

# ASH Position Paper: Home and Ambulatory Blood Pressure Monitoring

## When and how to use self (home) and ambulatory blood pressure monitoring

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### Abstract

This American Society of Hypertension position paper focuses on the importance of out-of-office blood pressure (BP) measurement for the clinical management of patients with hypertension and its complications. Studies have supported direct and independent associations of cardiovascular risk with ambulatory BP and inverse associations with the degree of BP reduction from day to night. Self-monitoring of the BP (or home BP monitoring) also has advantages in evaluating patients with hypertension, especially those already on drug treatment, but less is known about its relation to future cardiovascular events. Data derived from ambulatory BP monitoring (ABPM) allow the identification of high-risk patients, independent from the BP obtained in the clinic or office setting. While neither ABPM nor self-BP monitoring are mandatory for the routine diagnosis of hypertension, these modalities can enhance the ability for identification of white-coat and masked hypertension and evaluate the extent of BP control in patients on drug therapy. © 2008 American Society of Hypertension. All rights reserved.

*Keywords:* Ambulatory blood pressure monitoring; home and self-BP monitoring; out-of-office-blood pressure; ASH position paper.

### Statement of the Problem

The accurate measurement of blood pressure (BP) remains the most important technique for evaluating hypertension and its consequences, and there is increasing evidence that the traditional office BP measurement procedure may yield inadequate or misleading estimates of a patient's true BP status. The limitations of office BP measurement arise from at least four sources: 1) the inherent variability of BP coupled with the small number of readings that are typically taken in the doctor's office, 2) poor technique (e.g., terminal digit preference, rapid cuff deflation, improper cuff, and bladder size), 3) the white coat effect (the increase of BP that occurs in the medical care environment), and 4) the masked effect (a decrease of BP that occurs in the medical care environment that may lead to under treatment; in the case of 'masked' hypertension, the out-of-office BP is

hypertensive while the resting, in-office BP is normotensive, or substantially lower than the out-of-office BP).

Nearly 70 years ago there were observations made that office BP can vary by as much as 25 mm Hg between visits.<sup>1</sup> The solution to this dilemma is potentially two-fold: by improving the office BP technique (e.g., using accurate validated automated monitors that can take multiple readings), and by using out-of-office monitoring to supplement the BP values taken in the clinical environment.

Out-of-office monitoring takes two forms at the present time: self (or home), and ambulatory BP monitoring (ABPM). While both modalities have been available for 30 years, only now are they finding their way into routine clinical practice. The use of self-BP monitoring (also referred to as home BP monitoring) as an adjunct to office BP monitoring has been recommended by several national and international guidelines for the management of hypertension, including the European Society of Hypertension,<sup>2</sup> the American Society of Hypertension (ASH),<sup>3</sup> the American Heart Association (AHA),<sup>4</sup> the British Hypertension Society,<sup>5</sup> the European Society of Hypertension,<sup>6</sup> the Japanese Hypertension Society,<sup>7</sup> the World Health Organization – International Society of Hypertension,<sup>8</sup> and the Joint Na-

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tional Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7).<sup>9</sup> In the USA, the use of self-BP monitoring is growing rapidly: Gallup polls suggest that the proportion of patients who report that they monitor their BP at home increased from 38% in 2000 to 55% in 2005. In contrast, the use of ABPM in clinical practice remains limited, although exact numbers are not available.

### Techniques of Out-of-Office Monitoring

ABPMs are used only by physicians' offices. They require preprogramming to take readings at preset intervals (typically every 15 to 30 minutes) throughout the day and night. They are reasonably accurate and are lightweight ( $\leq 1$  lb). The majority of patients can obtain a full profile of BP and its variability over 24 hours. The hardware and software of ABPM devices have changed little during the past decade. Because the costs of ABPM have not been covered well by third party payers, their use has been limited in clinical practice. Medicare has granted reimbursement for ABPM but only for the limited indication of suspected white coat hypertension with an absence of target organ damage; in our experience, this payment is typically less than the true cost of the procedure. Other insurers are becoming more liberal in reimbursing for ABPM but prior authorization is the rule rather than the exception.

Self-monitoring (home) BP devices have undergone substantial changes during the past decade. The first generation were aneroid devices that were hand-held, and required manual inflation and deflation. These devices are now rarely used, and have been replaced by automated oscillometric devices, which take single readings that are displayed on a liquid crystal display (LCD) screen. The more basic devices do not have memory or a printer, so patients are required to keep a written log of their BP readings. The accuracy with which patients obtain and write down the BP readings has been found to be questionable.<sup>10</sup> The monitors that have been formally validated have been found to be reasonably accurate; but many marketed self-monitoring devices have not been formally tested. As self-BP devices are readily available for purchase by patients and are inexpensive, their use has increased rapidly over the past decade. Freestanding devices, such as those found in pharmacies, may not be regularly maintained and may not be reliable.

The newest generation of self/home BP monitors have the same BP measurement technique as older devices but have increasingly sophisticated electronics. Many have memory so that they can easily compute the average values of the BP. Some of them will automatically take three readings at fixed intervals (e.g., one minute) following one press of a button. The latest models can be programmed to take readings at preset times, which might include periods of sleep. With this exception, the ability to record the nighttime pressure has been the exclusive domain of ambulatory mon-

itors and there is increasing evidence that nighttime pressure is an independent predictor of cardiovascular risk.<sup>11</sup> The ability of programmable self/home BP monitors could make nighttime readings more practical, although experience is limited at present.

The more sophisticated self/home BP monitors are distinctly more expensive than the currently available ones, and it is not clear whether they will be optimally used. Some patients will purchase these more expensive devices for self use but it is also possible that physicians will purchase these recorders and charge patients a modest fee for a diagnostic evaluation. This might include a week's worth of morning and evening readings plus a number of nighttime readings. The monitors often have models with different size cuffs – the inflatable part of the cuff should cover at least 80% of the circumference of the upper arm. About half of the users may need a large cuff.

### Clinical and Scientific Background

Self and ABPM can provide unique information that may be of help both for making treatment decisions and for evaluating the response to treatment (Table). The mainstay for the justification of both procedures is that there is steadily increasing and substantial evidence that both measures give a better prediction of risk than office BP. This has been shown in numerous studies using ambulatory BP measurements,<sup>11–18</sup> and in several studies using self-monitoring of the BP.<sup>18–21</sup> In general, when there is a discrepancy between the office BP and the out-of-office BP, the risk follows the latter more closely. Thus, patients with white coat hypertension (high office BP and normal out-of-office BP) are at relatively low risk,<sup>17</sup> while patients whose out-of-office BP is higher than anticipated from the office BP are at relatively high risk.<sup>15</sup> This latter condition has been referred to as masked, or hidden hypertension, on the grounds that it is not normally detected by conventional office BP measurements.<sup>22</sup> Even in treated hypertensive patients, a high out-of-office BP is a marker for increased risk.

Attributable to its inherent variability, using a small number of readings yields poor reproducibility for the BP level. By increasing the number of readings used to calculate the average, both self and 24-hour ambulatory monitoring give much better estimates of the average. In one study,<sup>23</sup> home BP was the most reproducible (lowest standard deviation of the differences between sets of measurements: 6.9/4.7 mm Hg for systolic and diastolic pressures for self-BP, 8.3/5.6 mm Hg for ambulatory BP, and 11.0/6.6 mm Hg for office BP). Self-measured BP readings may be more reproducible than ambulatory BP readings if they are taken under more standardized conditions.

**Table**

Comparison of office, ambulatory, and self (home) blood pressure monitoring

	Office BP Monitoring	ABPM	Self-BP Monitoring
Predicts events	Yes	Yes	Yes
Diagnostic utility	Yes	Yes	Yes
Detects white coat and masked hypertension	No	Yes	Yes (limited)
Evaluates the circadian rhythm of BP	No	Yes	No
Evaluation of therapy	Yes	Yes (limited repeat uses)	Yes
Normal limit for average risk patients (mm Hg)	140/90	130/80 (24-hour) 135/85 (awake) 120/75 (sleep)	135/85
Cost	Low	High	Low
Reimbursement	Yes	Partial	No

ABPM, ambulatory blood pressure monitoring; BP, blood pressure.

## Deciding When to Use Ambulatory and Home BP Monitoring

BP measured over 24 hours by an ambulatory recording is the best method for estimating an individual's cardiovascular risk related to hypertension. This has been established in a large number of prospective cohort studies,<sup>11–17</sup> most of which have shown that the office BP has negligible prospective value if the 24-hour BP is known. There are fewer prospective studies using home BP,<sup>18–21</sup> and only two that have compared ambulatory with self-BP monitoring (the Ohasama<sup>14,19</sup> and PAMELA studies<sup>18</sup>). Both of these studies found that the two methods had similar predictive value for future cardiovascular events. In principle, one would expect that 24-hour ambulatory BP would give a better prediction of risk because there are important aspects of the circadian profile of BP that are detected by ambulatory recordings, but not by self/home BP measurements. These include BP variability, the morning surge of BP, and the related measures of dipping, and the nocturnal BP.<sup>24</sup> Numerous studies have claimed that the nondipping pattern (a diminution or reversal of the normal fall of BP during the night), and a high nighttime BP predict risk independently of the 24-hour level; other studies have not confirmed this.<sup>24</sup> At the present time, there are no official guidelines relating to the interpretation of these additional measures, and a 24-hour BP of 130/80 mm Hg and a self/home BP of 135/85 mm Hg are the useful cut-off points for patients in whom antihypertensive therapy is being considered.<sup>24,25</sup> In the highest risk population, there are no official guidelines defining the ambulatory BP and self-BP equivalent of an office BP of <130/80 mm Hg.

An area where ABPM is particularly useful and superior to self-BP monitoring is the evaluation of the efficacy of antihypertensive drugs in clinical trials.<sup>26–28</sup> In clinical practice, however, clinic and self monitoring of the BP are the preferred methods for the clinical evaluation of re-

sponses to treatment, because performing multiple ABPM sessions in the same patient is impractical.

## Practical Considerations and Recommendations

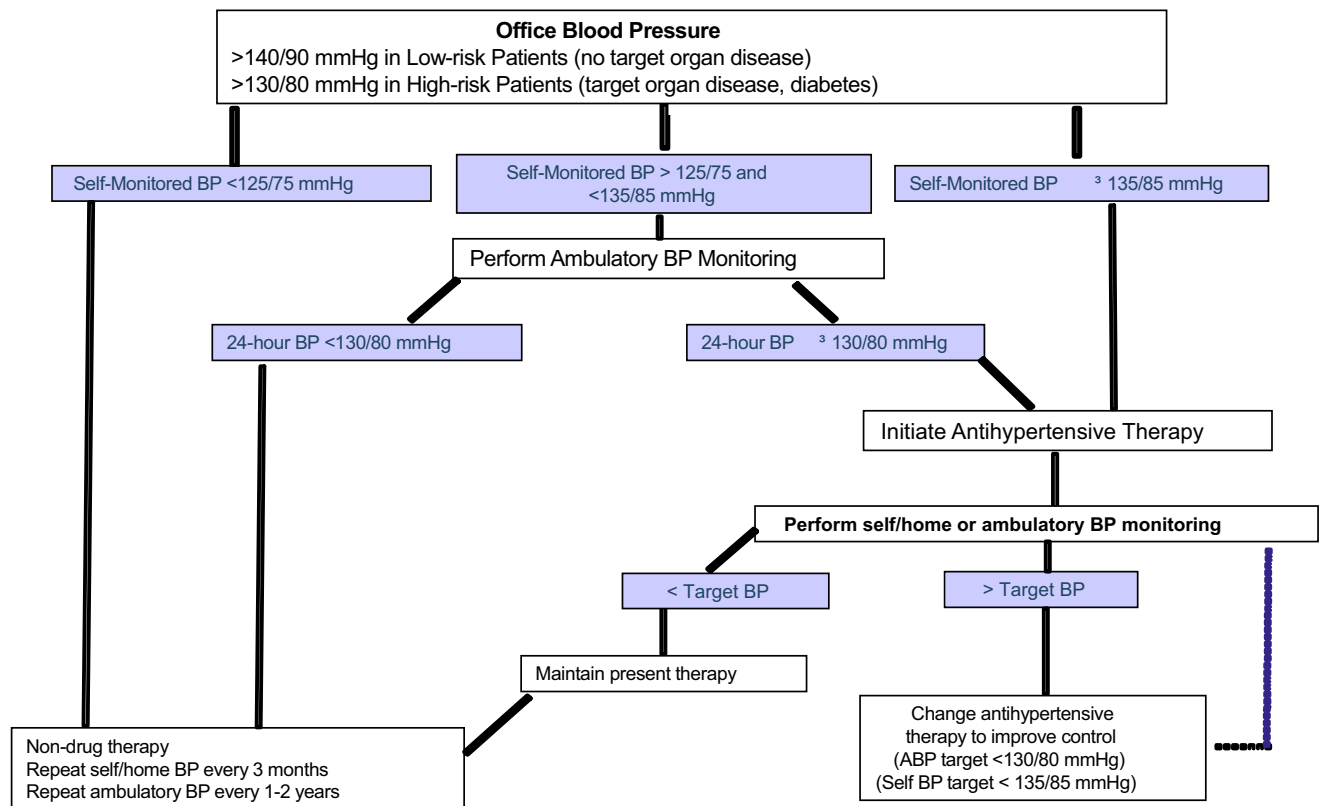
### *Finding the Appropriate Monitor for Self-Measurement*

For both ambulatory and self-BP monitoring, use of the upper arm is recommended.<sup>4</sup> While wrist monitors are popular for self-BP monitoring by patients, they are generally not recommended. Wrist monitors are limited by the need to hold the device very still at the level of the heart; however, in subjects with very obese upper arms, wrist monitors may be the only practical method. Finger devices are not reliable.

It is essential that only monitors that have been independently validated for accuracy according to a well established protocol be utilized. This is of particular relevance to self-BP monitors, because there are many such devices on the market that have not been independently tested. An updated list of validated monitors is available on the educational website (<http://www.dableducational.org/>). Manufacturers frequently change the model numbers of self-BP devices, making it hard to know if the validation results still apply. To remedy this, manufacturers are now being asked to sign a Declaration of Blood Pressure Measuring Device Equivalence.

### *Means to Utilize Self/Home BP Monitoring in Clinical Practice*

It is of utmost importance to educate patients in the proper use of their prescribed self/home BP devices. An appropriate cuff size should be selected based on arm circumference according to American Heart Association Guidelines for small, adult, and large adult cuff and bladder assemblies.<sup>4,29</sup> Patients should be instructed to take their



**Figure.** Practical use of self/home BP monitoring and ABPM in clinical practice. Self-BP monitoring should be performed according to strict guidelines prior to clinical decision-making (see text for details). Following antihypertensive therapy, the determination to use self/home BP monitoring vs. ABPM is made according to availability, clinical judgment, and insurance coverage. ABPM, ambulatory blood pressure monitoring; BP, blood pressure.

readings in the seated position (both legs on the floor, back supported, arm supported at heart level) after resting for five minutes. Three readings should be taken in succession (at one minute intervals) both first thing in the morning (prior to antihypertensive drugs) and in the evening (prior to dosing of antihypertensive drugs, if taken at that time). Duplicate readings taken in the morning and evening for one week and recorded and averaged will yield self/home BP values that can be utilized for diagnostic and therapeutic purposes.<sup>29</sup> Standing BPs can be obtained when indicated, for instance in diabetic autonomic neuropathy, when orthostatic symptoms are present, or when a dose increase in antihypertensive therapy has been made.

### Using ABPM in Clinical Practice

While ABPM is not widely available in primary care practice, it is generally offered by centers specializing in hypertension or cardiovascular medicine. Ambulatory BP measurement has particular utility in detection of masked hypertension, white coat hypertension, and assessment of antihypertensive therapy responses in patients on complex antihypertensive treatment regimens. As noted previously, ABPM is also the most effective means to determine the BP

values during sleep when nocturnal hypertension or nondipping profiles are suspected. Ambulatory monitoring studies should be performed on typical working days if the patient is employed; during the daytime it is advisable that the patient refrain from sleeping, performing vigorous exercise, and spending long periods of time driving (motion artifact). Diaries or journals documenting times of wakefulness and sleep as well as timing of antihypertensive medication doses are useful for interpretation of the data.

The ambulatory BP devices may not work well in some patients with very irregular cardiac rhythms including atrial fibrillation, or in patients with rigid arteries such as dialysis patients. In these individuals, the BPs should be compared with those obtained with auscultatory devices when the clinician is uncertain.

A schema showing how both self/home and ambulatory BP measurements may be used in clinical practice is shown in the Figure. Self-BP monitoring may be used as an initial step to evaluate the out-of-office BP, and if ABPM is available it is most helpful in cases where the self/home BP is borderline (between 125/75 mm Hg and 135/85 mmHg).<sup>27,29,30</sup> The target BP for self/home BP is usually 135/85 mm Hg for those whose target office BP is 140/90

mm Hg and 125/75 to 130/80 mm Hg for those whose target office BP is 130/80 mm Hg.<sup>29</sup> Equivalent values for ambulatory BP in low risk hypertensive patients are 130/80 mm Hg for 24-hour BP, 135/85 mm Hg for the awake BP, and 125/75 mm Hg for the sleep BP.<sup>4</sup>

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