White-Coat Hypertension and Carotid Artery Atherosclerosis

A Matching Study

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Background: Blood pressure (BP) measurements obtained in the clinic have long served as the basis for determining risk of hypertensive vascular disease, yet many patients with high BP in the physician’s office are normotensive elsewhere. It remains unclear whether such patients with “white coat” hypertension elude the risk of atherosclerosis.

Methods: Community residents 40 to 70 years of age and not receiving any cardiovascular medications were recruited to participate in a study of cardiovascular risk factors. On the basis of clinic and daytime ambulatory BP and a threshold criterion of 140/90 mm Hg, subjects were classified as having persistent hypertension, white-coat hypertension, or persistent normotension. One-to-one matching was conducted in male participants on the basis of race and BP. Subjects with persistent hypertension and white-coat hypertension were matched on clinic BP, and those with white-coat hypertension and normotension were matched on daytime ambulatory BP.

Results: The 3 matched groups of men (n=40 in each group) were similar in age, smoking status, and fasting glucose and lipid levels. Compared with the normotensive subjects, subjects with either persistent or white-coat hypertension had greater mean body mass index, waist-hip ratio, and fasting insulin concentration. On the basis of standardized duplex ultrasound examination of the carotid arteries, mean maximal intimal-medial thickness and plaque index in subjects with white-coat hypertension were greater than among normotensive subjects and equal to that of the subjects with persistent hypertension.

Conclusion: When compared with unmedicated individuals with comparable elevations in clinic BP, individuals with white-coat hypertension appear not to be protected from the atherosclerotic sequelae of hypertension.

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Physicians and, increasingly, the public are widely aware of the propensity of some persons to manifest hypertension in the office yet have normal blood pressure (BP) elsewhere. Labeled as exhibiting “white-coat hypertension,” such individuals do not necessarily report anxiety surrounding clinic visits or during normal daily activities.1 Nonetheless, such situational BP elevations are generally understood to represent classic stress responses. In any case, physicians still struggle to understand the importance of white-coat hypertension and remain uncertain as to the best measure of BP to (1) establish a patient’s risk for stroke, heart attack, congestive heart failure, and hypertensive renal disease and (2) guide antihypertensive treatment. Are high office readings in such patients diagnostic errors, or are individuals with white-coat hypertension at elevated risk for vascular disease events?

Noninvasive measures of subclinical vascular disease have been used by several investigators seeking to determine the importance of white-coat hypertension. Echocardiography is considered to be informative because left ventricular hypertrophy predicts coronary events independently of BP levels. Among studies of white-coat hypertension, most,2-6 though not all,7,8 have found abnormalities on echocardiograms, typically, increased left ventricular mass. Two of these investigations provide evidence that the magnitude of the white-coat effect—rise in BP in the clinical setting—is associated with increasing left ventricular mass,3,5 although individuals with white-coat hypertension have somewhat lower left ventricular relative wall thickness and calculated mass than those with persistent hypertension.6 Together, this evidence suggests that subjects with white-coat hypertension have cardiac morphological indexes that are intermediate between those...
SUBJECTS AND METHODS

Subjects in this investigation were recruited by mass mailings inviting them to participate in the Reactivity and Cardiovascular Risk Trial, a study of cardiovascular risk factors in normotensive adults and persons with untreated (or minimally treated) hypertension. All subjects were 40- to 70-year-old residents of Allegheny County in southwestern Pennsylvania. Subjects were excluded if they received a cardiovascular medication at any time during the past 2 months. (No individual had his or her treatment suspended for this study.) Subjects were also excluded if they had received notable previous antihypertensive treatment. This was defined as drug therapy for more than 1 year during the past 5 years or greater than 2 years during their lifetime. (Median duration of treatment across all subjects was less than 1 month.) Other exclusion criteria included angina pectoris, myocardial infarction or angioplasty in the past 12 months, congestive heart failure, valvular heart disease, atrial fibrillation, renal insufficiency (serum creatinine level, >177 µmol/L [>2 mg/dL]), suspected secondary hypertension, stroke or other neurological disorders, or cancer. Subjects were also excluded if they had undergone coronary bypass, carotid, or peripheral vascular surgery, or if they had received any glucocorticoid or psychotropic medications. Diabetics were excluded if they reported neuropathy, were receiving insulin, or were found to have a fasting serum glucose level greater than 11 mmol/L (200 mg/dL). Written informed consent was obtained from all subjects, as approved by the University of Pittsburgh Biomedical Institutional Review Board, Pittsburgh, Pa. Individuals found to have hypertension were advised verbally and by letter to seek medical care for their high BP.

Individuals attended 2 screening appointments at which 3 BP measurements were taken in the right arm, with the subject in the seated position with the arm supported, by means of the appropriate-size cuff. Radial pulse was counted for 30 seconds to determine resting heart rate. The second and third BP readings at each of the visits were averaged. Subjects also underwent 24-hour ambulatory BP monitoring. Specifically, a monitor (Accutracker; Suntech, Raleigh, NC) was applied to the nondominant arm between the hours of 8 and 11 AM and removed at the same time on the following day. The BP was automatically recorded every 30 minutes between 7 AM and 11 PM, and hourly at night. Subjects were instructed to keep their arm as still as possible during inflations to avoid artifacts. Daytime ambulatory BP was determined as the average of BP readings recorded between the hours of 7 AM and 11 PM.

Subjects were considered to have hypertension if they had elevated systolic BP ($\geq$140 and $\leq$180 mm Hg) and/or elevated diastolic BP ($\geq$90 and $\leq$120 mm Hg) on both screening visits. Among hypertensive subjects, those with elevated daytime ambulatory BP (systolic BP $\geq$140 mm Hg and/or diastolic BP $\geq$90 mm Hg) were classified as having persistent hypertension. Hypertensive subjects with normal daytime ambulatory BP (systolic BP <140 mm Hg and diastolic BP <90 mm Hg) were labeled as having white-coat hypertension. Participants whose office BP readings were less than 140/90 mm Hg on both screening visits and whose daytime ambulatory BP was less than 140/90 mm Hg were designated as having normotension.

Matching was carried out from a total pool of 398 male participants to identify subjects equivalent in race, and either office or daytime ambulatory BP, to strengthen planned group comparisons of carotid artery morphological characteristics and plaque. It was necessary to limit this analysis to men because of the small number of hypertensive women in the investigation (n=36). Matching was based on mean BP, which was calculated as diastolic BP plus one third of the pulse pressure. For each individual with white-coat hypertension, a same-race individual with persistent hypertension was identified who had identical or very similar clinic mean BP (within 3 mm Hg). These same subjects with white-coat hypertension were then matched with normotensive participants on the basis of race and mean daytime ambulatory BP (within 3 mm Hg). Thus, the 2 hypertensive groups were matched on office BP but differed on ambulatory BP, and the subjects with white-coat hypertension and normotension were matched on ambulatory BP but differed substantially on office BP. A total of 40 individuals (25 whites and 15 blacks) in each of the 3 subject groups were successfully matched.

CAROTID DOPPLER SCANNING

Trained readers measured the average IMT across 1-cm segments of the near and far walls of the distal common carotid
artery and the far wall of the carotid bulb and the internal carotid artery on both the right and left sides. Measures from each location were then averaged to produce an overall measure of mean IMT. Maximum IMT was calculated as the average of the maximum IMT measures at each location. We used a modified computerized reading program developed for the Cardiovascular Health Study.7

Readers also scored the ultrasound images for plaque in the proximal carotid artery and the external carotid artery. Plaque was defined as a distinct area of hypercholesterogeneity and/or a focal protrusion into the lumen of the vessel. The plaque index, a measure of focal plaque, was created on the basis of the size and number of the plaques at each location. The plaque index has been used as a measure of focal plaque for a number of years and has been found to be a valid and reproducible measure of carotid atherosclerosis in several populations.18 For each segment, the degree of plaque was graded as follows: 0, no plaque; 1, 1 small plaque less than 30% of vessel diameter; 2, 1 medium plaque 30% to 50% of the vessel diameter or multiple small plaques; and 3, 1 large plaque greater than 50% of the vessel diameter or multiple plaques with at least 1 medium plaque. To evaluate reproducibility of the carotid measures in the parent investigation, 15 participants had carotid scans performed by 2 sonographers on 2 occasions approximately 2 weeks apart. Each scan was then read by 2 readers. When all sources of variation were accounted for, the intraclass correlation for average IMT was 0.88 and the intraclass correlation for the plaque index was 0.93.

**BLOOD AND URINE MEASURES**

Levels of fasting serum total cholesterol, high-density lipoprotein cholesterol, and triglycerides were determined by the Heinz Nutrition Laboratory, Department of Epidemiology, University of Pittsburgh Graduate School of Public Health, which has met the criteria of the Centers for Disease Control and Prevention–National Heart, Lung, and Blood Institute Lipid Standardization Program since 1982. Low-density lipoprotein cholesterol level was calculated by means of the Friedewald equation. Fasting serum glucose was oxidized to form gluconate and hydrogen peroxide, then reacted with dye precursors catalyzed by peroxidase, which were detected with standard colorimetry at 540 nm. Insulin concentration was measured in duplicate with a radioimmunoassay with iodine 125 (Code-a-COUNT; Diagnostic Products, Inc, Los Angeles, Calif). An estimate of insulin resistance was calculated on the basis of the homeostasis model assessment as follows: insulin resistance = [serum insulin (in microunits per milliliter) \( \times \) fasting blood glucose (in millimoles per liter)]/22.5.19,20

Urinary catecholamine levels were determined by high-performance liquid chromatography with electrochemical detection (reverse phase, 5-µm column; Biophase ODS Bioanalytic Systems Inc, West Lafayette, Ind). Peak catechol heights were measured by liquid chromatography (ChromGraph; Bioanalytic Systems, Inc) and compared with standards pretested for high-performance liquid chromatography purity (Bioanalytic Systems, Inc). The interassay coefficients of variation are 2.2% for norepinephrine and 3.7% for epinephrine.

**DATA ANALYSES**

Data on each variable were available for at least 117 of the 120 subjects (>97% complete) with the exception of low-density lipoprotein cholesterol (missing in 6 subjects because hypertriglyceridemia precluded calculation of low-density lipoprotein cholesterol level). On the basis of the construction of groups matched for sex, race, and BP, statistical analyses for paired observations were used. For continuously distributed variables, paired t tests were used, and the Wilcoxon signed rank test was used for categorical or nominal data. In each case, parallel analyses compared the normotensive and white-coat hypertensive groups, and the white-coat hypertensive and persistent hypertensive groups.

Initial analyses were performed on the BP data to verify that the matching procedure was successful. Next, the groups were compared with respect to other variables known to influence BP, atherosclerosis, or both. Finally, the data generated from the carotid duplex scanning were analyzed. Plaque grades were summed across right and left carotid arteries to create an overall measure of extent of focal plaque, and subjects were categorized into 3 groups: no plaque, total plaque score of 1 to 2, and plaque score of 3 or more. An α level of .05 was used for all statistical analyses.

coat hypertension was matched with a person with persistent hypertension on mean clinic BP, and with a normotensive control subject on the basis of mean daytime ambulatory BP. Race and sex were included as matching criteria, and all participants were untreated. The constituted groups of subjects with persistent hypertension, white-coat hypertension, and normotension were examined by means of carotid artery duplex ultrasonography to measure preclinical vascular disease.

**RESULTS**

As displayed in Table 1, all 3 groups consisted of 40 men, including 25 whites and 15 blacks. The 2 hypertensive groups had nearly identical office systolic and diastolic BP, and the white-coat hypertensive and normotensive groups had virtually identical systolic and diastolic daytime ambulatory BP. This indicated that matching was successful. By design, the 2 hypertensive groups differed markedly in daytime ambulatory BP, and the subjects with white-coat hypertension and normotension differed substantially in office BP. Stated differently, the groups with persistent hypertension and normotension had stable BP s in, and outside of, the clinic, whereas the individuals with white-coat hypertension manifested substantially lower ambulatory BP compared with clinic readings. Daytime ambulatory systolic and diastolic BP were lower on average in subjects with white-coat hypertension than in those with persistent hypertension by 21 mm Hg (95% confidence interval [CI], 18-24 mm Hg) and 8 mm Hg (95% CI, 6-11 mm Hg), respectively. Office systolic and diastolic BP were higher in subjects with persistent white-coat hypertension than those with normotension by an average of 19 mm Hg (95% CI, 15-22
mm Hg) and 11 mm Hg (95% CI, 8-13 mm Hg), respectively.

Additional characteristics important to BP and atherosclerosis risk are provided in Table 2. Among the variables examined, the 2 hypertensive groups were very similar, and no statistically significant differences were identified. The groups with white-coat hypertension and normotension were also generally similar, except with respect to body habitus and evidence of insulin resistance. Compared with their normotensive counterparts, the subjects with white-coat hypertension were heavier (mean difference in body mass index [calculated as weight in kilograms divided by the square of height in meters], 1.7; 95% CI, 0.5-2.9) and had greater waist-hip ratios (mean difference, 0.07; 95% CI, 0.04-1.0). The subjects with white-coat hypertension also had higher fasting serum insulin concentrations (mean difference, 24 pmol/L; 95% CI, 0.7-47 pmol/L) and increased estimated insulin resistance (mean difference, 0.98; 95% CI, 0.11-1.86). The 2 hypertensive groups did not differ in mean body mass index, waist-hip ratio, or fasting insulin level. Fasting blood glucose and lipid concentrations, and urinary catecholamine excretion, did not differ notably among the 3 groups.

Measures derived from the carotid artery duplex scans showed that the 2 hypertensive groups had similar mean and maximal IMT, whereas subjects with white-coat hypertension had significantly greater maximum IMT than their normotensive counterparts (mean difference, 0.10 mm; 95% CI, 0.01-0.19 mm). The numbers of subjects with total carotid plaque scores of 0, 1 to 2, and 3 or more in the normotensive group were 21, 14, and 5, respectively; among the group with white-coat hypertension, 13, 13, and 14, respectively; and in the group

Table 1. Matching Characteristics of Subject Groups

<table>
<thead>
<tr>
<th></th>
<th>Normotensive Subjects</th>
<th>Subjects With White-Coat Hypertension</th>
<th>Subjects With Persistent Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, No. (%) M</td>
<td>40 (100)</td>
<td>40 (100)</td>
<td>40 (100)</td>
</tr>
<tr>
<td>Race, No. white/black</td>
<td>25/15</td>
<td>25/15</td>
<td>25/15</td>
</tr>
<tr>
<td><strong>Office measurements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP, mm Hg</td>
<td>123 (9)</td>
<td>141 (10)</td>
<td>143 (9)</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg</td>
<td>80 (5)</td>
<td>90 (6)</td>
<td>90 (6)</td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
<td>71 (8)</td>
<td>74 (11)</td>
<td>75 (10)</td>
</tr>
<tr>
<td><strong>Daytime ambulatory measurements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP, mm Hg</td>
<td>128 (7)</td>
<td>129 (7)</td>
<td>150 (9)</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg</td>
<td>80 (6)</td>
<td>80 (5)</td>
<td>89 (7)</td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
<td>78 (9)</td>
<td>77 (10)</td>
<td>78 (11)</td>
</tr>
</tbody>
</table>

*Data are given as mean (SD) unless otherwise specified. BP indicates blood pressure.

Table 2. Physical, Behavioral, and Biochemical Characteristics of Subject Groups

<table>
<thead>
<tr>
<th></th>
<th>Normotensive Subjects</th>
<th>Subjects With White-Coat Hypertension</th>
<th>Subjects With Persistent Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>56 (10)</td>
<td>57 (10)</td>
<td>54 (9)</td>
</tr>
<tr>
<td>BMI</td>
<td>26.6 (2.6)</td>
<td>28.5 (2.6)</td>
<td>28.5 (3.8)</td>
</tr>
<tr>
<td>Waist-hip ratio</td>
<td>0.93 (0.06)</td>
<td>1.00 (0.06)</td>
<td>0.98 (0.08)</td>
</tr>
<tr>
<td>Significant alcohol, No. (%)†</td>
<td>5 (13)</td>
<td>5 (13)</td>
<td>7 (18)</td>
</tr>
<tr>
<td>Current smokers, No. (%)</td>
<td>7 (18)</td>
<td>5 (13)</td>
<td>8 (20)</td>
</tr>
<tr>
<td>Fasting glucose, mmol/L‡</td>
<td>5.0 (0.5)</td>
<td>5.3 (1.0)</td>
<td>5.1 (0.4)</td>
</tr>
<tr>
<td>Fasting insulin, pmol/L</td>
<td>73 (28)</td>
<td>98 (57)</td>
<td>95 (55)</td>
</tr>
<tr>
<td>Insulin resistance§</td>
<td>2.35 (1.1)</td>
<td>3.25 (2.1)</td>
<td>3.00 (1.8)</td>
</tr>
<tr>
<td>Total cholesterol, mmol/L‖</td>
<td>5.15 (0.87)</td>
<td>5.44 (0.72)</td>
<td>5.35 (1.04)</td>
</tr>
<tr>
<td>Triglycerides, mmol/L ‡</td>
<td>1.29 (0.55)</td>
<td>1.33 (1.77)</td>
<td>1.61 (1.26)</td>
</tr>
<tr>
<td>HDL cholesterol, mmol/L</td>
<td>1.30 (0.25)</td>
<td>1.39 (0.31)</td>
<td>1.32 (0.38)</td>
</tr>
<tr>
<td>LDL cholesterol, mmol/L</td>
<td>3.27 (0.79)</td>
<td>3.44 (0.74)</td>
<td>3.28 (0.93)</td>
</tr>
<tr>
<td>Urine epinephrine, nmol/d</td>
<td>40 (26)</td>
<td>34 (15)</td>
<td>34 (16)</td>
</tr>
<tr>
<td>Urine norepinephrine, nmol/d</td>
<td>277 (95)</td>
<td>272 (77)</td>
<td>301 (106)</td>
</tr>
<tr>
<td>Carotid artery IMT, mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.85 (0.11)</td>
<td>0.88 (0.12)</td>
<td>0.90 (0.15)</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.06 (0.15)</td>
<td>1.16 (0.20)</td>
<td>1.16 (0.24)</td>
</tr>
</tbody>
</table>

*Data are given as mean (SD) unless otherwise specified. BMI indicates body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; and IMT, intima-media thickness.
†Greater than or equal to 14 drinks per week.
‡To convert fasting glucose from millimoles per liter to milligrams per deciliter, divide millimoles per liter by 0.0555.
§Estimated for the homeostasis model assessment.17,18
‖To convert total cholesterol, HDL cholesterol, and LDL cholesterol from millimoles per liter to milligrams per deciliter, divide millimoles per liter by 0.0259.
¶To convert triglycerides from millimoles per liter to milligrams per deciliter, divide millimoles per liter by 0.0113.
with persistent hypertension, 14, 14, and 12, respectively. This greater prevalence of plaque in subjects with white-coat hypertension than in normotensive control subjects was statistically significant (P = .03), whereas the 2 hypertensive groups were quite similar. These data are illustrated as pie charts in the Figure.

Three individuals with white-coat hypertension had mild elevations in fasting glucose level (mean, 7.5 mmol/L [135 mg/dL]). However, none was receiving pharmacological therapy for diabetes, and their mean carotid artery total plaque score was identical to that of the rest of the group with white-coat hypertension (2.0).

**COMMENT**

Unlike any previous report on white-coat hypertension, this investigation matched individuals on the basis of clinic or ambulatory BP and thereby best eliminated important sources of bias and confounding. The 3 subject groups—normotension, white-coat hypertension, and persistent hypertension—were identical or highly comparable with respect to sex, race, age, and matched BP. All were unmedicated, and none had received long-term antihypertensive medication in the past. The principal finding was that, on carotid artery ultrasonography, maximal IMT and plaque score among subjects with white-coat hypertension were significantly greater than in normotensive subjects and similar to those of subjects with persistent hypertension. Also notable, both hypertensive groups were overweight, had more abdominal fat, and had elevated fasting serum insulin concentrations, compared with the normotensive subjects.

An important and growing body of literature suggests that prevailing BP level is the key determinant of vascular disease risk. For example, average ambulatory BP has been reported to be superior to clinic readings in predicting left ventricular mass, carotid artery disease, and clinical events.21-23 Considering that individual BP readings are generally unreliable, because of both measurement error and moment-to-moment BP variability, 24-hour ambulatory BPs are superior to clinic readings, at least in part, simply because they are based on the average of many readings. That is, mean BP derived from ambulatory monitoring has eliminated much of the measurement error inherent in single BP determinations. Greater reliability begets statistical and clinical advantage.

Nonetheless, even ambulatory BP does not correctly estimate disease risk in all individuals. Certainly in this study, persons with white-coat hypertension would be mischaracterized on the basis of ambulatory BP alone, as at low risk for atherosclerotic vascular disease. Perhaps it would be most accurate to consider both clinical and ambulatory BP useful measures, acknowledging that either one in isolation may be misleading. After all, the 2 measures are distinct from one another. Clinic readings of BP are measured after 5 minutes' rest in the seated position in a medical setting, and ambulatory monitoring obtains multiple readings during various postures and activities that vary both between and within patients. Interestingly, Devereux and colleagues24 found that ambulatory BP during a workday was superior to monitoring on a nonworkday in predicting left ventricular mass. Perhaps even for ambulatory BP, obtaining measures during some degree of provocation or stress enhances its validity as a measure of vascular disease risk.

Two recent prospective studies have compared the clinical outcomes of patients with persistent and white-coat hypertension.25,26 Enrolling 479 and 1187 hypertensive patients, respectively, these investigators classified the participants according to their 24-hour ambulatory BP and observed the groups for several years. Both studies found that cardiovascular events occurred significantly less frequently in subjects with white-coat hypertension than in those with persistent hypertension. As noted earlier, cross-sectional studies of individuals with white-coat hypertension have generally found abnormalities on echocardiography, and the current investigation found evidence of premature carotid artery atherosclerosis. Because neither left ventricular mass nor carotid artery IMT perfectly predicts clinical events, unshared variance may undermine the apparent disagreement between prospective and cross-sectional studies.

Prospective studies similar to the 2 just cited are necessary to ultimately resolve questions regarding white-coat hypertension, but the reported evidence of its innocent nature is not definitive. In the report by Verdecchia et al,27 individuals with persistent hypertension were older, had higher clinic BPs, and had higher mean fasting glucose levels than subjects with white-coat hypertension. Statistical adjustment for these factors was included, but clearly the 2 hypertensive groups differed in cardiovascular risk at baseline. Normotensive controls were recruited, in part, from physicians in training and hospital staff and were therefore not best suited for comparison with hypertensive patient samples. Also, study end points were defined to include several “soft” clinical events, such as angina or transient ischemic attack. With only 3 total events recorded among subjects with white-coat hypertension, the study could not reliably measure patients' disease risk. In the study by Khattar and colleagues,26 several differences in vascular disease risk existed between subjects with white-coat and persistent hypertension at baseline, and the study did not include a normotensive control group. There is no mention of diabetes or vascular disease as exclusion criteria, and the prevalence of such factors is neither reported nor included in statistical analyses. Finally, in both stud-
ies, antihypertensive treatment varied among subjects and between groups before as well as after study enrollment.

Epidemiological studies have noted that hypertension is related to obesity and to a constellation of metabolic abnormalities (sometimes called “syndrome X”) consisting of insulin resistance, increased abdominal fat, and dyslipidemia. In one of the first important articles on white-coat borderline hypertension exhibited metabolic and vascular abnormalities that included increased weight, elevated insulin levels, dyslipidemia, and increased vascular resistance. The current investigation replicated this pattern with respect to obesity, increased abdominal fat, and hyperinsulinemia and, further, found that persons with white-coat hypertension were indistinguishable from those with persistent hypertension on each of these measures. However, neither hypertensive group had an abnormal serum lipid pattern. Nonetheless, this constellation of metabolic abnormalities is hypothesized to contribute to vascular disease in patients with established hypertension and may do so similarly in those with white-coat hypertension.

The clinical significance of white-coat hypertension remains undetermined. The finding of subclinical carotid artery atherosclerosis in healthy men with white-coat hypertension indicates that it is premature to consider isolated elevation of BP in the office as benign. Nonetheless, studies have begun to compare health care utilization during treatment guided by either clinical or ambulatory BP measurement and report that significantly less intensive therapy is required when ambulatory readings are used. Given our results and evidence that more than half of all individuals with hypertension do not have their hypertension adequately controlled, any transition to less aggressive treatment of hypertension warrants careful scrutiny.

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