Why Is Out-of-Office Blood Pressure Measurement Needed?

**Home Blood Pressure Measurements Will Increasingly Replace Ambulatory Blood Pressure Monitoring in the Diagnosis and Management of Hypertension**

Gianfranco Parati, Stefano Omboni, Grzegorz Bilo

**Over the last decades, 2 main techniques for measuring blood pressure (BP) out of the physician’s office have gained increasing importance in the clinical approach to arterial hypertension, both being supported by recent international hypertension management guidelines.**

These techniques are home BP monitoring (HBPM) and 24-hour ambulatory BP monitoring (ABPM). Their diffusion in clinical practice has been favored by a number of factors, including on one side technical progress and wider availability of accurate HBPM and ABPM devices and on the other side the increasing awareness of the limitations of office BP (Table 1). Office BP is in fact characterized by a random error affecting casual BP readings and by a systematic error related to the patient’s alerting reaction to the measurement procedure and setting, known as “white coat effect.” Both ABPM and HBPM are devoid of these limitations and, thus, provide more stable and reproducible information on BP values, which is also of greater prognostic relevance (Table 2). Furthermore, office BP readings are unable to collect information on BP during a subject’s usual activities and over a long period of time, an important limitation in everyday management of hypertensive subjects that can be overcome by out-of-office BP monitoring.

ABPM was initially confined to specialized hypertension centers because of its relatively high cost, but over the years its availability has steadily increased. HBPM, on the other hand, has been used rather reluctantly by physicians in routine management of hypertensive patients. Although its potential usefulness in clinical practice was acknowledged many years ago, its application has been limited until the end of last century by the need to use auscultatory measurements, an approach that is difficult to apply correctly, particularly in the home setting, and prone to providing inaccurate information, especially when using aneroid devices. A major breakthrough came with the introduction of inexpensive, easy-to-use, and accurate automated oscillometric BP measuring devices, leading to a widespread use of HBPM. At present, in developed countries ~70% of hypertensive patients regularly assess their BP at home, and the clinical usefulness of this approach is generally acknowledged by physicians.

Such a rapidly growing diffusion of HBPM in clinical practice has inevitably raised the question of whether HBPM and ABPM should be considered as alternative methods to obtain the same information or whether instead they represent sources of complementary data. In the former case, the use of ABPM, this approach being a more expensive and more difficult technique, could hardly be justified. This important issue is still being debated, and our article is aimed at providing a contribution to this discussion.

**Similarities Between HBPM and ABPM**

The most important common denominator of HBPM and ABPM is the fact that they both provide out-of-office BP measurements.

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values, ie, BP values obtained in the patient’s “natural” environment. Thus, these values are basically devoid of the alarm reaction associated with office BP measurement, responsible for the white coat effect.30,31 Another important common advantage of ABPM and HBPM is that, when current recommendations are followed, they both make use of automated, validated oscillometric devices.6,7,32 This makes the obtained BP values operator independent, thus avoiding some common limitations affecting office measurements.33 Importantly, the application of these techniques is possible in a vast majority of cases, the 2 most relevant exceptions including important arrhythmias, eg, frequent extrasystoles or atrial fibrillation, where oscillometric measurements are unreliable, and obesity with

Table 1. Comparison of Main Features of 3 Main Methods of BP Measurement

<table>
<thead>
<tr>
<th>Feature</th>
<th>Office BP</th>
<th>ABPM</th>
<th>HBPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of readings</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>White coat effect</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Operator dependency</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Need of device validation</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Daytime BP</td>
<td>+</td>
<td>+ + +</td>
<td>+ +</td>
</tr>
<tr>
<td>Nighttime BP and dipping</td>
<td>−</td>
<td>+ + +</td>
<td>−</td>
</tr>
<tr>
<td>Morning BP</td>
<td>±</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>24-h BP variability</td>
<td>−</td>
<td>+</td>
<td>±</td>
</tr>
<tr>
<td>Long-term BP variability</td>
<td>−</td>
<td>±</td>
<td>+ +</td>
</tr>
<tr>
<td>WCH and MH diagnosis</td>
<td>−</td>
<td>+ +</td>
<td>+ +</td>
</tr>
<tr>
<td>Placebo effect</td>
<td>+ +</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Reproducibility</td>
<td>Low</td>
<td>High (24-h average values)</td>
<td>High (average of several values)</td>
</tr>
<tr>
<td>Prognostic value</td>
<td>+</td>
<td>+ + +</td>
<td>+ +</td>
</tr>
<tr>
<td>Patient involvement</td>
<td>−</td>
<td>−</td>
<td>+ +</td>
</tr>
<tr>
<td>Need of patient training</td>
<td>−</td>
<td>±</td>
<td>+ +</td>
</tr>
<tr>
<td>Physician involvement</td>
<td>+ + +</td>
<td>+ +</td>
<td>+</td>
</tr>
<tr>
<td>Patient acceptance</td>
<td>+ +</td>
<td>±</td>
<td>+ +</td>
</tr>
<tr>
<td>Monitoring of treatment effects</td>
<td>Limited information</td>
<td>Extensive information on diurnal BP profile, cannot be repeated frequently</td>
<td>Appropriate for long-term monitoring, limited information on BP profile</td>
</tr>
<tr>
<td>Hypertension control improvement</td>
<td>+</td>
<td>+</td>
<td>+ + +</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Availability</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Data are from Reference,6 modified WCH indicates white coat hypertension; MH, masked hypertension.

Table 2. Home BP Measurements and Outcome

<table>
<thead>
<tr>
<th>Study Name</th>
<th>Population</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ohasama8,11</td>
<td>Treated and untreated general population aged ≥40 y</td>
<td>Cardiovascular, noncardiovascular, and all-cause mortality</td>
</tr>
<tr>
<td>Ohasama12</td>
<td>Treated and untreated general population aged ≥40 y</td>
<td>Total stroke morbidity</td>
</tr>
<tr>
<td>Ohasama13</td>
<td>Treated and untreated general population aged ≥40 y</td>
<td>Total stroke morbidity</td>
</tr>
<tr>
<td>Ohasama14</td>
<td>Treated and untreated general population aged ≥40 y</td>
<td>Total, hemorrhagic, and ischemic stroke morbidity</td>
</tr>
<tr>
<td>Ohasama15</td>
<td>Treated and untreated general population aged ≥40 y</td>
<td>Total stroke morbidity</td>
</tr>
<tr>
<td>Kahoku16</td>
<td>Treated and untreated community-dwelling elderly individuals aged ≥65 y</td>
<td>Cardiovascular, noncardiovascular and all-cause mortality</td>
</tr>
<tr>
<td>Kahoku17</td>
<td>Treated and untreated community-dwelling elderly individuals aged ≥75 y</td>
<td>Disability, cardiovascular and all-cause mortality, cardiovascular and stroke morbidity</td>
</tr>
<tr>
<td>SHEAF18</td>
<td>Treated hypertensive patients aged ≥60 y</td>
<td>Cardiovascular and all-cause mortality, total cardiovascular morbidity</td>
</tr>
<tr>
<td>PAMELA9,10</td>
<td>Treated and untreated general population aged 25–74 y</td>
<td>Cardiovascular and all-cause mortality</td>
</tr>
<tr>
<td>CKD veterans19</td>
<td>Treated veterans with chronic kidney disease</td>
<td>Morbidity of end stage renal disease, all-cause mortality</td>
</tr>
<tr>
<td>Flanders20</td>
<td>Treated and untreated general population aged ≥60 y</td>
<td>Major cardiovascular events (cardiovascular death, myocardial infarction, and stroke)</td>
</tr>
<tr>
<td>Didima21</td>
<td>Treated and untreated general population aged ≥18 y</td>
<td>Total cardiovascular morbidity and mortality</td>
</tr>
</tbody>
</table>

SHEAF indicates Self-Measurement of Blood Pressure at Home in the Elderly; PAMELA, Pressioni Arteriose Monitorate e Loro Associazioni; CDK, chronic kidney disease. Data are from Reference,6 by permission.
extremely large arm circumference and/or conical shaped arms, where fitting an appropriate cuff may be difficult. In the latter case the use of wrist devices for HBPM might possibly be justified, whereas otherwise upper arm devices should always be preferred.6

The above advantages, together with the ability of HBPM and ABPM to provide a much larger number of values than office BP measurements, result in more stable estimates of the prevailing BP in a given subject, reflecting the actual BP burden on cardiac and vascular targets more precisely than office readings. This has not only methodological but also clinical relevance, as documented by a number of studies showing the prognostic superiority of HBPM or ABPM over isolated office BP measurements (Table 2).6–10,34 These observations are further reinforced by the demonstration that a worse prognosis characterizes subjects with normal office and elevated out-of-office BP, assessed by either HBPM or ABPM (masked hypertension), than subjects with normal out-of-office but elevated office BP (white coat or isolated office hypertension; Figure 1).9,18,30,35

**Differences Between ABPM and HBPM**

Notwithstanding the above similarities, there are major differences between HBPM and ABPM that importantly influence their possible clinical and research applications. One of the key issues is the economic aspect of using either HBPM or ABPM. Although the price of validated ABPM devices has fallen considerably over the last years, making them more easily and widely available, still, the costs of the system and its maintenance remain relatively high, unquestionably higher than those of HBPM.6 This is of particular relevance when promoting BP monitoring in low-resource settings, where the prevalence of hypertension is increasing and the limited availability of economic resources does not allow costly equipment to be considered in a population setting.4 Thus, should HBPM and ABPM provide equivalent clinical information, the former technique would have to be preferred on the background of the possibility to reduce patients’ management costs.36,37

Admittedly, however, ABPM has a number of clinically relevant features that are not directly available with HBPM, which makes the former approach not easily replaceable by the latter. One of the peculiar advantages of ABPM lies in its ability to provide a series of frequent and automated BP measurements throughout the 24 hours, which makes ABPM, at variance from HBPM, capable to dynamically assess BP changes over relatively short periods of time. This might have clinical implications in light of the evidence supporting the adverse prognostic relevance of specific patterns of BP variability over 24 hours, including reduced nocturnal BP fall,38 increased short-term BP variability,39,40 and possibly also an excessive morning BP surge.41 Nevertheless, the actual clinical usefulness of assessing these dynamic BP features remains controversial because of the lack of universally accepted normal reference values for their interpretation, lack of well-defined interventions able to counteract their adverse effects, and missing evidence that their modification by treatment may significantly reduce cardiovascular risk. Thus, unless fur-
effect is usually assessed with ABPM and typically quantified through trough:peak ratio, an HBPM-derived index, known as the morning:evening ratio, was proposed as an alternative approach, although its validity has not been sufficiently documented so far.46 The above examples demonstrate that HBPM application has been proposed even in areas where ABPM was traditionally considered to be the only available solution.

An important field of ABPM application is in clinical pharmacology, when investigating the size and distribution over 24 hours of the effects of newly developed antihypertensive agents. At the moment, ABPM remains the most frequently used tool in such a research setting because of its documented superiority over office BP. However, the use of HBPM is an alternative solution increasingly gaining importance in research on antihypertensive therapies, especially in studies where large populations are being studied and where a compromise between the precision of BP assessment and the cost of wide application of BP monitoring has to be reached.6,47

On top of this, HBPM has a number of features not available with ABPM, which are currently boosting its increasing use in clinical practice. First, it allows BP monitoring to be performed repeatedly and regularly over extended periods of time, which is crucial to optimize BP control in treated patients and is not easily achievable with ABPM. In addition, HBPM encourages the patient’s active involvement in the management of his or her high BP condition, thus improving compliance with treatment48; it may reduce the need to frequently attend medical check-ups49; it favors a faster optimization of treatment regimens50; and, because of all of the above, it may by itself contribute to BP lowering.50 An important and frequently overlooked practical aspect is that a substantial proportion of patients do not tolerate repeated ABPM recordings, whereas HBPM is usually welcome by them.

Furthermore, technological progress provides new functionalities of HBPM devices, which make them increasingly interesting for both clinicians and patients. These include drug intake reminders; internal memory facilities for easy storage and review of measured BP values; possibility of data printout or download to a computer; built-in programs for structured measurement schedules with automatic calculation of average daily and weekly values; and, finally, teletransmission of BP data to a remote centralized server.51 The last possibility allows the incorporation of HBPM in telemonitoring systems, further contributing to an improvement in hypertension control (Figure 3).52

**Conclusions and Perspectives for the Future**

The current position is that HBPM and ABPM should coexist and be used as complementary tools, providing different information on a subject’s BP status.6,7 However, HBPM may be a valid alternative to ABPM in many cases, possibly even in settings where ABPM is currently considered the method of choice, eg, identification of isolated office hypertension and of masked hypertension, clinical evaluation of BP variability, and assessment of antihypertensive drug coverage. In fact, in clinical practice, HBPM is increasingly replacing ABPM, with use of the former being recommended in all treated hypertensive subjects by recent guidelines,6,53 a recommendation that cannot apply to ABPM. This is because HBPM is an ideal first-line tool because of its low cost, high availability, and easy application. It may also be the most reasonable option for the initial assessment of untreated subjects, in whom white coat or masked hypertension is suspected, ie, those with highly variable office BP, with office BP close to diagnostic thresholds, with isolated out-of-office BP values discrepant from office BP, with evidence of organ damage contrasting with office BP findings, etc. Moreover, HBPM is clearly the tool of choice in monitoring BP control in treated subjects over extended periods of time, also because it has the particular advantage of promoting a better therapeutic adherence.48 Possible exceptions are cases
where recommendation of HBPM use to a patient ends up in obsessively frequent self-BP measurements, or, even worse, in self-modification of treatment on the basis of isolated and ill-interpreted BP findings. Still, in many such cases, an appropriate interaction between patient and physician, including patient education, may be sufficient to overcome this kind of problem so that only in a few cases should HBPM be discouraged and ABPM used instead. Finally, whereas ABPM remains the leading method in research on antihypertensive therapies, in outcome trials carried out in large populations, where the effects of BP lowering are assessed over many months or years, HBPM may be an interesting alternative solution.

Therefore, we believe that priority should be given to HBPM in most patients when out-of-office BP assessment is needed. Possible exceptions, where ABPM should definitely be used, include high-risk patients with severe, difficult-to-control hypertension, in whom an adequate 24-hour BP control is crucial, and patients where the assessment of short-term BP variability and of the behavior of nocturnal BP is specifically indicated. ABPM might be also used as a second choice whenever HBPM does not provide clear answers to diagnostic questions, ie, when HBPM values are borderline or when it is likely that they have been influenced by methodological factors, as in the case of inappropriate use by patients with cognitive impairment or inaccurate BP data reporting. According to such an approach, out-of-office BP measurement would be available to a wide range of subjects with relatively modest costs, leaving the more expensive ABPM to selected cases only.

In summary, both HBPM and ABPM are extremely useful in hypertension management, with a partial overlap of their clinical indications. Given that the clinical information they provide is not identical, both of these methods are likely to remain in use by physicians in daily practice. However, because of the important scientific and technological progress taking place in the field of HBPM, it may be expected that the number of HBPM applications and indications will be increasing, making this approach often preferable to ABPM. More studies are still needed, though, to define situations where the information provided by HBPM is sufficient for clinically successful and cost-effective hypertension management, including prognostic stratification of hypertensive patients. Finally, we cannot exclude that progress in technology might soon lead to the development of inexpensive, automated BP measuring devices combining the functionalities and advantages of ABPM and HBPM tools (eg, HBPM devices with the capacity of automatically obtaining nighttime and/or ambulatory measurements), thus providing a practical solution to the current debate on the choice between these 2 approaches.

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G.P. has received lecture honoraria from Omron Healthcare and Microlife; G.B. has received lecture honoraria from Docleader SrL; S.O. has received lecture honorarium from Omron Healthcare.

References
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Response to Why Is Out-of-Office Blood Pressure Measurement Needed?

Home Blood Pressure Measurements Will Increasingly Replace Ambulatory Blood Pressure Monitoring in the Diagnosis and Management of Hypertension

Paolo Verdecchia, Fabio Angeli, Giovanni Mazzotta, Giorgio Gentile, Gianpaolo Reboldi

Dr Parati et al suggest that home blood pressure measurements (HBPM) and 24-hour ambulatory blood pressure monitoring (24-hour ABPM) are complementary tools. We agree. HBPM is extremely useful to monitor BP in the long term. Being more expensive and sometimes not well accepted by patients, 24-hour ABPM is less suitable than HBPM for repeated determinations over extended periods of time.

However, Dr Parati et al’s suggestion that HBPM is an ideal tool for the initial assessment of untreated hypertensive subjects is less supported by evidence. None of the available outcome-based studies with HBPM was specifically conducted in initially untreated subjects with clinical diagnosis of hypertension. This is not the case for 24-hour ABPM. In several longitudinal outcome-based studies conducted in independent centers, the initial 24-hour ABPM was carried out in untreated hypertensive subjects.

In our opinion, 24-hour ABPM should be considered to refine risk stratification in most untreated hypertensive subjects. Over and beyond clinic BP and other traditional risk factors, the average 24-hour BP (in particular night-time BP) improves risk stratification. Additional clues may be provided by the day-night dip, the pulse pressure, the BP variability and the early morning rise in BP. However, more research is needed to clarify whether the prognostic information provided by these additional measures of ambulatory BP is independent from that provided by the average 24-hour BP or night-time BP.

A preferential role for HBPM in the long-term management of hypertensive subjects, and for 24-hour ABPM in their initial assessment, appears reasonable and supported by evidence.
Why Is Out-of-Office Blood Pressure Measurement Needed?: Home Blood Pressure Measurements Will Increasingly Replace Ambulatory Blood Pressure Monitoring in the Diagnosis and Management of Hypertension

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