

Prevalence of Inadequate Blood Pressure Control Among Veterans After Acute Ischemic Stroke Hospitalization

A Retrospective Cohort

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Background—Reducing blood pressure (BP) after stroke reduces risk for recurrent events. Our aim was to describe hypertension care among veterans with ischemic stroke including BP control by discharge and over the 6 months after the stroke event.

Methods and Results—The Office of Quality and Performance Stroke Special Study included a systematic sample of veterans hospitalized for ischemic stroke in 2007. We examined BP control (<140/90 mm Hg) at discharge excluding those who died, enrolled in hospice, or had unknown discharge disposition (n=3640, n=3382 adjusted analysis). The second outcome was BP control (<140/90 mm Hg) within 6-months after stroke, excluding patients who died/readmitted within 30 days, were lost to follow-up, or did not have a BP recorded (n=2054, n=1915 adjusted analysis). The population was 62.7% white and 97.7% men; 46.9% were <65 years of age; and 29% and 37% had a history of cerebrovascular or cardiovascular disease, respectively. Among the 3640 stroke patients, 1573 (43%) had their last documented BP before discharge as >140/90 mm Hg. Black race (adjusted odds ratio, 0.77; 95% confidence interval, 0.65 to 0.91), diabetes (odds ratio, 0.73; 95% confidence interval, 0.62 to 0.86), and hypertension history (odds ratio, 0.51; 95% confidence interval, 0.42 to 0.63) were associated with lower odds for controlled BP at discharge. Of the 2054 stroke patients seen within 6 months from their index event, 673 (32.8%) remained uncontrolled. By 6 months after the event, neither race nor diabetes was associated with BP control, whereas history of hypertension continued to have lower odds of BP control. For each 10-point increase in systolic BP >140 mm Hg at discharge, odds of BP control within 6 months after discharge decreased by 12% (95% confidence interval [8%, 18%]).

Conclusions—BP values in excess of national guidelines are common after stroke. Forty-three percent of patients were discharged with an elevated BP, and 33% remained uncontrolled by 6 months. (*Circ Cardiovasc Qual Outcomes*. 2011;4:399-407.)

Key Words: hypertension ■ quality of care ■ secondary prevention ■ stroke prevention

Reducing patients' blood pressure (BP) after a cerebrovascular event has been demonstrated to improve secondary prevention.¹ There is a continuous positive relationship between BP and risk of cardiovascular disease events.² Diet, exercise, and treatment with antihypertensive medications have also been associated with reductions in recurrent stroke, myocardial infarction, and vascular events regardless of whether the patient had a history of hypertension.³ How-

ever, the extent to which this potential benefit has been realized in routine clinical practice is much less clear. Deficiencies in delivery of secondary prevention and in the quality of care have been noted after incident cardiovascular and cerebrovascular events.⁴⁻⁷

A proposed means to realize the potential benefits of secondary prevention emphasizes treatment initiation at hospital discharge. Organized approaches that initiate secondary

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prevention medications before hospital discharge may improve adherence to guidelines.^{8–10} Studies suggest that in-hospital behavior strongly influences after discharge community practice.¹¹ There is, however, increasing evidence that BP among patients with stroke remains poorly controlled after stroke hospitalization, leading to high rates of recurrent strokes.^{6,12,13} Although stroke care guidelines provide recommendations regarding the in-hospital initiation of management for some stroke risk factors such as lipids,^{14,15} no specific recommendations are made regarding the initiation of antihypertensive agents at hospital discharge. The American Heart Association/American Stroke Association strongly recommends that treatment of hypertension should be instituted after the acute period in patients who have consistently elevated BP.¹⁵ Similarly, the *Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7)* guidelines suggest that for the stroke patient, hypertension treatment be initiated with an angiotensin-converting enzyme inhibitor (ACEI) combined with a thiazide-type diuretic, based on the results of the Perindopril Protection Against Recurrent Stroke study (PROGRESS trial).¹⁶

WHAT IS KNOWN

- Deficiencies in delivery of secondary preventative care have been noted after stroke; and reducing patients' blood pressure after stroke has been demonstrated to improve risk for recurrent stroke.
- Treatment of hypertension should be instituted after the acute stroke period in patients who have consistently elevated blood pressure.

WHAT THE STUDY ADDS

- Forty-three percent of patients with acute ischemic stroke had their last documented in-hospital blood pressure value as $\geq 140/90$ mm Hg, and 33% remained uncontrolled by 6 months after hospitalization; the probability of being controlled remained significantly lower for patients with history of diabetes and/or hypertension.
- Only 15% of patients received the recommended antihypertensive combination of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers and thiazide diuretics at the time of discharge.
- We propose that the quality of care for patients with cerebrovascular events could be beneficially affected through the systematic in-hospital initiation of secondary prevention strategies, thus enhancing guideline adherence and improving care among those at highest risk for a vascular event.

We had a unique opportunity to assess poststroke BP care among nearly all veterans admitted to a Veterans Health Administration (VHA) facility for an acute ischemic stroke event. This allowed us to address a major gap in the literature regarding the quality of hypertension care and characteristics of high-risk veterans admitted with an ischemic stroke. We

perceive this to be a critical first step in the potential design of interventions targeted to persons at greatest risk of uncontrolled BP. Our aim was to describe the quality of hypertension care among veterans after hospitalization for an acute ischemic stroke. The quality of hypertension management was assessed on the basis of 3 outcomes: BP control at discharge, antihypertensive medications prescribed at discharge, and BP control over the 6 months after the ischemic stroke event. We hypothesized that certain risk factors including diabetes and multiple comorbidities would lead to suboptimal BP control among stroke patients at discharge and in the 6 months after discharge. We also hypothesized that the prescription of combination ACEI with a thiazide diuretic at discharge would be associated with better BP control over the 6 months after the acute stroke hospitalization.

Methods

Study Design, Setting, and Data Sources

The Office of Quality and Performance Stroke Special Study was a retrospective cohort of veterans admitted to a Veterans Affairs Medical Center (VAMC) in the United States and Puerto Rico during Fiscal Year (FY) 2007 (October 1, 2006, through September 30, 2007) with a primary discharge diagnosis of ischemic stroke, identified using a modified high-specificity algorithm¹⁷ of the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes ($n=5721$ possible stroke events). A systematic sample of 5000 medical records was identified, using an approach that included all ischemic stroke patients at VAMCs with 55 or fewer ischemic stroke hospitalizations in FY 2007 and an 80% random sample of ischemic stroke patients at VAMCs with >55 ischemic stroke hospitalizations in FY 2007. Because of this sampling strategy, the number of stroke patients per VAMC who were included in this study ranged from 1 to 198 (mean=38, standard deviation [SD]=28). Medical record abstraction on the 5000 charts was performed by the West Virginia Medical Institute External Peer Review Program using remote electronic medical records. Chart abstraction by this professional review organization involved a computer-guided chart abstraction and customized reporting system. Among the 307 data elements, 90% demonstrated good or very good inter-rater reliability (κ statistic ≥ 0.70). The lowest interobserver reliability that we used was for history of hypertension ($\kappa=0.67$). Kappa statistics for abstracted BP was between 0.70 and 1.0 (highest for discharge BP; lower agreement for BP obtained in outpatient setting within 6 months after discharge). Kappa statistics for elements of the discharge medication list varied between 0.81 and 0.95. Veterans were excluded from the cohort ($n=1013$) if they were hospitalized for transient ischemic attack or were admitted for poststroke rehabilitation, had an ischemic stroke during a hospitalization for another condition, or were admitted for elective carotid endarterectomy during the index hospitalization. This left 3987 patients seen in 130 VAMCs in the Office of Quality and Performance study sample. The date of admission for stroke hospitalization was considered the index event date.

Analytic Population

From this inception cohort of 3987 patients, we excluded veterans who died during the index hospitalization, enrolled in hospice or comfort care, or had an unknown discharge disposition. We also excluded patients for whom there was no BP recorded throughout hospital stay. This population was the analytic population for the first analysis in which the outcome was BP control at the time of discharge. For analysis 2, we included patients who had follow-up at a VHA outpatient clinic within 6 months of their index hospitalization. We excluded patients who died or were readmitted within 30 days, those who were lost to follow-up, and those who were seen in a VHA outpatient clinic but who did not have BP measurement.

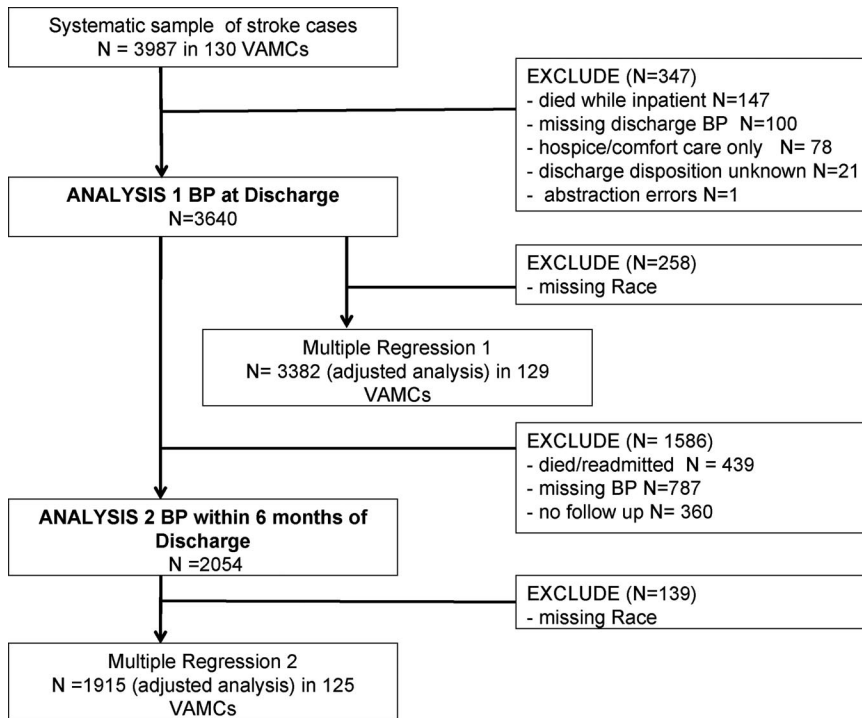


Figure. Flow chart of patients included in each analysis.

Outcomes

BP Control at Discharge

To identify BP control at the time of discharge, we used the last available inpatient BP measurement before discharge from the hospital. Suboptimal BP was defined according to the Veterans Affairs/Department of Defense guidelines for uncontrolled BP (systolic BP ≥ 140 mm Hg or diastolic BP ≥ 90 mm Hg).¹⁸

New BP Medications at Discharge

We also examined all antihypertensive medications prescribed at admission and at discharge. Antihypertensive medications were classified into 1 of 7 potential categories including (1) thiazide-type diuretics, (2) ACEIs/angiotensin receptor blockers (ARBs), (3) β -blockers, (4) calcium channel blockers, (5) α -adrenergic agents, (6) centrally acting antihypertensive medications, and (7) other diuretics. We compared the discharge list of antihypertensive medication categories with the admission list of antihypertensive medication categories for each patient and determined if they received a new prescription for a drug class at the time of discharge.

BP Control Within 6 Months

Regarding BP control within 6 months of the stroke event, if more than 1 BP was available during the 6-month postdischarge period, we used the last available BP reading during that time frame. According to VHA performance measures addressing hypertension, only outpatient BPs obtained at primary care and selected specialty care clinics were used (online-only Data Supplement). BP measurements taken in the emergency department, ambulatory surgery, urgent care visit, or during an inpatient admission were excluded. Consistent with our definition of BP control, we used a threshold of $<140/90$ mm Hg as controlled for all patients.

Covariates

We determined a priori covariates for inclusion in each model on the basis of clinical significance. These included patient age (18 to 64, 65 to 74, ≥ 75 years old), sex, race (white, black, other), stroke severity measured by the National Institutes of Health (NIH) stroke scale (which was recorded retrospectively when not available) (0 to 2, 3 to 9, and 10+), and multiple measures of comorbidity including the number of preadmission medications, history of cardiovascular

disease or cerebrovascular disease, diabetes, hypertension, hyperlipidemia, and the number of comorbidities at admission. For the models that examined BP control within 6 months after the index event, we also included covariates known to be important in long-term BP control including the systolic and diastolic BP at the time of discharge, the number of visits since hospital discharge, and the type of antihypertensive category prescribed at discharge.

Statistical Analysis

Descriptive analyses such as frequency, mean, standard error, and cross-tabulations were used to describe patient characteristics at the time of hospitalization for ischemic stroke. Because patient BP control was a binary outcome (controlled or uncontrolled), we used logistic regression models. To accommodate the correlation of outcomes for patients from the same facility, we included a random facility effect.

For the analysis examining BP control at discharge, the predictor variables of interest were the presence of multiple comorbidities and diabetes. For the analysis examining BP control within 6 months of discharge, we postulated that receipt of combination thiazide diuretic and an ACE/ARB at discharge would increase the odds of BP control. Patients who left the hospital with uncontrolled BP were considered an important subgroup for the evaluation of BP outcomes within 6 months of follow-up; therefore they were examined separately. We also conducted a sensitivity analysis to determine if addition of a new antihypertensive medication during the index hospitalization was associated with BP control at the 6-month BP measurement. Odds ratios (OR) and 95% confidence intervals (95% CI) are reported. Statistical analyses were conducted using the NL mixed procedure in SAS for Windows version 9.1 (SAS Institute, Cary, NC). This study received institutional review board approval. A Health Insurance Portability and Accountability Act (HIPAA) waiver and waiver of consent were obtained to review medical records of patients, and all information contained in the analytic dataset was considered a limited dataset.

Results

The flow of patients included in each analysis is shown in the Figure. Of the 3987 patients in the inception cohort who were hospitalized for an acute ischemic stroke, we excluded 347

cases (8.7%) for the following reasons: in-hospital death (n=147), missing BP information (n=100), hospice or comfort care (n=78), and unknown disposition or abstraction errors (n=22). Thus, in the first analysis (unadjusted analysis) there were 3640 patients, and another 258 (7.1%) patients were excluded from the adjusted analysis because of missing race data (n=3382 in 129 facilities).

For the second analysis, we excluded 1586 of the 3640 cases (43.6%) for the following reasons: 30-day mortality or readmission (n=439), missing BP information (n=787), and no follow-up visit within 6 months in the VHA system (n=360). Thus, in second analysis of BP control at 6 months (unadjusted analysis) there were 2054 patients, and another 139 patients (6.8%) were excluded from the adjusted analysis because of missing race data (n=1915 patients in 125 facilities).

Characteristics

Patient characteristics are shown in Table 1. Twenty-one percent had no history of hypertension at the time of their stroke. The study population was predominately white (62.7%) and male (97.7%); 46.9% were <65 years of age, and 30.7% were ≥75 years of age; 29% had a history of cerebrovascular disease and 37% had a history of cardiovascular disease. Fifty percent of patients had an NIH stroke scale of 0 to 2, indicating a relatively mild stroke; however, at admission patients had a high burden of comorbid illness. Patients had an average of 3.5 comorbidities and had a mean Charlson comorbidity score of 4.7 (SD, ±2.0). Scores of 0 indicate no diabetes, heart disease, cancer, chronic pulmonary disease, connective tissue disease, cerebrovascular disease, peripheral vascular disease, renal disease, or liver disease; higher scores indicate a greater burden of comorbidity. The mean number of admission medications was 7 (SD, ±5). Two-thirds of the sample (67.5%) was discharged home, and the remainder was discharged to nursing homes or other facilities.

Characteristics of patients excluded from the 6-month BP analysis for missing BP or visits compared with those included are shown in the online-only Data Supplement. Patients who were excluded from the analysis tended to be older and sicker, as evidenced by a higher NIH stroke scale at admission and a lower proportion being discharged to home. More excluded patients were discharged to nursing home facilities.

BP Control and Antihypertensive Medications at Discharge

Among the 3640 patients hospitalized for stroke, 1573 (43%) had the last documented BP before discharge as ≥140/90 mm Hg. In the adjusted analysis (n=3382), black race (adjusted OR, 0.77; 95% CI, 0.65 to 0.91), diabetes (OR, 0.73; 95% CI, 0.62 to 0.86), and history of hypertension (OR, 0.51; 95% CI, 0.42 to 0.63) were associated with decreased odds for controlled BP at hospital discharge. Increased number of admission medications was associated with increased odds of controlled BP (OR, 1.32; 95% CI, 1.08 to 1.60 for 4 to 7 medications; and OR, 1.34; 95% CI, 1.10 to 1.63 for 8 or more medications) compared with those on 0 to 3 medications at admission (Table 2).

The proportions of patients with discharge prescriptions for antihypertensive medications are reported in Table 3. Fifteen percent of patients (n=548/3640) received a discharge prescription for combination ACEI or ARB and a thiazide diuretic. Fifty-four percent of patients were discharged with a prescription for an ACEI/ARB (n=1969 prescriptions). Of these, >25% were new prescriptions for an ACEI/ARB. The second most commonly prescribed antihypertensive at discharge was β -blockers (1737 prescriptions; 47.7%) and 22% were new prescriptions. Calcium channel blockers constituted 928 discharge prescriptions (25.5%), and of these, 20% were new. Thiazide diuretics were 22% of the discharge prescriptions (n=794), and of these, 30% were new prescriptions.

BP Control Within 6 Months of Stroke Hospitalization

There were 2054 patients who had a follow-up BP measurement within 6 months of discharge from the stroke and were eligible for the second analysis. For approximately 30% of this cohort, that follow-up BP measurement was within 3 months of discharge from the index event. Another 37% had a follow-up BP measurement 4 to 5 months after the stroke event and the remaining 32% had their BP measurement obtained at 6 months after the stroke event. Of the 2054 stroke patients seen within 6 months from their index event (analysis 2 cohort), 673 (32.8%) were uncontrolled at their follow-up BP measurement. Results of the multivariable logistic regression model assessing BP control by 6 months are reported in Table 4. By 6 months after the event, the association for decreased odds for controlled BP seen at hospital discharge disappeared among black patients and those with diabetes but remained among those with a history of hypertension. Increasing systolic but not diastolic BP at the time of hospital discharge was associated with decreased odds of BP control within the 6 month follow-up (OR, 0.99; 95% CI, 0.98 to 0.99 for a 1 mm Hg increase in systolic); or, for each 10-point increase in systolic BP >140 mm Hg at discharge, the odds of BP control within 6 months after discharge decreased by 12% (95% CI, 8% to 18%). The prescription for combination ACEI/thiazide diuretic at discharge was not associated with improved odds of BP control at 6 months (OR, 1.20; 95% CI, 0.88 to 1.62).

Subgroup and Sensitivity Analysis

Among the subgroup of patients who were discharged from the hospital with a last documented BP of ≥140/90 mm Hg (n=1573), 885 (56.3%) had a follow-up BP measurement available within 6 months after the stroke event. Among this subgroup of 885 patients, 360 patients (40.7%) remained uncontrolled at their follow-up BP measurement within 6 months of hospital discharge. Patient with diabetes or a history of hypertension had lower odds of BP control compared with those patients without these diseases. Higher systolic or diastolic BP at hospital discharge was also associated with lower odds of BP control (online-only Data Supplement).

We conducted a sensitivity analysis to examine the effect of receiving any new antihypertensive medication at discharge on BP control at the 6-month follow-up time point.

Table 1. Characteristics of Patients Admitted for Ischemic Stroke Stratified by History of Hypertension (Percent Shown Unless Otherwise Indicated)

	Full Cohort (n=3640)	Hypertension History (n=2877, 79%)	No Hypertension History (n=763, 21%)
Sex, %			
Male	97.7	98.0	96.7
Age, y, %			
<65	46.9	45.4	52.4
65–74	22.4	23.8	17.2
75+	30.7	30.8	30.4
Race, %			
White	62.7	61.3	68.0
Black	23.5	24.8	18.4
Other	6.8	6.8	6.4
Missing race	7.1	7.1	7.2
NIH stroke scale, %			
0–2	50.9	50.4	52.8
3–9	40.0	40.5	38.3
10+	9.0	9.1	8.9
Weight available, %	81.0	80.0	84.7
Weight, median (interquartile range)	185 (159–214)	187 (162–217)	174 (149–201)
Current smoker, %	35.9	34.3	42.1
Charlson score, mean±SD	4.7±2.0	4.8±1.9	4.4±2.1
No. of comorbidities at admission, mean±SD	3.5±2.1	3.9±2.0	2.0±1.8
Comorbidities, %			
Cerebrovascular disease*	28.8	31.3	19.1
Cardiovascular disease†	36.8	39.1	27.8
Atrial fibrillation	15.2	16.2	11.5
Diabetes	40.1	44.8	22.4
Hyperlipidemia	48.7	53.8	29.6
Renal disease	1.1	1.2	0.5
Liver disease	2.0	1.9	2.0
HIV	0.8	0.7	1.2
Cancer‡	7.3	7.0	8.7
Pulmonary disease	15.7	15.2	17.4
Use of antipsychotic medication	5.3	5.2	5.8
Depression	16.8	17.0	16.4
Dementia	7.3	7.6	6.2
Peptic ulcer disease	1.6	1.5	2.1
Rheumatologic disorders§	0.5	0.6	0.4
No. of medications at admission, mean±SD	7.1±4.9	7.6±4.8	5.4±4.9
Discharged to home, %	67.5	67.5	67.8

*Cerebrovascular disease includes carotid endarterectomy, carotid stent, ischemic stroke, or transient ischemic attack.

†Cardiovascular disease includes history of coronary artery disease, acute myocardial infarction, coronary artery bypass, percutaneous transluminal coronary angioplasty with or without stent placement, or any history of peripheral vascular disease.

‡Cancer includes any diagnosis of leukemia, lymphoma, or any solid tumor in past 5 years, metastatic tumor, or multiple myeloma.

§Rheumatologic disorders include lupus and any vasculitis.

||Antipsychotics include chlorpromazine, fluphenazine, thioridazine, trifluoroperazine, thiothixene, aripiprazole, clozapine, haloperidol, loxapine, molindone, olanzapine, quetiapine, risperidone, and ziprasidone.

The results of this sensitivity analysis were consistent with the results of the main analysis in that higher discharge systolic BP and presence of hypertension were associated with lower odds of BP control. Among patients with uncontrolled 6-month BP, 248 of 673 (36.8%) patients had a new

drug added compared with 372 of 1381 (26.9%) of those with controlled BP (adjusted OR, 0.69; 95% CI, 0.55 to 0.86). We also examined the rate of postdischarge BP control among those persons with a follow-up BP who were discharged home (n=1637) compared with those with follow-up BPs but

Table 2. Adjusted Odds of Controlled BP (<140/90 mm Hg) at Time of Hospital Discharge Among 3640 Patients Hospitalized for Acute Ischemic Stroke

	BP Uncontrolled (n=1573), %	BP Controlled (n=2067), %	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)
Sex				
Male	97.6	97.9	Ref	Ref
Female	2.4	2.1	0.88 (0.56–1.37)	0.86 (0.53–1.39)
Age, y				
<65	46.2	47.3	Ref	Ref
65–74	23.4	21.6	0.90 (0.76–1.07)	0.86 (0.72–1.03)
75+	30.2	31.1	1.00 (0.86–1.17)	0.88 (0.74–1.04)
Race				
White	64.0	70.0	Ref	Ref
Black	28.6	22.8	0.73 (0.62–0.86)	0.77 (0.65–0.91)
Other	7.4	7.2	0.90 (0.69–1.18)	0.95 (0.72–1.25)
NIH stroke scale				
0–2	53.0	49.3	Ref	Ref
3–9	38.6	41.1	1.15 (1.00–1.32)	1.16 (0.99–1.35)
10+	8.4	9.6	1.24 (0.97–1.58)	1.29 (1.00–1.66)
No. of medications at admission				
0–3	27.0	23.9	Ref	Ref
4–7	30.6	31.9	1.17 (0.98–1.40)	1.32 (1.08–1.60)
8+	42.4	44.2	1.18 (1.00–1.39)	1.34 (1.10–1.63)
No. of comorbidities at admission, mean±SD	3.6±2.0	3.4±2.1	0.98 (0.94–1.01)	1.01 (0.95–1.08)
Comorbidities				
Cerebrovascular disease	29.4	28.2	0.94 (0.81–1.09)	0.90 (0.76–1.08)
Cardiovascular disease	35.2	37.9	1.12 (0.98–1.28)	1.15 (0.94–1.41)
Diabetes	44.0	37.2	0.75 (0.66–0.86)	0.73 (0.62–0.86)
Hypertension	85.0	74.5	0.52 (0.43–0.61)	0.51 (0.42–0.63)
Hyperlipidemia	49.4	48.1	0.95 (0.83–1.08)	1.02 (0.86–1.20)

*The adjusted logistic regression model had 3382 patients; 258 patients were excluded because of missing information on race. The model included sex, age, race, NIH stroke scale, number of preadmission medications, history of cardiovascular disease, cerebrovascular disease, diabetes, hypertension, hyperlipidemia, and the mean centered number of comorbidities at admission with facility as a random effect (n=129).

discharged to nursing homes and other facilities (n=417). Of the 1637 discharged to home 1087 (66.4%) had controlled BP at the 6-month follow-up visit. Of the 417 patients discharged to nursing homes and other facilities, 294 (70.5%) were controlled at the 6-month follow-up visit.

Discussion

The main findings of our study demonstrate that 43% of patients with acute ischemic stroke had their last documented in-hospital BP value as $\geq 140/90$ mm Hg, and 33% remained uncontrolled by 6 months after hospitalization. BP values in

Table 3. Proportion of Antihypertensive Medications Prescribed at Discharge and Proportion That Are New Prescriptions for Antihypertensive Medications

	Discharge Prescriptions (n=3640 Patients), %	History of Hypertension (n=2877), %	No History of Hypertension (n=763), %	New Prescription* for Antihypertensive at Discharge
Combination ACE/ARB + thiazide	548 (15.0)	505 (17.6)	43 (5.6)	197/548=36.0%
Thiazide diuretics	794 (21.8)	710 (24.7)	84 (11.0)	240/794=30.2%
ACEI/ARB	1969 (54.1)	1722 (59.8)	247 (32.4)	498/1969=25.3%
β -blockers	1737 (47.7)	1513 (52.6)	224 (29.4)	378/1737=21.8%
Calcium channel blockers	928 (25.5)	846 (29.4)	82 (10.8)	187/928=20.2%
α -Adrenergic	487 (13.4)	410 (14.2)	77 (10.1)	74/487=15.2%
Centrally acting agents	231 (6.4)	214 (7.4)	17 (2.2)	86/231=37.2%
Other diuretics	579 (15.9)	507 (17.6)	72 (9.4)	88/579=15.2%

Total sum is >100% because some patients received >1 prescription.

*New prescription was determined by comparing the discharge list of medications with the admission list of medications; 2760 patients had at least 1 antihypertensive drug at admission and 2985 patients had at least 1 antihypertensive drug at discharge.

Table 4. Odds of Controlled BP (<140/90 mm Hg) Within 6 Months After Stroke Hospitalization (n=2054 Unadjusted)

	BP Uncontrolled (n=673), %	BP Controlled (n=1381), %	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Sex				
Male	97.4	97.4	Ref	Ref
Female	2.6	2.6	0.97 (0.54–1.74)	0.87 (0.47–1.62)
Age, y				
<65	53.8	49.1	Ref	Ref
65–74	21.6	22.0	1.12 (0.88–1.42)	1.25 (0.96–1.63)
75+	24.6	28.9	1.28 (1.03–1.61)	1.23 (0.95–1.59)
Race*				
White	59.8	69.1	Ref	Ref
Black	30.0	24.2	0.69 (0.55–0.86)	0.84 (0.66–1.06)
Other	10.0	6.8	0.59 (0.41–0.84)	0.63 (0.44–0.91)
No. of comorbidities at admission, mean±SD	3.4±2.0	3.5±2.0	1.03 (0.98–1.08)	1.06 (0.96–1.17)
Comorbidities				
Cerebrovascular disease	24.6	28.0	1.20 (0.97–1.49)	1.16 (0.89–1.50)
Cardiovascular disease	32.6	36.5	1.19 (0.98–1.45)	1.02 (0.76–1.36)
Diabetes	46.2	40.2	0.78 (0.65–0.94)	0.81 (0.64–1.03)
Hypertension	87.0	77.3	0.51 (0.39–0.66)	0.52 (0.38–0.71)
Hyperlipidemia	50.8	54.2	1.15 (0.95–1.38)	1.08 (0.86–1.37)
Systolic BP at discharge, mm Hg, mean±SD	141±22	133±19	0.98 (0.98–0.99)	0.99 (0.98–0.99)
Diastolic BP at discharge, mm Hg, mean±SD	79±14	75±12	0.97 (0.97–0.98)	0.99 (0.98–1.00)
No. of visits after discharge, mean±SD	5.8±4.9	6.2±4.8	1.02 (1.00–1.04)	1.02 (0.99–1.04)
Antihypertensives at discharge				
Thiazide+ACE/ARB	18.2	15.9	0.85 (0.66–1.08)	1.20 (0.88–1.62)
Thiazide	6.4	6.7	1.06 (0.72–1.54)	1.24 (0.80–1.91)
ACE/ARB	40.2	39.8	0.98 (0.81–1.19)	1.09 (0.86–1.39)
β-blockers	52.0	47.6	0.84 (0.70–1.01)	0.90 (0.72–1.11)
CCB	31.6	25.3	0.73 (0.60–0.90)	0.90 (0.72–1.13)
All other classes	33.6	31.0	0.89 (0.73–1.08)	0.89 (0.71–1.11)

*One hundred thirty-nine patients were missing race information; BP uncontrolled n=45 (6.7%) and BP controlled n=94 (6.8%). The resulting adjusted logistic model had 1915 patients and included the variables sex, age, race, history of cardiovascular disease, cerebrovascular disease, diabetes, hypertension, hyperlipidemia, number of comorbidities at admission, systolic and diastolic BP at discharge, number of visits since hospital discharge, and class of antihypertensive drugs prescribed at discharge. Facility was a random effect (n=125).

excess of national guidelines are common,^{19,20} particularly after stroke.^{7,21–23} After adjustment for age, sex, and other confounders that might influence a patient's BP, the probability of being controlled remained significantly lower for patients with a history of diabetes and/or hypertension. These data suggest that increased efforts to improve hypertension management at discharge and follow-up may be beneficial to certain subgroups of patients. BP is the most consistent and powerful predictor of stroke, such that hypertension is causally involved in nearly 70% of all stroke cases.²⁴ Veterans with uncontrolled hypertension are vulnerable to cardiovascular events and are at a particularly high risk for a recurrent or secondary cerebrovascular event.

The second finding of our study is that only 15% of patients received the antihypertensive combination of ACEI/ARB and thiazide diuretics. There is a large body of evidence that has demonstrated the beneficial effects of BP control in

secondary stroke prevention, even among those without a history of hypertension. A meta-analysis of clinical trials noted a risk reduction of 28% (95% CI, 15% to 39%) for any recurrent stroke with antihypertensive treatment among those who have previously had a stroke.²⁵ High BP is a powerful risk factor for recurrent stroke among stroke survivors. The PROGRESS trial of poststroke patients demonstrated that therapy with a diuretic and ACEI lowered BP by 12/5 mm Hg and reduced recurrence of stroke by 43% among those randomly assigned to perindopril and indapamide therapy (absolute risk reduction, 0.9% per year).³ We postulated that the prescription of both combination ACEI/ARB and thiazide diuretic at discharge would more often lead to BP control by 6 months; however, our data did not confirm this hypothesis. Moreover, none of the medication classes we investigated or receipt of a new BP medication at discharge were associated with improved BP control at 6 months. We also found that the

receipt of a new BP medication was associated with decreased odds of BP control at 6 months. This finding may be due to confounders in that sicker patients may be more likely to receive new medication prescriptions and are more likely to have the outcome of interest (poor BP control). A more recent meta-analysis suggested that the reduction in stroke risk is related to the magnitude of BP reduction,¹ although a J-shaped phenomena has been suggested within the literature.^{26,27} Any of the commonly used antihypertensive medications have the potential to reduce the risk of stroke through reductions in BP.²⁸ The key is not which agent to use but to use an agent and to treat to goal. Our findings did confirm that the higher the discharge BP, the lower the odds of BP control within 6 months after discharge.

There are limitations to our study because of its retrospective design. First, the population that we studied was predominantly male veterans who were admitted with ischemic stroke and may not be representative of hypertension management in poststroke patients in the private sector. However, hypertension management in the private sector has often been described as suboptimal, with the VHA being held as a gold standard for quality care.^{29–36} Another limitation is the use of a single BP measurement in the determination of BP control both at discharge and at 6 months. In 2004, Tierney et al³⁷ set out to determine the predictive ability of a single outpatient BP measurement on the 5-year risk of myocardial infarction, stroke, ischemic heart disease, heart failure, renal insufficiency, and death from any cause. These investigators found that for each 10-mm Hg increase in systolic BP at a single outpatient visit, there was a 10% (95% CI, 2% to 18%) increase in the 5-year risk of having a first myocardial infarction, 7% (95% CI, 3% to 11%) increased risk of first or recurrent stroke, 9% (95% CI, 3% to 15%) increased risk of ischemic heart disease, and 13% (95% CI, 6% to 21%) increased risk of developing renal insufficiency. Our results demonstrate that by using a single outpatient measurement of BP, almost 33% of patients have uncontrolled BP by 6 months after the event. We were also relatively limited in the sample size for this 6-month follow-up analysis. We required that patients have at least 1 postevent BP available in an outpatient clinic and remain alive after their event. It is possible that patients who were well controlled, or, conversely, had severe disease, did not have an outpatient visit (or were treated by a provider in the private sector) and therefore did not have a recorded BP. The comparison of those included to those missing BP or outpatient visits demonstrated that those with missing BP values were significantly older and sicker with more severe strokes, and fewer were discharged home (online-only Data Supplement). The rate of postdischarge BP control was very similar for persons with a follow-up BP who were discharged home compared with those with follow-up BPs but discharged to nursing homes and other facilities. Because the postdischarge sample consisted largely of persons with milder strokes and those discharged home, our results may be more generalizable to this patient population. It is also possible that patients received their antihypertensive care outside the VHA. Additionally, on the basis of our data, we are unable to determine which BP medications people had been taking before stroke

hospitalization and found ineffective. Nor could we examine how effectively BP had been controlled in the outpatient setting before the stroke. Finally, the medications that we analyzed are currently limited to the medications prescribed at discharge. Currently we do not have access to the pharmacy benefits data for the time subsequent to discharge to investigate if these antihypertensive medications were filled, refilled, or actually taken after discharge. Medication adherence to the prescribed antihypertensive regimen after the stroke event may remain a barrier to achieving BP control among stroke patients because of the newly acquired cognitive, communicative, and physical limitations that may prevent patients from refilling their medications after the stroke.

In conclusion, we describe the quality of hypertension care among patients who have been hospitalized for an acute ischemic stroke. We propose that secondary prevention should include efforts to initiate risk factor control and antihypertensive medication initiation before hospital discharge. In-hospital initiation of secondary prevention strategies has become the standard of care for patients with cardiovascular disease.^{38,39} Future interventions could also target those at highest risk for poorly controlled BP, including those with a prior diagnosis of hypertension and multiple comorbidities including diabetes. The quality of care for patients with cerebrovascular events could be beneficially affected through the systematic in-hospital initiation of secondary prevention strategies, thus enhancing guideline adherence and improving the care among those at highest risk for a vascular event.

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