Using a Multidisciplinary Team and Clinical Redesign to Improve Blood Pressure Control in Patients With Diabetes

Hae Mi Choe, PharmD, CDE; Steven J. Bernstein, MD, MPH; David Cooke, MD; David Stutz, MD; Connie Standiford, MD

Objective: Optimal blood pressure (BP) control in patients with diabetes poses a challenge in primary care clinics because of the complexity of the disease and competing patient care demands. We used a multidisciplinary team to standardize and improve hypertension care for patients with diabetes by implementing a visual and action-oriented high BP prompt, collaborative practice agreement, medication intensification protocol, and home BP monitoring machine loan program. Design: Prospective, pre-/poststudy. Setting: General medicine clinic affiliated with a large academic healthcare system. Patients: Two hundred sixty-three patients with type 2 diabetes mellitus. Results: Hypertension control (ie, BP < 135/80 mm Hg) in patients with diabetes improved from 53.6% to 69.3% (P < .001) after implementing a standardized BP assessment and treatment process. There was also a significant decrease of 4 mm Hg in both the mean systolic and diastolic BPs after the intervention. The improvement in BP control was associated with an increase in the average number of antihypertensive medications from 1.56 to 1.93. Conclusions: The use of a process-oriented clinical redesign and a multidisciplinary team approach resulted in improved BP management in patients with diabetes in a primary care setting.

Key words: *clinical redesign, diabetes, hypertension*

Diabetes mellitus is a common and devastating disease that has enormous impact on quality of life, mortality risk, and economic costs. Cardiovascular disease is the leading cause of death among patients with diabetes and is responsible for significant morbidity and expense.[1,2] Optimizing blood pressure (BP) control among patients with diabetes is critical to preventing cardiovascular and renal disease.[3] Optimal treatment of hypertension in patients with diabetes mellitus is one of the most beneficial treatments in medicine.[4] To encourage aggressive treatment of hypertension in patients with diabetes, the National Committee on Quality Assurance recently adopted hypertension control as a performance measure. The United Kingdom Prospective Diabetes Study and the Hypertension Optimal Treatment trial demonstrated that for patients with diabetes with marked hypertension, improved BP control substantially decreased both macrovascular and microvascular diabetic complications, including visual impairment, end-stage renal disease, and cardiovascular disease.[5,6] Unfortunately, despite its demonstrated importance, BP control is suboptimal in many of these patients. The level

Author Affiliations: College of Pharmacy (Dr Choe) and Department of Internal Medicine (Drs Bernstein, Cooke, Stutz, and Standiford), University of Michigan, Ann Arbor; and Health Services Research and Development, VA Ann Arbor Healthcare System, Ann Arbor, Michigan (Dr Bernstein).

Corresponding Author: Hae Mi Choe, PharmD, CDE, College of Pharmacy, University of Michigan, Ann Arbor, MI 48109 (haemi@umich.edu).

defining optimal BP control in patients with diabetes has been gradually moving lower in the past several years. Initially, a level below 140/90 mm Hg was considered adequate; today, some groups are advocating that the threshold should be below 130/80 mm Hg. With this change the proportion of patients considered to have their BP controlled has declined from 59%[7,8] to as low as 35%.[9–11]

Improving BP control, however, has proven challenging. Physicians face the competing demands of managing both chronic illnesses and acute problems during a clinic visit. Interventions focusing on improving physician education and reminders have had only limited success.[12] The exact reasons for this have not been clearly identified, but "clinical inertia" remains a major challenge in providing optimal care.[13]

An alternative approach to improving care of patients with chronic disease has focused on improving workflow processes and assigning tasks to nonphysician healthcare providers. Because busy physicians frequently do not have the time to manage both chronic care needs and acute problems during clinic visits, a team-based approach with delegation of some responsibilities and tasks to other professionals and staff offers many opportunities for improving care. A team-based approach is being promoted by many organizations nationally and is a component of the advanced medical home.[14,15] Clinical pharmacists are valuable members of the healthcare team and several studies have shown that they help improve care. The professional training and experience of pharmacists seem particularly well-suited for the management of hypertension, given its emphasis on medication-based interventions.[16–20]

A second approach focuses on increasing patients' knowledge about their clinical condition. For hypertension, 1 way to increase patient awareness of their hypertension is through self-monitoring of BP. Although home BP monitoring is a relatively inexpensive means to monitor BP levels, there are significant barriers to its adoption. Home BP monitoring machines are not a covered benefit for many insurance plans. In addition, patients are concerned about purchasing a home BP monitoring machine they may never use. A home BP monitoring machine loan program for patients with hypertension would reduce both of these barriers. By borrowing a BP monitoring machine, patients can determine whether they would use the machine and whether they found the information of value to them without having to first purchase the machine.

In this article, we report on the use of both of these approaches by our multidisciplinary team to improve hypertension control among patients with diabetes in a general internal medicine clinic at an academically owned practice serving a community population.

METHODS

Process development and implementation

In January 2006, we formed a multidisciplinary team composed of medical assistants, clerical staff, physicians, and a clinical pharmacist. The team used a series of rapid plan-do-study-act or clinical redesign cycles to develop and implement a patient care algorithm and treatment protocol (Table 1) to standardize hypertension care for patients with diabetes. The patient care algorithm assisted staff in triaging patients with elevated BP. To foster collaboration, we made significant changes in team member roles and responsibilities. The hypertension treatment protocol guided physicians and the clinical pharmacist in selecting cost-effective medications and an appropriate medication titration schedule. Our goal for patients with diabetes was of BP less than 135/80 mm Hg on the basis of our evidence-based institutional diabetes mellitus clinical care guideline.[21]

On the day of clinic appointment, all patients with diabetes are automatically identified through our health system's computerized registry. Each morning, medical assistants print out patient-specific clinical reminder sheets for the physicians. This 1-page sheet lists diabetes examinations (eg, foot and eye), tests (eg, LDL-cholesterol and hemoglobin A_{1c}), and medications (eg, antihypertensive and antiglycemic medications and aspirin) that need to be addressed. When the patient arrives, the medical assistants take each patient's BP manually and flag those patients

Table 1

STEPWISE PHARMACOLOGIC TREATMENT OF HYPERTENSION IN PATIENTS WITH DIABETES

Patients with microalbuminuria	Patients without microalbuminuria
Step 1. *Elevated BP (systolic BP ≥ 135 and/or diastolic BP ≥ 80) uncontrolled by prior lifestyle modifications*	
Initiate therapy with an angiotensin-converting enzyme (ACE) inhibitor	Initiate therapy with a thiazide diuretic
Lisinopril 10 mg daily	Hydrochlorothiazide 12.5 mg daily
Titrate by doubling dose every 2–4 weeks until the blood pressure goal is met (maximum dose: 40 mg)	Titrate by doubling dose in 2–4 weeks
Patients with contraindication to ACE inhibitors (hypersensitivity reaction and angioedema) or documented persistent cough should alternately be initiated on an angiotensin II receptor blocker	If blood pressure goal not met (maximum dose—25 mg)
Irbesartan (Avapro) 150 mg daily	
Titrate by doubling dose in 2–4 weeks if blood pressure goal not met (maximum dose—300 mg)	
Step 2. *If dose is optimized on 1 of the agents from Step 1 and patients' blood pressure remains ≥ 135/80 then add thiazide diuretic or ACE-I/angiotensin II receptor blocker to the first agent.*	
Consider combination therapy, that is, lisinopril and hydrochlorothiazide, hydrochlorothiazide and irbesartan (Avalide).	
Step 3. *If above agents are contraindicated or dose is optimized and patient blood pressure remains ≥ 135/80 mm Hg.*	
Initiate therapy with a β-blocker	
Metoprolol tartrate 50 mg bid	
Titrate by doubling dose every 2–4 weeks until blood pressure goal met (maximum dose—200 mg)	
OR	
Atenolol 25 mg daily	
Titrate by doubling dose every 2–4 weeks until blood pressure goal met (maximum dose—100 mg)	
Step 4. *If above agents are contraindicated or dose is optimized and patient blood pressure remains ≥135/80 mm Hg.*	
Initiate therapy with a dihydropyridine calcium channel blocker	
Amlodipine (Norvasc) 5 mg daily	
Titrate by doubling dose in 2–4 weeks if blood pressure goal is not met (maximum dose—10 mg)	

with a BP greater than or equal to 135/80 mm Hg, our target goal, by placing a bright green sticker on the billing/disposition form. This sticker had 2 functions (1) it prompts the physician to recheck the BP when they see the patient and (2) it instructs clerical staff to schedule a follow-up BP assessment appointment with the physician or clinical pharmacist in 2 to 4 weeks.

At the follow-up appointment, the clinical pharmacist provides basic education regarding lifestyle and pharmacologic hypertension management skills. This includes counseling on the importance of setting self-management goals. Such goals focus on lifestyle modifications, adherence to medications, and monitoring of treatment efficacy and tolerability. In addition, on the basis of a collaborative practice agreement with the practice's physicians, the pharmacist might initiate and adjust medications, on the basis of the medication protocol, as well as order laboratory tests. The pharmacist may also contact the patient

by phone if more frequent assessments are needed. All management changes by the pharmacist are documented and the physician informed of their patient's status.

To raise awareness and engage patients in managing their BP, we developed a home BP monitoring machine loan program, using 8 automated home BP monitoring machines purchased with healthcare center funds. Each machine was loaned for a period of 2 to 4 weeks. The loan procedure required the patient to provide a $20 refundable deposit. A process to clean the machines between borrowers was developed by the infection control program. Patients were taught to use the home BP monitoring machine by the clinical pharmacist. They were also provided written instructions on home BP monitoring machine use and given a daily BP log sheet that they were asked to either bring back with them at their follow-up visit in 2 to 4 weeks or to fax the home BP readings to the clinical pharmacist. The medical assistants played a vital role in loaning and maintenance of the BP monitoring machines.

Study population and data collection

Before our implementing this new process, there were 362 patients with diabetes managed at our clinic. Patient volume increased to 523 patients over the 18-month period (January 2006–July 2007) following our process launch. For evaluation purposes, this article will focus on the 267 patients who were managed during both pre- and postintervention periods (paired analysis).

Data were extracted from our diabetes registry, which is stocked by the health system's electronic medical record and includes BPs of patients. We also surveyed those patients who participated in the home BP monitoring program regarding their understanding of BP, ease of BP monitoring machine use, frequency of using the home BP monitoring machine, how helpful the BP monitoring machine loan program was, and their interest in buying a home BP monitoring machine on a 5-point Likert scale ranging from *strongly disagree* to *strongly agree* or *not at all helpful* to *very helpful.*

Data analysis

Descriptive analysis is presented using means and standard deviations for continuous data. Frequency data are presented using count and percentage information. To compare our pre- and postintervention periods a paired t test (continuous data) or a McNemar's test (categorical data) was used.

RESULTS

Of 267 patients with paired data, the mean age was 57.9 ± 11.7 and 51% of the patients were male. The proportion of patients whose BP was less than 135/80 mm Hg increased from 53.6% in the preintervention period to 69.3% following the intervention ($P < .001$; Table 2). There was also a significant decrease of 4 mm Hg in both the mean systolic and diastolic BPs after the intervention (Table 3). However, there was no significant change in either the mean hemoglobin A_{1c} or mean LDL-cholesterol levels, areas not targeted by the intervention. Thus, whereas the intervention improved BP control, it had no significant impact on these other outcome measures. The improvement in BP control was associated with an increase in the average number of medications used to treat hypertension, increasing from 1.56 in the preintervention to 1.93 in the postintervention period ($P < .001$), among the 267 patients followed up in both periods. As expected, therefore, the proportion of patients receiving 2 or more antihypertensive medications also increased from 48.7% to 54.7% ($P < .05$).

So far, we have loaned BP monitoring machines to 42 patients. Thirty-five patients completed a postloan

Table 2

CHANGES IN BLOOD PRESSURE GOAL ATTAINMENT[a]

Blood pressure controlled	Pre	Post	*P*
Yes	143 (53.6%)	185 (69.3%)	< .001
No	124 (46.4%)	82 (30.7%)	

[a] Comparison performed using McNemar's test.

Table 3

DIABETES QUALITY INDICATORS[a]

	N	Pre[b]	Post[b]	95% CI	*P*
Blood pressure	263				
SBP		127.6 ± 15.1	123.8 ± 14.4	1.6 to 5.9	.001
DBP		73.6 ± 10.6	69.8 ± 9.8	2.5 to 5.2	$< .001$
Hemoglobin A$_{1c}$	234	7.4 ± 1.5	7.5 ± 1.7	-0.3 to 0.1	.225
LDL	210	86.6 ± 26.6	84.1 ± 25.2	-1.1 to 6.1	.176

Abbreviations: DBP, diastolic blood pressure; LDL, low-density lipoprotein; SBP, systolic blood pressure.
[a]Between-group comparisons were performed using a paired *t* test.
[b]Continuous data are reported as mean $\pm$ SD (range).

survey. Thirty-three patients (94%) reported that borrowing the home BP monitoring machine was very helpful and the remaining 2 patients (6%) reported it was somewhat helpful and no patient believed it was not helpful. Thirty-three patients (94%) agreed or strongly agreed that they have a better understanding of their BP since using the home BP monitoring machine. Fourteen patients subsequently purchased a home BP monitoring machine, 14 additional patients are considering purchasing a machine, and the remaining 7 patients declined to purchase a machine because of cost.

DISCUSSION

In this study, clinical redesign using medical assistants to identify and provide BP reminder prompts, follow-up with a clinical pharmacist, and self-management promotion through a home BP monitoring program was implemented. These efforts resulted in 69% of our patients with diabetes achieving their BP target. This represents a substantial incremental improvement in BP control at our study site as compared with our entire institution where BP control is 57%.

Many quality improvement strategies have been reported to improve hypertension control.[22] These strategies include reminders to healthcare providers, facilitated relay of clinical data, audit and feedback, healthcare provider education, patient education, patient reminders, promotion of self-management, and organizational change. Studies focusing on organizational change or patient education, alone or in combination with other strategies, report greater improvement in BP control as compared with studies that did not include either of these strategies.[23] Patient reminders and audit and feedback to clinicians, either alone or when used together, show less improvement in BP control as compared with other interventions.[24] In general, the majority of quality improvement studies focusing on hypertension control use more than 1 strategy.

In addition to the targeted efforts reported in this article, other strategies are utilized for all patients with diabetes at our institution to enhance BP control. These strategies include healthcare provider education, audit and feedback, and patient reminders. Prior to this study all primary care clinicians received education on the diabetes mellitus clinical care guideline including target BP for patients with diabetes and recommended medication intensification protocols. In addition, patient-specific audit data on several diabetes quality measures, including BP control, are sent to clinicians semiannually and are displayed in comparison with peers and the overall health system average, as well as used in annual performance evaluations. Finally, patients with diabetes receive reminder letters annually to see their physician if their last recorded BP is greater than 150/90 mm Hg. Despite these strategies BP control at our institution remains suboptimal at 57%.

Are higher levels of BP control achievable at our health center? We believe that although there may be some additional room for improvement, that it is limited. Why? First, patient nonadherence with antihypertensive medications may result in elevated BP at the time of the visit. Second, some patients cannot receive higher doses of medications despite an elevated systolic pressure as their diastolic pressure may be too low (eg, BP < 70 mm Hg) and additional medications may increase a patient's risk of hypotension or adverse outcomes. Third, some patients may already be on 4 or more antihypertensive medications and physicians may be reluctant to prescribe more medications or patients may not want to take additional medications. There are no randomized-control trials that demonstrate that using more than 4 antihypertensive agents to lower the BP leads to better patient-related outcomes. In our study patients with diabetes were only on an average of 1.56 antihypertensive medications prior to the intervention and 1.93 antihypertensive medications postintervention. Hence, there may be opportunity for additional medication intensification.

Problems with clinical inertia and the competing demand of addressing acute and chronic medical care during a clinic visit are potential reasons why patients' BP levels are not controlled.[25] Engaging the entire healthcare team to assist in care delivery is becoming increasingly important and consistent with the Chronic Care Model and Advanced Medical Home concepts.[14,15] There is also significant interest in implementing practice redesign and workflow enhancements to optimize the provision of care. At our institution, patients with chronic illness such as diabetes are frequently given a routine follow-up appointment in 2 to 3 months despite having chronic medical problems (ie, hypertension, hyperglycemia, and hyperlipidemia) that are not under control. To address this clinical inertia, we implemented a simple sticker system to improve the timeliness of follow-up appointments in patients not achieving BP goal. Lack of appointment access to physicians was addressed by having patients follow up with the clinical pharmacist within 2 to 4 weeks. The clinical pharmacist, through a collaborative prac-

tice agreement, had the autonomy to add or change antihypertensive medications and order follow-up testing. We are currently piloting this process at other health centers utilizing clinic nurses to assist in medication titration, using an approved delegated nursing protocol. Finally, patients were encouraged to become involved in their self-management through monitoring their BP levels at home. As many patients were concerned about investing in a BP monitoring machine, we implemented a home BP monitor loaning program through the clinic. Patients who participated were very satisfied with our pilot home BP monitoring machine loan program and many found this to be valuable in making a decision to purchase a home BP monitoring machine.

There are several limitations to our study. First, our primary outcome was based on a fixed population and may not present what happens with a dynamic population (eg, patients entering and leaving the practice over time). However, when we examined the overall level of BP control among all patients with diabetes cared for at the healthcare center in the pre- and postintervention periods, we found that the average BP level still decreased by 17%. Second, the study was not blinded and when healthcare providers who measure the patient's BP know that a quality improvement study is under way they may be unconsciously biased by an expectation of improvement. Third, home BP monitoring alone was used only by a small number of patients, and its independent contribution to BP control among these patients cannot be assessed. However, on the basis of patient satisfaction survey, patients reported being extremely satisfied with the home BP loaning program, and such a program may be helpful in assisting patients to focus on BP control. Further studies to evaluate the impact of home BP monitoring on improving BP goal attainment are needed.

In summary, it is estimated that physicians need 10.6 hours a day, more time than they have available for patient care, to address the multitude of guideline recommendations for chronic disease management.[26] Many physicians have 15 to 20 minutes for a patient visit and find it difficult to address all chronic and acute care needs in this amount of time. In our study

we developed and implemented a multidisciplinary team approach to standardize and improve hypertension care for patients with diabetes. We demonstrated a significant improvement in BP control by using an action-oriented process and more intense treatment of hypertension. Additional studies are needed to determine how best to assist clinicians in meeting patient needs and ensuring that quality care related to chronic illness is met.

REFERENCES

1. Haffner SM, Lehto S, Ronnemaa T, Pyörälä K, Laakso M. Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction. *N Engl J Med.* 1998;339:229–234.
2. American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care.* 1998;21(2):296–309.
3. Resnick HE, Foster GL, Bardsley J, Ratner RE. Achievement of American Diabetes Association clinical practice recommendations among U.S. adults with diabetes, 1999–2002. *Diabetes Care.* 2006;29(3):531–537.
4. Vijan S, Hayward RA. Treatment of hypertension in type 2 diabetes mellitus: blood pressure goals, choice of agents, and setting priorities in diabetes. *Ann Intern Med.* 2003;138:593–602.
5. United Kingdom Prospective Diabetes Study Group. UK prospective diabetes study 38. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes. *BMJ.* 1998;317(7160):703–713.
6. HOT Study Group. Effects of intensive blood-pressure lowering and low-dose aspirin in patients with hypertension: principal results of the hypertension optimal treatment (HOT) randomized trial. *Lancet.* 1998;351:1755–1762.
7. Coffey RM, Matthews TL, McDermott K. *Diabetes Care Quality Improvement: A Resource Guide for State Action.* (Prepared by The Medstat Group Inc and The Council of State Governments under Contract No. 290-00-0004). Rockville, MD: Agency for Healthcare Research and Quality, Department of Health and Human Services; 2004. AHRQ Pub. No. 04-0072.
8. Hippisley J, O'Hanlon S, Coupland C. Association of deprivation, ethnicity, and sex with quality indicators for diabetes: population based survey of 53 000 patients in primary care. *BMJ.* 2004;329:1267–1269.
9. Centers for Disease Control and Prevention, National Center for Health Statistics. *National Health and Nutrition Examination Survey Data.* Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention; 2004.
10. Wang YR, Alexander GC, Stafford RS. Outpatient hypertension treatment, treatment intensification, and control in western Europe and the United States. *Arch Intern Med* 2007;167:141–147.
11. Wong ND, Lopez VA, Franklin SS. Inadequate control of hypertension in US adults with cardiovascular disease comorbidities in 2003–2004. *Arch Intern Med.* 2007;167(22):2431–2436.
12. Roumie CL, Elasy TA, Greevy R, et al. Improving blood pressure control through provider education, provider alerts, and patient education. *Ann Intern Med.* 2006;145:165–175.
13. Grant RW, Cagliero RW, Dubey E, et al. Clinical inertia in the management of type 2 diabetes metabolic risk factors. *Diabet Med.* 2004;21(2):150–155.
14. Barr M, Ginsburg J. *The Advanced Medical Home: A Patient-Centered, Physician-Guided Model of Health Care.* Philadelphia, PA: American College of Physicians Policy Monograph; 2006.
15. Future of Family Medicine Project Leadership Committee. The future of family medicine. A collaborative project of the Family Medicine Community. *Ann Fam Med.* 2004;2(suppl 1):S3–S32.
16. Morello CM, Zadvorny EB, Cording MA, Suemoto RT, Skog J, Harari A. Development and clinical outcomes of pharmacist-managed diabetes care clinics. *Am J Health Syst Pharm.* 2006;63:1325–1331.
17. McKenney JM, Slining JM, Henderson HR, Devins D, Barr M. The effect of clinical pharmacy services on patients with essential hypertension. *Circulation.* 1973;48:1104–1111.
18. Borenstein JE, Graber G, Saltiel E, et al. Physician-pharmacist co-management of hypertension: a randomized, comparative trial. *Pharmacotherapy.* 2003;23(2):209–216.
19. Bogden PE, Abbott RD, Williamson P, Onopa JK, Koontz LM. Comparing standard care with a physician and pharmacist team approach for uncontrolled hypertension. *J Gen Int Med.* 1998;13(11):740–745.
20. Erickson SR, Slaughter R, Halapy H. Pharmacists' ability to influence outcomes of hypertension therapy. *Pharmacotherapy.* 1997;17(1):140–147.
21. Vijan S, Choe HM, Funnell M, et al. *Management of Type 2 Diabetes Mellitus.* (Update) Ann Arbor, MI: Office of Clinical Affairs, University of Michigan Health System; 2007. www.guideline.gov. NGC-3788. Accessed December 19, 2007.
22. Walsh ME, McDonald KM, Shojania K, et al. Quality improvement strategies for hypertension management: a systematic review. *Med Care.* 2006;44:646–657.
23. Jha AK, Perlin JB, Kizer KW, Dudley A. Effect of the transformation of the veterans affairs health care system on the quality of care. *N Eng J Med.* 2003;348(22):2218–2227.
24. Jamtvedt G, Young JM, Krisoffersen DT, O'Brien MA, Oxman AD. Audit and feedback: effect on professional practice and health care outcomes. *Cochrane Database Syst Rev.* 2003(3):CD000259.
25. Phillips LS, Branch WT, Cook CB, et al. Clinical inertia. *Ann Intern Med.* 2001;135(9):825–834.
26. Ostbye T, Yarnall KSH, Krause KM, Pollak KI, Gradison M, Michener JL. Is there time for management of patients with chronic diseases in primary care? *Ann Fam Med* 2005;3:209–214.