Hypertension Control Among Patients Followed by Cardiologists

Ann Marie Navar-Boggan, MD, PhD; Joel C. Boggan, MD, MPH; Judith A. Stafford, MS; Lawrence H. Muhlbaier, PhD; Catherine McCarver, MBA, MHA; Eric D. Peterson, MD, MPH

Background—Hypertension control is an important and modifiable risk factor for cardiovascular disease. The overall rate of hypertension control among patients followed in cardiology clinics, as well as clinician variability in control rates, is unknown.

Methods and Results—We conducted a retrospective cohort study of patients with hypertension (n = 5979) routinely followed in a cardiology clinic (n = 47 physicians). Overall, 30.3% of patients with hypertension had suboptimal control (blood pressure [BP] ≥140/90 mm Hg) at the end of a 13-month follow-up period. Patient-level factors associated with control were younger age, male sex, white ethnicity, having a primary care provider at Duke, private insurance, Medicare/Medicaid, and comorbid diagnoses of heart failure or coronary artery disease. Unadjusted rates of suboptimal BP control among clinicians’ clinic patient panels ranged from 16% to 44%. Even after adjusting for patient factors, patients’ odds of BP control varied 6-fold, depending on their treating clinician. Using a patient’s average BP rather than their most recent BP did not result in significant changes in provider performance. In chart reviews (n = 300), clinicians failed to document a plan to address hypertension in 38% of patients with elevated BP in the clinic.

Conclusions—Up to one-third of patients followed routinely by cardiologists in clinic have suboptimally controlled BP, with wide variability in performance across individual clinicians. This variability, alongside evidence that elevated BP is often not acted on during clinic visits, demonstrates a potential opportunity for quality improvement. (Circ Cardiovasc Qual Outcomes. 2012;5:352-357.)

Key Words: hypertension ■ provider performance ■ performance measures ■ quality improvement

Hypertension is our nation’s most prevalent medically modifiable cardiovascular risk factor. Despite the availability of effective therapies, hypertension control remains elusive. In the United States, only approximately 50% of the nation’s hypertensive patients reach target blood pressure (BP) rates.1 As a result, the American College of Cardiology and the American Heart Association (AHA) have recently developed physician-level hypertension control performance measures that require that patients with coronary artery disease and hypertension achieve a target BP of <140 mm Hg systolic and <90 mm Hg diastolic.2,3 The recently launched Million Hearts Initiative, supported by the AHA, is a nationwide initiative from the Department of Health and Human Services to reduce the rate of heart attacks in the United States.4 A key indicator in this initiative is achievement of 65% BP control rates.5

The degree to which current cardiology practices achieve BP control and the reasons for suboptimal control remain poorly understood. To date, most studies of hypertension control have been conducted in primary care settings. Although patients with cardiovascular disease are more likely to receive treatment for hypertension,6,7 there is only limited evidence to suggest that patients treated by cardiologists have improved overall BP control compared with patients not seen by a cardiologist.5,8

Our study’s objectives were to (1) evaluate the extent to which patients cared for longitudinally in cardiology clinics meet the current hypertension control performance metric; (2) examine physician-level variation in hypertension control rates; (3) assess the degree to which variability in physician performance is explained by patient heterogeneity; and (4) determine clinician responses to elevated BP in the clinic.

Methods

Inclusion Criteria
A retrospective cohort study was conducted of patients with a history of hypertension followed routinely by cardiologists in one of the clinics at Duke University Medical Center. Patients were eligible if they had a diagnosis of hypertension made before the start of the study period or within the first 6 months of study initiation. Diagnoses of hypertension were identified by either (1) an International Classification of Diseases, Ninth Revision (ICD-9) code of hypertension (ie, 401–405) at any inpatient, outpatient, or emergency room visit in the past; or (2) if the patient had 2 or more
outpatient visits in the preceding year with a BP $\geq 140$ mm Hg systolic or $\geq 90$ mm Hg diastolic.

**WHAT IS KNOWN**

- Hypertension is one of the most prevalent modifiable risk factors for cardiovascular disease.
- Only half of patients with hypertension in the United States achieve adequate blood pressure control.

**WHAT THE STUDY ADDS**

- Nearly one-third of patients followed routinely by cardiologists at a large academic center did not reach blood pressure targets.
- Blood pressure is often not addressed, even when elevated, at clinic visits.
- Significant physician variability in hypertension control performance exists, suggesting room for quality improvement.

Patients were included in the study if they had at least 2 clinic visits with a cardiologist at Duke during the 13-month study period (from June 1, 2009, to June 30, 2010). This convenience sample included all patients seen at least twice during the study window. Multiple visits were required to ensure that the patient was longitudinally followed by the physician. A 13-month window ensured that patients seen routinely every 6 months would be captured. Cardiologists who saw fewer than 30 patients with hypertension during the study period were excluded.

**Assessment of BP Control**

Blood pressure readings were taken by trained nurses who entered triage vital signs electronically for patient visits. Clinicians could verify BP readings and reenter corrected readings into the electronic document. During the study period, clinicians were unaware that their patients’ BP results would be monitored for research or quality improvement reasons.

To assess hypertension control, the BP documented at the last visit in the study window was used to account for patients who started the study period with elevated BP but became controlled by their last clinic visit. In some instances ($n=190$ patients), patients had multiple physician visits in 1 day or multiple BP entries from the same clinic visit. For these patients, the lowest systolic and diastolic BPs were used. In only 39 patients were measurements not concordant for control.

**Data Analysis**

Rates of BP control by physician and 95% confidence intervals were generated using descriptive statistics. BP control was defined per the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) criteria, with systolic BP $\geq 140$ mm Hg or diastolic BP $\geq 90$ mm Hg as stage I hypertension and systolic BP $\geq 160$ mm Hg or diastolic BP $\geq 100$ mm Hg as stage II hypertension.

**Assessment of Physician Heterogeneity**

We used 2 different models to evaluate BP control. First, a frequentist approach was used to evaluate physician-specific rates of control for each physician using logistic regression. This regression calculated an odds ratio for each physician that represented a patient’s odds of control if he/she saw that physician compared with all other physicians. These odds were then recalculated after adjusting for patient-level factors potentially associated with BP control to determine the impact of patient heterogeneity on physician statistics.

Patient-level factors included patient age, sex, ethnicity, insurance status, number of hospitalizations in the past year, primary care within the same health system, and comorbid diagnoses of coronary artery disease, congestive heart failure, or diabetes. All data for patient-level factors were abstracted electronically using data available for all patients.

To determine what patient- and physician-level predictors were associated with BP control, multivariable logistic regression was performed using robust standard errors to account for clustering at the physician level. To assess what physician-level factors are associated with BP control, physician-level characteristics were also included. These were percentage of visits seen by a nurse practitioner or physician assistant, group of practice (ie, electrophysiology, heart failure/transplant, coronary artery disease/general cardiology, or structural/congenital), and number of visits with hypertensive patients during the past 13 months. Univariable logistic regression was performed for all characteristics significant at the $P<0.10$ level in univariable modeling to generate the final multivariable model. No priori variables were selected for retention.

Next, a multilevel, multivariable, random-effects logistic regression model with a random intercept at the physician level was created to determine whether there was statistically significant heterogeneity across cardiologists. This model included all patient-level factors potentially associated with hypertension control (regardless of statistical significance in multivariable modeling) to determine whether physician heterogeneity remained statistically significant after adjusting for patient characteristics.

All analyses were performed using STATA Version 9 (Stata Corp, College Station, TX).

**Sensitivity Analysis**

To assess the impact of using a different measure of BP control, data were reanalyzed using the patient’s average systolic and diastolic BP from all visits in the study period (rather than the last visit). Provider control rates were calculated using patient average BP. The correlation between provider control rates using the last BP and rates using the average BP was assessed using linear regression.

**Chart Reviews**

To assess clinician responses to elevated BP, a random sample of 300 patient visits with suboptimal BP was selected for chart review. Clinician notes from these visits were reviewed (A.M.N., J.C.B.) to ascertain any reasons for elevated BP, as well as any documented response by the clinician to the elevated BP. Descriptive statistics were used to evaluate data from chart reviews. This study was approved by the Institutional Review Board at Duke University Medical Center (Pro00027093).

**Results**

A total of 5979 patients routinely cared for in 47 cardiologists’ clinics were included in this analysis. Overall, the rate of suboptimally controlled BP among patients who saw cardiologists was 30.3%, and 7% of these patients had stage II hypertension (systolic BP $\geq 160$ or diastolic BP $\geq 100$). Figure 1 shows the distribution of systolic and diastolic BPs across all patients; 21.9% of patients had isolated systolic hypertension (systolic BP $\geq 140$), 2.4% had isolated diastolic hypertension (diastolic BP $\geq 90$), and 6% had both systolic and diastolic hypertension.

Table 1 shows the characteristics of the patient study population, as well as the characteristics of the physicians who evaluated these patients. The average age of patients was 66, and there were more men than women. Most patients (>98%) had some form of insurance. High rates of coronary artery disease, heart failure, and diabetes were seen in all...
Physician characteristics and HTN, hypertension.

Physician characteristics

In the 13-month study period, the average number of visits per physician for patients with hypertension was 692 (range, 92–1973). Most patients were seen in a general cardiology clinic (51.6%) followed by a heart failure/ transplant clinic (24.7%).

Table 2 shows patient and physician characteristics associated with achievement of optimal BP control in univariable and multivariable analyses. Patients with insurance (private or Medicare/Medicaid), those who received primary care in the same system, as well as patients with diabetes or heart failure, had improved rates of BP control. Increasing age, female sex, and nonwhite ethnicity were associated with worse BP control in multivariable analysis. Physicians with

Table 1. Characteristics of the Study Population

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Controlled BP (n=4167)</th>
<th>Elevated BP (n=1812)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean</td>
<td>66.0</td>
<td>67.0</td>
</tr>
<tr>
<td>Sex, % women</td>
<td>39.6</td>
<td>47.1</td>
</tr>
<tr>
<td>Ethnicity, % nonwhite</td>
<td>23.4</td>
<td>32.7</td>
</tr>
<tr>
<td>Primary care in Duke system, %</td>
<td>71.4</td>
<td>66.7</td>
</tr>
<tr>
<td>Hospitalizations in past year, n</td>
<td>0.64</td>
<td>0.57</td>
</tr>
<tr>
<td>Coronary artery disease, %</td>
<td>66.2</td>
<td>61.6</td>
</tr>
<tr>
<td>Heart failure, %</td>
<td>50.0</td>
<td>46.5</td>
</tr>
<tr>
<td>Diabetes, %</td>
<td>39.0</td>
<td>41.1</td>
</tr>
<tr>
<td>Uninsured, %</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Private insurance, %</td>
<td>32.8</td>
<td>27.9</td>
</tr>
<tr>
<td>Medicare/Medicaid, %</td>
<td>65.9</td>
<td>69.8</td>
</tr>
</tbody>
</table>

Physician characteristics

| Visits seen by NP or PA, % (range) | 12 (0 to 58) |
| Visits: patients with HTN, n (range) | 692 (92–1973) |
| Subspecialty, % visits            |             |
| Electrophysiology                 | 12.2        |
| Heart failure/transplant           | 24.7        |
| Valvular diseases/interventional   | 11.5        |
| General cardiology                | 51.6        |

BP indicates blood pressure; NP, nurse practitioner; PA, physician’s assistant; and HTN, hypertension.

Figure 1. Distribution of systolic and diastolic blood pressures (BP). This figure is a histogram of individual patients’ systolic and diastolic BP measurements at the final clinic visit in the study window.

Increased percentage of patients seen by a nurse practitioner or physician assistant had improved control rates, though this was not significant in multivariable analysis. Provider subspecialty was not associated with control.

Among physicians who were analyzed, rates of suboptimal BP control among patients seen in their clinics ranged from 16% to 44%. Figure 2 shows rates of suboptimal BP control among hypertensive patients by physician. Patient odds of suboptimal BP control by physician ranged from 0.53 for the highest performing physician to 2.54 for the lowest performing physician; therefore, a patient who saw the highest-performing physician had a 47% reduction in his/her odds of having optimal BP control when compared with the average across all other physicians. Adjustment for patient heterogeneity had limited impact on the degree of physician-level variation on BP control rates. After adjustment, the adjusted odds ratio for control ranged from 0.50 to 3.11.

In a multilevel, random-effects model, heterogeneity across physicians was highly statistically significant ($P<0.0005$) and remained significant after adjusting for patient characteristics ($P<0.0005$).

In a sensitivity analysis, we used a patient’s average BP (in contrast to last BP) to define hypertension control. Using this definition, the percentage of patients with suboptimal BP control ranged from 11% to 47% across providers and was highly correlated with their classification, based on the BP reading at the last clinic visit ($r=0.79$).

Reasons for and Responses to Elevated BP in the Clinic

In manual chart reviews of visits in which patients had elevated BP (systolic BP $\geq 140$ or diastolic BP $\geq 90$, n=300 patients belonging to 36 different cardiologists), an explanation for elevated BP was found in 35% of patients (Figure 3). In 8%, the physician manually rechecked the patient’s BP and documented that it was within goal. In 7%, patients were noncompliant with medications, whereas in 6%, another medical explanation was given (eg, medical indication for higher BP goal, temporary medication side effect, recently adjusted medications by an outside provider, etc). In 16%, the patient had BPs documented within goal either at home or during other clinic visits. However, in only 3 patients (1%) was ambulatory monitoring used to confirm white-coat syndrome–induced hypertension.

This left 65% of patients with elevated BP at a clinical visit eligible for medication adjustment. Of these patients, 86% were receiving 2 or more antihypertensive agents, and 62% were receiving 3 or more antihypertensive agents. Figure 4 shows clinician responses to elevated BP in the clinic. In 47% of visits, medication changes were recommended. Other responses included diet/exercise changes, recommendation to follow-up with a different provider, initiation or continuation of home monitoring, or a plan to follow-up at future visits. However, in 38% of visits, the clinician documented no response to elevated BP in the clinic note.

Discussion

In hypertensive patients routinely followed by a cardiologist, nearly 1 in 3 patients have suboptimal BP control as defined
by a systolic BP $\geq 140$ or diastolic BP $\geq 90$ in the clinic. Physician-specific performance varied significantly, with a 5-fold variation in an individual patient’s odds of BP control across physicians. This variability could not be attributed to variation in patient characteristics across physicians. Cardiologists made medication changes in less than half of patient visits where BP was elevated, demonstrating that hypertension is often not addressed in clinic visits.

This observational study was not designed to determine whether or not this was due to patient-level factors or the presence of a cardiologist. Patients often see a primary care provider more frequently than a cardiologist, and most studies of BP control have focused on the role of primary care. Given the important role of BP in modifying risk of cardiovascular disease, we believe that cardiologists should take on shared responsibility for BP management. Although prior data have suggested that patients followed by cardiologists may have better BP control, our study is the first of this magnitude to assess the rate of hypertension control in a population of patients routinely followed by cardiologists in ambulatory care. Compared with data from the National Health and Nutrition Examination Survey (NHANES), which showed that only 43% of patients have controlled BP, we found that patients in this health system that were followed routinely by cardiologists had better BP control. Indeed, cardiologists in this study are already exceeding target BP control rates in the Million Hearts Initiative.

Table 2. Patient and Physician Characteristics Associated With Blood Pressure Control: Univariable and Multivariable Analyses

<table>
<thead>
<tr>
<th></th>
<th>Univariable Analysis</th>
<th>Multivariable Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>P Value</td>
</tr>
<tr>
<td><strong>Patient characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, 10-y increase</td>
<td>0.94</td>
<td>0.08</td>
</tr>
<tr>
<td>Sex, female</td>
<td>0.74</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ethnicity, nonwhite</td>
<td>0.63</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Primary care in same system in past year</td>
<td>1.25</td>
<td>0.02</td>
</tr>
<tr>
<td>Rehospitalizations in past year</td>
<td>1.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>1.22</td>
<td>0.003</td>
</tr>
<tr>
<td>Heart failure</td>
<td>1.15</td>
<td>0.005</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.92</td>
<td>0.11</td>
</tr>
<tr>
<td>Uninsured</td>
<td>0.61</td>
<td>0.02</td>
</tr>
<tr>
<td>Private insurance</td>
<td>1.26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Physician characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visits seen by NP or PA, %</td>
<td>1.10</td>
<td>0.04</td>
</tr>
<tr>
<td>Visits: patients with HTN, n</td>
<td>1.01</td>
<td>0.22</td>
</tr>
<tr>
<td>Electrophysiology</td>
<td>1.11</td>
<td>0.29</td>
</tr>
<tr>
<td>Heart failure/transplant</td>
<td>1.19</td>
<td>0.26</td>
</tr>
<tr>
<td>Valvular diseases/interventional</td>
<td>0.81</td>
<td>0.06</td>
</tr>
<tr>
<td>General cardiology</td>
<td>0.92</td>
<td>0.42</td>
</tr>
</tbody>
</table>

CI indicates confidence interval; OR, odds ratio; NP, nurse practitioner; PA, physician’s assistant; and HTN, hypertension.

Multivariable analysis is the parsimonious model generated from backward stepwise regression including all variables with $P<0.10$ in univariable analysis.

Figure 2. Physician-specific rates of suboptimal blood pressure (BP) control by rank. This figure shows the percent of patients with elevated BP for each physician and 95% confidence interval for that estimate, arranged in order of physician rank. Rates of elevated BP ranged from 16% to 44%.
had regular access to subspecialty care, there appears to be room to improve BP control rates among ambulatory cardiology care practices.

A number of patient-level factors were found to be associated with improved odds of BP control, including younger age, male sex, white ethnicity, presence of a primary care provider in the same health system, and having private insurance or Medicare/Medicaid. Patients with a comorbid diagnosis of coronary disease and/or congestive heart failure were more likely to have controlled BP, possibly due to lower BP targets in this patient population. Notably, patients with diabetes were not more likely to have controlled BP, despite the JNC-7 recommendation for lower BP goal in diabetics.12

Our data suggest that clinicians have significant impact on rates of optimal BP control, with a 6-fold difference in a patient’s odds of achieving optimal control between the highest- and lowest-performing physicians. These differences persisted even after adjusting for patient heterogeneity. Physician volume and subspecialist group were not associated with improved performance. In the future, practices of the highest- and lowest-performing physicians should be examined to identify what other variables may contribute to physician heterogeneity.

Importantly, many variables are required to achieve BP control, not all of which are modifiable by the clinician. In our current study, only 7% of patients with elevated BP were noted to be noncompliant with medications, though not all patients may have revealed noncompliance to their clinician, and not all clinicians may have documented all suspected noncompliance. When physicians did not make medication changes, they often did not document a follow-up plan (eg, home monitoring). As a result, it appears that cardiologists in this study often did not aggressively treat BP, with more than one-third of eligible patients receiving no medication changes or counseling in response to elevated BP in cardiology clinics. This rate of medication changes was similar to that demonstrated in a large cohort of veterans with hypertension, in which 41% of patients with good medication adherence did not have treatment intensification.13

The reason for clinical inertia with respect to medication changes in these patients should be further explored. One study of physician reasons for lack of medication changes found the most common reason cited was that the patient usually had well controlled BP on current therapy. However, on review of BP recordings at other clinic visits, this was often an incorrect assumption.14

Our study had several limitations. First, our study took place in a single academic medical center setting; therefore, our findings may not be generalizable to cardiologists in private practice or even at other academic centers—particularly if BP control initiatives are already in place. However, one might imagine that these rates of control, as well as rates variability, may be underestimated using a single-center setting. Second, this study relied on BP readings taken at triage by nurses and did not include BP recordings repeated by clinicians; however, in chart reviews, additional measurements rarely changed designations of control, with only 8% of visits with elevated BP having a repeat BP by the clinician within goal. Third, nearly 1 in 6 patients with elevated BP in the clinic reported controlled BPs at home. Using only clinic BPs may overestimate the number of patients with uncontrolled BP. Physicians should take caution to completely trust patient reports of home BP readings, remaining cognizant that home BP cuffs may not be calibrated and patients may selectively report BP readings within goal. In patients with consistently elevated clinic BPs but normal home BPs,
24-hour ambulatory monitoring should be implemented to confirm white-coat hypertension. New NICE (National Institute for Health and Clinical Excellence) guidelines recommend offering ambulatory blood pressure monitoring to confirm a clinical diagnosis of hypertension.\textsuperscript{13} However, ambulatory monitoring was rarely used in this cohort, with only 1\% patients having documentation of ambulatory monitoring in chart reviews. Although clinic BP measurements may overestimate or underestimate BP control because they both can lack sensitivity and specificity,\textsuperscript{16,17} physicians will continue to rely on these measurements to make treatment decisions. Additionally, we found that 62\% of patients with suboptimal BP were already taking 3 or more antihypertensive agents; therefore, we are uncertain whether these patients were truly “refractory” or whether changes in drug type or dose could have resulted in improved BP control. Finally, this study relied on physician reporting of patient adherence, which probably underestimates patient nonadherence.

In summary, we found that nearly one-third of hypertensive patients followed by cardiologists had not achieved optimal BP control when measured in the clinic setting, with significant variability across physicians. Given the strong association with BP and risk of cardiovascular disease, cardiologists should be encouraged to aggressively treat BP, yet many patients who visit cardiology clinics do not receive medication adjustments in response to elevated BP. Our findings present an opportunity for quality improvement initiatives related to BP control.

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References
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