Home Blood Pressure as a Predictor of Future Blood Pressure Stability in Borderline Hypertension
The Tecumseh Study

Shawna D. Nesbitt, John V. Amerena, Eric Grant, Kenneth A. Jamerson, Hong Lu, Alan Weder, and Stevo Julius

We evaluated time-related blood pressure trends in the Tecumseh study participants, none of whom received antihypertensive treatment. At baseline the blood pressures were measured in the field clinic and by self measurement at home (twice daily for 7 days). After a mean of 3.2 ± 0.42 years, the clinic and home pressure readings were repeated. Nine hundred forty-six subjects had clinic and home blood pressure readings at baseline. Of these 735 (380 men, 355 women; average age, 32 years) also completed the second examination. Blood pressure, morphometric data, and biochemical measures at the first examination were used as predictors of future clinic blood pressures.

Five hundred ninety-six subjects were normotensive on both examinations (81%). Of 79 subjects (10.7%) with clinic hypertension (>140 mg Hg systolic or 90 mm Hg diastolic) at baseline, 38 remained hypertensive (“sustained hypertension”) and 41 became normotensive (“transient hypertension”) after 3 years. Another 60 normotensives at baseline (10.4%) became hypertensive on second examination (“de novo hypertensives”; incidence; 8.1%).

The home blood pressure readings on both examinations were reproducible. The three hypertensive groups had elevated home blood pressure, were overweight, had dyslipidemia, and higher insulin values. Only the home blood pressure proved predictive of subsequent blood pressure trends. A home blood pressure of 128 and 83 mm Hg or higher detected “sustained” hypertension with a 48% sensitivity and 93% specificity. Readings of 120 and 80 mm Hg or lower predicted future normotension with a 45% sensitivity and a 91% specificity.

We conclude that self determination of the blood pressure at home is useful in the management of borderline hypertension. An algorithm for the management of these patients is proposed. Am J Hypertens 1997;10:1270–1280 © 1997 American Journal of Hypertension, Ltd.

KEY WORDS: Tecumseh Study, borderline hypertension, home blood pressure, insulin resistance, sympathetic nervous system.
Early detection of hypertension is a clinical dilemma that has a direct impact on the risk of cardiovascular disease. Although the indications for treatment are quite clear with regard to those who have a diastolic blood pressure >95 mm Hg, there is notable ambivalence both nationally and internationally about the optimal treatment for a diastolic blood pressure of 95 to 90 mm Hg. For example, the yield in the Hypertension Detection and Follow-up Study (HDFP) has been meager; treating 100 patients for 5 years saved only one life. The Australian mild hypertension trial also showed a mild effect, but offered a tentative explanation for this finding. In the group of patients whose blood pressure spontaneously returned to normotensive, the prognosis was more favorable than in patients whose blood pressure was pharmacologically lowered to normotensive levels. The implication is that predicting individuals whose blood pressure may spontaneously decrease is clinically important. If clinicians were able to determine the specific group of patients who are most likely to remain hypertensive and reserve treatment only for them, the risk to benefit ratio of the treatment of hypertension would very likely improve.

In this study, we have examined the characteristics of four groups of individuals who have been followed for 3 years in Tecumseh: the normotensives, "sustained" hypertensives, "transient" hypertensives, and "de novo" hypertensives. We have concluded that 1) all three hypertensive groups were overweight on average and showed signs of dyslipidemia; 2) the transient and de novo hypertensives have home blood pressure values that, although in the normotensive range, are significantly higher than in normotensive subjects; 3) subjects with sustained hypertension have significantly elevated home blood pressure readings; and 4) home blood pressure is a reasonable tool in distinguishing transient from sustained hypertensives. Suggestions for applying these findings to clinical practice are discussed.

MATERIALS AND METHODS

Initial Examination The Tecumseh Blood Pressure Study includes a cohort of 946 subjects aged 18 to 42 years who reside in Tecumseh, Michigan. Subjects were recruited by phone by the staff. Only healthy subjects who had not been aware of having abnormal blood pressures were included. The subjects were visited in their homes and were instructed by a technician in the accurate measurement of their own blood pressure. Details and reliability of this procedure are described elsewhere. The home blood pressure values presented here are an average of 14 readings (7 days blood pressure monitoring with AM and PM readings).

The subjects were also evaluated at a field research clinic. The weight and percentage over ideal body weight (calculated using the Metropolitan Life Insurance tables) were assessed; then, after a minimal accommodation period of 2 min in a sitting position, a physician measured their blood pressures three times, which were averaged. Subsequently, they underwent morphometric measurements, forearm plethysmography, and blood tests. Blood samples for cholesterol, HDL, and triglycerides were collected after a 6-h fast. The samples were analyzed using the Kodak (Rochester, NY) Enzymatic method E-700. Minimal forearm vascular resistance (MFVR) was measured by plethysmography at the point of maximal postischemic vasodilation to provide an assessment of structural properties of forearm resistance vessels. Family history was also taken during the routine assessment.

Follow-up Examination At an average of 3 years after the first examination, subjects were contacted and asked to return to the Tecumseh Blood Pressure field clinic. They were again instructed on blood pressure technique and asked to perform home blood pressure measurements. Their clinic blood pressures and anthropometric measurements were again assessed. Of 946 eligible subjects at baseline, 735 completed both examinations and are presented in this article.

Definition of Hypertension In keeping with previous Tecumseh reports hypertension was diagnosed if on the first examination the clinic blood pressure reading exceeded 140 mm Hg systolic or 90 mm Hg diastolic. This classification is used in the main body of the article.

We also undertook a reanalysis of the data to match the number of home blood pressure readings with the number of clinic readings, comparing three blood pressure readings obtained on 2 different days for both the clinic and home readings. These readings were averaged and clinic hypertension was redefined if this new value exceeded 140 mm Hg systolic or 90 mm Hg diastolic. Details can be found in the results section.

Statistics All data are expressed as the mean ± SEM. The statistical analyzes using the SAS package include a one-way ANOVA, which was used to compare the variables in different blood pressure groups. A P < .05 was considered significant. The classification and regression tree method in the Splus package was used to find the cut points of home blood pressure for the best prediction of hypertension at the follow-up examination.

The visits were conducted at a field clinic in Tecumseh, with the approval of the Institutional Review Board of the University of Michigan Medical School. All subjects read and signed an informed consent that outlined the details of the study.
RESULTS

Blood Pressure Trends After 3 Years  Figure 1 shows the outcome of clinic blood pressure classification after 3 years of follow-up. A systolic reading of 140 or a diastolic reading of 90 mm Hg during the clinic examination is used as the definition for office hypertension. The mean age of the entire study population was 30.8 ± 5.14 years at baseline and 34 ± 5.28 years at the follow-up examination. There were no differences in age at baseline and follow-up between the groups.

Of 735 subjects who were seen at both the initial and 3-year follow-up examinations, 79 were originally classified as hypertensive. At the second examination, the number of hypertensive subjects increased to 98. However, 60 (61%) of these were new hypertensives. Of subjects who were hypertensive at the first examination, only 38 (49%) remained hypertensive also at the second examination, whereas 41 (51%) became normotensive after 3 years.

Characteristics of Subjects Whose Clinic Blood Pressure Remained Elevated on Both Examinations (Sustained Hypertensives) Subjects with sustained hypertension had significantly elevated home blood pressures during the first examination and continued to maintain elevated home blood pressures after 3 years (Figure 2 and Table 1). The reproducibility of home blood pressures in both the sustained and normotensive groups is remarkable.

Subjects with sustained hypertension were more overweight and showed significantly higher cholesterol and triglycerides levels. Plasma insulin values were higher and HDL values lower but the differences did not reach statistical significance. Minimal forearm vascular resistance was significantly elevated in the sustained hypertension group (Table 2).

Characteristics of Hypertensive Subjects Whose Clinic Blood Pressure Became Normotensive on the Second Examination (Transient Hypertensives) In Table 1 and Figure 2, the clinic blood pressures decreased to an entirely normal range on the second examination in transient hypertensives; however, the home blood pressures were similar on both examinations. The home blood pressures in the transient hypertensive group were significantly higher than in normotensive subjects, but the elevation was much less than in the sustained hypertensive group.
Akin to the sustained hypertensive group, the weight and cholesterol in the transient hypertensive group was significantly elevated. Similarly, plasma insulin was marginally higher, and the HDL was marginally lower. However, the triglycerides in the transient hypertensives were normal. Minimal forearm vascular resistance was marginally elevated in the transient hypertensive group (Table 2).

Characteristics of Individuals Who Became Hypertensive on the Second Clinic Examination (De Novo Hypertensives) Table 1 and Figure 2 show that the clinic systolic and diastolic blood pressures increased over 3 years (114/75 mm Hg). It is noteworthy that the clinic blood pressures of this group on the first examination (116/78 mm Hg) were strictly normal; however, their home blood pressures on both visits were reproducible and elevated in a similar manner as in transient hypertensives.

Again, as in other hypertensive groups, the de novo hypertensives were significantly overweight. With the exception of a marginal elevation of plasma insulin, this group did not show lipid abnormalities. However, they did show an elevated minimal forearm vascular resistance (Table 2).

Prediction of Blood Pressure Trends Our data suggest that clinic blood pressure readings are unreliable in predicting blood pressure trends after 3 years. However, 48% of subjects who were hypertensive at

### Table 1. Home and Clinic Blood Pressures at Baseline and 3-Year Examination of Subjects in Different Blood Pressure Categories

<table>
<thead>
<tr>
<th></th>
<th>Normotensive (n = 596)</th>
<th>Transient (n = 41)</th>
<th>De Novo (n = 60)</th>
<th>Sustained (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic BP I (mm Hg)</td>
<td>112 ± 0.45/74 ± 0.38</td>
<td>127 ± 1.5/91 ± 0.68*</td>
<td>116 ± 1.28/78 ± 1.03*</td>
<td>132 ± 2.03/94 ± 1.16*</td>
</tr>
<tr>
<td>Clinic BP II (mm Hg)</td>
<td>113 ± 0.4/76 ± 0.28</td>
<td>119 ± 1.24/81 ± 0.83*</td>
<td>130 ± 1.35/93 ± 0.77*</td>
<td>135 ± 2.0/95 ± 1.35*</td>
</tr>
<tr>
<td>Home BP I (mm Hg)</td>
<td>114 ± 0.42/71 ± 0.31</td>
<td>120 ± 1.73/76 ± 1.19*</td>
<td>121 ± 1.91/76 ± 0.95*</td>
<td>129 ± 2.01/82 ± 1.38*</td>
</tr>
<tr>
<td>Home BP II (mm Hg)</td>
<td>115 ± 0.45/73 ± 0.34</td>
<td>120 ± 1.58/79 ± 1.23*</td>
<td>121 ± 1.46/78 ± 1.05*</td>
<td>126 ± 2.57/82 ± 1.57*</td>
</tr>
</tbody>
</table>

Mean values given ± standard error.
* P values denote significance of .001 in comparison of each group to the normotensive group.
P values denotes significance in comparison within the groups over 3 years;
† P ≤ .05;
‡ P < .001.
baseline remained hypertensive after 3 years. The question arises whether this group has more severe hypertension or whether this is a chance classification in a group with variable blood pressure readings. The elevated home blood pressures in these individuals suggests that they may have a more severe form of hypertension. Furthermore, as Figure 3 shows, subjects with sustained hypertension had the highest blood pressures as children and young adults. These previous blood pressure trends, combined with the increased minimal forearm vascular resistance that reflects early structural changes in the resistance vessels, suggests that the sustained hypertensive group, indeed, has a more severe form of hypertension. It would be clinically important to predict future blood pressure trends in individuals who are found initially to be hypertensive. At baseline, all hypertensive groups had higher mean body weights and were more overweight than the normotensive group. Consequently, overweight is not a reliable predictor of fu-

### TABLE 2. METABOLIC AND FOREARM HEMODYNAMIC DATA OF SUBJECTS IN DIFFERENT BLOOD PRESSURE CATEGORIES AT BASELINE EXAMINATION

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normotensive (n = 596)</th>
<th>Transient (n = 41)</th>
<th>De Novo (n = 60)</th>
<th>Sustained (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>74 ± 0.64</td>
<td>84 ± 2.20‡</td>
<td>82 ± 2.14‡</td>
<td>86 ± 2.24‡</td>
</tr>
<tr>
<td>Overweight (%)</td>
<td>12 ± 0.81</td>
<td>33 ± 4.16‡</td>
<td>23.1 ± 2.77‡</td>
<td>29 ± 3.21‡</td>
</tr>
<tr>
<td>Cholesterol (mg/dL)</td>
<td>175 ± 1.48</td>
<td>194 ± 5.32‡</td>
<td>177 ± 4.80</td>
<td>195 ± 7.62‡</td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>93 ± 2.68</td>
<td>118 ± 16.37</td>
<td>106 ± 10.97</td>
<td>157 ± 24.23‡</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>44 ± 0.51</td>
<td>42 ± 1.98</td>
<td>43 ± 1.57</td>
<td>41 ± 1.89</td>
</tr>
<tr>
<td>Plasma insulin (μU/mL)</td>
<td>14.5 ± 0.50</td>
<td>18.2 ± 2.02</td>
<td>18.6 ± 2.50*</td>
<td>17.2 ± 1.38</td>
</tr>
<tr>
<td>Minimal forearm vascular resistance (arbitrary units)</td>
<td>2.00 ± 0.03</td>
<td>2.29 ± 0.15</td>
<td>2.57 ± 0.24‡</td>
<td>2.39 ± 0.18*</td>
</tr>
</tbody>
</table>

Mean values given ± standard error.
P values denote significance in the comparison of each group to the normotensive group; *P ≤ .05; †P ≤ .01; ‡P ≤ .001.

![FIGURE 3.](image) Previous blood pressure values of subjects in the present study. Readings were transcribed from the files of the Tecumseh Study.
ture blood pressure trends in hypertensive individuals. Furthermore (Figure 3), subjects with sustained hypertension had significantly elevated blood pressure readings at age 6 to 8 years, but their body weight was not elevated (Figure 4). As young adults (aged 20 to 23 years) they maintained their blood pressure elevation and at that point they had also gained weight. Interestingly, the other two hypertensive groups at age 20 to 23 years were also overweight. Obviously overweight at age 20 to 23 years predicted neither who will become hypertensive at mean age 30 nor the blood pressure trends 3 years later on repeat examination.

Because the home blood pressure in the sustained hypertensive group was consistently elevated, we sought to define the home blood pressure value that might reliably differentiate subjects who are likely to remain hypertensive from those whose blood pressures are likely to regress to a normal level. A cutoff of home blood pressure values that would provide maximum sensitivity with at least 90% specificity was sought by a computer program. For prediction of hypertension 3 years later, the best fit was at average home blood pressure values (based on two readings each day over 7 days) of 128 and 83 mm Hg. At these readings or higher the sensitivity of detection was 48% with a 93% specificity. The best predictor of normotension after 3 years in those who are hypertensive at baseline was a home blood pressure of 120 mm Hg systolic and 80 mm Hg diastolic, which yielded a sensitivity of 45% and a specificity of 91%. Unfortunately 50% of all subjects who were hypertensive at the initial examination could not be classified by this method.

The 3-year incidence of de novo hypertension among previously normotensive individuals was 8.1%. Because the body weight of the de novo hypertensives was elevated, we sought a low body mass index level that would be predictive of sustained normotension. This did not prove tenable, and at present we can not offer specific recommendations for predicting these future patients.

Analysis of Clinic and Home Blood Pressure Readings Using the Same Number of Measurements

This article implies that home blood pressure determination offers a practical advantage in the classification and management of patients who show marginally elevated readings in the clinic. It is conceivable that the advantage accrues from a larger number of readings obtained with self determination rather than from an intrinsic advantage of measurements taken in a more relaxed atmosphere outside a physician’s office. Therefore, we increased the number of clinic mea-
TABLE 3. HOME AND CLINIC BLOOD PRESSURES AT BASELINE AND 3-YEAR EXAMINATION OF SUBJECTS IN DIFFERENT BLOOD PRESSURE CATEGORIES

<table>
<thead>
<tr>
<th></th>
<th>Normotensive (n = 636)</th>
<th>Transient (n = 19)</th>
<th>De Novo (n = 74)</th>
<th>Sustained (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic BP I (mm Hg)</td>
<td>112 ± 0.44/76 ± 0.36</td>
<td>134 ± 2.46/90 ± 2.02*</td>
<td>123 ± 1.30/85 ± 1.07*</td>
<td>141 ± 2.81/99 ± 2.31*</td>
</tr>
<tr>
<td>Clinic BP II (mm Hg)</td>
<td>113 ± 0.38/76 ± 0.26</td>
<td>123 ± 2.13/82 ± 1.48*</td>
<td>131 ± 1.12/94 ± 0.78*</td>
<td>146 ± 2.44/96 ± 1.70*</td>
</tr>
<tr>
<td>Home BP I (mm Hg)</td>
<td>113 ± 0.42/70 ± 0.31</td>
<td>134 ± 2.32/83 ± 1.70*</td>
<td>123 ± 1.25/78 ± 0.91*</td>
<td>137 ± 2.77/84 ± 2.04*</td>
</tr>
<tr>
<td>Home BP II (mm Hg)</td>
<td>114 ± 0.46/73 ± 0.35</td>
<td>128 ± 2.49/81 ± 1.89*</td>
<td>123 ± 1.32/80 ± 1.01*</td>
<td>138 ± 3.44/84 ± 2.61*</td>
</tr>
<tr>
<td></td>
<td>NS/*</td>
<td>†/‡</td>
<td>†/‡</td>
<td>†/‡</td>
</tr>
</tbody>
</table>

Mean values given ± standard error. Based on the average of three clinic and home BP readings.
* P values denote significance of .001 in comparison of each group to the normotensive group.
P values denote significance of .001 in comparison within the groups over 3 years.
†P = .05; ‡P < .001.

measurements to include two additional values obtained on a different day. The three clinic readings were averaged and compared to an average of three blood pressure readings taken at home (AM and PM first day and AM second day). Hypertension was diagnosed if the average of three readings on different days exceeded 140 mm Hg systolic or 90 mm Hg diastolic. This reduced the number of subjects with hypertension on the first clinic examination from 79 to 34. However, as in this analysis we did not need metabolic and hemodynamic data, the total number of individuals increased from 735 to 744.

The increased number of clinic measurements did not improve the prediction of the clinic blood pressure classification at follow-up examination 3 years later using three different readings in different settings. Fifty-six percent (n = 19) of hypertensives at the first examination were normotensive on the second examination compared to 52% normotensives when the data from only one clinic day were used.

The restriction of the home blood pressure to only three readings did reduce the sensitivity and specificity of the prediction of future hypertension and the cut point moved to higher values. At an average home blood pressure reading of 134/88 mm Hg the specificity was 85% and the sensitivity 43%.

However, as is shown in Table 3, even at a reduced number of readings the home blood pressure proved more dependable than the clinic readings. Akin to the findings from an average of 14 readings the home blood pressure reading in all hypertension groups was significantly elevated and the home blood pressure reading values in all groups changed very little over time.

Suggested Algorithm for Management of Borderline Hypertension in Practice It is conceivable that in the new health care environment it will be possible to practice preventive medicine. Detecting borderline hypertensive individuals and managing them should become the cornerstone of such efforts. We believe that our data justify the use of the scheme outlined in Figure 5. The advantages and limitations of such a scheme will be discussed below.

DISCUSSION

The Metabolic Syndrome and Borderline Hypertension In his Banting lecture, Reaven11 described the frequent and close association of elevated plasma insulin levels, dyslipidemia, and hypertension as "syndrome X." This often reported relationship11–15 continues to attract investigative attention and of particular interest is the question whether elevated plasma insulin values, which could cause dyslipidemia,13 are also responsible for the elevation of the blood pressure. Insulin could increase the blood pressure by its action on the smooth muscle cell membrane,16–18 sodium retention,19,20 increased sympathetic tone,21–24 and through the trophic effect of insulin on smooth muscle proliferation.25

In earlier papers from the Tecumseh study, we reported on the cross-sectional association of borderline hypertension with elevated plasma insulin levels,26 and pointed out that insulin values tend to be elevated regardless of whether the subjects have a "white coat" or "sustained" hypertension.27 This impression that hypertension and high insulin levels are associated but that the insulin level does not necessarily track with the blood pressure trends is now also confirmed in the longitudinal portion of the study. The initial plasma insulin levels did not predict whether a subject will have sustained blood pressure elevation or whether he or she will become normotensive over the same time.

In the present study we found overweight not to be a predictor of future blood pressure. There is considerable debate about the impact of weight trends on the clinical management of hypertension.28–30 Whereas numerous studies show that these conditions coexist
commonly, it is less clear whether obesity can be used to predict reliably future BP trends in an individual. In a group of 112 young men followed over 32 years, changes in body weight correlated with changes in blood pressure yet baseline indices of weight correlated only with diastolic and not systolic blood pressure at follow-up. In another study of black male physicians who were followed for 22 years, those who were obese at baseline were no more likely to be hypertensive at follow-up than those who were of normal weight; however, those who became obese over the follow-up period were more likely to develop hypertension. The effect of weight on hypertension is frequently studied by analyzing the effect of weight loss on blood pressure. In the Trial of Antihypertensive Interventions and Management, a 4.4-kg weight loss in the diet/placebo group resulted in a similar blood pressure decrease as in the usual care/placebo group, which lost only 0.7 kg. However, when weight loss was combined with drug therapy, there was an additional 5 mm Hg reduction in diastolic blood pressure. Cumulatively, these studies suggest that although weight loss may assist in lowering blood pressure, and weight gain may be a risk factor for hypertension, in practical terms obesity alone cannot be used as a reliable predictor of individual blood pressure trends.

This appears to be particularly true for groups of young subjects with borderline hypertension described in this study. Subjects with sustained hypertension already had higher blood pressure as children (Figure 3) and only later became overweight as young adults (20 to 23 years old) (Figure 4). At 20 years old the transient hypertensives were overweight, they remained overweight at ages 30.8 and 34 years, yet their blood pressure varied independently of weight. The de novo hypertensive group was overweight but normotensive at ages 20 and 31.
years. Finally, changes in weight from baseline to 3 years later in the present study did not track the blood pressure changes over that period of time. (To simplify the presentation the follow-up weights are not shown in this article.)

Prediction of Blood Pressure Trends in Borderline Hypertension  The average clinic blood pressure at the first examination in our hypertensive group was minimally elevated (129/92 mm Hg). In spite of the fact that the excess mortality risk for an individual patient in this group is not dramatic, borderline blood pressure is very frequent and because of its frequency has a large impact on the mortality of the overall population. It is accepted that 25% of cardiovascular mortality from hypertension accrues among subjects whose diastolic blood pressure is 90 to 95 mm Hg. It is assumed that most of this excess accrues from transition from borderline to more advanced forms of hypertension. Borderline hypertension is a strong precursor of future hypertension. Consequently, one could reasonably expect that blood pressure reduction in this group of subjects may have a major impact on public health.

In spite of the excess mortality in borderline and very mild hypertension, the therapeutic trials show a statistically significant decrease of mortality, but in practical terms they offer little comfort. The absolute reduction in mortality in the HDFP study was 1% after a period of 5 years. The data presented in this article suggest one of the reasons why antihypertensive treatment in such patients is not fully effective. Obviously mild hypertension is not a uniformly progressive disease; after a few years of observation many such patients will be spontaneously “cured.” In the present study, depending on the definition, 52% to 56% of subjects with initial hypertension had normal blood pressure readings 3 years later. Similarly, the Australian National High Blood Pressure Study has shown that between 24% and 48% of hypertensive patients who are untreated became normotensive after 3 years. It follows that the effect of antihypertensive treatment would be much improved if only subjects who have a real and permanent problem would be subjected to treatment. Furthermore, the mortality in the placebo-treated group would be substantially higher if the group consisted only of patients with permanent hypertension.

On the basis of such thinking, we feel reasonably confident in suggesting the management scheme proposed in Figure 5. Our recommendation in Figure 5 assumes that the sustained hypertension group in fact has a more severe form of “true” hypertension rather than being a chance observation due to repeated sampling. We are comfortable with this assumption as, compared to other groups, our sustained hypertensives had a long history of higher BP readings at age 7, 20, and 30 years and the readings continued to be elevated at the 3 years of follow-up. The data also indicate that these elevated readings are associated with signs of vascular restructuring; the minimal forearm vascular resistance, a recognized marker of hypertrophy of resistance vessels has been elevated in this group of subjects.

The advantage of the scheme in Figure 5 is that it selects for treatment only a minority of subjects with casual hypertension in the physician’s office, that it proposes a close follow-up of subjects at intermediate risk for persistent hypertension, and that it eliminates from special care individuals who are not likely to develop hypertension-related problems in the foreseeable future. The disadvantage of the proposal is in the inadequate sensitivity of detection in subgroups who are likely to have permanent hypertension as well as those that may spontaneously improve. This leaves a large intermediate group (50% of subjects with casual hypertension in the physician’s office) that cannot be classified. We think it reasonable, but cannot prove, that these subjects should be managed nonpharmacologically and that the decision whether to give antihypertensive agents can be postponed for 1 year. Within that year of active observation, many of these subjects will “declare” whether they are heading toward improvement or in the opposite direction.

The other serious limitation of the proposed algorithm is in the assumption that special measures are not required in any of the subjects who are initially normotensive. This is clearly wrong as 8.1% of these individuals will actually show hypertensive readings 3 years later. Some of these future hypertensives could be detected by using the home blood pressure technique but we could not possibly suggest a routine use of home blood pressure measurements in all normotensive subjects. However, if a health care system were interested in detecting future hypertensives among normotensive subjects, home blood pressure monitoring in overweight subjects might be useful.

The proposed scheme uses blood pressure self-determination and the question arises whether this is practical particularly as, out of concern that electronic digital devices are inaccurate, we used auscultatory sphygmomanometers in Tecumseh and in previous studies. We demonstrated earlier that auscultatory home blood pressure self-measurement is very sensitive in detecting small blood pressure changes during pharmacologic or nonpharmacologic treatment of borderline hypertension. We also documented that the method is suitable for further stratification of subjects with borderline hypertension; only 30% of subjects who are hypertensive in the clinic will remain hypertensive at home. Finally, in the Tecumseh study we found that after a short period of instruction, 99% of
all subjects could measure accurately their blood pressure. The ability to measure blood pressure was not affected by the patient's educational or socioeconomic status and the readings were highly reproducible. This combined with the fact that cheap sphygmomanometers with built-in stethoscopes in the cuff are readily available suggests that blood pressure self-measurement is an easy procedure that can be used routinely in clinical practice. Our data suggest that to use the home blood pressure for prediction of future blood pressure trends one needs to average a large number of home readings. In practical terms this is not a problem; once they learn the technique, patients do not mind obtaining multiple readings particularly if they are provided with a handy daily log for blood pressure recording.

We did not detail in the proposed scheme exactly what is meant under "nonpharmacologic" and "intensive nonpharmacologic treatment." Weight loss, dynamic physical exercise, behavioral methods can reduce the blood pressure, but the selection will much depend on the local circumstances. The "intensive" nonpharmacologic treatment refers to a system of supervised activities and care by specialized personnel. The less intensive treatment consists of advice of supervised activities and care by specialized personnel. The less intensive treatment consists of advice

ACKNOWLEDGMENTS

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