The Potency of Team-Based Care Interventions for Hypertension

A Meta-analysis

Barry L. Carter, PharmD; Meaghan Rogers, PharmD; Jeanette Daly, RN, PhD; Shimin Zheng, PhD; Paul A. James, MD

Background: Team-based care is the strategy that has had the greatest effect on improving blood pressure (BP). The purpose of this systematic review was to determine the potency of interventions for BP involving nurses or pharmacists.

Methods: A MEDLINE search for controlled clinical trials that involved a nurse or pharmacist intervention was conducted. Mean reductions in systolic (S) and diastolic (D) BP were determined by 2 reviewers who independently abstracted data and classified the different intervention components.

Results: Thirty-seven articles met the inclusion criteria. Education about BP medications was significantly associated with a reduction in mean BP (−8.75/−3.60 mm Hg). Other strategies that had large effect sizes on SBP include pharmacist treatment recommendations (−9.30 mm Hg), intervention by nurses (−4.80 mm Hg), and use of a treatment algorithm (−4.00 mm Hg). The odds ratios (95% confidence intervals) for controlled BP were: nurses, 1.69 (1.48-1.93); pharmacists within primary care clinics, 2.17 (1.75-2.68); and community pharmacists, 2.89 (1.83-4.55). Mean (SD) reductions in SBP were: nursing studies, 5.84(8.05) mm Hg; pharmacists in clinics, 7.76(7.81) mm Hg; and community pharmacists, 9.31 (5.00) mm Hg. There were no significant differences between the nursing and pharmacy studies (P ≥ .19).

Conclusions: Team-based care was associated with improved BP control, and individual components of the intervention appeared to predict potency. Implementation of new hypertension guidelines should consider changes in health care organizational structure to include important components of team-based care.

Arch Intern Med. 2009;169(19):1748-1755

Blood pressure (BP) is poorly controlled in the United States.1-3 The 8th Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-8) is currently considering strategies to improve the implementation of the guidelines and achieve higher BP control rates. Investigators from the Stanford University/University of California, San Francisco, Evidence-Based Practice Center conducted an analysis of controlled clinical trials examining quality improvement strategies and found that the only strategy that significantly improved BP involved interdisciplinary, team-based care.4 Most of the quality improvement interventions included multiple components. These different strategies or the potency of the intervention may explain the apparent differences in effect sizes.5

One strategy to improve guideline adherence is to use team-based care involving pharmacists or nurses.6-11 The purpose of the present study was to conduct a systematic review of the research literature and to evaluate the potency of team-based care involving pharmacists or nurses. We theorized that the effect size would be greater for nurses or pharmacists working in a physician’s office or more independently by protocol than with more distant interventions, such as recommendations from a community pharmacist.

We followed the same process as Walsh et al6 by including quasi-randomized trials, controlled before-after studies, interrupted time-series studies, patient-randomized trials, and cluster-randomized trials. Quasi-randomized trials were defined as those that included at least 2 patient cohorts identified prospectively using an arbitrary but nonrandom allocation procedure.6 Controlled before-after studies were defined as those with contemporaneous observation of cohorts that differed primarily with respect to exposure to the intervention.6 Interrupted time series required that the study re-
port outcomes from at least 3 time points in the preintervention and postintervention periods.6

SEARCH STRATEGY
Walsh et al5 performed their search of the MEDLINE database from January 1, 1980, through July 31, 2003, and we extended the search to include articles published from January 1, 1970, through February 5, 2009. The search was conducted by a research librarian. Titles and abstracts were then screened to determine whether the article included team-based care of hypertension involving pharmacists or nurses. Next, we searched the reference list of included papers and the reviews by Walsh et al5 to identify additional citations. Once the full-text articles were selected, 2 reviewers (1 clinical pharmacist with a PharmD [doctor of pharmacy] degree [M.R.] and 1 nurse with a PhD [doctor of philosophy] degree [J.D.]) independently determined whether each paper met the study criteria. If so, the reviewers independently abstracted critical information including study design, setting, type of intervention, components of the intervention, and degree of SBP and DBP change. The intervention components included supplying free medications, education about BP medications, counseling about lifestyle modifications, assessing medication compliance, algorithms for treatment, home visits, prescribing medications by intervention health care providers (nurses or pharmacists), laboratory tests ordered by intervention health care providers (nurses or pharmacists), clinical pharmacist interventions delivered in community pharmacies, and interventions by community pharmacists working within a primary care office. We performed sensitivity analyses to determine the effect of assigning studies to different categories when they had multiple strategies (eg, involved both community pharmacists and nurses).

STATISTICAL ANALYSIS
Stepwise regression analyses and non-parametric analyses were performed using the Mann-Whitney test to evaluate the postintervention difference between the intervention and control groups for mean SBP and DBP while controlling for study sample size. Analyses were performed using SPSS statistical software, version 17.0.0 (SPSS Inc, Chicago, Illinois).

One study had a large number of informed dropouts and found no significant difference between nurse versus physician management.3 A stepwise regression analysis was conducted without this study (n=36) to predict the effect of individual intervention components on BP. Unadjusted ORs for controlled BP were calculated so studies could be compared. The ORs were compared using a simple logistics regression model with 1 variable, unadjusted for any other item. We created a funnel plot of the log of the OR plotted against the standard error for each study to assess the possibility that publication bias might exist.

\[ \Delta \text{in BP} = (\text{Postintervention BP} - \text{Preintervention BP})_{\text{study group}} - (\text{Postintervention BP} - \text{Preintervention BP})_{\text{control group}} \]

Blood pressure control was defined as a BP lower than 140/90 mm Hg for patients with uncomplicated BP and lower than 130/80 mm Hg for those with diabetes mellitus or chronic kidney disease.14 The net change in BP control rates attributable to the intervention for each study was defined as:

\[ \Delta \text{in BP Control} = (\text{Postintervention BP Control} - \text{Preintervention BP Control})_{\text{study group}} - (\text{Postintervention BP Control} - \text{Preintervention BP Control})_{\text{control group}} \]

The odds ratio (OR) and 95% confidence interval (CI) for controlled BP was calculated (22 studies) and weighted by the sample size of the study.8,15-17 For 15 studies, ORs could not be calculated.36-40 We divided the studies into 3 groups to evaluate intervention potency: nursing interventions, pharmacist interventions delivered in community pharmacies, and interventions by clinical pharmacists working within a primary care office. We performed sensitivity analyses to determine the effect of assigning studies to different categories when they had multiple strategies (eg, involved both community pharmacists and nurses).

INTERVENTION EFFECT SIZE
We calculated effect size by determining the change in SBP or DBP attributable to the intervention for each study defined as:

The literature review identified 583 citations and 37 articles that met the inclusion criteria (Figure 1). Interrater reliability for the 2 reviewers was good (Pearson product moment correlation r=0.74; P < .001). Each study specified unique health care provider qualifications and training. For instance, studies involving community pharmacists may have included pharmacists with BS (bachelor of science) degrees28,29 or those with PharmD degrees.22,23 Nearly all studies that involved pharmacists in clinics included clinical pharmacists with PharmD or MS (master of science) degrees who had completed postdoctoral residency training in primary care and whose duties involved direct patient management.41-46 Although several studies did not provide these details,25-27,35,46-48 most of the studies involving nurses did not specify their qualifications,17,19,33,38-41,44,45,47 but some noted that health care providers were registered nurses (RNs)42,49 or nurse practitioners.16,18 Training of the intervention nurses or pharmacists typi-
Table 1. Stepwise Regression Analysis of the Intervention Effect on BPa

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Regression Coefficient</th>
<th>Predicted Change, mm Hg</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systolic BP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmacist recommended medication to physician</td>
<td>-9.68</td>
<td>-27.21</td>
<td>.002</td>
</tr>
<tr>
<td>Counseling about lifestyle modification</td>
<td>5.20</td>
<td>-12.63</td>
<td>.03</td>
</tr>
<tr>
<td>Pharmacist performed the intervention</td>
<td>6.13</td>
<td>-11.70</td>
<td>.03</td>
</tr>
<tr>
<td>Treatment algorithm used</td>
<td>9.37</td>
<td>-8.46</td>
<td>-.001</td>
</tr>
<tr>
<td>Drug profile and/or medication history completed</td>
<td>9.55</td>
<td>-8.28</td>
<td>.001</td>
</tr>
<tr>
<td>Overall intervention potency scoreb</td>
<td>-2.76</td>
<td>NA</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Diastolic BP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Referral made to specialist</td>
<td>-7.71</td>
<td>-19.61</td>
<td>.04</td>
</tr>
<tr>
<td>Physical examination conducted</td>
<td>-6.65</td>
<td>-18.55</td>
<td>.08</td>
</tr>
<tr>
<td>Education about BP medications</td>
<td>-5.70</td>
<td>-17.60</td>
<td>.003</td>
</tr>
<tr>
<td>Length of intervention</td>
<td>0.04</td>
<td>-10.13</td>
<td>.06</td>
</tr>
<tr>
<td>Treatment algorithm used</td>
<td>3.12</td>
<td>-7.88</td>
<td>.05</td>
</tr>
<tr>
<td>Drug profile and/or medication history completed</td>
<td>4.63</td>
<td>-7.27</td>
<td>.006</td>
</tr>
<tr>
<td>Pharmacist performed the intervention</td>
<td>7.87</td>
<td>-4.03</td>
<td>.04</td>
</tr>
<tr>
<td>Nurse performed the intervention</td>
<td>7.96</td>
<td>-3.94</td>
<td>.04</td>
</tr>
</tbody>
</table>

Abbreviations: BP, blood pressure; NA, not applicable.
aThis variable was controlled for in the analyses and was only significant for systolic BP.
bThis variable was controlled for in the analyses and was only significant for systolic BP.

This study found that interventions involving pharmacists or nurses were associated with significantly improved BP control. These results ex-
findings based on the dose, duration, and potency of the intervention. For instance, Carter et al. conducted 3 studies in community pharmacies, where the pharmacists had no prior established relationships with the physicians and the interventions were only 4 and 5 months in length. These studies had modest ORs for controlled BP (1.56, 1.74, and 2.46). Carter et al. recently completed a randomized, controlled effectiveness (ie, pragmatic) study of a 6-month pharmacist intervention among 402 patients from 6 family medicine clinics that was not included in this systematic review because it had not been published at the time of our evaluation. In that study, SBP was reduced by 12.0 mm Hg more in the intervention group than the control group, and the OR for controlled BP was 3.2 (95% CI, 2.0–5.1). Finally, these investigators conducted an efficacy study in which BP was controlled in 54% of participants in the physicians’ office.22 We could also have classified this study as “pharmacist in the clinic,” which would have reduced the OR for community pharmacy studies and increased the OR for studies involving pharmacists in clinics. Second, we classified one study as a nursing intervention for the OR calculations, but the intervention involved both a nurse and a community pharmacist (OR, 1.79).19 Excluding the first 2 studies and adding the third study to the analysis of community pharmacy studies would have resulted in an OR closer to 1.8 for the community pharmacy group.

Finally, one large study was conducted within a managed care organization that involved education by a pharmacist via the Internet.23 We classified this study as one within primary care, but the effect was not as great (OR, 1.88) compared with studies in which the pharmacist adjusted therapy either alone or in collaboration with physicians (ORs, 7.38–9.98). Without that study, the OR would have been 3.27 for pharmacists in clinics.

It may be possible to explain our findings based on the dose, duration, and potency of the intervention. For instance, Carter et al. conducted 3 studies in community pharmacies, where the pharmacists had no prior established relationship with the physicians and the interventions were only 4 and 5 months in length. These studies had modest ORs for controlled BP (1.56, 1.74, and 2.46). Carter et al. recently completed a randomized, controlled effectiveness (ie, pragmatic) study of a 6-month pharmacist intervention among 402 patients from 6 family medicine clinics that was not included in this systematic review because it had not been published at the time of our evaluation. In that study, SBP was reduced by 12.0 mm Hg more in the intervention group than the control group, and the OR for controlled BP was 3.2 (95% CI, 2.0–5.1). Finally, these investigators conducted an efficacy study in which BP was controlled in 54% of patients in the control group and 89% in the intervention group (OR, 7.38; 95% CI, 3.43–15.91).22 The main reason for high BP control in this latter study was attributed to assertive and frequent medication management by the pharmacist.
intensification recommended by the pharmacist. Therefore, the ORs for the 5 studies by these investigators were: community pharmacy studies (BS-trained pharmacists), between 1.56 and 2.46; the pragmatic trial of clinical pharmacists (PharmD with residency or fellowship), 3.20; and the efficacy trial (ideal intervention delivery) with clinical pharmacists (PharmD with residency), 7.38.

Therefore, when the literature involving team care is evaluated, it is critical to assess the duration of the intervention, the type of organization in which the intervention is performed (home, work site, community pharmacy, or primary care clinic), and whether the study is an efficacy or effectiveness trial. These factors, as well as the intervention procedures, predict the potency of the intervention.

Studies involving community pharmacists largely involved making recommendations to physicians by telephone or facsimile. Studies involving pharmacists in clinics typically involved pharmacists employed in the clinic who worked collaboratively with physician colleagues and/or provided more autonomous care. Pharmacists within primary care clinics work closely with physicians, and the expected levels of trust and cooperation might be higher than with community pharmacists, for whom interaction is usually not in person and occurs from distant locations.23,31,32 In fact, recommendations to change BP medications were accepted 95% of the time from pharmacists within the same clinic30 but only 45% to 50% when recommend-
of their recommendations could be owing to lower levels of trust and cooperation by physicians.51,52

Many of the nursing studies did not describe the types of nurses, their educational background, or training, but 4 studies used either RNs or nurse practitioners.16,18,42,49 Nursing interventions seemed more likely to involve home visits, use of a treatment algorithm, and patient engagement than pharmacy studies. It is likely that many of the interventions involving nurses or pharmacists increased patient empowerment, but few studies specifically provided such descriptions. Only 5 nursing studies described a patient-led process,17,47,49 or home BP monitoring,41,42 and 3 pharmacy studies used home BP monitoring.23,34,35 We suspect that nurse practitioners would have more autonomy than RNs, and, in some cases, nurse practitioners can prescribe medications. We could not detect whether nursing degree or training influenced the results. However, using a treatment algorithm or making a home visit both had a predicted reduction in SBP of 4 mm Hg. Each intervention or combination of intervention components is unique. It is not possible to state that either nurses or pharmacists can improve BP control without first determining the patient population, the organizational structure involved, and the amount of autonomy the interventionist has to alter therapy. Strategies that provided medication education were the most effective, but this strategy is impossible to evaluate alone because it was usually provided with additional strategies by the nurse or pharmacist who may have recommended therapy changes or personally changed therapy within a primary care office. Any incremental addition of components from Table 2 that a physician office or health system can implement should improve BP control rates, but this requires additional research. We believe that nurses possess unique skills in patient management and nonmedication counseling techniques that pharmacists usually do not. Likewise, pharmacists receive 4 years of concentrated education in medication pharmacology, pharmacokinetics, pharmacodynamics, therapeutics, and chronic disease drug-therapy guidelines. Including both nurses and pharmacists in an integrated hypertension management program should be even more effective, and more cost-effective, than including either group alone. Consistent with our findings, the pharmacists could adjust medications until BP is controlled, while the nurse provides continuity and counseling about lifestyle and social support.9,50 The nurse would continue to serve as a case manager between physician visits when BP is controlled. The pharmacist would then only be involved if BP is no longer controlled. Such an approach cannot only improve BP control rates but markedly improve the efficiency and productivity of the physician.54,55 Including many of the components of these interventions in hypertension management programs could improve the implementation of the JNC-8 or other chronic disease guidelines.

The vast majority of the studies (32 of 37 [86%]) were randomized, controlled trials (eTable; http://www.archinternmed.com). The quality of the studies supports the findings that these interventions are likely to be effective. There were, however, large differences in the duration of the intervention (4-24 months), sample size (26-1534), and participant dropout rate (2%-62%). Nearly all of the studies adequately described the most important characteristics of the patients, but many did not adequately describe the number, educational background, and training of the intervention pharmacists or nurses. Our analysis could not determine if there is a preferred level of qualifications, such as a PharmD degree with residency or an MS nurse practitioner degree. Likewise, many studies did not describe the intervention training, but those that did typically noted one-half- to 2-day training programs on the hypertension guidelines and BP measurement. It is possible that RNs or pharmacists with BS degrees may have required more intense or longer training than nurse practitioners or pharmacists with PharmD degrees with residencies, but this could not be determined from these studies. Future interventional studies of this type should specify the educational background, postgraduate training, and specific training programs used to implement the intervention.

Only 1 study performed a cost-effectiveness analysis.68 Clinic visit costs were significantly higher in the pharmacist-managed clinic ($131 per patient) than the physician clinic ($74) (P < .001), but the costs for emergency department visits were significantly lower in the pharmacist-managed clinic than in the physician clinic ($0 vs $10.84 per patient; P < .04). The cost of decreasing SBP was $27 per millimeter of mercury for the pharmacist-managed clinic and $193 for the physician clinic. The cost of decreasing DBP...
CONCLUSION

This evaluation of team-based care for hypertension found that interventions involving nurses or pharmacists are effective strategies to improve BP control. Several individual components were associated with improvements in BP. Research involving team-based care must be carefully designed, reported, and interpreted to include the organizational structure in which the intervention is performed, the educational level and training of the intervention providers, and the individual components of the intervention so that similar interventions can be implemented within a given health system.

Accepted for Publication: June 26, 2009.

Correspondence: Barry L. Carter, PharmD, Department of Pharmacy Practice and Science, Room 527, College of Pharmacy, The University of Iowa, Iowa City, IA 52242 (barry-carter@uiowa.edu).

Author Contributions: All authors had full access to all the data and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Carter and James. Acquisition of data: Carter, Rogers, and Daly. Analysis and interpretation of data: Carter, Rogers, and Zheng. Drafting of the manuscript: Carter. Critical revision of the manuscript for important intellectual content: Carter, Rogers, Daly, Zheng, and James. Statistical analysis: Zheng. Obtained funding: Carter. Administrative, technical, and material support: Rogers, Daly, Zheng, and James. Study supervision: Carter.

Financial Disclosure: None reported.

Funding/Support: This study was supported in part by grant HL070740 from the National Heart, Lung, and Blood Institute; cooperative agreement 5U18HS016094 from the Agency for Healthcare Research and Quality Centers for Education and Research on Therapeutics; and grant HFP 04-149 from the Center for Research in Implementation in Innovative Strategies in Practice, Veterans Health Administration Health Services Research and Development Service, US Department of Veterans Affairs (Dr Carter).

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs.

Additional Information: The eTable is available at http://www.archinternmed.com.

REFERENCES

20. McKenney JM, Stining JM, Henderson HR, Devins D, Barr M. The effect of clinical pharmacy ser-

REPRINTED ARCH INTERN MED/VOL 169 (NO. 19), OCT 26, 2009 WWW.ARCHINTERNMED.COM 1734

©2009 American Medical Association. All rights reserved.


50. Lee JK, Grace KA, Taylor AJ. Effect of a pharmacy care program on medication adherence and persistence, blood pressure, and low-density lipoprotein cholesterol: a randomized controlled trial. JAMA. 2006;296(21):2563-2571.


