Improving Adherence to Guidelines for Hypertension Drug Prescribing: Cluster-randomized Controlled Trial of General Versus Patient-specific Recommendations

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Objective: To determine whether an intervention focusing clinician attention on drug choice for hypertension treatment improves concordance between drug regimens and guidelines.

Study Design: Cluster-randomized controlled trial comparing an individualized intervention with a general guideline implementation in geographically diverse primary care clinics of a university-affiliated Department of Veterans Affairs healthcare system.

Methods: Participants were 36 attending physicians and nurse practitioners (16 in the general group and 20 in the individualized group), with findings based on 4500 hypertensive patients. A general guideline implementation for all clinicians, including education about guideline-based drug recommendations and goals for adequacy of blood pressure control, was compared with addition of a printed individualized advisory sent to clinicians at each patient visit, indicating whether or not the patient's antihypertensive drug regimen was guideline concordant. We measured change from baseline to end point in the proportion of clinicians' patients whose drug therapy was guideline concordant.

Results: The individualized intervention resulted in an improvement in guideline concordance more than twice that observed for the general intervention (10.9% vs 3.8%, $t = 2.796$, $P = .008$). Bootstrap analysis showed that being in the individualized group increased the odds of concordance 1.5-fold ($P = .025$). The proportion of patients with adequate blood pressure control increased within each study group; however, the difference between groups was not significant.

Conclusion: An individualized advisory regarding drug therapy for hypertension given to the clinician at each patient visit was more effective in changing clinician prescribing behavior than implementation of a general guideline.

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Active steps are required to translate clinical practice guidelines into practice.[1-4] Provision of education and feedback to clinicians based on drug profiling of panels of patients effectively changes practice in various settings,[5] including hypertension management.[6] The influence of feedback can be extended by reminder messages.[7] An intervention that coincides with a clinic visit is particularly effective in improving physician compliance with guidelines for preventive care.[8] The consequences of implementing evidence-based guidelines have been studied mainly for preventive care[7,9-12] rather than chronic disease management.

We studied implementation of hypertension guidelines because drug prescribing for hypertension frequently deviates from evidence-based clinical practice guidelines.[13-17] Clinicians may not recognize their lack of guideline adherence.[18] We designed an intervention to address known barriers to clinician guideline adherence,[2,19-21] using education, performance feedback, recommendations about drug therapy for specific patients delivered to the clinician during the clinic visit, and requests for a response from the clinician. Multifaceted quality improvements have been found more effective than single-component strategies in changing clinician behavior.[4]

We hypothesized that an intervention with information individualized to particular patients would increase clinician adherence to drug-therapy guidelines in primary care clinics of a large healthcare system.

METHODS

Sites and Subjects

The study was conducted at the Department of Veterans Affairs Palo Alto Health Care System (VAPAHCS), which has rural, suburban, and urban sites in the San Francisco Bay and Central Valley areas of

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California. All sites with established clinics at the start of the study were included: Palo Alto, San Jose, Monterey, Livermore, Menlo Park, and Stockton. All attending physicians and nurse practitioners with primary care clinics in which they provided direct patient care (rather than providing only supervision of residents, which takes place at 1 site) were included. Because the intervention was provided to clinicians, we randomized by clinicians. The randomization, performed by the biostatistician (Dr Lavori) using the S-Plus 2000 statistical program (Insightful Corporation, Seattle, Wash), was done for all clinicians at the same time, and was stratified by physician versus nurse practitioner. Of 42 clinicians randomized, 4 left the primary care clinics before the intervention began and 2 more left shortly after, all for reasons unrelated to this study; their patients were reassigned to the 36 remaining clinicians. Participants were not informed of their study group assignment.

Study patients had a diagnosis of hypertension on their problem list, an active prescription for an antihypertensive drug at the start of the study, and at least 1 primary care clinic visit with a study clinician during the study period; and they were not dually followed in the Hypertension Clinic. The 36 study clinicians had a total of 4533 patients meeting the study criteria. Of these, 33 patients (19 in general intervention and 14 in individualized intervention) died during the study period, leaving 4500 patients. At the end point, 124 patients no longer had active prescriptions for antihypertensive drugs; these patients were not included in the concordance analysis, which was based on drugs prescribed, but they were included in the blood pressure (BP) analyses.

Table 1. Sample Advisory to Clinician About a Patient in Category 4

Computer records indicate this hypertensive patient has diabetes mellitus.
This case would be classified as NOT in adherence to the VA hypertension guideline's performance standards.
VISN hypertension guidelines recommend using either an ACE inhibitor or an angiotensin II receptor blocker in this cohort WHEN CONTRAINDICATIONS TO THESE AGENTS DO NOT EXIST.
Consider adding an ACE inhibitor or an angiotensin II receptor blocker if clinically appropriate for this patient.
If this patient does not have diabetes mellitus, please delete the diagnosis using the patient's encounter form.

ACE indicates angiotensin-converting enzyme; VA, Department of Veterans Affairs; VISN, Veterans Integrated Service Network.

Guidelines Implemented

We implemented the guidelines described in the *Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure* (JNC 6),[13] the version of JNC that was in effect at that time, and the Department of Veterans Affairs (VA) national guidelines.[22] To operationalize these guidelines and set up measurable performance standards, Veterans Integrated Service Network (VISN) 21, the region of VA where VAPAHCS is located, had adopted performance standards for drug therapy of hypertension.[23]

Intervention

Because VISN 21 mandated a hypertension guideline for all patients, it was not possible to have a "usual care" comparison group, so the study was designed to compare 2 interventions. The trial compared a general intervention with an individualized intervention that supplemented the general intervention. All clinicians received the general intervention, including a printed copy of JNC 6 guidelines, VA national hypertension guidelines, and the VISN 21 performance standards; all physicians also received information about the proportion of hypertensive patients at VAPAHCS whose drug therapy was concordant with the performance standards. In addition, the VA national guidelines and the VISN 21 guidelines for management of hypertension were reviewed and discussed in small-group workshops held 2 months after the start of the study period. In the encounter packet was a form for each scheduled clinic visit of a study patient, listing the antihypertensive drugs prescribed for that patient. This general intervention was designed to improve concordance with guidelines for drug therapy of hypertension and also to increase awareness of the importance of adequacy of BP control.

Clinicians in the individualized-intervention group received all the general interventions described above. In addition, their version of the encounter packet form included an advisory about guideline concordance of the patient's antihypertensive drug regimen (**Table 1**). We asked clinicians to sign and return the forms, as a measure to enhance the effectiveness of the advisory.[21]

All clinicians received a form at each visit of a study patient; except for the presence or absence of the advisory; these forms were similar in appearance. We sent clinic clerks 11 056 forms for separate clinic appointments, with an average of 2.5 (median = 2) forms

(scheduled visits) per patient. We estimated that personnel time required to compute, print, and mail all the forms for both the general-intervention and individualized-intervention groups was approximately one half day per week (10% full-time equivalent) for the duration of the intervention.

We also sent the clinicians in the individualized-intervention group drug profiles for their own panel of patients. These drug profiles were sent at the beginning of the study period as a "priming" strategy to make them aware of their own rates, and at 3 months into the study period as a "reinforcing" strategy.[20]

The intervention occurred from February through November 1999.

Outcome Measures

Concordance With Drug Guidelines. The major outcome measure for the study was the change from baseline to end point in the proportion of patients in the clinicians' panels whose drug regimen was guideline concordant. This measure takes into account the baseline concordance.

The concordance of each patient's drug regimen was calculated as follows:

Patients were classified into the VISN 21 hypertension patient categories (**Table 2**).

The patient's active prescriptions were analyzed to determine whether the recommended drug was part of the patient's regimen.

For example, if a category 1 patient had an active prescription for a thiazide diuretic, the patient was classified as "concordant" at that time point. Each patient's category was determined at baseline and at the end point, using the same 2 calendar dates for all patients. Using the same end point date for all patients allowed us to capture medication changes made at the last visit.

The guideline-concordance determinations described above were done by a computer program applied to the patients' electronic medical record data without regard to the study group assignment. Hence, the assessment was blinded to group assignment.

Blood Pressure. Blood pressure measurements were done as part of routine clinical care using IVAC automated machines (ALARIS Medical Systems, San Diego, Calif). Before the start of the study, the VISN 21 statement on accurate measurement of BP was reviewed with nurse managers in each clinic, with the support of nursing administration.

To obtain BP data for each study clinician, we reviewed charts of a random sample of 10 study patients who had at least 2 clinic visits with BP measurements at least 30 days apart (to allow time for any drug changes to take effect), for a total of 350 patients. (If the clinician had fewer than 10 study patients, all charts were reviewed.) All recorded BPs taken at baseline (first primary care clinic visit during study period) and outcome (last visit) were noted. Measurements were averaged if there were multiple readings at a visit. Adequacy of BP control had been defined dichotomously by VA national quality assurance criteria as systolic BP less than 140 and diastolic BP less than 90. Criteria were not defined for subgroups of patients such as diabetics; for comparability with other studies,[24] we used the VA criteria. For a second sample, we analyzed the BPs that had been entered by the clinic nurses into the computerized BP records. Because not all clinic

Table 2. Hypertension Drug Therapy Guidelines Applied in the Study

Hypertension Patient Category*	Regimen Should Include 1 of These Drugs†
1. Without comorbid DM or HF	Thiazide diuretic or β-adrenergic receptor antagonist
2. With CAD and without DM or HF	β-adrenergic receptor antagonist (unless the patient has a contraindication to this class of drugs)‡
3. With HF	ACE inhibitor or angiotensin II receptor antagonist
4. With DM	ACE inhibitor or angiotensin II receptor antagonist
5. With both HF and DM	ACE inhibitor or angiotensin II receptor antagonist

ACE indicates angiotensin-converting enzyme; CAD, coronary artery disease; DM, diabetes mellitus; HF, heart failure; VISN, Veterans Integrated Service Network.
*The categories are mutually exclusive and cumulatively exhaustive. For example, patients who would have met criteria both for categories 1 and 2 (ie, patients with CAD and without DM or HF) who did not have contraindications to β-adrenergic receptor antagonists were classified only into category 2.
†These drug therapy recommendations were guidelines, not rules, because a particular drug may not be appropriate for all patients in the category. These guidelines were designed to be computable from data in the electronic medical record. VISN 21 recognized that not all patients in a category would be suitable candidates for the preferred drugs and that not all potential contraindications would be identifiable from computer data. VISN 21 accepted angiotensin II receptor antagonists as alternatives to ACE inhibitors for the purpose of assessing concordance with these guidelines; formulary restrictions for angiotensin II receptor antagonists generally limited their use to cases in which ACE inhibitors were not tolerated.
‡VISN performance standards allowed these diagnoses as *possible* contraindications to β-adrenergic receptor antagonists: asthma, chronic obstructive pulmonary disease, peripheral vascular disease, and depression. Two hundred forty-six patients with these diagnoses who would otherwise have been in patient category 2 were placed into patient category 1.

sites were entering these data at the time of the study, these BPs were available for only 1817 (40%) of the patients, of which 829 (46%) were in the general-intervention group and 988 (54%) were in the individualized-intervention group.

Data Analysis

We summarized each clinician's adherence to the drug guidelines by a single measure: namely, the change in percent guideline concordance, reflecting the average change in concordance from the beginning to the end of the study period for that clinician's patient panel. Patients who had no active prescriptions for antihypertensive drugs at the end point (124 patients) were not eligible for guideline drug concordance scoring, which applied only to patients prescribed antihypertensive therapy; therefore, those patients were excluded from the concordance reports. Average systolic BPs and diastolic BPs for clinician panels were compared from baseline to outcome by paired *t* tests and across intervention groups by independent *t* tests. The outcome measures were analyzed in clinician-level tests, the most conservative type of analysis. Primary analyses were done with SPSS statistical software (SPSS Inc, Chicago, Ill). As a secondary form of analysis, the "bootstrap" function in S-Plus 2000 (5000 bootstrap samples) was used to assess the concordance with drug guidelines by using patient-level data analyzed in a logistic regression of posttreatment concordance of the patients' drugs on 2 clinician-level variables (physician vs nurse practitioner; clinic site). We also analyzed patient-level data with the general estimating equation[25,26] in S-Plus 2000 to take account of clustering by clinician.

These were intention-to-treat analyses with per-protocol exclusions. The study protocol was approved by the Medical Human Subjects Panel of Stanford University, with waiver of individual informed consent.

RESULTS

At baseline, the clinicians in the 2 intervention groups were similar with respect to panel size, clinic site, and guideline concordance; their patients had similar average systolic BPs and diastolic BPs, and adequacy of BP control (**Table 3** and **Table 4**). The clinicians' patients were distributed similarly across the patient categories at baseline. More than half of the patients were classified into patient category 1 (hypertensive without diabetes or heart failure); more than one quarter of the patients had diabetes mellitus. Guideline concordance at baseline was generally higher for the categories in which angiotensin-converting enzyme inhibitors were the recommended drugs (ie, patients with diabetes and heart failure) compared with the categories for which thiazides or beta-adrenergic receptor antagonists were the recommended drugs.

The mean number of primary care clinic visits during the study period was 2.4 for the general-intervention group and 2.2 (P = .52) for the individualized-intervention group; these visits may or may not have been arranged on account of the patients' hypertension. Overall, 1264

Table 3. Characteristics of Clinicians at Baseline

Characteristic	General-intervention Group	Individualized-intervention Group	Both Groups*
Type of clinician			
Attending physician	12	13	25 (70%)
Nurse practitioner	4	7	11 (30%)
Total	16 (44%)	20 (56%)	36
Study patients per clinician panel, mean (SD)	122 (88)	127 (91)	125 (89)†
Site			
Palo Alto	6	8	14 (39%)
Livermore	5	5	10 (28%)
Other	5	7	12 (33%)
Guideline concordance of prescribed medications, mean (SD)‡	59.4% (9.6%)	58.1% (8.1%)	58.7% (8.7%)

*Comparisons between study groups at baseline were nonsignificant by independent sample *t* tests.
†Range was 10-374 patients.
‡Clinician percent guideline concordance is the mean over the clinician's proportion of patients in the panel.
Clinician panels included 1958 patients in the general-intervention group and 2542 patients in the individualized-intervention group (total 4500 patients).

Table 4. Patient Characteristics and Disease Categories

Characteristic or Disease Category	General-intervention Group		Individualized-intervention Group		Both Groups*	
Blood pressure (mm Hg)[†,‡]						
Systolic, mean (SD)	143 (4.7)		142 (5.7)		142 (5.3)	
Diastolic, mean (SD)	78 (5.6)		79 (3.6)		79 (4.6)	
Adequacy of blood pressure control	43%		39%		40.7%	
% Male, mean (SD)	97 (2)		97 (4)		97	
% White race, mean (SD)[‖]	73 (9)		73 (9)		73	
Age, y (SD)[†]	66 (2.4)		65 (2.9)		65 (2.7)	
Category	**Mean No. per Panel (%)**	**% Guideline Concordant[¶] (SD)**	**Mean No. per Panel (%)**	**% Guideline Concordant[¶] (SD)**	**Mean No. per Panel (%)**	**% Guideline Concordant[¶] (SD)**
Without DM or HF	68 (56)	49 (17)	69 (55)	48 (12)	68 (55)	49 (14)
With CAD and without DM or HF	11 (7)	63 (27)	12 (9)	56 (17)	11 (8)	59 (21)
With HF	6 (5)	55 (35)	7 (5)	70 (31)	6 (5)	64 (33)
With DM	33 (27)	77 (11)	34 (27)	73 (16)	34 (27)	75 (14)
With HF and DM	5 (4)	79 (28)	5 (4)	86 (16)	5 (4)	83 (22)

CAD indicates coronary artery disease; DM, diabetes mellitus; HF, heart failure.
*Comparisons between study groups at baseline were nonsignificant by independent sample *t* tests.
[†]Clinician blood pressure measurements are the means over the clinician's panel of patients. Age is the mean over the clinician's proportion of patients in the panel.
[‡]Blood pressure measurements were based on a sample of 350 patients. See the text for further details about sampling.
[§]Blood pressure control was considered "adequate" according to the Department of Veterans Affairs national quality management standard: systolic blood pressure < 140 mm Hg and diastolic blood pressure < 90 mm Hg.
[‖]Race is self-reported in Department of Veterans Affairs records. Race was not reported by 1722 patients (38%). Of those reporting race, the distribution was 73% white, 13% non-Hispanic black, 9% white or black Hispanic, and 6% other. Total is greater than 100% due to rounding.
[¶]Mean over the clinician's proportion of patients in the panel with an active prescription for guideline-recommended drug.

(28%), 1810 (40%), 1018 (23%), and 408 (9%) patients had, respectively, 1, 2, 3, and 4 or more clinic visits. The average number of antihypertensive drugs per patient per clinician at baseline was 2.0 for the general group and 1.9 for the individualized group (P = .08). At the end point, the average number of antihypertensive drugs per patient was 2.0 in both groups (P = .75).

Guideline Concordance of Clinician Prescribing

Concordance with the drug therapy guidelines for hypertension improved in both study groups, with substantially more improvement in the individualized-intervention group compared with the general-intervention group. Concordance improved almost 11% with the individualized intervention compared with 4% with the general intervention (t = 2.796, P = .008; **Table 5**); this absolute increase of 11% represents a 26% relative improvement over baseline nonconcordance in the individualized group versus 7% in the general group. The **Figure** shows the change for each clinician: in the individualized-intervention group, every clinician except 1 improved his/her guideline drug concordance.

Bootstrap analysis showed that being in the individualized-intervention group increased the odds of concordance 1.5-fold (2-sided P = .03, z = 2.23; 95% confidence interval = 0.05, 2.12). There was no significant physician versus nurse practitioner effect. In the logistic regression model with general-estimating-equation correction for clustering by clinician, the odds of concordance after the intervention were increased by 1.69-fold if the patient's clinician was in the individualized-intervention group (z = 2.78, P < .01) compared with the general-intervention group.

Blood Pressure

Changes in average BP per clinician panel from the random sample of abstracted charts are shown in **Table 6.** Blood pressure measurements decreased during the course of the study within each group; the difference between the general-intervention group and the individ-

Table 5. Change in Concordance With Guidelines for Antihypertensive Drug Therapy at End Point

Change	General-intervention Group	Individualized-intervention Group	Statistics Comparing Groups
Percent of clinicians' panels that were guideline concordant, mean (SD)	63 (8)	69 (9)	$t = 1.94$, $P = .06$*
Change from baseline in percent of clinicians' panels that were guideline concordant, mean (SD)†	+3.8 (7)‡	+10.98 (8)§	$t = 2.796$, $P = .008$†

*Degrees of freedom = 34.
†Changes from baseline are reported as the percent change from before to after the intervention.
‡Paired *t* test for within-group comparison before and after the intervention: $t = 2.139$, $P = .049$.
§Paired *t* test for within-group comparison before and after the intervention: $t = -5.975$, $P < .001$.

ualized-intervention group was not significant. The proportion of patients with adequate BP control changed from 43% to 45% and from 39% to 47% in the general-intervention and individualized-intervention groups, respectively. These analyses were repeated using the data from 1817 patients with computer-recorded BPs; the findings were similar.

DISCUSSION

Implementation of a hypertension clinical practice guideline via an individualized intervention, with recommendations about individual patients presented to clinicians at the time of scheduled clinic appointments and drug profiling of the clinicians' patient panel, led to a significantly greater proportion of patients receiving prescriptions for guideline-concordant drugs than a more general intervention. Clinicians receiving the individualized intervention had a percent change in guideline concordance twice as large as that seen in the comparison group. These results were found with clinician-level statistical analysis, demonstrating that the effect of the intervention is robust enough to be detected using the most conservative analysis. This improvement in guideline concordance was achieved without worsening of BP control.

We selected hypertension as a model for study of guideline implementation because of its prevalence and seriousness, and because, despite widely promoted evidence-based guidelines,[22] hypertension management often diverges from guideline-recommended drug selection and BP goal values.[15-17,24] Our finding that the individualized intervention improved guideline concordance is encouraging both for treatment of hypertension and also for the potential extension of this approach to other chronic diseases. A managed care practice could set up the organizational and payment system for the personnel time required by implementation of our approach.

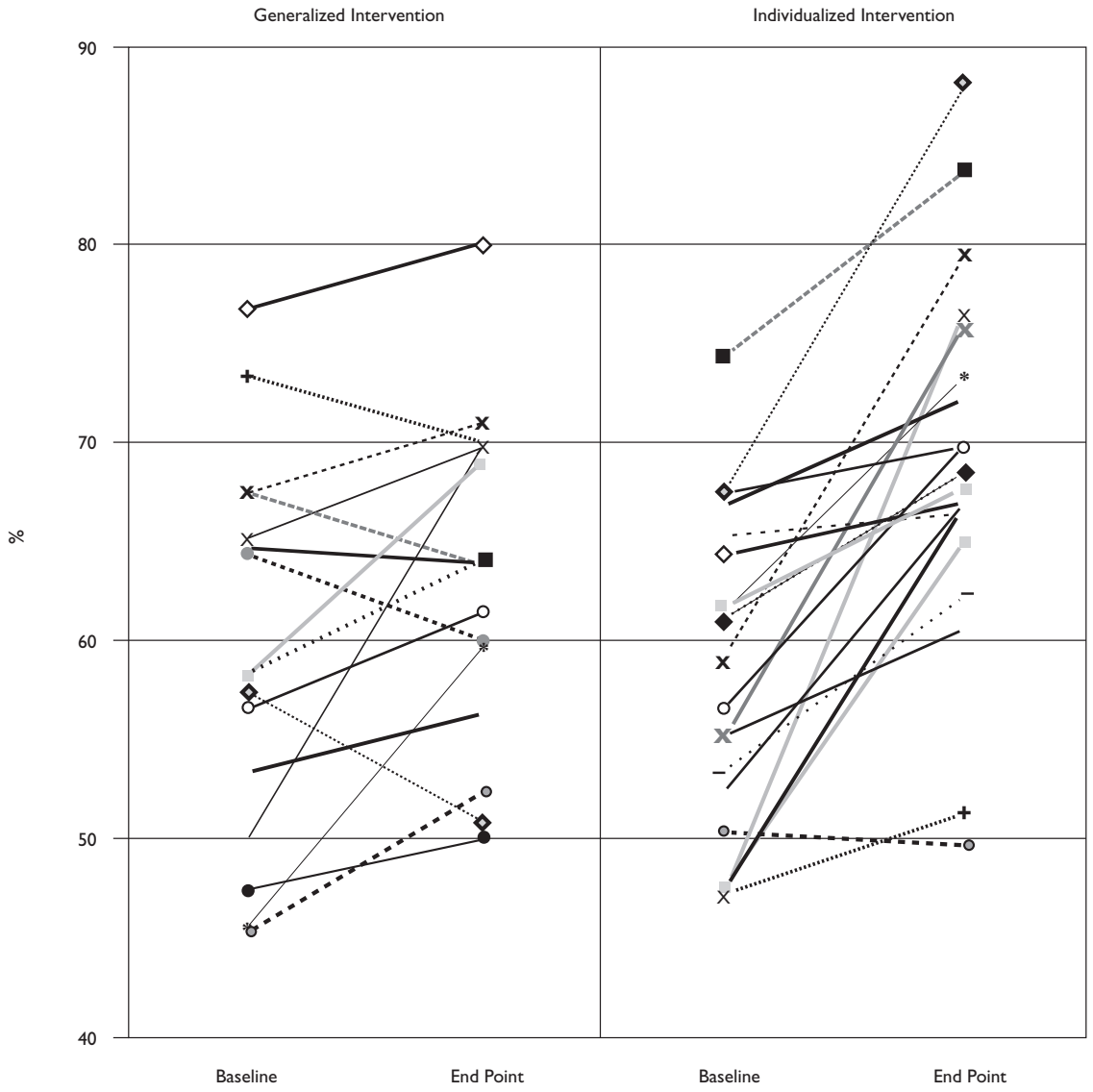
Changing Clinician Behavior

Clinical practice often deviates from guidelines.[1,27] Methods of implementation such as handing out guidelines (passive dissemination) are generally ineffective in changing practice.[2,3] Our intervention builds on previous approaches to changing physician behavior.[3,28] It incorporated features advocated by the "awareness-to-adherence" model[20]: a priming strategy of drug profiling with feedback to the clinician to demonstrate lack of guideline concordance, an educational intervention offered to all clinicians at a workshop, and a reinforcing strategy of recommendations delivered at the time of clinical decision making. We took advantage of the availability of a computerized record system to perform automated analysis of patient records and generation of individualized advisories. Computerized record systems with the data needed to carry out our intervention—diagnoses, drug lists, and appointment schedules—are much more widely available than complete electronic medical records; hence, our approach has wide applicability.

Reminder systems have been used extensively and effectively to foster adherence to preventive medicine guidelines.[7,9,11,12,29-31] Reminder systems and feedback systems also have been used for hypertension; most of these systems, identified in a systematic review,[32] have focused on BP measurement and follow-up.[6,33-35] A study of a computerized clinical reminder system for standards of care in ambulatory practice found that the hypertension reminder had no effect.[31]

A recent systematic review of quality improvement strategies for hypertension found that the median improvement in the proportion of provider adherence to recommended practices was 3.3%.[36] Our intervention led to more substantial improvement. A United

Figure. Change in Percent Guideline Concordance for Each Clinician



The figure shows the change in guideline drug concordance from baseline to end point for each clinician, with connecting lines to facilitate visualization.

Kingdom National Health Service study concluded that a greater health gain could theoretically be obtained by improving professional standards for the treatment of hypertension than by improving patient adherence to treatment; our intervention offers 1 method for improving clinician management of hypertension.[37]

Effect on Blood Pressure

The aim of the individualized intervention was to modify clinician prescribing to make drug selection more concordant with guidelines. The guideline drugs are recommended on the basis of improved cardiovascular or renal outcomes rather than inherently greater efficacy in lowering BP. Interestingly, we found that both groups showed improved BP control. Indeed, we may be underestimating the impact of our interventions on BP because the short duration of the study probably did not allow sufficient time for clinicians to titrate drugs to optimally effective doses. Because the drop in BP was seen only in observational data, and is not a finding from the randomized trial, it could be due to a secular trend. Consequently, we

Table 6. Change in Blood Pressure from Baseline to End Point*

Change	General-intervention Group	Individualized-intervention Group	Statistics Comparing Groups†
Average blood pressure at end point for clinicians' panels of patients, mm Hg (SD)			
Systolic	141 (6.8)	140 (5.6)	$t = 0.627$, $P = .54$
Diastolic	75 (5.8)	77 (4.3)	$t = 1.189$, $P = .24$
Change in average blood pressure from baseline to end point‡			
Systolic	−2.12 (6.7) $t = 259$, $P = .23$	−2.70 (5.46) $t = 2.212$, $P = .04$	$t = 0.289$, $P = .78$
Diastolic	−3.3 (5.5) $t = 2.398$, $P = .03$	−2.25 (3.4) $t = 2.966$, $P = .008$	$t = 0.702$, $P = .488$
Blood pressure adequacy of control at end point, mean proportion of panels (SD)	45% (11.9%)	47% (20.3%)	$t = 0.429$, $P = .671$

*Blood pressure measurements were based on a sample of 350 patients, as in Table 4. Blood pressure means are means over the clinician's panel of patients. Blood pressure adequacy of control is the mean of the clinician's proportion of patients in the panel with adequate control.
†Degrees of freedom = 34.
‡Change in blood pressure from baseline to end point (ie, from before to after intervention) is reported with a paired *t* test for within-group comparisons and with an independent sample *t* test for between-group comparisons. The median time between the baseline and end point visits was 142 days (range = 34 - 262 days).

cannot conclude that either intervention brought about improved BP; nonetheless, we are reassured that the intervention did not worsen BP.

Limitations

This study was conducted in a healthcare system that was implementing clinical practice guidelines, including hypertension guidelines. As there was no group without a general guideline intervention, it was not possible to determine the full impact of the individualized intervention compared with usual care. The general-intervention clinicians could have been moved in the direction of increased concordance by discussion with individualized-intervention clinicians. It is possible that the impact of the individualized intervention would have been greater if it could have been compared with usual care.

This study was conducted within a single healthcare system; however, VAPAHCS is geographically dispersed. Indeed, the largest numbers of patients in this study group were seen at sites remote from the Palo Alto campus, which is a tertiary-care hospital staffed largely by university-affiliated physicians. The other sites, where many physicians have no academic affiliation, include small primary care clinics in remote sites and intermediate-sized facilities with urgent care, general medical clinics, and visiting subspecialists. There are many nurse practitioners. Consequently, this system includes components found in many healthcare systems nationally; it is likely that the findings are generalizable to primary care clinics in other large healthcare systems.

Because the VA patient population is largely male, we have limited understanding of how our intervention affects women. However, it is difficult to imagine a mechanism by which our approach would amplify any existing treatment disparities between men and women, or create new ones.

We lack data on treatment of hypertension before implementation of the general and individualized interventions. It is possible that guideline concordance was steadily increasing among clinicians prior to the study. Even so, our results demonstrate that the individualized intervention produced greater guideline concordance than the general intervention—regardless of whether both study arms were "riding" an upward concordance trend at baseline.

By having only a few clinical categories of patients with hypertension, the VISN 21 guidelines did not take into account some important patient variables. Future interventions would preferably include (where electronic medical records allow it to be done efficiently) more detailed information about patients. Systems with more sophisticated recommenda-

tions[38-41] may be able to achieve even more impressive outcomes.

CONCLUSION

Individualized recommendations about drug therapy for hypertension presented to clinicians at the time of a patient visit are effective in changing prescribing to achieve higher rates of guideline adherence. Providing individualized recommendations to clinicians can be done in healthcare systems with electronic pharmacy and diagnostic data, even in the absence of a complete electronic health record. Generation and distribution of recommendations can be done efficiently if these activities are integrated with existing procedures.

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