An Evidence-Based Review of Patient-Centered Behavioral Interventions for Hypertension

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Introduction: While behavioral interventions may be viewed as important strategies to improve blood pressure (BP), an evidence-based review of studies evaluating these interventions may help to guide clinical practice.

Methods: We employed systematic review and meta-analysis of the literature (1970–1999) to assess the independent and additive effects of three behavioral interventions on BP control (counseling, self-monitoring of BP, and structured training courses).

Results: Of 232 articles assessing behavioral interventions, 15 (4072 subjects) evaluated the effectiveness of patient-centered counseling, patient self-monitoring of BP, and structured training courses. Pooled results revealed that counseling was favored over usual care (3.2 mmHg [95% CI, 1.2–5.3] improvement in diastolic blood pressure [DBP] and 11.1 mmHg [95% CI, 4.1–18.1] improvement in systolic blood pressure [SBP]) and training courses (10 mmHg improvement in DBP [95% CI, 4.8–15.6]). Counseling plus training was favored over counseling (4.7 mmHg improvement in SBP [95% CI, 1.2–8.2]) and afforded more subjects hypertension control (95% [95% CI, 87–99]) than those receiving counseling (51% [95% CI, 34–66]) or training alone (64% [95% CI, 48–77]).

Conclusions: Evidence suggests that counseling offers BP improvement over usual care, and that adding structured training courses to counseling may further improve BP. However, there is not enough evidence to conclude whether self-monitoring of BP or training courses alone offer consistent improvement in BP over counseling or usual care. The magnitude of BP reduction offered by counseling indicates this may be an important adjunct to pharmacologic therapy.

Medical Subject Headings (MeSH): hypertension, meta-analysis, patient-centered care
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Introduction

Over 43 million individuals in the United States have hypertension, and less than one third reach adequate levels of blood pressure (BP) control.[1,2] Heightened awareness of inadequate levels of BP control for a majority of patients has helped bring to light the need to refocus strategies to improve hypertension control.[3] While medications are arguably the most important therapy for hypertension, behavioral strategies have long been recommended as first-line initial and adjunctive therapy.[1,4,5] Specifically, educational approaches designed to help patients incorporate commonly accepted lifestyle changes (e.g., nutrition, weight loss, exercise, and social behaviors, including altering tobacco and ethanol use) into their daily living have been advocated.[6–13] It has also been proposed that increasing patient participation in hypertension care through techniques such as self-BP monitoring may increase patients' vigilance about their condition and potentially improve adherence to medications, ultimately leading to improvement in BP control.[14]

Improving BP through adjunctive, patient-centered, education-based behavioral interventions might have other potential salutary effects such as decreased costs of pharmaceuticals to patients and insurers, improved patient compliance with appointments, and decreased risk of complications from polypharmacy. However,

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some physicians may have difficulty employing such techniques because of increasing time pressures, limited resources and reimbursement for interventions such as counseling, and uncertainty regarding which approaches to patient education are most effective. At the same time, other physicians may employ these techniques without substantive evidence to support the time, energy, and resources required to appropriately carry out these interventions.

To address these issues, we performed a systematic review to assess the independent and incremental effects of three commonly performed patient education–based behavioral interventions on BP control: counseling techniques, structured training courses, and patient self-monitoring of BP.

Methods

Study Design and Eligibility Criteria

We conducted a systematic review of the literature describing behavioral interventions for hypertension. We sought to address two hypotheses in this review: (1) that the structure of multidimensional patient education may be important in relaying commonly accepted lifestyle advice, and (2) that patient self-BP monitoring (alone or in combination with patient education), by more directly involving patients in their care, may offer independent and/or incremental advantages over education approaches alone. To address these hypotheses, we investigated the effectiveness of counseling, structured training courses, and patient self-BP monitoring interventions when used singly or in combination to improve BP control.

We included only peer-reviewed English-language articles, published from January 1970 through July 1999, which focused on counseling, structured training courses, and patient self-BP monitoring. Self-monitoring of BP was defined as home BP monitoring performed by the patient for the purposes of recording or monitoring BP. Counseling was defined as individual or group discussion and teaching with a personalized approach, set in a nonclassroom format in which individuals or group members might often share their personal experiences. Training courses, which were curriculum-based courses aimed at teaching several people at once, were less personal than group counseling and usually occurred in a classroom setting with one or more curriculum leaders. Both counseling and training interventions were multidimensional in nature, primarily advocating general, commonly accepted lifestyle practice changes: encouraging healthy diet, weight loss, exercise, and tobacco cessation. We sought to assess common clinical practice in terms of counseling structure and general content of patient education, and we hypothesized that many primarily diet-focused interventions might, through attempts to drastically decrease weight and serum sodium, have additional effects on blood pressure reduction. Thus, although we included studies incorporating general dietary counseling as a part of a multidimensional education program, we eliminated several studies that were centered primarily on diet and weight loss—focusing on efficacy of treatment rather than effectiveness—or that focused on a specific diet prescription. For example, studies with interventions featuring meals that were prepared for participants were excluded, as were studies with interventions featuring diets with a prescribed amount of sodium, potassium, magnesium, or calorie intake. Finally, we included studies that were primarily "patient-centered." That is, we sought to evaluate studies that were designed to detect the effects of changes in patient behavior on BP as a result of the intervention, not interventions in which the healthcare provider was the unit of analysis.

We excluded efficacy studies for drug therapy for hypertension and any articles that did not measure a clinical outcome (e.g., blood pressure, hypertension control, or patient compliance with medical regimen). In addition, we excluded articles with a total sample size of <50 people or <25 people in each study arm.

Identification of Articles

To find eligible articles, we searched medical and psychology electronic databases (Medline, PsychInfo, CINAHL, Health Star, Sociologic Abstracts, Social Science Abstracts, EI Compendex, and Current Contents) using keywords and medical subject headings (MeSH) including: blood pressure, community based, coping behavior, counseling (group, individual), disease detection, health behavior, health education, hypertension, locus of control, managed care, meta-analysis, occupational health, patient compliance, physician behavior, preventive health services, research synthesis, screening, and treatment compliance. For each relevant article, we reviewed the references for additional candidate studies, and we obtained references from experts in hypertension.

Data Extraction

Using a structured abstraction instrument, data were abstracted on content, quality, and outcomes of studies.[15] Six reviewers participated in literature abstraction, with two reviewers independently abstracting data on each article. General information (e.g., study subject characteristics, setting, and design) was abstracted, as well as more specific characteristics of the intervention (e.g., leader of intervention, length of each session of the intervention, frequency of sessions, duration of the entire study, and the criteria used for BP control).

Follow-up BP measurements for study groups receiving the intervention of interest were abstracted. Up to seven discrete outcomes were reported: difference in either (1) diastolic blood pressure (DBP) or (2) systolic blood pressure (SBP) between treatment and control groups at follow-up, difference in change in (3) DBP or (4) SBP between treatment and control groups, change in either (5) DBP or (6) SBP at follow-up, and (7) percentage of subjects with hypertension control at follow-up. Difference in change in DBP and SBP between follow-up represents the difference between the change in BP for one group from start to end of the study minus the change in the other group from start to end of the study. After initial independent data abstraction by each reviewer, the two reviewers adjudicated differences in quality ratings and data abstraction until they came to an agreement.

Assessment of Article Quality

We developed a 100-point scale to describe the internal and external validity of the studies, as well as the reporting of

important study characteristics. This scale included three dimensions: (1) study population description, (2) intervention design/outcomes description, and (3) methods of analysis and results reporting. Study population description focused on the articles' descriptions of sociodemographic characteristics of those who enrolled versus those who did not enroll and reasons for eligible subjects not enrolling. Study intervention design/outcomes description focused on how the intervention was described, quality of randomization and blinding (if applicable), handling of withdrawals or crossovers, comparability of treatment groups (if applicable), length and frequency of the intervention, percentage of subjects completing the intervention, and assessment of outcomes. Study analysis focused on appropriateness of statistical tests chosen and presentation of statistical significance. Dimensions were weighted similar to Chalmers et al.[16] (Study population/design=70% of the total possible score; study analysis=30% of the total possible score.)

Data Synthesis and Statistical Analysis

We evaluated initial agreement between raters for the assessment of article quality by calculating the observed percentage agreement and the κ coefficient for interrater reliability.[17]

To include all evidence available to evaluate these interventions, we assigned a "study type" to each article for the purpose of statistical analysis: (1) single-intervention group, and (2) between-intervention groups. An intervention group was defined as a group of study participants receiving a particular intervention.

Single-Intervention Group Analysis

If an article described a study comparing more than one intervention but not all the interventions met the eligibility criteria for this review, we abstracted information on only the intervention groups receiving the interventions of interest. We then analyzed these abstracted results as if the study were designed to evaluate only that intervention (with no companion or control groups available for comparison). For example, if a study compared two groups of patients—one receiving biofeedback and one receiving counseling—we abstracted only information on the group of participants receiving counseling. In what we call the "single-group" statistical analysis, we then pooled abstracted information from this study along with information similarly abstracted from other studies with intervention groups who received counseling. As such, individual intervention groups were treated as small separate prospective studies, and results were pooled to obtain the magnitude of BP improvements among single groups from beginning to end of each intervention.

Between-Intervention Groups Analysis

Studies with suitable comparison intervention groups containing either usual care or one of the three interventions of interest were incorporated into a separate analysis, evaluating differences between treatment (interventions of interest) and control (usual care or alternative intervention) groups. If a study group contained any other interventions besides the three interventions of interest, it was excluded from both types of analyses.

For each analysis, results were pooled across studies, using both fixed- and random-effects models to estimate summary effects for all combined studies.[17,18] In the fixed-effects analyses, homogeneity was assessed both overall and within subgroups (chi-square test). Variances for individual study results were calculated from standard errors when provided, from p values or reported t-test results for studies for which raw data were not available, using the largest p value consistent with the published data for studies not reporting exact p values (e.g., $p<0.05$ was considered to be $p=0.05$). For differences between treatment and control groups, if raw data were not provided, pooled variance estimates were calculated as described by Greenland.[18] Calculations were performed using Microsoft Excel 2000 (Microsoft Corp, Redmond, WA) and STATA Statistical Software: Release 6.0 (Statacorp, College Station, TX).

Subgroup analysis for articles focusing on counseling was performed by categorizing articles by year of publication, leader of intervention, duration of intervention, age of participants, percentage of white participants, and quality scores of articles.

Results

Yield of Relevant Articles

The initial search identified 232 articles focusing on hypertension detection and management. Of these, 15 articles (studying a total of 4072 people) contained interventions focusing exclusively on counseling, self-monitoring of BP, and training courses.[19–33]

Characteristics of Articles

Table 1 describes primary characteristics of the articles included in the analysis. The majority of articles were published between 1980 and 1999, with most focusing on counseling. Study settings varied, with the majority occurring at hospital- or community-based clinics. The mean total number of subjects per study was 310 (range 53 to 1880, median 130), and among those articles reporting gender, the mean percentage of male subjects was 53% (range 21 to 100, median 49). Among articles reporting on age and race, the mean age of subjects was 57 years (range 50 to 65, median 55), and the mean percentage of white subjects was 34% (range 0 to 97, median 11). The mean intervention group size was 63 (range 23 to 115, median 54). Seven studies contained intervention and design characteristics compatible for the between-intervention group analysis, while nine studies contained interventions that could be used only for the single-intervention group analysis. Subjects in 13 of the studies were taking concomitant antihypertensive medications.

Table 2 includes selected characteristics of each individual intervention. Nurses, physicians, and pharmacists led the majority of interventions. The length of each episode of the intervention of interest varied from 5 to 90 minutes; 12 studies did not report on the length of each intervention interval.[19–24,26,28–31,33] The frequency with which episodes of each intervention oc-

Table 1. Characteristics of articles examining blood pressure interventions

			Subjects							Outcomes						
Study	Intervention	Setting	Total N	% Male	Mean age (years)	% White	Group N	On meds	Study type	Δdbp	Δsbp	HC	Ddbp	Dsbp	DΔdbp	DΔsbp
Counseling interventions																
Billault et al.[19]	C	HBC	200	63	53	—[a]	85	Yes	S	x	x					
Bond et al.[20]	C	HBC	214	—	—	—	58	Yes	S			x				
Erickson et al.[22]	C	HBC	80	31	65	11	40	Yes	B/S	x	x				x	x
Heirich et al.[23]	C	WS	1880	—	—	—	88	—	S			x				
Logan et al.[26]	C	WS	194	72	50	84	91	Yes	B/S	x			x		x	
Morisky et al.[27]	C	HBC	400	30	54	14	44	Yes	S			x				
Park et al.[29]	C	P	53	49	60	97	23	Yes	B/S	x	x	x			x	x
Pheley et al.[30]	C	CBC	200	44.5	55	—	108	Yes	S	x	x	x				
Stamler et al.[31]	C	NS	115	100	—	—	115	No	S	x	x					
Webb et al.[32]	C	CBC	123	21	62	0	31	Yes	B			x				
Monitoring interventions																
Johnson et al.[25]	M	H	136	60	53	—	34	Yes	S	x			x		x	
Training interventions																
Webb et al.[32]	T	CBC	123	21	62	0	37	Yes	B			x	x			
Combination interventions																
Carnahan et al.[21]	C M	HBC	100	98	55	—	50	Yes	B				x			
Iso et al.[24]	C + T	CHS	111	56	59	—	48	Yes	B				x	x		
Muhlhauser et al.[28]	C + M +T	CBC	200	45	51	—	86	Yes	S	x	x					
Wyka-Fitzgerald et al.[33]	C + T	HBC	66	—	—	—	66	Yes	S			x				

[a] Not reported.
Intervention: C, counseling; T, training; M, monitoring.
Setting: CBC, community-based clinic; HBC, hospital-based clinic; CHS, community health center; H, home; P, pharmacy; WS, work site.
Analysis: S, single arm; B, between arm.
Quality score: 12-point scale weighted with population description 30%, study intervention description 40%, and analysis 30%.
Outcomes: DBP, diastolic blood pressure; SBP, systolic blood pressure; Δdbp, change in DBP at follow-up; Δsbp, change in SBP at follow-up; HC, percentage of subjects with hypertension control at follow-up; Ddbp, difference in DBP between treatment groups at follow-up; Dsbp, difference in SBP between treatment groups at follow-up; DΔdbp, difference in change in DBP between treatment groups at follow-up; DΔsbp, difference in change in SBP between treatment groups at follow-up.

Table 2. Characteristics of interventions

Study	Intervention		Leader	Length of each interval	Frequency of intervals	Duration of study
Counseling interventions						
Billault et al.[19]	C		Physician	—[a]	—	8 months
Bond et al.[20]	C		Pharmacist	—	—	9 months
Erickson et al.[22]	C		Pharmacist	—	—	5 months
Heirich et al.[23]	C		Counselor	—	—	72 months
Logan et al.[26]	C		Nurse	—	Every 1–3 months	12 months
Morisky et al.[27]	C		Physician, Social worker	5–10 minutes	—	24 months
Park et al.[29]	C		Pharmacist	—	Every 1 month	4 months
Pheley et al.[30]	C		Nurse	—	Every 2–4 weeks	12 months
Stamler et al.[31]	C		—	—	Every 1–3 months	60 months
Webb et al.[32]	C		Social worker	60 minutes	Every 3 weeks	6 months
Monitoring interventions						
Johnson et al.[25]	M		Trained personnel	NA	Daily	6 months
Training interventions						
Webb et al.[32]	T		Nurse	60 minutes	Every month	6 months
Combination interventions						
Carnahan et al.[21]	C + M	C	Nurse	—	2 to 8 sessions per 6 months	6 months
		M	Nurse/Self	NA	Twice daily	6 months
Iso et al.[24]	C + T	C		—	7 sessions per 18 months	18 months
		T	Physician	30 minutes	7 sessions per 18 months	18 months
Muhlhauser et al.[28]	C + M + T	C	Physician and Assistants	—	—	19 months
		M	Physician and Assistant/Self	NA	Twice daily	19 months
		T	Physicians and Assistants	60–90 minutes	Four consecutive weeks	19 months
Wyka-Fitzgerald et al.[33]	C + T	C	Nurse Practitioner	—	—	1.25 months
		T	Nurse Practitioner	90 minutes	Five consecutive weeks	1.25 months

[a] Not reported.
C, counseling; M, monitoring; T, training.

Table 3. Quality attributes of articles

Study	Intervention	Population description[a] (maximum possible = 24)	Study and intervention description[b] (maximum possible = 46)	Analysis description and appropriateness[c] (maximum possible = 30)	Summary score[d]
Counseling interventions					
Billault et al.[19]	C	11.6	23.8	17.5	52.9
Bond et al.[20]	C	7.0	34.4	16.8	58.2
Erickson et al.[22]	C	14.0	40.8	30.0	84.8
Heirich et al.[23]	C	10.5	32.1	20.6	63.2
Logan et al.[26]	C	18.8	34.9	27.5	81.2
Morisky et al.[27]	C	16.6	37.4	19.4	73.4
Park et al.[29]	C	15.8	34.0	15.0	64.8
Pheley et al.[30]	C	10.5	32.4	16.8	59.7
Stamler et al.[31]	C	0	7.0	13.1	20.1
Webb et al.[32]	C	15.5	36.5	27.5	79.5
Monitoring interventions					
Johnson et al.[25]	M	13.3	33.2	22.5	69.0
Training interventions					
Webb et al.[32]	T	15.5	36.5	27.5	79.5
Combination interventions					
Carnahan et al.[21]	M	15.8	33.7	20.1	69.6
Iso et al.[24]	C + T	21.3	31.5	16.9	69.7
Muhlhauser et al.[28]	C + M + T	20.8	36.5	24.4	81.7
Wyka-Fitzgerald et al.[33]	C + T	7.2	25.3	14.8	47.3

[a] Four to seven questions focused on characteristics of study population, randomization (if applicable), sociodemographics of those who enrolled and those who did not enroll, and reasons for eligible subjects not enrolling.
[b] Six questions focused on how well intervention was described, blinding (if applicable), comparability of treatment groups (if applicable), handling of withdrawals or crossovers, comparability of retained subjects to withdrawals, length and frequency of intervention, percentage of subjects completing intervention, and standardized/valid assessment of outcomes.
[c] Four questions focusing on the appropriateness of statistical tests chosen, presentation of statistical significance, mention of power calculations, and adjustments for potential confounders or differences between groups.
[d] Sum of population description, study and intervention description, and analysis description and appropriateness scores.
C, counseling; M, monitoring; T, training.

curred during the study varied as well, ranging from every 2 weeks to every 3 months for counseling interventions, daily to twice daily for monitoring interventions, and weekly to several months for combined interventions. Finally, the mean study duration was 17.2 months (range 1.25 to 72, median 12 months).

Assessment of Article Quality

Prior to adjudication of differences, initial interrater agreement for assessment of article description of study population ranged from 73% to 85% (κ=.56), agreement for assessment of intervention design items ranged from 78% to 97%(κ=.69), and agreement for article reporting and appropriateness of analysis and 86% to 98% (κ=.80). Table 3 demonstrates quality scores for all studies, divided into three areas. Summary quality scores ranged from 20.1 to 84.8 points out of a possible 100 points (mean quality score 65.9). Notably, 14 articles had quality score deductions in the areas of description of population, intervention, and outcome measurements.

An assessment of how investigators obtained BP measurements was included in the quality score for description of study, intervention, and outcome measurements. Table 4 illustrates the reporting characteristics of articles regarding the ascertainment of BP outcome measurements. Investigators in only eight studies directly obtained BP measurements. In addition, few of the studies reported the type of sphygmomanometer used to measure BP, and the protocols reported for measurement varied.

Outcomes

Table 1 shows the BP outcomes measured in each study. (Actual data from individual studies are included in the Appendix.) Figures 1 and 2 demonstrate the pooled evidence supporting the interventions singly and in combination; Figure 1 demonstrates the results of the "between-group analysis" (results of comparison studies), while Figure 2 demonstrates the results of the "single-group analysis" (magnitude of effect of an intervention on single groups).

Table 4. Reporting characteristics of articles regarding ascertainment of blood pressure (BP) outcomes

Study	Intervention	BP measured directly by investigators?	Method of ascertainment of BP by investigator	Type of sphygmomanometer	Protocol reported
Counseling interventions					
Billault et al.[19]	C	No	Chart review	—[a]	—
Bond et al.[20]	C	No	Chart review	—	—
Erickson et al.[22]	C	Yes	Sphygmomanometer	—	1 reading, seated 15 minutes
Heirich et al.[23]	C	Yes	Sphygmomanometer	—	—
Logan et al.[26]	C	Yes	Sphygmomanometer	—	3 readings
Morisky et al.[27]	C	No	Chart review	—	—
Park et al.[29]	C	Yes	Sphygmomanometer	Mercury	2 consecutive readings
Pheley et al.[30]	C	No	Chart review	—	—
Stamler et al.[31]	C	Yes	Sphygmomanometer	—	—
Webb et al.[32]	C	No	Chart review	—	—
Monitoring interventions					
Johnson et al.[25]	M	Yes	Sphygmomanometer	—	Patient report
Training interventions					
Webb et al.[32]	T	No	Chart review	—	—
Combination interventions					
Carnahan et al.[21]	C+M	Yes	Sphygmomanometer	—	Patient report
Iso et al.[24]	C+T	Yes	Sphygmomanometer	Random zero mercury	3 readings, 30 seconds apart, seated 5 minutes
Muhlhauser et al.[28]	C+M+T	No	Chart review	—	—
Wyka-Fitzgerald et al.[33]	C+T	No	—	—	—

[a] Not mentioned or not reported.
C, counseling; M, monitoring; T, training.

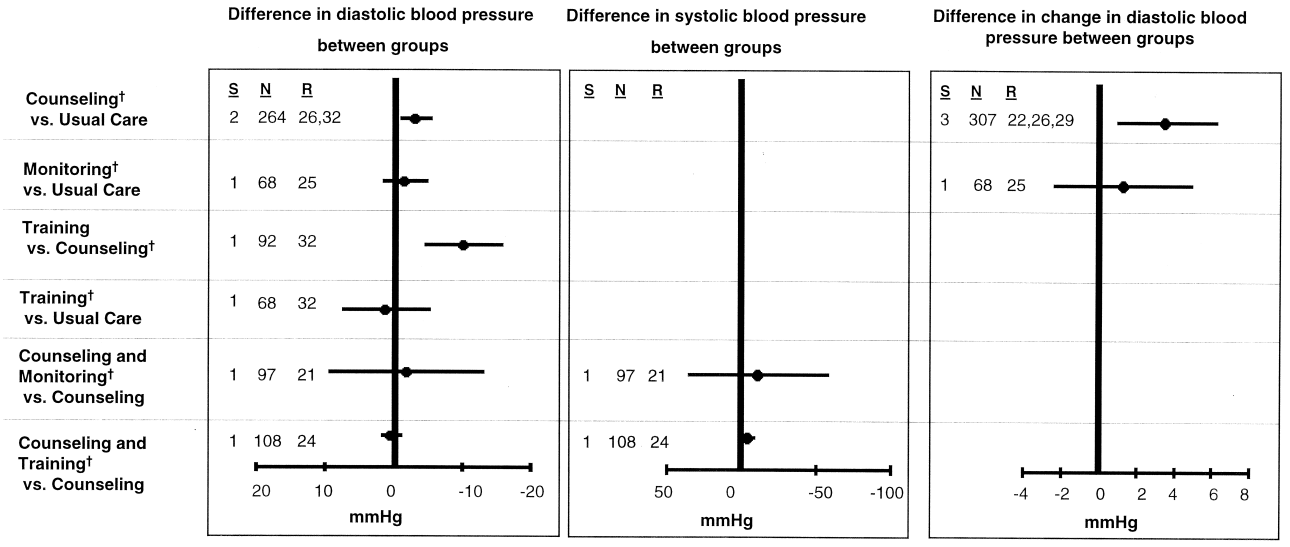

Figure 1. Blood pressure outcomes by intervention, between-intervention group analysis. Results reported in figures are estimates obtained using fixed-effects models and were supported by results obtained with random-effects models (results in text). Findings to the right of 0 favor the intervention group.

Counseling

Counseling offered significant BP improvement over usual care in four comparison studies (Figure 1).[22,26,29,32] Counseling groups had a 3.2mmHg improvement in follow-up DBP (95% confidence interval [CI], 1.2–5.3) over groups receiving usual care (two studies, total 264 subjects) and a 3.5 mmHg improvement in DBP (95% CI, 1.0–6.2) over usual care groups at follow-up (three studies, total 307 subjects). Counseling groups also had an 11.1 mmHg improvement in SBP (95%CI, 4.1–18.1) over usual care groups at follow-up (two studies, total 109 subjects; not shown in figure).[22,29]

Ten studies assessed the magnitude of BP control afforded groups receiving counseling (Figure 2).[19,20,22,23,26,27,29–32] Groups receiving counseling had 5.0 mmHg (95% CI, 2.7–7.2) and 6.2 mmHg (95% CI, 2.4–10.0) changes in DBP and SBP, respectively. These BP changes were not statistically significantly different from changes observed in subjects receiving monitor-

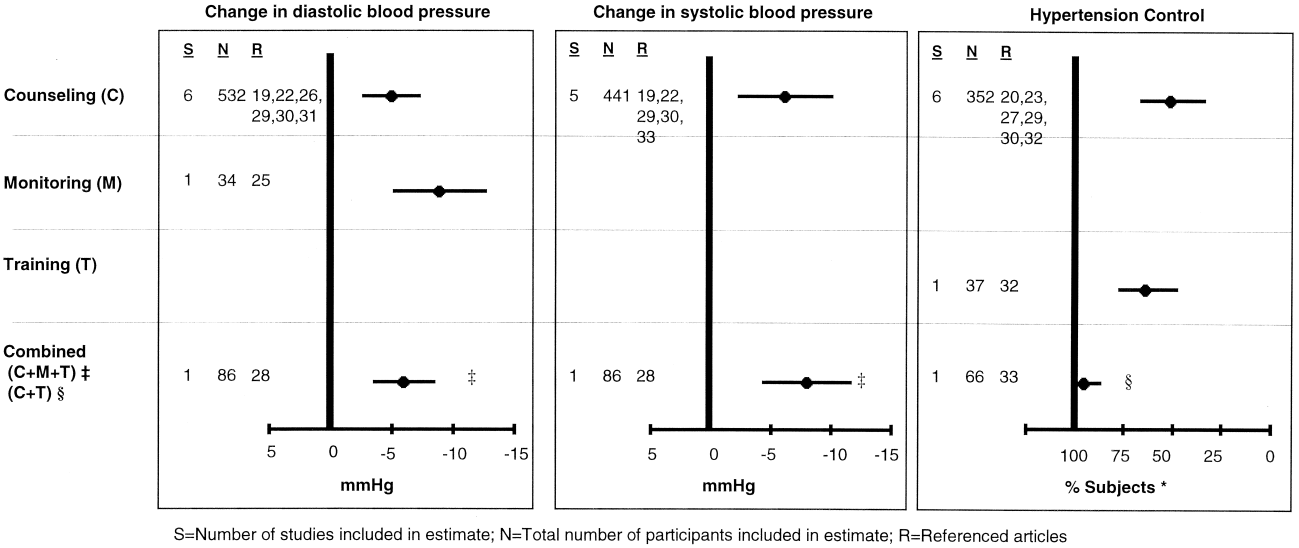

Figure 2. Blood pressure outcomes by intervention, analysis of single-intervention group. Results reported in figures are estimates obtained using fixed-effects models and were supported by results obtained with random-effects models (results in text). Findings to the right of 0 favor the intervention group.

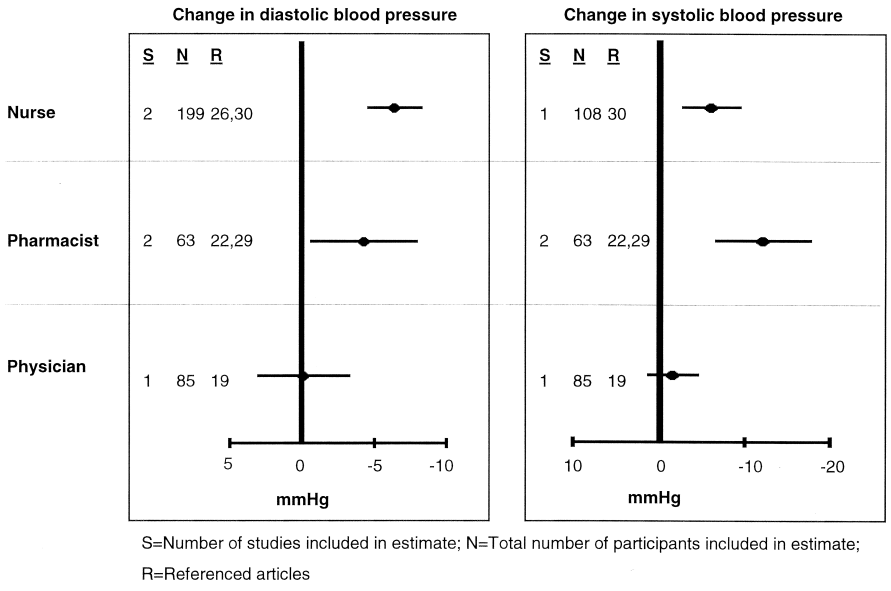

Figure 3. Subgroup analysis of counseling intervention, categorized by leader of the counseling intervention. Results reported in figures are estimates obtained using fixed-effects models and were supported by results obtained with random-effects models (results in text). Findings to the right of 0 favor the intervention group.

ing or subjects receiving all three interventions in combination. Similarly, 51% (95% CI, 34–66) of subjects had BP control at follow-up after receiving counseling. While the magnitude of hypertension control was statistically significantly less than that experienced by groups receiving counseling plus monitoring, it was not statistically significantly different from groups receiving training.

Because of heterogeneity among some studies that assessed the effect of counseling on difference in DBP between treatment and control groups at follow-up (p=0.038), the absolute magnitude of change in DBP (p<0.01) and SBP (p<0.01), and hypertension control (p<0.01), we also used a random-effects model, which assumed BP changes varied not only within each of the studies (as reflected by the study standard error) but also between studies. Using this approach, estimates from comparison studies of counseling versus usual care were not appreciably different, but confidence intervals were wider: Counseling offered a 5.4 mmHg (95% CI, −3.1–13.9) improvement over usual care in follow-up DBP. For the two remaining estimates from comparison studies (difference in change in SBP and DBP), there was no significant heterogeneity and the fixed-effects estimates were maintained, supporting counseling over usual care. Using the random-effects approach, the estimates of magnitude of BP reduction were similar as well, although confidence intervals were wider: The magnitude of DBP and SBP reductions were 5.0 mmHg (95% CI, −1.8–11.6) and 7.8 mmHg (95% CI, −1.0–16.6), respectively. Random-effects modeling did not appreciably change the estimate of percentage of subjects afforded hypertension control with counseling: 51% (95% CI, 31–73).

Subgroup analyses of studies featuring counseling demonstrated interesting trends when articles were categorized according to the leader of the intervention, the year of publication, and their quality scores.[19,22,26,29,30] In studies where pharmacists and nurses led the counseling interventions, statistically significant improvements in DBP and SBP were observed (Figure 3). This contrasts with a single study in which physicians led the counseling intervention and no improvement in DBP or SBP was seen. Pharmacist-led counseling interventions had a 4.3 mmHg change in DBP (95% CI, 0.7–7.9) and a 12.2 mmHg change in SBP (95% CI, 6.8–17.6), while nurse-led counseling interventions had a 6.4 mmHg improvement in DBP (95% CI, 4.6–8.2) and a 6.2 mmHg improvement in SBP (95% CI, 2.9–9.5). Increased BP reductions were observed in studies with earlier publication dates and in studies with higher quality scores, but these differences were not statistically significant.

Patient Self-BP Monitoring

In the one study evaluating patient self-BP monitoring, comparison of self-monitoring of BP versus usual care demonstrated statistically insignificant differences between the group receiving monitoring and the group receiving usual care (Figure 1).[25] In this study, the magnitude of BP reduction for the single group receiving self-monitoring of BP was an 8.9 mmHg change in DBP from baseline (95% CI, 5.2–12.6) (Figure 2). When compared to single groups evaluating counseling, training, and combined interventions, this effect was not statistically significantly different from the

change in DBP seen in individuals receiving counseling alone or all three interventions combined.

Training Courses

One comparison study evaluated training courses, comparing training to both usual care and counseling separately.[32] Counseling was favored over training courses (decrease in DBP at follow-up of 10 mmHg [95% CI, 4.8–15.6]; Figure 1). Sixty-four percent of subjects (95% CI, 48–77) in this study had hypertension control at follow-up. This effect was not significantly larger than the magnitude of hypertension control afforded by counseling, but the effect was significantly less than the percentage of subjects with hypertension control who received counseling and training combined (95% [95% CI, 87–99]) (Figure 2).

Combination Interventions

Four studies featured combined interventions, including two comparison studies of combined interventions versus counseling: (1) counseling plus monitoring versus counseling, and (2) counseling plus training versus counseling.[21,24,28,33] SBP changes were different for the two interventions. No statistically significant SBP reduction was seen for counseling plus monitoring over counseling; in contrast, counseling plus training offered a 4.7 mmHg (95% CI, 1.2–8.2) SBP reduction over counseling. Neither combination offered improvements in DBP over counseling (Figure 1).

Two studies assessed the magnitude of BP reduction afforded to groups receiving combined interventions.[28,33] Subjects receiving counseling, monitoring, and training combined as a single intervention experienced reductions in both DBP and SBP: change in DBP 6.0 mmHg (95% CI, 3.6–8.4), change in SBP 8.0 mmHg (95% CI, 4.4–11.6). These BP reductions were not statistically significantly different from those observed in groups receiving counseling alone or monitoring alone. In contrast, among subjects receiving counseling plus training in a separate study, 95% achieved hypertension control (95% CI, 87–99). This represented a statistically significant improvement over the magnitude of hypertension control afforded subjects receiving training alone and for subjects receiving counseling alone (Figure 2).

Discussion

While patient-centered, education-based behavioral interventions may be viewed as important strategies to educate patients and improve BP control, definition of the clinical benefits through careful and systematic review of these approaches in hypertension care is necessary to guide evidence-based practice. As such, this systematic review assessed in incremental and combined fashion the BP benefit provided by these three patient-centered behavioral interventions.

Pooled results favor counseling over usual care with an absolute decrease in DBP of 3.2 mmHg and improvements in changes in DBP and SBP of 3.5 mmHg and 11.1 mmHg, respectively. Counseling is also favored over training courses, offering a 10.2 mmHg reduction in DBP over training at follow-up. The magnitudes of DBP and SBP reductions for single groups receiving counseling alone are 5.0 mmHg and 6.2 mmHg, respectively. In contrast, neither self-monitoring of BP nor training courses offer any statistically significant improvement in DBP at follow-up over usual care, and the combined interventions do not demonstrate substantial improvement over counseling except when looking at hypertension control in one study, in which 95% of subjects achieved hypertension control, which is statistically significantly more than with counseling and training.

Nearly all articles we reviewed used these interventions as adjunctive therapy to pharmacologic approaches for hypertension management. A previous systematic review of first-line pharmacologic agents used to treat hypertension (beta blockers, calcium channel blockers, and thiazide diuretics) reported that SBP and DBP benefits gained from these agents ranged from 10.0 mmHg to 15.6 mmHg and from 5.0 mmHg to 7.3 mmHg, respectively.[34] Our results indicate that additional BP benefit gained from adding counseling could be as high as 5 to 6 mmHg reductions in both DBP and SBP. This improvement may be mediated by enhanced patient compliance with medication regimens and physician visits, improved patient behaviors, as well as potentially heightened patient awareness regarding ongoing needs for continued aggressive hypertension management.

Notwithstanding the strength of this systematic review, there are limitations. First, despite an extensive search, 15 articles met our criteria, focusing specifically on these three commonly practiced interventions. Because we sought to address only the effects of these three behavioral interventions singly or in combination with each other, it was necessary to eliminate many studies that included these interventions combined with other important interventions. This resulted in a very small number of studies evaluating patient self-BP monitoring or training courses, limiting our statistical power to estimate accurately the effect of these two interventions. Second, there was moderate heterogeneity of interventions in terms of content, leader, and duration. This reflects variation in how these interventions have been implemented and evaluated. Although our subgroup analyses were limited in statistical power, there is a strong suggestion that effectiveness of these interventions may differ based on these more detailed aspects of intervention implementation. However, the small number of studies available inhibited our ability to draw conclusions regarding any possible dose-re-

sponse effects in terms of length and frequency of interventions. Third, there were few randomized experimental trials, which are considered the best study design to derive inferences about the efficacy of interventions. Many of our studies employed noncomparative designs and reported varying outcomes, prohibiting less complex approaches to evaluating intervention effectiveness. Lack of control groups may also prohibit assessment of potential placebo and Hawthorne effects.[35] Finally, our review of article quality revealed that, in many cases, less than optimal attention was paid toward reporting important aspects of study population and intervention description. Nevertheless, this body of evidence is what is available to guide clinical practice.

In summary, this study provides substantive evidence that behavioral interventions can play an important role in improving BP management. Counseling is supported by the evidence as an effective technique to further lower BP beyond the benefit afforded by medications alone. Substantial evidence is lacking on training or self-monitoring of BP interventions. Theoretically, combining interventions should provide even an even greater degree of BP control, although consistent evidence is lacking to support this theory.

There is a clear need for more focused research that addresses individual interventions separately. Improvements in descriptions of interventions (e.g., the leader of the intervention, the precise content of counseling, the length and duration of the interventions) as well as provision of more standardized reporting mechanisms for outcomes will further strengthen the existing evidence regarding patient-centered interventions for hypertension and will help guide development of recommendations for clinical practice.[30–33]

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Appendix. Outcome data obtained from studies

		Outcomes						
Study	**Intervention**	**ΔDBP[a]**	**ΔSBP[a]**	**HC[a]**	**DDBP[b]**	**DSBP[b]**	**DΔDBP[b]**	**DΔSBP[b]**
Counseling interventions								
Billault et al.[19]	C	0.1 (1.6)	1.6 (1.4)	—[c]	—	—	—	—
Bond et al.[20]	C	—	—	69% (6)	—	—	—	—
Erickson et al.[22]	C	4.7 (1.7)	12 (3.4)	—	—	—	9.3 (12.5)	2.1 (5.0)
Heirich et al.[23]	C	—	—	43% (5)	—	—	—	—
Logan et al.[26,d]	C	10.5 (1.1)	—	—	2.8 (0.6)	—	2.8 (1.2)	—
Morisky et al.[27,d]	C	—	—	53% (9)	—	—	—	—
Park et al.[29]	C	3.7 (2.0)	12 (2.4)	52% (10)	—	—	5 (1.8)	13 (13.1)
Pheley et al.[30]	C	4.4 (0.8)	6.2 (1.7)	44% (5)	—	—	—	—
Stamler J et al.[31]	C	8 (2.4)	11 (3.2)		—	—	—	—
Webb P et al.[32]	C	—	—	53% (9)	—	—	—	—
Monitoring interventions								
Johnson et al.[25,d]	M	8.9 (1.9)	—	—	1.6 (2.4)	—	1.3 (3.4)	—
Training interventions								
Webb et al.[32]	T	—	—	64% (8)	1.1 (9.8)	—	—	—
Combination interventions								
Carnahan et al.[21,d]	C + M	—	—	—	—	11.4 (561)	—	—
Iso et al.[24,d]	C + T	—	—	—	0.4 (0.9)	4.7 (3.2)	—	—
Muhlhauser et al.[28]	C+ M + T	6.0 (1.2)	8.0 (1.8)	—	—	—	—	—
Wyka-Fitzgerald et al.[33]	C + T	—	—	95% (2)	—	—	—	—

[a] Estimate (Standard error).
[b] Estimate (Variance).
[c] Not reported.
[d] In these studies, outcomes assessors were blinded to treatment assignment.
Intervention: C, counseling; M, monitoring; T, training.
Outcomes: ΔDBP = change in diastolic blood pressure (DBP) at follow-up; ΔSBP= change in systolic blood pressure (SBP) at follow-up; HC= percent of subjects with hypertension control at follow-up; DDBP = difference in DBP between treatment groups at follow-up; DSBP = difference in SBP between treatment groups at follow-up; DΔDBP = difference in change in DBP between treatment groups at follow-up; DΔSBP = difference in change in SBP between treatment groups at follow-up.
Note: All outcomes except HC expressed as mmHG.