Blood Pressure Exceeding National Guidelines Among
Women After Stroke

Walter N. Kernan, MD; Catherine M. Viscoli, PhD; Lawrence M. Brass, MD;
Robert W. Makuch, PhD; Philip M. Sarrel, MD; Ralph I. Horwitz, MD

Background and Purpose—After a transient ischemic attack or stroke, the risk for recurrence may be reduced by treatment
of hypertension. The purpose of this study was to determine how commonly blood pressure exceeds national guidelines
among patients who have had one of these events.

Methods—Subjects were 644 women participating in a randomized trial of estrogen for secondary stroke prevention. We
measured blood pressure 1 month after the stroke or TIA while patients were under the care of their personal physicians.
Among 536 patients, a second measure was made at an average of 2.9 years after the first.

Results—The mean age of participants was 71 years, and 73% reported a history of hypertension. At baseline, only 44%
(280/644) of the women had blood pressure values within national guidelines (≤140/90 mm Hg). With separate
guidelines used for diabetics (≤130/85 mm Hg) and nondiabetics (≤140/90 mm Hg), the proportions of women within
the guidelines were 27% and 44%, respectively. Overall, 39% of patients were within the diabetes-adjusted guidelines.
Among patients whose blood pressure exceeded 140/90 mm Hg at first examination, 55% were still in excess at
follow-up. Features associated with severe hypertension at first examination (≥160/100 mm Hg) were history of
hypertension, education less than college, and higher cognitive functioning.

Conclusions—Blood pressure values in excess of national guidelines are common after stroke and TIA, especially among
diabetic patients. Efforts to lower blood pressure control may enhance secondary prevention. (Stroke. 2000;31:415-419.)

Key Words: cerebrovascular disorders ■ hypertension ■ adherence ■ prognosis ■ randomized clinical trials ■ health services research

Hypertension is the most important remediable risk factor for
stroke. Lowering diastolic blood pressure (DBP) by 5 to
6 mm Hg reduces the odds of any (fatal or nonfatal) stroke by
42% after only 2 to 3 years. A similar magnitude of stroke
reduction has been observed for isolated systolic hypertension
for men and women ≥60 years old. On the basis of these
cumulative data, The Joint National Committee on Prevention,
Detection, Evaluation, and Treatment of High Blood Pressure
(JNC) recommends that all persons have their blood pressure
measured regularly to achieve and maintain a systolic blood
pressure (SBP) <140 mm Hg and a DBP <90 mm Hg and
lower if tolerated.

Research has demonstrated that many hypertensive patients
do not achieve the goals advocated by the JNC. In a cohort of
800 hypertensive veterans attending an outpatient clinic, for
example, only 60% achieved a blood pressure ≤160/90 mm Hg.
In the 1988 to 1991 National Health and Nutrition Examination
Survey, only 24% of patients with a diagnosis of hypertension
achieved a value of <140/90 mm Hg. Research on the reasons
for nonachievement of treatment goals has called attention to
patient factors (eg, medication adherence),
physician factors (eg, failure to make timely medication changes), and system
factors (eg, lack of health insurance).

Because stroke patients are at high risk for vascular
morbidity and mortality, achievement of treatment goals may
be particularly important. The research on achievement of
hypertension treatment goals, however, has included primarily
patients who are free of manifest vascular disease. The
few studies among patients with cerebrovascular disease
involve small cohorts or preliminary communications. To
closely examine hypertension treatment after stroke among a
large population, we examined the achievement of hyperten-
sion treatment goals among 644 postmenopausal women who
had had a recent TIA or nondisabling ischemic stroke.

Subjects and Methods

Subjects and Data Collection

Eligible subjects included all women participating in the Women’s
Estrogen for Stroke Trial (WEST), including those assigned to either
active or placebo treatment, for whom a baseline right arm blood pressure was available. The design of the WEST has been published in detail. The WEST is an ongoing trial with the primary aim of determining whether 1 mg of 17β-estradiol, compared with placebo, can reduce the risk of recurrent stroke or death among postmenopausal women who have experienced a recent TIA or nondisabling ischemic stroke. Eligible women were recruited from hospitals and medical practices in Connecticut and Massachusetts. Subjects were required to be >44 years of age, postmenopausal, not on estrogen at the time of their stroke, and free of breast or uterine cancer. In addition, they must have had an expected survival of at least 3 years. Before randomization, blood pressure was measured by registered nurses using aneroid manometers. Measurements were always made with patients sitting after 5 minutes of quiet rest. Two readings were recorded from each arm, but no specific protocol dictated the order in which readings were made or the interval between readings. Systole was defined by the appearance of the first Korotkoff sound and diastole by the disappearance of the fifth.

WEST participants received all medical care from their personal physicians, including treatment for hypertension. In early communications, WEST investigators informed personal physicians of the baseline, prerandomization blood pressure readings for their patients, encouraged treatment to the JNC guidelines, and provided reference guidelines. By the WEST protocol, follow-up blood pressure readings were taken at 2 weeks and at 6 months, and repeated every 6 months thereafter. The mean of the last two visits during the follow-up period was used.

Baseline Characteristics

Among 652 women in the WEST, 644 with a baseline right arm blood pressure composed the cohort for this study. Baseline characteristics of participants are shown in Table 1. The average age was 71 years. Among all participants, 84% were white and 16% were minorities. The qualifying event was a stroke for 74% and TIA for 26%. Comorbid conditions were common, including diabetes for 32%, prior stroke for 19%, and prior myocardial infarction for 27%. A history of hypertension was reported by 74% of patients, among whom 84% were on treatment. In the entire cohort, 71% of patients were on hypertension medication.

Data Analysis

For the primary analysis in this report, our purpose was to describe the distribution of SBP and DBP values among WEST participants ~1 month after their stroke. For DBP, the described categories are ~79, 80 to 84, 85 to 89, 90 to 99, and ~100 mm Hg. For SBP, the described categories are 129, 130 to 139, 140 to 159, 160 to 180, and ~180 mm Hg. WEST patients were classified into blood pressure categories on the basis of the mean of paired readings from the right arm. Because some guidelines suggest the use of readings from the arm with the highest mean systolic value, we conducted a separate analysis with this criterion.

To provide a summary estimate of blood pressure control that accounts for both DBP and SBP, in a separate analysis we grouped patients according to JNC categories. Although these categories were developed to classify blood pressure for adults who are not on antihypertensive treatment, we believe they provide a familiar and convenient means to describe severity among treated patients. In the JNC schema, normal is defined as SBP <120 mm Hg and DBP <80 mm Hg. High-normal is defined as SBP 130 to 139 mm Hg or DBP 85 to 89 mm Hg. Stage 1 hypertension is SBP 140 to 159 or DBP 90 to 99, stage 2 is SBP 160 to 179 or DBP 100 to 109, and stage 3 is SBP ≥180 or DBP ≥110. When SBP and DBP fall into different categories, the higher category is selected.

The basic recommendation of JNC-VI is for all patients to achieve a DBP <90 mm Hg and an SBP <140 mm Hg. We calculated the proportion of our patients who were within this guideline. Because guidelines commonly recommend different blood pressure treatment goals for diabetics (<130/85) than for nondiabetics (<140/90), we also calculated the proportion of patients within these guidelines.

To identify clinical features of patients at risk for moderately or severely elevated blood pressure after TIA or ischemic stroke (ie, SBP ≥160 or DBP ≥100), we calculated odds ratios for 12 candidate features. Impaired mental status was defined as a score of <24 on the Folstein Mini-Mental State Examination. Impaired physical functioning was defined as a score <23 points on the Physical Performance Test. Obesity was defined as a body mass index [weight in kg/height in meters squared] >27. Depression was defined by a score of >16 on the 20-item Center for Epidemiologic Studies Depression Scale (CES-D).

Results

Baseline Characteristics

Among 652 women in the WEST, 644 with a baseline right arm blood pressure composed the cohort for this study. Baseline characteristics of participants are shown in Table 1. The average age was 71 years. Among all participants, 84% were white and 16% were minorities. The qualifying event was a stroke for 74% and TIA for 26%. Comorbid conditions were common, including diabetes for 32%, prior stroke for 19%, and prior myocardial infarction for 27%. A history of hypertension was reported by 74% of patients, among whom 84% were on treatment. In the entire cohort, 71% of patients were on hypertension medication.

Blood Pressure in Excess of National Guidelines

As shown in the Figure, DBP was ~79 mm Hg for 398 patients (62%), 80 to 84 mm Hg for 116 (18%), 85 to 89 mm Hg for 49 (7%), 90 to 99 mm Hg for 62 (10%), and ~100 mm Hg for 19 (3%). SBP was ~129 mm Hg for 179 patients (28%), 130 to 139 mm Hg for 109 (17%), 140 to 159 mm Hg for 232 (36%), 160 to 179 mm Hg for 90 (14%), and ~180 mm Hg for 34 (5%). The mean time from entry TIA or stroke to blood pressure assessment was 37 days.

As a summary measure of blood pressure status taking account of both SBP and DBP, we calculated the proportion of patients for whom the DBP and SBP were within specific boundaries recommended by the JNC-VI (ie, DBP <90 mm Hg and SBP <140 mm Hg). Only 44% (280/644) of the patients were within this boundary. Using blood pressure
TABLE 1. Baseline Features of 644 Participants in the WEST

<table>
<thead>
<tr>
<th>Age, y</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>45–70</td>
<td>278</td>
<td>43</td>
</tr>
<tr>
<td>71–&gt;80</td>
<td>366</td>
<td>57</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>538</td>
<td>83</td>
</tr>
<tr>
<td>Black</td>
<td>80</td>
<td>12</td>
</tr>
<tr>
<td>Hispanic</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Qualifying event</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonocular TIA</td>
<td>155</td>
<td>24</td>
</tr>
<tr>
<td>Amaurosis fugax</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Stroke</td>
<td>478</td>
<td>74</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>208</td>
<td>32</td>
</tr>
<tr>
<td>Cigarette smoking (ever)</td>
<td>403</td>
<td>63</td>
</tr>
<tr>
<td>Prior stroke</td>
<td>119</td>
<td>19</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>39</td>
<td>7</td>
</tr>
<tr>
<td>History of hypertension</td>
<td>472</td>
<td>74</td>
</tr>
<tr>
<td>History of hypercholesterolemia</td>
<td>304</td>
<td>47</td>
</tr>
<tr>
<td>History of myocardial infarction</td>
<td>146</td>
<td>27</td>
</tr>
</tbody>
</table>

readings from the arm with the highest pressure, 38% (246/644) were within the boundary. The proportion of patients within JNC-VI guidelines (<140/90) differed among patients with and without a history of hypertension. For patients who gave a self-report of hypertension on admission to the WEST, the proportion within the guidelines was 36% (171/472). For patients without a history of hypertension, the proportion was 63% (107/170).

Because JNC5 and American Diabetes Association15 guidelines recommend lower blood pressure target values for diabetic patients than for nondiabetic patients, we calculated the proportion of patients at these separate targets. Among 208 diabetic patients, we defined the target blood pressure according to American Diabetic Association Guidelines of SBP ≤130 mm Hg and DBP ≤85 mHg. Among 436 nondiabetic patients, we defined the target blood pressure according to the JNC-VI guidelines of SBP <140 mm Hg and a DBP <90 mm Hg. The proportion of diabetic patients with blood pressure <130/85 was 27% (57/208), and the proportion of nondiabetics with blood pressure <140/90 was 44% (192/436). Among both diabetics and nondiabetics, only 39% (249/644) were within treatment targets according to the separate criteria. When patients with and without a history of hypertension were compared by the diabetes-adjusted analysis, the proportions of patients at target blood pressure were 32% (149/472) and 58% (98/170), respectively.

TABLE 2. Association Between Selected Clinical Features and Moderately or Severely Elevated Blood Pressure (Systolic ≥160 mm Hg or Diastolic ≥100 mm Hg) After TIA or Ischemic Stroke

<table>
<thead>
<tr>
<th>Feature</th>
<th>n</th>
<th>Unadjusted 95% CI</th>
<th>Adjusted 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of hypertension*</td>
<td>472</td>
<td>3.4 (1.9–5.9)</td>
<td>3.3</td>
</tr>
<tr>
<td>Renal disease*</td>
<td>27</td>
<td>1.7 (0.7–3.9)</td>
<td>1.3</td>
</tr>
<tr>
<td>Education less than college*</td>
<td>457</td>
<td>1.5 (1.0–2.4)</td>
<td>1.6</td>
</tr>
<tr>
<td>Married</td>
<td>261</td>
<td>1.1 (0.8–1.7)</td>
<td>...</td>
</tr>
<tr>
<td>Daily alcohol use</td>
<td>49</td>
<td>1.1 (0.6–2.3)</td>
<td>...</td>
</tr>
<tr>
<td>Diabetes</td>
<td>208</td>
<td>1.1 (0.8–1.7)</td>
<td>...</td>
</tr>
<tr>
<td>Age &gt;75 y</td>
<td>245</td>
<td>1.0 (0.7–1.5)</td>
<td>...</td>
</tr>
<tr>
<td>Impaired physical functioning</td>
<td>494</td>
<td>1.0 (0.6–1.5)</td>
<td>...</td>
</tr>
<tr>
<td>Obesity</td>
<td>305</td>
<td>0.9 (0.7–1.4)</td>
<td>...</td>
</tr>
<tr>
<td>Depression</td>
<td>204</td>
<td>0.9 (0.6–1.4)</td>
<td>...</td>
</tr>
<tr>
<td>Black ethnicity</td>
<td>80</td>
<td>0.8 (0.4–1.5)</td>
<td>...</td>
</tr>
<tr>
<td>Current cigarette use</td>
<td>80</td>
<td>0.7 (0.4–1.4)</td>
<td>...</td>
</tr>
<tr>
<td>Impaired mental status*</td>
<td>86</td>
<td>0.4 (0.2–0.8)</td>
<td>0.4</td>
</tr>
</tbody>
</table>

*Features in bold type were selected for inclusion in a logistic regression model (to yield adjusted ORs) because the unadjusted OR was ≥1.4 or <0.7.

Predictors of Markedly Elevated Blood Pressure
In univariate analysis, 4 clinical features were associated (RR >1.4 or <0.7) with SBP ≥160 mm Hg or DBP ≥100 mm Hg: history of hypertension, education less than college, renal disease, or impaired cognition. In a logistic regression model including these 4 features, only history of hypertension, education less than college, and impaired mental status remained important (95% CIs exclude 1). Hypertension and low education increased risk for uncontrolled blood pressure, but impaired mental status protected against it.

Temporal Stability of Blood Pressure
Follow-up blood pressure measurements were available for 536 WEST patients at a mean of 2.9 years from study entry (range, 11 to 2015 days). Measurements were not available for 108 because of death (n = 85), refusal (n = 2), or technical reasons (n = 5). Mean DBP did not change for the group defined by baseline DBP ≤79 mm Hg (n = 318) but fell by 9, 12, 12, and 21 mm Hg in groups defined by baseline DBPs of 80 to 84 (n = 104), 85 to 89 (n = 38), 90 to 99 (n = 52), and ≥100 mm Hg (n = 16), respectively. Compared with the baseline mean SBP, the follow-up mean pressure rose by 10 mm Hg for the ≤129 group (n = 150) but fell by 4, 8, 22, and 47 in all other groups defined by baseline SBPs of 130 to 139 (n = 93), 140 to 159 (n = 190), 160 to 179 (n = 78), and ≥180 mm Hg (n = 25). Mean DBP for the entire group of 536 patients fell from 75 to 70 mm Hg. Mean SBP fell from 142 to 135 mm Hg.

Among the 536 patients for whom follow-up pressure values were available, 44% (235/536) had a baseline blood pressure value ≤140/90 compared with 55% (297/536) at follow-up. Among those with a blood pressure value <140/90 at baseline, 69% (165/235) were still within this limit at follow-up. Among those who were ≥140/90 at baseline, 55% (166/301) were still ≥140/90 at follow-up.
Discussion

Our findings indicate that blood pressure in excess of customary guidelines (<140/90) is common 1 month after stroke or TIA. Patients with an elevated pressure at 1 month, furthermore, commonly continue to have an elevation at 3 years.

To identify clinical characteristics of patients with moderately or severely elevated blood pressure (SBP ≥160 mm Hg or DBP ≥100 mm Hg), we performed an analysis that revealed associations with a history of hypertension, lower educational attainment, and higher Mini-Mental Status Score. The association of elevated pressure with hypertension history makes obvious sense. The association of elevated pressure with lower educational attainment may plausibly be related to access to care or health awareness. The association of elevated pressure with higher cognitive functioning is harder to explain and requires validation in another cohort.

A surprising finding was that among patients with no history of hypertension at baseline, only 64% had a blood pressure <140/90. Although it is plausible that our baseline measurement overestimated patients’ true blood pressure, this seems unlikely, because measurement error in sphygmomanometry usually leads to underestimation. It is also unlikely that our baseline measurements were elevated because of recent stroke. Although blood pressure is increased in the setting of acute stroke, the effect is transitory and resolves within a few days. We believe it is more likely that many of these patients had undiagnosed hypertension. This interpretation is consistent with findings from NHANES III that 31% of patients with hypertension are unaware of their diagnosis. In all cases, we notified personal physicians of our findings.

The problem of blood pressure in excess of conventional treatment goals after stroke has received little attention in the medical literature. In fact, we are aware of only 2 reports involving a US cohort. Schneck and colleagues reported that 27% of treated hypertensive patients in the African-American Anti-Platelet Stroke Study have SBP >160 mm Hg or DBP >100 mm Hg. Joseph and colleagues reported that >50% of stroke patients attending a stroke clinic had blood pressures exceeding JNC guidelines of 140/90 mm Hg. In each of these reports, hypertension was only 1 of several risk factors examined. To the best of our knowledge, ours is the first original report to focus exclusively on blood pressure in a US cohort.

The paucity of literature on hypertension control after stroke is surprising, because clues to the magnitude of the problem have existed in incidental data from clinical trials and observational studies. In the European Atrial Fibrillation Trial, for example, 76 of 375 patients (20%) in the placebo group had an SBP >160 mm Hg. In the UK TIA Aspirin Trial, 1327 of 2435 patients (54%) had a sustained SBP ≥150 mm Hg during follow-up over several years. (A. Rodgers, MD, personal communication, May 26, 1998).

The lack of attention to hypertension control after stroke may reflect skepticism on the part of physicians and policy makers that improved blood pressure control is feasible or effective for secondary prevention of stroke. One reason for this skepticism may be the paucity of evidence that hypertension adversely affects prognosis after or that treatment among stroke patients is beneficial. Observational studies relating a single blood pressure measurement or serial measures to risk of recurrence have produced inconsistent findings. Clinical trials have predominantly supported the hypothesis of a treatment effect, but only 3 exist. Two detected a treatment benefit, and 1 did not. A recent meta-analysis of 6752 stroke patients in 9 trials (including the 3 dedicated randomized clinical trials described above) found that active treatment reduced the incidence of recurrent stroke by 28%. Despite the absence of complete and consistent data that hypertension therapy after stroke reduces recurrence or mortality, experts commonly recommend treatment. Our findings demonstrate that patients are not achieving these stroke-specific recommendations or the more generally applied recommendation of the JNC. We are particularly concerned about the rate of blood pressure in excess of guidelines among diabetic patients, whose risk for recurrent stroke, cardiac events, and death is twice that of nondiabetic patients. Improved hypertension control for diabetics may substantially reduce morbidity and mortality.

Our findings add to the growing literature showing undertreatment of vascular risk factors among patients with symptomatic vascular disease. For patients with heart disease, for example, researchers have detected underuse of β-blockers, aspirin, anticoagulation, and cholesterol-reducing medications. Detection of a high rate of blood pressure in excess of national guidelines among stroke patients raises the possibility that efforts to reduce blood pressure may lower rates of recurrent stroke and other vascular events.

Acknowledgment

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