The common phenomena of white-coat and masked hypertension have established the need for assessing blood pressure (BP) out of the office, particularly using 24-hour ambulatory monitoring (ABPM). In the last 2 decades, evidence on the usefulness of the alternative method for out-of-office BP assessment, namely home BP monitoring (HBPM), has accumulated, and guidelines on using this method have recently been published in the United States and Europe.1,2 As with ABPM, HBPM allows the detection of white-coat and masked hypertension and has additional advantages, such as wide availability, low cost, and excellent acceptability by hypertensive patients for repeated use.1,2

In this issue of Hypertension, Niiranen et al present the results of Finn-Home, an outcome study of HBPM in the general population in Finland.3 Strengths of this study are the large data set (>14,000 subject-years, with 162 documented cardiovascular events) and the use of optimal methodology for office BP measurement (nurses using mercury sphygmomanometers) and HBPM (validated electronic device and guidelines-recommended monitoring schedule with 7-day duplicate morning and evening measurements).

This study contributes to the HBPM and outcome database that now comprises 8 large long-term prospective studies1–10 including 17,688 subjects and almost 100,000 person-years of follow-up (Table). There are important differences among these studies regarding the study population, the BP measurements, the definition of primary outcomes, and the methods of statistical adjustment. Studies have been performed in Europe and Japan. Five studies included general population samples,3–5,7,9 1 included patients registered in a single primary care practice after excluding those with previous cardiovascular disease,8 and 2 focused on treated hypertensives.6,10 Office BP was measured using conventional mercury sphygmomanometers, apart from the Ohasama study,4 which used electronic devices; and that of Okumiya et al,5 which did not report on office measurements. In 3 studies, office BP was measured in a single visit (2 to 3 readings),3,4,8 and in another 3 studies, it was measured in 2 visits (6 readings)6,7,9 (unclear in 1 study10). HBPM was self-performed by participants using electronic devices, apart from the Flanders study,8 where HBPM was performed in a single occasion by a physician or assistant physician using a mercury device. The HBPM schedule also varied considerably among studies, with 5 of them having morning and evening measurements5,5–7,9 and 3 having only morning measurements.4,8,10 The Ohasama, SHEAF, Finn-Home, and Okumiya et al studies obtained 20 to 28 home readings,3–6 Didima obtained 12 readings,9 Flanders obtained 3 readings8 and PAMELA obtained only 2 readings7 (readings not specified in J-HEALTH10). Variations in the definitions of outcomes and adjusting factors in the multivariate analyses are shown in the Table.

Despite the considerable methodological and clinical heterogeneity of these studies, a comparison of the prognostic ability of home versus office BP measurements is possible, because in most of the studies both methods have been applied in the same subjects.3,4,6–9 All these studies consistently showed home BP to be a significant predictor of cardiovascular events (Table). More importantly, in most of the studies, the cardiovascular risk was better predicted by HBPM than by office measurements (Table).3,4,6–8 Even when the same number of home versus office measurements were compared, the prognostic ability of HBPM was again superior, suggesting that its advantage is not attributed only to the larger number of readings.4,7 A random-effects summary of the adjusted hazard ratios yields values of 1.015 (95% CI 1.010 to 1.020) and 1.024 (1.017 to 1.032) per mm Hg for systolic and diastolic home BP versus 1.007 (1.004 to 1.011) and 1.015 (1.003 to 1.026), respectively, for office BP. This difference is beyond chance for systolic BP. A more informative analysis would be to consider both HBPM and office BP measurements in the same adjusted model. This has been done in different analytic approaches in 5 studies. The Finn-Home,3 SHEAF,6 Ohasama,4 and Flanders8 studies found that HBPM, but not office BP, was significantly predictive when both were considered, whereas the PAMELA study7 found that both office and HBPM conferred independent information. One would like to see also formal reclassification analyses that examine whether the addition of HBPM changes the classification of participants into categories where different treatment would be indicated11 and thus outcomes could be improved. Ideally, reclassification evaluations could be done in an individual-level data meta-analysis to allow standardization of the...
Table. Studies Assessing the Prognostic Value of Home Blood Pressure (Systolic/Diastolic) for Cardiovascular Events

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Subjects</th>
<th>Follow-Up (Years)</th>
<th>Country</th>
<th>CV Events</th>
<th>Definition of CV Events</th>
<th>HR per 1 mm Hg BP Increase*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohasama*</td>
<td>1789</td>
<td>6.6</td>
<td>Japan</td>
<td>52</td>
<td>CV death</td>
<td>HR in categories</td>
</tr>
<tr>
<td>Okumiya et al5</td>
<td>1186</td>
<td>4</td>
<td>Japan</td>
<td>57</td>
<td>CV death</td>
<td>1.021/1.015</td>
</tr>
<tr>
<td>SHEAFg</td>
<td>4932</td>
<td>3.2</td>
<td>France</td>
<td>324</td>
<td>CV death, MI, stroke, TIA, angina or CHF (H), PCI, CABG</td>
<td>1.015‡/1.020‡</td>
</tr>
<tr>
<td>PAMELA7</td>
<td>2051</td>
<td>10.9</td>
<td>Italy</td>
<td>56</td>
<td>CV death</td>
<td>1.046‡/1.055‡</td>
</tr>
<tr>
<td>Flanders8</td>
<td>391</td>
<td>10.9</td>
<td>Belgium</td>
<td>86</td>
<td>CV death, MI, stroke</td>
<td>1.012‡/1.034‡</td>
</tr>
<tr>
<td>Didima9</td>
<td>662</td>
<td>8.2</td>
<td>Greece</td>
<td>67</td>
<td>CV death, MI, angina or CHF (H), pulmonary edema, PCI, CABG, stroke, TIA, aortic aneurysm rupture</td>
<td>1.003/1.011</td>
</tr>
<tr>
<td>J-HEALTH10</td>
<td>4596</td>
<td>3.5</td>
<td>Japan</td>
<td>60</td>
<td>CV death, MI, stroke</td>
<td>1.021/1.034‡</td>
</tr>
<tr>
<td>Finn-Home4</td>
<td>2081</td>
<td>6.8</td>
<td>Finland</td>
<td>162</td>
<td>CV death, MI, stroke, CHF (H), PCI, CABG</td>
<td>1.015‡/1.024‡</td>
</tr>
</tbody>
</table>

Random-effects meta-analysis estimates

CV indicates cardiovascular; HR, hazard ratio; MI, myocardial infarction; TIA, transient ischemic attack; CHF, congestive heart failure; H, hospitalization; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; RR, relative risk.

*All HRs shown are adjusted, apart from that for the PAMELA study. Adjusting factors included (n of studies) age, sex, smoking status (5); CV disease history, diabetes mellitus, antihypertensive medication (4); hypercholesterolemia (3); heart rate, body mass index (1).

†Data on stroke have also been published for the same cohort at an 11.7-year follow-up.

‡Nominally statistically significant (P<0.05).

§Risk estimates are not reported per mm Hg; instead HR or RR are given for BP categories, but overall they show a significant increasing risk of events with higher BP. Okumiya et al5 also suggest an increased risk of events with very low BP. PAMELA not considered.

Now that HBPM is readily available and recommended, the question that remains is how to make the best use of this method in routine clinical practice. With ABPM there is reassurance that an unbiased BP profile is obtained because the patient/user cannot decide the time or number of measurements, neither select which readings to report to the physician. Standardization of the monitoring schedule and reporting should also be the case for HBPM. Indeed, there is evidence that patients often misreport (under- or overreport) their HBPM values, which might mislead the physician’s decision.1,2 Current technology of HBPM software can easily implement the recommended monitoring schedule together with automated memory at low cost to ensure that an unbiased and guidelines-based assessment of home BP is made. This is an essential prerequisite for HBPM to be used by physicians in making treatment decisions in clinical practice and hopefully should also improve clinical outcomes.

Disclosures

None.

References

pressure measurement has a stronger predictive power for mortality than
does screening blood pressure measurement: a population-based obser-
5. Okumiy K, Matsubayashi K, Wada T, Fujisawa M, Osaki Y, Doy Y,
Yasuda N, Ozawa T. A U-shaped association between home systolic
blood pressure and four-year mortality in community-dwelling older men.
J, Mallion JM. Cardiovascular prognosis of “masked hypertension”
detected by blood pressure self-measurement in elderly treated hyper-
G. Prognostic value of ambulatory and home blood pressures compared
with office blood pressure in the general population: follow-up results
from the Pressioni Arteriose Monitorate e Loro Associazioni (PAMELA)
8. Fagard RH, Van Den Broeke C, De Cort P. Prognostic significance of
blood pressure measured in the office, at home and during ambulatory
monitoring in older patients in general practice. J Hum Hypertens. 2005;
9. Stergiou GS, Baibas NM, Kalogeropoulos PG. Cardiovascular risk pre-
diction based on home blood pressure measurement: the Didima study.
H, Yoshiike N. The importance of home blood pressure measurement for
preventing stroke and cardiovascular disease in hypertensive patients: a
sub-analysis of the Japan Hypertension Evaluation with Angiotensin II
Antagonist Losartan Therapy (J-HEALTH) study, a prospective
11. Tzoulaki I, Liberopoulos G, Ioannidis JP. Assessment of claims of
improved prediction beyond the Framingham risk score. J Am Med Assoc.
Home Blood Pressure as a Cardiovascular Outcome Predictor: It's Time to Take This Method Seriously
George S. Stergiou, Konstantinos C.M. Siontis and John P.A. Ioannidis

Hypertension. 2010;55:1301-1303; originally published online April 12, 2010;
doi: 10.1161/HYPERTENSIONAHA.110.150771

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://hyper.ahajournals.org/content/55/6/1301

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Hypertension can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Hypertension is online at:
http://hyper.ahajournals.org//subscriptions/