SI]), or (3) a control group that received usual care. Both the intervention groups were designed to receive the identical intervention for the first 9 months, at which time the BI was discontinued and the SI was designed to be continued for 24 months. Subjects in the control group received usual care. Study coordinators (SCs) conducted identical study visits and data collection procedures in all the 3 groups, including research BP measurements at baseline, 6, 9, 12, 18, and 24 months. The study design, baseline data, description of the sites, and how office personnel were trained can be found in the Supplement.

We used a validated survey instrument to score clinical pharmacy services before the intervention.14 This survey determined the degree to which pharmacists provided direct patient care, managed medications, ordered laboratory tests, and documented their activities in the medical record. Scores could range from 0 to 150 and were similar to previous findings.14,15 Offices with a great deal of direct patient management scored high (114–143), whereas pharmacists who provided mostly halfway consultations and education scored low (19–113). Specific scores for individual offices can be found in the Data Supplement.

Pharmacists in control offices were instructed to avoid intervention for study participants with hypertension, but they could provide usual care curbside consultations if physicians specifically asked questions. Control offices participated in an alternative distractor intervention for patients with asthma.16 The proposed intervention included medical record review by the pharmacist and a structured interview with the subject, including (1) a medication history; (2) an assessment of knowledge of BP medications, dosages and timing, and potential side effects; and (3) other barriers to BP control (eg, side effects and nonadherence). The model recommended a telephone call at 2 weeks, structured face-to-face visits at baseline, 1, 2, 4, 6, and 8 months and additional visits if BP remained uncontrolled. Because this was an implementation trial, we did not require strict adherence to the model in an effort to replicate actual clinical practice, but all pharmacist visits were tracked. The pharmacist created a care plan with recommendations for the physician to adjust therapy.14,17 Most pharmacist communication with the physician was face-to-face but some were via e-mail. Recommendations to physicians were based on the 7th report of the Joint National Committee (JNC-7), and the BP goals were <140/90 mm Hg for uncomplicated hypertension or <130/80 mm Hg for patients with diabetes mellitus or chronic kidney disease (CKD). The pharmacists did not follow algorithms or protocols other than JNC-7. Physicians were free to accept or to reject any recommendation or to modify the plan. Recommendations to patients focused on medication education, improving adherence, and strategies to implement lifestyle modifications.

The grant provided funding for a SC (R.N., L.P.N., or M.A.) employed in each office who recruited subjects and collected study data. SCs came to the University of Iowa and were provided day-long—structured training on data collection and use of the web-based data entry system designed by the D.C.C.12,19 One investigator (B.L.C.) trained SCs on proper BP measurement using an automated Omron HEM 907-XL device and proper techniques.

The recruitment process is described in the Data Supplement. Subjects were eligible if they were English or Spanish speaking, >18 years of age with uncontrolled BP as measured by the SC on the baseline visit.

The SC measured BP in the sitting position after appropriate rest using a standard research technique at baseline, 6, 9, 12, 18, and 24 months.6,9,12,19 The BP was measured once using the automated device but this value was not used for the official research BP. Two additional BPs were obtained a minute apart and were averaged if they were within 4 mm Hg. If >4 mm different, another BP was obtained and the 2 closest values were averaged using previous research procedures.20 The SC collected the following at baseline: height, weight, and pulse, the duration of hypertension, presence of other cardiovascular risk factors, symptoms and adverse drug reactions, sociodemographics, comorbidities, current medications, and dose. Subjects self-reported race. Medication adherence was evaluated using validated 4-item instrument that asked about difficulties in taking BP medications.21,22 Each yes response was given 1 point. Good adherence was defined as 0 to 1 and poor adherence as 2 to 4. Scripted questionnaires were administered by bilingual SCs or translators if subjects spoke only Spanish. Trained study monitors from the D.C.C. visited each office to review the completeness and accuracy of the data by comparing the medical records and the web-based database. All discrepancies were corrected. The study monitors also recertified each SC in BP measurement at each yearly monitoring visit.

Data Analysis

The study aims and hypotheses, based on a previous efficacy study conducted by our research team,3 can be found in the Data Supplement. The primary objective of the study was to determine if subjects in clinics randomized to the intervention groups (both the intervention groups combined at 9 months because the intervention was identical at that time) achieved better BP control than subjects in offices randomized to the control group. The primary end point was the dichotomous variable of BP control at 9 months (controlled or uncontrolled).12 BP control was defined according to whether a subject had diabetes mellitus or CKD at baseline. If neither was reported at baseline, CKD was considered to be present if the calculated glomerular filtration rates from the 2 most recent creatinine tests were <60 mL/min per 1.73 m² using a standard formula.23 For subjects

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\[ \text{For subjects} \]
with diabetes mellitus/CKD at baseline, BP control was defined as an average SBP<130 mm Hg and diastolic BP (DBP) ≤80 mm Hg. For subjects with neither condition, BP control was defined as having average SBP<140 mm Hg and DBP<90 mm Hg.

The primary analysis used a nonlinear mixed effects model with the logit link function to estimate the log-odds of BP control in the intervention group (2 combined intervention groups) relative to the control group over time. The model incorporated the observed BP control variable at both the 6- and the 9-month visits. The odds ratio (OR) of BP control at 9 months was then estimated using the appropriate linear contrast of the model parameter estimates. The office random effects were assumed to be normally distributed and have a compound symmetrical covariance structure. The nested within subject random effects were assumed to have a first order autoregressive (AR(1)) covariance structure. We examined potential confounding variables at baseline, and performed sensitivity analyses to adjust for any covariates that differed across treatment groups.

We also considered 3 a priori interactions between intervention groups and 3 variables describing provider level characteristics: 2 theory of planned behavior scores (separate scores assessing physician and pharmacist attitudes toward the intervention) and the clinic pharmacy structure (classified as high or low). These separate analyses were based on the same model as described above, with the exception that terms were added to address the 2-way interaction between the intervention groups and provider level characteristics. If the interactions were not significant, but the provider characteristics were related to outcome, sensitivity analyses were reported to assess the effect of intervention after adjustment for these relevant provider characteristics.

The primary analysis was based on the intention-to-treat principle, with all subjects analyzed in the group to which their office was randomized. For the primary analysis, subjects who did not provide a BP measurement at a particular visit were assumed not to have controlled BP. However, we also performed a series of sensitivity analyses, using only subjects with observed data (no imputation) and using a last observation carried forward approach, to determine the potential dependence of the results of the primary analysis on the missing values.

Sample Size Calculation
A previous study found BP control rates of 25% versus 60% at 6 months, with an observed intraclass correlation coefficient (ICC) estimate of 0.0012. On the basis of the assumption that BP control would continue to improve in the control group from 6 to 9 months, we chose to power the study to detect an increase in BP control rates from 35% in the control group to 60% in the intervention groups for minority subjects with a 5% level test (α) using the method described by Donner and Klar. To be conservative, we also assumed an ICC value of 0.002 for the sample size calculations. Assuming 40% of subjects in each group were minorities, the calculations suggested 648 subjects in 27 offices would be needed. For the primary comparison at 9 months, this provided 90% power to detect a difference in BP control rates of 35% versus 50% in the total population.

Interim Monitoring
A Data and Safety Monitoring Board (DSMB) assessed 2 interim reviews of study outcomes using a Lan-DeMets α spending function approach with O’Brien–Fleming stopping boundaries to assess efficacy, and conditional power to assess futility. The DSMB approved a statistical analysis plan describing all preplanned analyses before the presentation of any interim data.

Secondary Analyses (9 Months)
A secondary objective was to determine if subjects in offices randomized to the combined intervention groups achieved lower mean BP than subjects in the control group at 9 months. Separate analyses were conducted for both the SBP and the DBP, and used a linear mixed model with random effects for office and subject within office to estimate the difference in mean BP for subjects in the 2 intervention groups relative to the control group. As with the primary analysis, the center random effects were assumed to be normally distributed and have a compound symmetrical covariance structure, and the nested within subject errors were assumed to have an AR(1) covariance structure.

An additional secondary objective was to determine if subjects from minority populations in offices randomized to the intervention groups achieved higher BP control rates and lower mean BP levels than minority subjects in the control group at 9 months. This was assessed in the same manner as described above, except the models included additional terms for minority strata and the interaction between interventions and minority strata. Final results were reported separately for both the minority and the nonminority subjects from the model that includes the interaction.

Secondary Analyses (After 9 Months)
Another secondary objective was to assess whether clinics randomized to the intervention groups maintained higher BP control rates and lower mean BP levels than the control group at 12, 18, and 24 months. These analyses used models similar to those in the primary analyses, with the exception that the 2 intervention groups were no longer combined (because the groups were only identical with respect to the intervention during the first 9 months of the study). To allow the difference in BP control rates and mean BP levels to differ across time points of interest, interaction terms between intervention groups and time points were included in the model. Differences for BP control rates and mean BP levels for the 3 pairwise comparisons of interest were assessed separately within each time point using an appropriate linear contrast of the model parameter estimates. During the past year of the trial, funding constraints by the sponsor required the study to end earlier than planned but this did not affect the 9- or 12-month time points. Because of the early closure of the study, there were many enrolled subjects whose 18- or 24-month follow-up visits fell after the date of study closure. Missing data for all visits scheduled before and including June 28, 2013 were imputed in the same manner as above for the 9-month primary analysis (assumed BP uncontrolled). For missing visits scheduled to occur after June 28, 2013, the data were not considered missing for the purposes of this analysis, no imputation was performed, and that observation was excluded from the analysis. These decisions about early termination and proposed data analyses modifications were reviewed and approved by the DSMB.

A final secondary objective was to determine if subjects from minority populations in offices randomized to the intervention groups achieved higher BP control rates and lower mean BP levels than minority subjects in the control group. This was assessed in the same manner as described above, except the models included additional terms for minority strata, the relevant 2-way interactions with minority strata, and the 3-way interaction between minority strata, intervention groups, and time. The final results were reported separately by time point for both the minority and the nonminority subjects from the model that includes the interaction.

Safety
All reported serious adverse events were evaluated by 2 medical safety monitors, and classified as at least potentially related to the intervention or unanticipated.

The medical safety monitors and DSMB reviewed blinded tabulated summaries of cumulative serious adverse events at regular intervals during the study.

Results
Recruitment began in March 2010 and the last subject completed the trial in June 2013. Clinic stratification, randomization, and subjects consented (n=1053) are displayed in Figure. Although there seem to be differences in the consent rate, many of the eligible subjects were not approached once a clinic met its enrollment targets. At enrollment, 402 (38%)
were excluded for controlled BP when measured by the SCs, 8 for excessive BP, and 25 for other reasons (eg, failed mental status examination [10], untreated sleep apnea [4], arm too large for cuff [2], recent myocardial infarction, angina, stroke, heart failure, renal failure or elevated liver tests [6], not a patient in the study office [1], declined mental status examination [1], or withdrew consent [1]). The remaining 625 subjects entered the trial with complete data in 100%, 86%, 82%, 78%, and 79% at the baseline, 9-, 12-, 18-, and 24-month visits, respectively.

Over half of the enrolled subjects were minorities (Table 1), the majority of which were blacks (n=239) or Hispanic (n=89). Many subjects had annual incomes ≤$25,000 (49%) or had Medicaid (14%) or free care/self-pay (11%). Notably, 314 (50%) had diabetes mellitus or CKD. The 3 study arms were comparable at baseline, with the exception subjects in the BI arm were significantly more likely to be married and to have private insurance (Table 1). Baseline BP levels, comorbidities, medication adherence scores, and number of antihypertensive medications were similar across all the 3 study arms (Table 2). Pharmacist encounters averaged 0.58 per subject per month and 0.50 per subject per month in the BI and SI groups, respectively, during the first 9 months. The average encounters were 0.07 per month in the BI compared with 0.26 per month in the
There were significantly more dose increases or medication additions in the BI (3.1±3.2) and the SI (2.7±3.1) than the control group (0.7±1.0; P=0.001) during the first 9 months of the study. There were nearly twice as many dose increases or medication additions in the SI compared with the control group in the past year of the study, including at 12 (0.3±0.8 versus 0.1±0.5; P=0.25), 18 (0.4±1.2 versus 0.3±0.7; P=0.31), and 24 (0.3±0.9 versus 0.2±0.5; P=0.21) months. This latter finding may demonstrate that providers in the intervention group were attempting to overcome the lower BP control in this group seen at 12 and 18 months that then achieved better BP control at the 24-month visit.

**Primary Outcome**

BP control was 43% in the intervention groups and 34% in the control group at 9 months (adjusted OR, 1.57 [95% CI, 0.99–2.50]; P=0.059). Similar results were observed for the set of sensitivity analyses (Data Supplement), as well as a sensitivity analysis that adjusted the models for marital and insurance status (variables with statistically significant baseline differences). Of note, the observed ICC of 0.030 was larger by a factor >10 from the assumed ICC (0.002). As a consequence, only about two thirds of the desired level of information required for the original power analysis was observed at the end of the study, which implies that the actual power of the study was <90% target. This concern was raised by the DSMB, and a subsequent post hoc power calculation using the observed ICC value suggested that the study power remained near 80%. Thus, when interpreting the results of both the primary analysis and the set of sensitivity analyses, there was an observed trend toward a 10% nonstatistically significant absolute increase in the rate of BP control in the intervention groups.

**Secondary Outcomes**

There was a significantly greater reduction in adjusted mean SBP and DBP in the intervention groups compared with the control group at 9 months (Table 3). Furthermore, a preplanned secondary evaluation found that offices with a higher pharmacy score (measure of direct patient management by pharmacists), had a 4.0/2.0 mm Hg lower BP at 9 months (P=0.013 and P=0.016) compared with offices with lower pharmacy score, regardless of study arm.

At 9 months, there was no evidence of an interaction between minority status and intervention group on BP control rates, mean SBP/DBP, suggesting that the effects of the intervention were consistent for minority and nonminority subjects. BP control at 9 months was 37% in minority intervention subjects and 28% in minority control subjects (adjusted OR, 1.54 [95% CI, 0.83–2.86]; P=0.17). Reductions in adjusted mean SBP and DBP in the intervention groups compared with the control group at 9 months in minority subjects were comparable in magnitude to those observed for the overall population (Table 2). There were also important observed interactions after 9 months, suggesting that the effects over time differed by race. The odds for BP control for minority subjects in the intervention groups were significantly better than the control group at 18 and 24 months (Table 4). Interestingly, the reductions in BP in nonminority subjects...
BP control was achieved in 61% of intervention subjects and 45% of control subjects at 9 months [adjusted OR, 2.03 [95% CI, 1.29–3.22]; P=0.003]. At the 24-month visit, BP control was 63%, 57%, and 46% in the BI, SI, and control groups, respectively. The adjusted OR for the BI compared with the control group was 1.84 [95% CI, 0.89–3.78]; P=0.098 and for the SI to the control group was 1.67 [95% CI, 0.86–3.26]; P=0.13.

Discussion

The primary outcome for this study was negative. Although there was a 57% greater odds that the intervention improved BP control, this primary result did not attain statistical significance (P=0.059). However, differences in mean BP were pre-specified secondary outcomes. Mean SBP was 6.1 mm Hg lower in all subjects and 6.4 mm Hg lower in minority subjects at 9 months in the intervention and control groups, respectively. By 24 months, the reduction was 4.9 and 7.9 mm in nonminority subjects and 8.2 and 9.2 mm Hg in minority subjects in the brief and sustained groups, respectively. The Community Preventive Services Task Force recently evaluated 44 studies of team-based care and found a mean effect of −5.4 mm Hg in SBP when compared with usual care.27 A recent review indicated that the strongest evidence for collaborative care was found with pharmacists.8 Another group of investigators updated their previous meta-analysis to include 39 randomized controlled trials in 14,224 patients and found pharmacist interventions reduced SBP −7.6 mm Hg (95% CI, −9.0 to −6.3 mm Hg) compared with usual care. These authors concluded that pharmacist interventions were highly effective but that comparative effectiveness studies with longer duration of follow-up are still needed to determine the most efficient methods of implementation. Our comparative effectiveness trial was designed to address these recommendations and we found similar outcomes to these previous studies suggesting that the effect can be attained in diverse clinics and patient populations. The most probable explanation for these findings was the greater intensification of BP medications in the intervention groups, which was seen in other studies.5,17

Exploratory Outcomes

During the course of the trial, national recommendations for BP control evolved toward higher goals. Therefore, we conducted a secondary analysis to evaluate BP control using the new 2014 hypertension guidelines.26 These guidelines increased the target BP goals for patients with diabetes mellitus or CKD to <140/90 mm Hg, and to <150/90 mm Hg for those aged ≥60 years. We excluded 138 subjects who would have had controlled BP at baseline using the new guidelines.

Table 2. Baseline BP Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Brief* (n=194)</th>
<th>Sustained† (n=207)</th>
<th>Control (n=224)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of high BP, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤3 y</td>
<td>30 (15.5)</td>
<td>28 (13.5)</td>
<td>44 (19.6)</td>
</tr>
<tr>
<td>&gt;3–10 y</td>
<td>55 (28.4)</td>
<td>90 (43.5)</td>
<td>80 (35.7)</td>
</tr>
<tr>
<td>&gt;10 y</td>
<td>109 (56.2)</td>
<td>89 (43.0)</td>
<td>100 (44.6)</td>
</tr>
<tr>
<td>Baseline systolic BP Mean (SD)</td>
<td>147.6 (13.7)</td>
<td>149.8 (15.6)</td>
<td>149.6 (15.3)</td>
</tr>
<tr>
<td>Baseline diastolic BP Mean (SD)</td>
<td>83.5 (12.4)</td>
<td>86.6 (11.6)</td>
<td>84.3 (12.6)</td>
</tr>
<tr>
<td>Comorbidities Mean (SD)</td>
<td>2.2 (1.5)</td>
<td>2.2 (1.4)</td>
<td>2.2 (1.4)</td>
</tr>
<tr>
<td>No. of antihypertensive medications Mean (SD)</td>
<td>2.0 (1.1)</td>
<td>2.2 (1.1)</td>
<td>2.0 (1.1)</td>
</tr>
<tr>
<td>Medication adherence score, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medication adherence=1</td>
<td>155 (79.9)</td>
<td>159 (76.8)</td>
<td>177 (79.0)</td>
</tr>
<tr>
<td>Medication adherence=2</td>
<td>28 (14.4)</td>
<td>42 (20.3)</td>
<td>32 (14.3)</td>
</tr>
<tr>
<td>Missing</td>
<td>11</td>
<td>6</td>
<td>15</td>
</tr>
</tbody>
</table>

BP indicates blood pressure.
*Nine-month intervention.
†Twenty-four-month intervention

seemed to deteriorate in both the intervention groups at 12, 18, and 24 months (Table 5), but were sustained in minority subjects (Table 6). For additional data at follow-up visits see the Data Supplement.

There were no overall differences in the frequency of subjects reporting any serious adverse event across the 3 intervention groups. When restricted to serious adverse events related to the study, no significant trends were observed across the 3 intervention groups either overall or by type.

Table 3. Mean Blood Pressure at 9 Mo

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention</th>
<th>Group</th>
<th>Group</th>
<th>Adjusted Difference P Value Between Groups (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All subjects</td>
<td>n=345</td>
<td>n=194</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean SBP (SD)</td>
<td>131.6 (15.8)</td>
<td>138.2 (19.7)</td>
<td>6.1 (9.75 to 2.39)</td>
<td>0.002</td>
</tr>
<tr>
<td>Mean DBP (SD)</td>
<td>76.3 (11.1)</td>
<td>78.0 (14.5)</td>
<td>2.9 (4.85 to 0.93)</td>
<td>0.005</td>
</tr>
<tr>
<td>Minorities</td>
<td>n=187</td>
<td>n=97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean SBP (SD)</td>
<td>133.0 (16.3)</td>
<td>140.3 (21.4)</td>
<td>6.4 (11.16 to 1.68)</td>
<td>0.009</td>
</tr>
<tr>
<td>Mean DBP(SD)</td>
<td>77.9 (10.7)</td>
<td>78.8 (15.9)</td>
<td>2.9 (5.88 to 0.08)</td>
<td>0.044</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DBP, diastolic blood pressure; and SBP, systolic blood pressure.
rates when we considered these new goals.26 The providers were probably aware of the evolving data and might not have pushed doses to the defined goal, which was confirmed in our post hoc analysis.

There are few comparisons of team-based care in minority subjects with nonminorities. This is the first study to demonstrate that an intervention with pharmacists embedded within the medical office could achieve similar reductions in BP across racial groups and that the effect could be sustained. This finding is important because most minority subjects were from urban areas, the stroke belt or near the Rio Grande valley (Data Supplement). Nearly half had annual household income <$25,000, 36% had Medicaid or self-pay insurance, and only 36% had a high school education or less suggesting that many of the subjects were socioeconomically disadvantaged. The long-term effect of the intervention was greater in minority subjects than nonminority subjects (Table 5). A nurse-based telephone intervention was found to be effective in blacks and in non-Hispanic whites.28 Another study of combined telephone intervention was found to be effective in blacks but not in non-Hispanic whites.29 The reasons for these racial differences require additional investigation.

Table 4. Blood Pressure Control at Follow-Up

<table>
<thead>
<tr>
<th>Model</th>
<th>Brief</th>
<th>Sustained</th>
<th>Control</th>
<th>Adjusted OR (95% CI); P-Value Brief vs Control</th>
<th>Adjusted OR (95% CI); P-Value Sustained vs Control</th>
<th>Adjusted OR (95% CI); P-Value Brief vs Sustained</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Mo</td>
<td>n=194</td>
<td>n=207</td>
<td>n=224</td>
<td>0.93 (0.48–1.80); 0.82</td>
<td>0.66 (0.32–1.35); 0.25</td>
<td>1.41 (0.69–2.77); 0.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonminority</td>
<td>48%</td>
<td>34%</td>
<td>40%</td>
<td>2.16 (1.08–4.33); 0.03</td>
<td>1.72 (0.88–3.35); 0.11</td>
</tr>
<tr>
<td></td>
<td>Minority</td>
<td>38%</td>
<td>33%</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Mo</td>
<td>n=186</td>
<td>n=207</td>
<td>n=219</td>
<td>1.06 (0.54–2.07); 0.87</td>
<td>0.89 (0.43–1.81); 0.74</td>
<td>1.19 (0.58–2.44); 0.62</td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonminority</td>
<td>46%</td>
<td>30%</td>
<td>42%</td>
<td>2.47 (1.22–5.01); 0.01</td>
<td>2.31 (1.17–4.56); 0.02</td>
</tr>
<tr>
<td></td>
<td>Minority</td>
<td>38%</td>
<td>39%</td>
<td>18%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 Mo</td>
<td>n=143</td>
<td>n=195</td>
<td>n=155</td>
<td>1.39 (0.68–2.87); 0.36</td>
<td>1.25 (0.59–2.63); 0.55</td>
<td>1.11 (0.53–2.33); 0.77</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nonminority</td>
<td>56%</td>
<td>53%</td>
<td>45%</td>
<td>3.25 (1.49–7.10); 0.003</td>
<td>3.27 (1.57–6.79); 0.002</td>
</tr>
<tr>
<td></td>
<td>Minority</td>
<td>39%</td>
<td>36%</td>
<td>19%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; and OR, odds ratio.

Table 5. Mean Blood Pressure at Follow-Up (Nonminority Subjects)

<table>
<thead>
<tr>
<th>Period, mo</th>
<th>Brief Mean (SD)</th>
<th>Sustained Mean (SD)</th>
<th>Control Mean (SD)</th>
<th>Model-Adjusted Difference (95% CI); Brief vs Control</th>
<th>Model-Adjusted Difference (95% CI); Sustained vs Control</th>
<th>Model-Adjusted Difference (95% CI); Brief vs Sustained</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SBP 131.5 (17.1)</td>
<td>130.5 (16.3)</td>
<td>136.6 (15.4)</td>
<td>−3.79 (−9.62 to 2.04); P=0.20</td>
<td>−4.67 (−11.10 to 1.74); P=0.15</td>
<td>0.88 (−5.57 to 7.33); P=0.79</td>
</tr>
<tr>
<td></td>
<td>DBP 73.2 (10.8)</td>
<td>75.7 (12.5)</td>
<td>77.3 (11.8)</td>
<td>−2.49 (−5.92 to 0.94); P=0.15</td>
<td>−2.07 (−5.84 to 1.71); P=0.28</td>
<td>−0.43 (−4.22 to 3.37); P=0.82</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SBP 130.1 (16.1)</td>
<td>134.5 (17.7)</td>
<td>134.6 (14.7)</td>
<td>−3.40 (−9.37 to 2.58); P=0.26</td>
<td>1.51 (−4.92 to 7.95); P=0.64</td>
<td>−4.91 (−11.40 to 1.56); P=0.14</td>
</tr>
<tr>
<td></td>
<td>DBP 73.9 (11.8)</td>
<td>76.4 (13.3)</td>
<td>75.9 (11.9)</td>
<td>−0.14 (−3.65 to 3.37); P=0.94</td>
<td>0.33 (−3.46 to 4.11); P=0.87</td>
<td>−0.46 (−4.27 to 3.34); P=0.81</td>
</tr>
<tr>
<td>24</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>SBP 130.3 (18.7)</td>
<td>126.1 (17.4)</td>
<td>135.2 (16.9)</td>
<td>−4.91 (−11.10 to 1.54); P=0.13</td>
<td>−7.90 (−14.70 to −1.13); P=0.020</td>
<td>2.99 (−3.64 to 9.61); P=0.37</td>
</tr>
<tr>
<td></td>
<td>DBP 73.6 (12.4)</td>
<td>72.9 (11.6)</td>
<td>74.9 (10.2)</td>
<td>−1.45 (−5.23 to 2.33); P=0.45</td>
<td>−4.33 (−8.32 to −0.35); P=0.033</td>
<td>2.88 (−1.01 to 6.78); P=0.15</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DBP, diastolic blood pressure; and SBP, systolic blood pressure.
Table 6. Mean Blood Pressure at Follow-Up (Minority Subjects)

<table>
<thead>
<tr>
<th>Period, Mo</th>
<th>Brief Mean (SD)</th>
<th>Sustained Mean (SD)</th>
<th>Control Mean (SD)</th>
<th>Model-Adjusted Difference (95% CI); Brief vs Control</th>
<th>Model-Adjusted Difference (95% CI); Sustained vs Control</th>
<th>Model-Adjusted Difference (95% CI); Brief vs Sustained</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>SBP 134.5 (20.4) 131.7 (16.3) 143.2 (20.0)</td>
<td>−6.00 (−12.00 to −0.03); P=0.049</td>
<td>−9.74 (−15.50 to −3.99); P=0.001</td>
<td>3.75 (−2.15 to 9.64); P=0.21</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>DBP 77.1 (11.1) 78.4 (11.7) 79.8 (13.3)</td>
<td>−3.97 (−7.48 to −0.46); P=0.027</td>
<td>−3.69 (−7.07 to −0.31); P=0.033</td>
<td>−0.28 (−3.75 to 3.18); P=0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>SBP 131.6 (18.4) 130.0 (14.7) 144.7 (19.5)</td>
<td>−9.96 (−16.10 to −3.81); P=0.002</td>
<td>−12.70 (−18.50 to −6.91); P=0.001</td>
<td>2.76 (−3.33 to 8.85); P=0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DBP 76.8 (12.1) 75.1 (8.9) 80.4 (15.9)</td>
<td>−4.22 (−7.84 to −0.60); P=0.023</td>
<td>−6.52 (−9.93 to −3.10); P=0.001</td>
<td>2.29 (−1.28 to 5.87); P=0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>SBP 133.9 (19.9) 133.4 (19.3) 144.0 (17.9)</td>
<td>−8.22 (−15.50 to −0.94); P=0.027</td>
<td>−9.16 (−15.60 to −2.68); P=0.006</td>
<td>0.94 (−5.76 to 7.63); P=0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DBP 78.1 (11.8) 77.7 (11.9) 81.1 (14.7)</td>
<td>−4.31 (−8.58 to −0.04); P=0.048</td>
<td>−4.93 (−8.73 to −1.14); P=0.011</td>
<td>0.62 (−3.31 to 4.54); P=0.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI indicates confidence interval; DBP, diastolic blood pressure; and SBP, systolic blood pressure.

Conclusions
This study was not able to conclude significant differences between the 3 groups for the primary end point of BP control after a 9-month pharmacy intervention. However, the trend was in the right direction and significant improvement was observed in the key secondary end point of mean BP. Mean BP and control rates seemed to deteriorate in nonminorities at 12, 18, and 24 months but were maintained in minority subjects after the intervention was discontinued in the 9-month intervention group. These findings suggest that an established team-based care model involving pharmacists can be adopted in a large number of offices to reduce racial disparities in BP control.

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Disclosures
None.

References


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