Measuring the Impact of a Continuing Medical Education Program on Patient Blood Pressure

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An increased focus on hypertension prevention and control, especially in high-risk populations, may have a substantial impact on cardiovascular health outcomes. A continuing medical education (CME) program trained primary care providers in evidence-based guidelines for hypertension prevention and control. This study evaluated its effectiveness in reducing patients' blood pressure for the sessions occurring from 2003 to 2007. Using the Hypertension Initiative Database, 8183 patients of CME providers (CME patients) were paired with controls and changes in blood pressure, provider visits, prescription months, and the proportion of patients with blood pressure <140/90 mm Hg before and after the intervention date were estimated. In the 2-year period before training and the 2-year period afterwards, CME patients' systolic blood pressure decreased by 1.99 mm Hg and diastolic blood pressure decreased by 1.49 mm Hg. The CME patients displayed an increase in provider visits but no statistically significant change in prescription months. Restricting the analysis to the subsample of patients with uncontrolled hypertension (>140/90 mm Hg), the changes in blood pressure were similar in magnitude to those in the entire population. The CME program, by promoting evidence-based practice, improves patients' blood pressure and could serve as a positive model for future hypertension interventions. *J Clin Hypertens (Greenwich).* 2011;13:517–522. ©2011 Wiley Periodicals, Inc.

Hypertension currently affects approximately 65 million people in the United States.[1] Recent data indicate that only 50% of all hypertensive individuals and 51% of treated hypertensive patients have their blood pressure (BP) under control.[2] Clinical trials suggest that antihypertensive therapy may significantly reduce the incidence of stroke, myocardial infarction, and heart failure.[3] Therefore, an increased focus on hypertension prevention and control, especially in high-risk populations, may have a substantial impact on cardiovascular health outcomes.

The Centers for Disease Control and Prevention (CDC) created the Division for Heart Disease and Stroke Prevention (DHDSP) to support state programs concentrating on cardiovascular health. Founded in 1998, DHDSP currently directs funding to 41 states and the District of Columbia for programs and partnerships that target heart disease and stroke prevention. Prevention interventions that are both efficacious and cost-effective are critical to reducing the burden of heart disease and stroke.[4]

This study evaluated the effectiveness of a continuing medical education (CME) program to train primary care providers in evidence-based guidelines for hypertension prevention and control. The program is conducted by the Carolinas and Georgia chapter of the American Society of Hypertension (ASH), the Medical University of South Carolina (MUSC), and the Heart Disease and Stroke Prevention Division of the South Carolina Department of Health and Environmental Control (DHEC), a DHDSP-funded and state-run program. The CME program consists of provider trainings focused on the diagnosis of, treatment for, and special populations with hypertension. The courses were targeted at providers in areas of the Carolinas and Georgia with high age-adjusted mortality rates for stroke, diabetes, end-stage renal disease, and uncontrolled hypertension.

Patient populations in high risk areas may benefit by increasing provider awareness of hypertension and its treatment because many patients do not receive recommended treatments. For example, nationally, only 65% of patients receive recommended best-practice preventive care.[5] Translation of published guidelines to clinical practice through such mechanisms as CME programs has shown to be effective at changing provider practice patterns.[6] However, the impact of CME programs on clinical outcomes remains an open question.[7,8]

To estimate this program's effectiveness, a case-control/pre-post methodology was used with data from the Hypertension Initiative Database (HID) to analyze patient-level outcomes.[9] The results of our analysis suggest that the program can have a significant role in reducing patients' BP.

ABOUT THE CME PROGRAM

The CME program for primary care providers, a collaboration among ASH, MUSC, and DHEC, aims to (1) raise awareness of the epidemiology of hypertension and feasibility of improving control, (2) educate providers about evidence-based guidelines and clinical trials that can improve daily practice, (3) facilitate

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TABLE I. Patient Characteristics in the HID and Selected Subsamples

Class	Variable	All Patients (N=1,214,036)	CME Patients[a] (n=8183)	Control Patients[b] (n=8183)	Difference Between CME and Controls
Demographics					
	Mean age, y	48.5	52.5	52.4	0.1
	Male	58.6	44.2	44.5	−0.3
	Black	14.9	42.4	42.5	−0.1
	White	23.1	35.3	35.3	0.01
Race, other/missing	62.0	22.3	22.2	0.1	
Diagnoses[c]					
	High cholesterol	26.6	32.2	32.2	−0.1
	Diabetes	13.6	22.5	22.5	0.02
Insurance					
	Medicaid	4.1	0.01	0.01	0
	Medicare	4.3	0.01	0.01	0
Weight Information					
	Underweight	2.9	1.7	1.5	0.2
	Overweight	20.2	20.3	20.7	−0.4
	Obese	23.3	34.6	35.1	−0.5
	Missing weight	41.1	31.0	30.0	1.0

Values are expressed as percentage unless otherwise indicated. No differences are significant between continuing medical education (CME) patients and control patients at the 5% level. [a]CME patients had at least 1 blood pressure reading both pre-CME and post-CME date with the same CME trained provider. [b]Control patients saw providers who did not attend a CME program and were matched to CME patients using propensity score matching. No variables are statistically different from the CME patients at the 95% confidence level. [c]Diagnoses were observed in the Hypertension Initiative Database (HID) only if the provider diagnosed the condition and informed the patient of the diagnosis.

participation in a community practice network and database, and (4) encourage providers to become clinical hypertension specialists.[9] ASH is the initiator and primary sponsor of the program. MUSC is the Carolinas and Georgia chapter headquarters for ASH and provides administrative and instructional staff. DHEC is a funding partner and helps choose the training sites within South Carolina and promotes the CME events. The three organizations conducted trainings in South Carolina, North Carolina, and Georgia. Average attendance was 22 attendees per training. We analyzed 21 CME classes occurring between November 2003 and October 2007.

Locations for training were selected to reach areas away from large academic centers (eg, MUSC) and with high mortality rates from cardiovascular-related illnesses. Many of the CME programs emphasized patient adherence to prescribed medications and provided strategies for providers to improve adherence. The training features in-depth case study discussion among the participants and faculty instructors. More than 87% of participants report that the CME program positively impacted their practice. This study represents the first formal evaluation of the program.

THE HYPERTENSION INITIATIVE DATABASE

The data used to evaluate the effectiveness of the CME program come from the HID.[9] Clinical data were obtained primarily through electronic medical record systems of participating practices, which sign a Business Associate Agreement with the Hypertension Initiative. The HID data run from 2000 to 2008 and consist of 2.2 million patients with approximately 5 visits per patient. They contain information on each patient's demographics, vital signs, diagnoses, medications, and laboratory values. Providers at participating practices receive quarterly provider reports summarizing their patients' demographics and clinical values, comparing each provider's patient panel to the rest of the patients in the network and providing information on continuity of care.

Approximately 24% of the CME attendees submitted clinical data to the database. Of the 12,584 providers in the HID, 110 took part in at least one of the 21 CME classes between November 2003 and October 2007 (two providers attended two CME classes). Table I presents the characteristics of the 1.4 million patient subsample of the HID used in this study.

METHODS

To measure the effectiveness of the CME program, a case-control/pre-post approach was employed to estimate the average change in BP (systolic and diastolic), the number of provider visits, the number of prescription months, and the proportion of patients with BP <140/90 mm Hg. Prescription months were calculated by summing the duration, in months, that a prescription lasted. Using only adults older than 18 years, ''CME patients'' were matched to ''control patients'' using a propensity score technique (described below). After matching, a comparison was conducted of the change in the outcomes of interest

among the CME patients to the change among the control patients to estimate the effectiveness of the program.

Sample Selection

For purposes of this analysis, CME patients needed to have seen the same CME-trained provider before and after the provider's CME training and have at least one BP reading within the 2-year period before and the 2-year period after the provider's CME training date (N=8813). The intervention date or "CME date" for the patient was the date of the first visit after the provider's first CME training. BP readings that were recorded on the CME date were classified as part of the pre-intervention period. All readings that occurred during visits 2 years before and 2 years after the CME date were considered for this study.

Control patients consisted of individuals who did not see a CME-trained physician at any point in the HID. After control patients were paired with a case patient (see below), they were assigned a pseudo-CME date. The control patient's pseudo-CME date was the CME date for his/her matched CME patient. Table I shows sample sizes and characteristics of the original data set, those patients who saw a CME provider at any point in the HID, and the analysis sample of CME patients.

Propensity Score Matching

Propensity score matching allows the researcher to randomize subjects in observational data by matching intervention patients with control patients with similar observable characteristics pre-intervention.[10] CME and control patients were matched on several observable characteristics using a propensity score. The propensity score estimates the probability of being in the intervention group based on the patient characteristics using predicted probabilities via a probit regression. The predicted values from the probit regression summarize multiple patient characteristics (ie, independent variables) into a single propensity score, with similar scores indicating overlap in patient characteristics. Two assumptions are required for propensity scoring: common support and unconfoundedness.[11] These assumptions were maintained throughout the analysis.

For purposes of this study, the propensity score equaled the probability of seeing a CME-trained provider. The propensity score probit regression included the following independent variables: age, race (white, black, other/missing), sex, government insurance status (Medicare and Medicaid), diagnoses of diabetes and dyslipidemia (high cholesterol), weight class (obese, overweight, normal weight, underweight, missing body mass index), and interactions of age, race, sex, and the two condition diagnoses. The diagnoses of diabetes and dyslipidemia were only observed in the HID if the provider recognized the condition and it was recorded in the patient's chart. The government insurance status variable is meant to proxy for patient's (unobserved) socioeconomic status and is measured with error in the HID.

Nearest neighbor matching was used to match each CME patient with one control patient with the nearest propensity score. In addition to selecting control patient pairs based on propensity score, the control patient needed to have at least one BP measure on record both before and after the pseudo-CME date. We drew from the pool of control patients with replacement. Thus, a given control patient may be matched to multiple CME patients. Our sample contained 1248 duplicated controls with one control being represented 9 times, the maximum. However, 907 of the 1248 duplicated controls were represented only twice.

Because subsample analyses may not be valid with propensity scoring, we followed Dehejia in re-matching a subsample of uncontrolled hypertensive CME patients to the set of controls.[12] The CME patients were identified as having uncontrolled hypertension in the pre-CME period if their systolic BP was $\geq$140 mm Hg or if their diastolic BP was $\geq$90 mm Hg. The probit regression specification did not include indicators for government insurance status because of their collinearity with CME participation. Additional restrictions were placed on the controls after matching to ensure uncontrolled hypertensive matches. Uncontrolled, stage 1 hypertensive CME patients were matched only with uncontrolled, stage 1 hypertensive controls. Stage 2 hypertensive CME patients were matched similarly. The resulting sample size was 1626 CME patients.

Outcome Estimation

For each outcome (systolic and diastolic BP, provider visits, prescription months, and an indicator for BP $<$140/90 mm Hg) and patient group (CME and matched controls), the mean of all measures 2 years before (pre) and 2 years after (post) the (pseudo-)CME date was calculated. The change in each outcome variable was then calculated between the pre- and post-periods for all patients. The effectiveness of the intervention was defined as the mean change in the outcome for CME patients netting out the mean change among control patients.

Two separate analyses were conducted: the first for all the patients in the CME sample and their matched controls and the second restricting the sample to uncontrolled hypertensive CME patients and their matched controls. To estimate the change in the number of prescription months, the sample was reduced to include only patients whose prescriptions contained a non-missing end date. All analyses were conducted in Stata 10.1 (StataCorp, College Station, TX) with the psmatch2 command used for propensity scoring.[13,14]

RESULTS

The CME patient restrictions and propensity score matching provided two sets of 8183 patients. CME

TABLE II. Comparison of Hypertensive States Among CME Patients (n=8183) and Matched Control Patients

Blood Pressure Category	Category Definition, mm Hg	CME Patients, %	Control Patients, %
Normal	SBP <120 and DBP <80	23.8	21.0
Prehypertension	SBP 120–139 or DBP 80–89	47.6	49.5
Stage 1 hypertension	SBP 140–159 or DBP 90–99	21.1	23.9
Stage 2 hypertension	SBP ≥160 or DBP ≥100	7.5	5.6

Abbreviations: CME, continuing medical education; DBP, diastolic blood pressure; SBP, systolic blood pressure.

TABLE III. Program Effectiveness: CME Patients (n=8138) vs Matched Control Patients[a]

Measure	Group	Pre-CME[b]	Post-CME	Difference
Systolic blood pressure	CME patients	131.52	129.58	−1.94
	Control patients	131.54	131.59	0.06
	Effect of CME			−1.99[c]
	Standard error[d]			(0.38)
Diastolic blood pressure	CME patients	77.12	75.68	−1.45
	Control patients	77.16	77.20	0.04
	Effect of CME			−1.49[c]
	Standard error			(0.22)
Number of provider visits	CME patients	4.65	5.84	1.19
	Control patients	5.93	5.34	−0.59
	Effect of CME			1.78[c]
	Standard error			(0.20)
Number of hypertension prescription months[e]	CME patients	0.48	0.58	0.10
	Control patients	0.35	0.28	−0.06
	Effect of CME			0.16
	Standard error			(0.20)

[a]Continuing medical education (CME) and control patients were each represented once in the pre-CME and once in the post-CME period for systolic blood pressure, diastolic blood pressure, and the number of provider visit regressions. This resulted in a regression with 32,732 observations. [b]Estimates represent mean measures 2 years before (pre) and 2 years after (post) CME date. [c]Estimate is significant at the 95% confidence level. [d]Standard errors were clustered at the patient level. [e]Sample restricted to patients with complete start and end dates for prescriptions (n=4728 CME patients). CME patients and their matched controls were represented in the pre-CME and post-CME period. This resulted in a regression with 18,912 observations.

patient and control characteristics are summarized in Table I. The mean patient age for both groups was 53 years. Approximately one third of the sample had high cholesterol and more than one third was classified as obese.

The two populations displayed comparable characteristics with no characteristic differing by more than 1%, indicating that the propensity score matching was successful. Two-sample *t* tests (for age) and proportionality tests (for all other variables) of the differences between these variables revealed no statistically significant differences at the 95% confidence level. The similarity of the CME patients and the controls along these dimensions indicate that, on average, the propensity score matching was successful.

CME patients and control patients displayed small differences in the four BP classifications: normal, prehypertension, stage 1 hypertension, and stage 2 hypertension.[15] Table II shows the proportion of patients in each category. CME patients were more likely (23.8% vs 21.0%; $P<.05$) to have normal BP than control patients. However, the total number of patients with hypertension, either stage 1 or stage 2, was approximately the same: 28.6% for CME patients and 29.5% for control patients. In a two-sample test of proportionality, this difference was not statistically different from zero at the 95% confidence level.

The effectiveness estimates (Table III) show that the CME program is moderately effective in reducing BP for the entire patient population. Mean systolic BP for CME patients before the CME date was 131.52 mm Hg. This estimate is consistent with the control patient averages of 131.54 mm Hg pre-CME date and 131.59 mm Hg post-CME date. After the CME date, CME patients exhibited, on average, a 1.99-mm Hg decrease in systolic BP relative to the change among controls. A comparable change occurred for diastolic BP: post-CME date, CME patients experienced a 1.49-mm Hg decrease in diastolic BP relative to the change among controls. Both of these results were statistically significant.

CME patients visited their providers more often after the CME date. In the 2 years prior to the CME date, CME patients saw their providers an average of 4.65 times or 2.32 times per year. This figure is much lower than the 2.97 times the control patients saw their providers. After the CME date, CME patients saw their providers almost one (0.9 visits) more visit per year ($P<.05$). The CME program also generated a small increase in the number of prescription months. However, this difference was not statistically significant.

When the analysis was restricted to the uncontrolled hypertensive CME patients, the changes in BP were similar in magnitude to those in the entire population (Table IV). Uncontrolled hypertensive CME patients had statistically significant reductions of 1.67 mm Hg and 1.30 mm Hg in systolic BP and diastolic BP, respectively. These estimates translate to a 0.84-mm Hg reduction in systolic BP and a 0.65-mm Hg reduction in diastolic BP per year.

The proportion of patients with BP <140/90 mm Hg increased from 71% of the population to 76% (Table V). After controlling for the increase in control patients, this represents a 2.3% point increase in patients with BP <140/90 mm Hg.

TABLE IV. Program Effectiveness: Uncontrolled Hypertensive CME Patients (n=1626) vs Uncontrolled Hypertensive Matched Control Patients[a]

Measure	Group	Pre-CME[b]	Post-CME	Difference
Systolic	CME patients	151.44	142.64	−8.80
blood	Control patients	150.70	143.57	−7.13
pressure	Effect of CME			−1.67[c]
	Standard error[d]			(0.75)
Diastolic	CME patients	83.89	79.81	−4.08
blood	Control patients	83.34	80.56	−2.78
pressure	Effect of CME			−1.30[c]
	Standard error			(0.42)
Number of	CME patients	2.45	4.61	2.17
provider	Control patients	6.08	5.38	−0.70
visits	Effect of CME			2.87[c]
	Standard error			(0.26)
Number of	CME patients	0.07	0.28	0.21
hypertension	Control patients	0.29	0.36	0.08
prescription	Effect of CME			0.13
months[e]	Standard error			(0.22)

[a]Uncontrolled hypertensive continuing medical education (CME) patients were CME patients with a pre-CME systolic blood pressure of ≥140 mm Hg or a pre-CME diastolic blood pressure of ≥90 mm Hg using mean blood pressure measured in the pre-CME period. Stage 1 hypertensive CME patients (systolic blood pressure 140–159 mm Hg or diastolic blood pressure 90–99 mm Hg) were matched with stage 1 controls. Stage 2 hypertensive CME patients (systolic blood pressure ≥160 mm Hg or diastolic blood pressure ≥100 mm Hg) were matched with stage 2 hypertensive controls. Both CME patients and controls were each represented once in the pre-CME and once in the post-CME period for systolic blood pressure, diastolic blood pressure, and the number of provider visits regressions. This resulted in a regression with 6504 observations. [b]Estimates represent mean measures 2 years before (pre) and 2 years after (post) CME date. [c]Estimate is significant at the 95% confidence level. [d]Standard errors were clustered at the patient level. [e]Sample restricted to patients with complete start and end dates for prescriptions (n=1180 CME patients). CME patients and their matched controls each were represented once in the pre-CME and once in the post-CME period. This resulted in a regression with 2776 observations.

DISCUSSION

Although implementation of clinical guidelines has been proposed as an effective way to improve clinical outcomes, previous studies (eg, Bonds and colleagues) have failed to show an impact of CME in reducing patient hypertension.[8,16] Recent work, however, indicates that CME programs can change provider prescriptive behavior by prescribing more effective treatment, such as β-blockers.[17] Furthermore, De Rivas and colleagues[7] estimated that patients whose providers underwent a combination of live and online training saw a small but significant reduction in BP 1 year after training.

Our results show that the CME program was effective in reducing BP, increasing how often patients see their provider, and reducing the number of uncontrolled hypertensive patients without increasing the number of prescriptions required by the patients. By enhancing provider awareness of important hypertension information, the CME program imparted benefits to its patient population without an increase in the number of prescriptions per month.

The reductions in BP were comparable to the effects of provider-recommended lifestyle changes. For example, Sacks and colleagues found that an intervention reducing sodium intake from "intermediate" to "low" levels displayed systolic BP effects (a 1.9-mm Hg drop) similar to the ones presented in this study.[15,18] The magnitude of the systolic and diastolic BP effects of the CME are also consistent with reductions resulting from dietary fiber supplementation.[19] Finally, our CME results are comparable to the CME results by De Rivas and colleagues[7] who reported a systolic BP reduction of 1.1 mm Hg. Furthermore, the HID did not permit an assessment of patient adherence, but that may provide a plausible explanation for the results and could be addressed in future studies.

The CME program's reduction in average BP may mean a considerable decrease in downstream events as well. Stamler reported that a drop in systolic BP of 2 mm Hg, similar in magnitude estimated for CME patients, may reduce mortality due to stroke by 6%, coronary heart disease by 4%, and total mortality by 3%.[20,21] Cook and colleagues[22] estimated that a 2-mm Hg decrease in diastolic BP for white US residents, 35 to 64 years, would result in a 17% decrease in the prevalence of hypertension, a 14% decrease in the risk of stroke and transient ischemic attacks, and a 6% decrease in the risk of coronary heart disease. Furthermore, a reduction of 2.3% in South Carolina's uncontrolled hypertensive patients could decrease the total

TABLE V. Program Effectiveness: Reduction in Uncontrolled Hypertension Prevalence for CME Patients (N=8138) vs Matched Control Patients[a]

Measure[b]	Group	Pre-CME	Post-CME	Difference
Proportion of patients with	CME patients	0.714	0.755	0.041
blood pressure <140/90 mm Hg[c]	Control patients	0.705	0.724	0.018
	Effect of CME			0.023[d]
	Standard error			(0.010)

[a]Continuing medical education (CME) patients and their matched controls each were represented once in the pre-CME and once in the post-CME period. This resulted in a regression with 32,732 observations. [b]The linear probability model was used to estimate the regression coefficients. [c]Uncontrolled hypertension is defined as having a systolic blood pressure of ≥140 mm Hg or a diastolic blood pressure of ≥90 mm Hg. [d]Estimate is significant at the 95% confidence level.

number of patients with this condition by more than 38,000.[23]

LIMITATIONS

These findings, however, should be generalized with caution. The sample is restricted to the providers that contributed to the HID, patients with regular visits, and prescription data for patients whose providers reported complete start and end dates. To the extent to which this is not a representative population, it is unclear what the impact would be on a larger primary care population.

Another limitation may be that the CME providers who submit their data to the HID could be a select group of top performers. If the sample contains top performers, our results would be biased upward as a result. Unfortunately, data limitations prevented us from addressing this issue by controlling for provider characteristics. However, the similarities between the CME patients and the control patients in Table I and in the pre-CME period may mitigate this concern.

Unobserved variables in the HID may also challenge the unconfoundedness assumption required by the propensity score matching. Motivated and/or diligent patients may have been more likely to have made lifestyle changes on their own and to have selected high-quality, CME-trained providers, resulting in an overestimation of the CME program's effectiveness. However, the evidence suggests that the CME patients were visiting their providers fewer times prior to the CME training than the control group. Furthermore, we did not observe any differences in BP prior to the CME date, indicating that any unobserved differences between CME and control patients did not result in differences in baseline BP. The case-control/pre-post methodology should control for trends common to both CME and control patients. Regression to the mean was more likely to be similar across groups since pre-CME BP was similar for CME and control patients.

CONCLUSIONS

Our assessment provides evidence that the CME program, by increasing provider awareness of hypertension, has a considerable and positive impact on patients' BP. Additional evidence suggests that the CME program is accomplishing its goals without increasing prescriptions. The fact that almost one third of South Carolinians have been told they have high BP[23] shows a strong need for effective interventions to control hypertension. The CME program may serve as a model for other CME programs that aim to reduce the burden of hypertension.

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References

1. Ong K, Cheung B, Yan Y, et al. Prevalence, awareness, treatment and control of hypertension among United States adults 1999–2004. *Hypertension*. 2007;49:69–75.
2. Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988-2008. *JAMA*. 2010; 303:2043–2050.
3. Neal B, MacMahon S, Chapman N. Effects of ACE inhibitors, calcium antagonists, and other blood-pressure-lowering drugs: results of prospectively designed overviews of randomised trials. Blood pressure lowering treatment trialists collaboration. *Lancet*. 2000; 356:1955–1964.
4. Kahn R, Robertson R, Smith R, et al. The impact of prevention on reducing the burden of cardiovascular disease. *Circulation*. 2008; 118:575–585.
5. Schuster MA, McGlynn EA, Brook RH. How good is the quality of health care in the United States? *Milbank Q*. 1998;76:517–563.
6. Prior M, Guerin M, Grimmer-Somers K. The effectiveness of clinical guideline implementation strategies—a synthesis of systematic review findings. *J Eval Clin Pract*. 2008;14:888–897.
7. De Rivas B, Barrios V, Redon J, et al. Effectiveness of an Interventional Program to Improve Blood Pressure Control in Hypertensive Patients at High Risk for Developing Heart Failure: HEROIC study. *J Clin Hypertens (Greenwich)*. 2010;12:335–344.
8. Bonds DE, Hogan PE, Bertoni AG, et al. A multifaceted intervention to improve blood pressure control: The Guideline Adherence for Heart Health (GLAD) study. *Am Heart J*. 2009;157:278–284.
9. Egan BM, Lackland DT, Igho-Pemu P, et al. Cardiovascular risk factor control in communities—Update from the ASH Carolinas-Georgia Chapter, the hypertension initiative, and the community physicians' network. *J Clin Hypertens (Greenwich)*. 2006;8:879–886.
10. Rosenbaum P, Rubin D. The central role of the propensity score in observational studies for causal effects. *Biometrika*. 1983;70:41–55.
11. Caliendo M, Kopeinig S. Some practical guidance for the implementation of propensity score matching. *J Econ Surv*. 2008;22:31–72.
12. Dehejia R. Practical propensity score matching: a reply to Smith and Todd. *J Econom*. 2005;125:355–364.
13. *Stata Statistical Software: Release 10.1* [computer program]. College Station, TX: Statacorp LP; 2008.
14. *PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing* [computer program]. Version 3.1.4: Leuven, E., Sianesi, B.; 2003.
15. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA*. 2003;289:2560–2572.
16. Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet*. 1993;342:1317–1322.
17. Simon SR, Majumdar SR, Prosser LA, et al. Group versus individual academic detailing to improve the use of antihypertensive medications in primary care: a cluster-randomized controlled trial. *Am J Med*. 2005;118:521–528.
18. Sacks FM, Svetkey LP, Vollmer WM, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med*. 2001;344:3–10.
19. Streppel MT, Arends LR, van 't Veer P, et al. Dietary fiber and blood pressure: a meta-analysis of randomized placebo-controlled trials. *Arch Intern Med*. 2005;165:150–156.
20. Stamler R. Implications of the INTERSALT study. *Hypertension*. 1991;17(suppl 1):I16–I20.
21. Whelton PK, He J, Appel LJ, et al. Primary prevention of hypertension: clinical and public health advisory from The National High Blood Pressure Education Program. *JAMA*. 2002;288:1882–1888.
22. Cook N, Cohen J, Hebert P, et al. Implications of small reductions in diastolic blood pressure for primary prevention. *Arch Intern Med*. 1995;155:701–709.
23. Behavioral Risk Factor Surveillance System. Prevalence and trends data, South Carolina—2007, hypertension awareness. http://apps.nccd.cdc.gov/brfss/display.asp?cat=HA&yr=2007&qkey=4420&state=SC. Accessed March 3, 2009.