

Home *versus* ambulatory blood pressure monitoring: which method wins the battle for out-of-office measurements? A review of recent literature

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Abstract

Out-of-office blood pressure monitoring has gained increasing importance in diagnosing and managing hypertension. The 2021 European Guidelines for out-of-office measurements provide a detailed guide on both methods' use, advantages and disadvantages. While ambulatory blood pressure monitoring (ABPM) has long been considered the gold standard, recent data have suggested that home blood pressure monitoring (HBPM) may be as useful or more as ABPM in managing long-term hypertension and improving soft and hard endpoints. These data also indicate that the two methods are complementary, have different indications and have different thresholds for diagnosing blood pressure. The J-HOP study (Japan Morning Surge-Home Blood Pressure) and the Improving the Detection of Hypertension (IDH) study both indicated that HBPM might be modestly superior to ABPM in terms of cardiovascular disease prognosis and left ventricular hypertrophy. This puts an end to the circular reasoning that ABPM was the gold standard for which anointing was performed without prospective studies. The present review provides critical insights into recent data in search of the best evidence-based recommendations for out-of-office BP measurement.

Keywords: ambulatory blood pressure monitoring, home blood pressure monitoring, hypertension guidelines.

Introduction

Guidelines for out-of-office blood pressure measurements were published for the first time in 2021

[1]. In that insightful paper, it was clear that we had two types measuring blood pressure that are not the same, but also that the choice of the method is not “either or”, but it was once again upon the physician to decide which method is best according to the patient that he had in front of him. Recent studies have shown promising results on the predictive capacity of home blood pressure measurements for cardiovascular events. These have advanced the position of the home BP higher than originally thought.

It is a fact that until recently, ABPM was considered the golden standard and all other methods

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were compared against that standard. Therefore, a *circular reasoning* started when ABPM was on the throne and all the other methods were compared for their validity to ABPM. This notion left no room for debate on ABPMs superiority until recently when the two methods were compared in terms of their predictability of soft and hard endpoints. Home blood pressure monitoring was thought to be a reasonable confirmatory method because there is less evidence to support its use. In a 2011 article, McManus and colleagues stated that if ambulatory monitoring is taken as the reference standard, treatment decisions based on clinic or home blood pressure alone might result in substantial overdiagnosis. Ambulatory monitoring before the start of lifelong drug treatment might lead to more appropriate treatment targeting, particularly around the diagnostic threshold. Therefore, the British guidelines were the first to adopt ABPM as a clinical tool for initial diagnosis and treatment [2]. Other guidelines were followed, such as the American and Canadian guidelines, and ABPM was placed as the preferred out-of-office measurement technique.

In contrast, the European, Chinese, and Australian guidelines showed no preference between the two out-of-office measurement techniques [1, 3–6]. The diversity in the guidelines is due to the fact that at the time of their release, no well-designed studies on the comparison of the two methods were published regarding soft or hard endpoints. We now have some studies that have addressed this issue in a well-designed and correctly powered manner [7–10]. The objective of this review is to discuss these recent findings.

Two complementary methods for measuring blood pressure

Home and ambulatory BP measurements are indeed two weapons in the armamentarium of a physician trying to diagnose and control blood pressure. As the 2021 guidelines for out-of-office BP measurement state, the two methods are complementary with different main indications, namely, home blood pressure is the preferred method for long-term follow-up of treated patients. However, ABPM is the preferred method for initial diagnosis. HBPM is mostly used to screen patients, whereas the perplexity of ABPM makes it unsuitable for large-scale population screening. Although the initial diagnosis is a strong point for both methods, ABPM is a better tool. Even though both can be used for treatment titration, HBPM is more suitable for long-term follow-up. The two methods have different thresholds for diagnosing BP, namely $\geq 135/85$ for home and $\geq 130/80$ mmHg for ABPM [1].

Problems in clinical practice

The limitations of both types of measurement are well known. Potential issues with HBPM include the need for medical supervision to ensure accurate readings, non-validated devices or inappropriate cuff sizes, frequent monitoring in the wrong positions, inducing anxiety in some patients, the risk of unsupervised treatment changes by patients, and selective reporting of readings by patients. Additionally, doctors may estimate instead of calculating the average home blood pressure, and there is no information on blood pressure at work or during sleep [1]. However, neither ABPM is the ideal standard for validation issues; anxiety, posture, rest, and talking can impact blood pressure measurements, further affecting their accuracy [1]. One study also found that side effects associated with ABPM ranged from bruising (7%) to device awakening during sleep (70%) [11]. In a more recent study that was conducted by investigators from the Centers for Disease Control and Prevention (CDC), 55% of participants reported that ABPM interfered with sleep [12].

Involving the patient

HBPM is a useful tool for cooperation between doctors and patients. Involving the patient in managing their health is a strong incentive for improvement and a sense of control of their BP in their own hands. Technology is helpful in this sense, as electronic databases of measurements linked via Bluetooth with HBPM monitors are available and easily accessible. One study showed that integrating home blood pressure readings into an electronic health record (EHR) workflow using a visualization tool is feasible and enhances sense-making and patient engagement in decision-making. The study found that access to home blood pressure readings during hypertension management visits, regardless of viewing mode, positioned the physician and patient to assess blood pressure management and make decisions about treatment modification if needed [13]. In this sense, the patient will be more accepting of the physician proposing ABPM if HBPM shows high variability or the physician cannot draw definite conclusions on the diagnosis or control of BP.

Home versus ambulatory BP measurement - Intermediate endpoints

Few studies have conducted head-to-head comparisons of ABPM and HBPM with intermediate cardi-

ovascular endpoints. In one study, within the first two hours following awakening, the partial correlation coefficients of carotid-femoral pulse wave velocity and urinary albumin-to-creatinine ratio with home morning BPs were higher than those with ambulatory morning pressures (0.21-0.37 versus 0.15-0.24; $P<0.05$). In contrast, associations with ambulatory morning SBP became non-significant after full adjustment for 24-hour blood pressure, except for the carotid-femoral pulse wave velocity association with ambulatory morning (6:00-10:00) systolic blood pressure. The coefficients of variation were 11% for ambulatory morning BPs and 5% for home self-measurements among 135 participants who underwent repeated ABPM and home self-measurements within a month. The authors concluded that home morning blood pressure might be preferred over ambulatory measurements because of its better reproducibility and stronger correlation with vascular indices [14].

In another study in Taiwan, the correlation coefficient was significantly greater for the relationship between daytime home SBP and LVMI than for that between ambulatory SBP and LVMI ($P<0.01$). The goodness of fit of the association between SBP and LVMI improved with the addition of home daytime SBP to other SBPs ($P<0.001$). The authors concluded that morning SBP assessed by home monitoring appeared to be a better predictor than other BP measures in determining preclinical hypertensive cardiovascular damage in patients with early-stage hypertension [15].

Moreover, in a study comparing ABPM with HBPM and their relationship to hypertensive organ damage, which was assessed by the urinary albumin-to-creatinine ratio and electrocardiographic criteria for left ventricular hypertrophy, the authors concluded that both home and ambulatory BPs were associated with organ damage [16].

Home versus ambulatory BP measurement - Cardiovascular endpoints

In 2016, a systematic review of ABPM vs. HBPM in cardiovascular disease demonstrated an association of blood pressure on ABPM and, separately, on HBPM with an increased risk of CVD events and/or mortality. However, a firm conclusion cannot be made regarding whether ABPM or HBPM is superior for assessing CVD risk. Therefore, no strong empirical evidence supports the guidelines that recommend ABPM over HBPM for the diagnosis and management of hypertension [9]. Recently, however, there has been accumulating evidence that HBPM is a stronger prognostic risk factor for cardiovascular events both in community-based populations and in hypertensive patients [17].

In 2021, Mancia et al. found that HBPM and ABPM predicted cardiovascular risk, but adding HBPM to office measurements improved the prediction more than ABPM [18]. Also, the results of the Improving Hypertension Detection (IDH) study supported a new paradigm which is when office BP, ABPM and HBPM were conducted using guideline-recommended approaches, HBPM is superior to ABPM and office blood pressure. These results are derived from the higher association of HBPM with left ventricular mass index (LVMI). The authors concluded that ABPM is unnecessary when both office and home BP are performed [19]. In 2023 the J-HOP study, HBPM showed a modest superiority of compared to ABPM in predicting cardiovascular disease prognosis [20]. The study also found that uncontrolled morning HBPM was associated with cardiovascular risks, even in patients with well-controlled ABPM [20]. In the Ohasama study, HBPM was found to be complementary to ABPM in predicting stroke, but there were no distinct groups that clearly showed the predictive power of each method [21]. In addition, a study by Mokwatsi et al. for the J-HOP study in 2020 [6] found that HBPM is comparable to ABPM in terms of measuring night-time blood pressure and detecting nocturnal hypertension.

The importance of night-time blood pressure

One factor that was thought to contribute to the predictive superiority of ABPM was its ability to measure night-time BP. The nocturnal BP pattern has an independent prognostic value in normotensive and hypertensive patients when compared to office BP measurements [22, 23]. HBPM did not provide data on night-time BP until recently when new units for measuring night-time BP were on the market, which can be programmed to automatically capture three nocturnal readings. In the J-HOP study, nocturnal hypertension defined by HBPM was associated with an increased risk of future cardiovascular events: total cardiovascular events (coronary artery disease and stroke events; 1.78 [1.00–3.15]) and stroke (2.65 [1.14–6.20]), independent of office SBP. These results were absent for nocturnal hypertension, as defined by the ABPM. This is the first prospective study to compare uncontrolled nocturnal hypertension defined by HBPM (independent of office SBP) as a predictor of future cardiovascular events [24]. According to Kollias et al., in a systematic review, the available evidence suggests that night-time HBPM and night-time ABPM have similar values and comparable relationships with target organ damage. However, there is a need for studies on the prognostic value of night-time HBPM [25].

How many days of HBPM are enough

For diagnosing home hypertension, there was good agreement with a minimum of three days of HBPM using the average of two morning and two evening measurements or a single morning and single evening BP reading [19]. Groenland et al. showed that at least 4.5 consecutive days of HBPM are required for a reliable diagnosis of home hypertension [26], so it looks like the recommended by the guidelines of 7 days are more than enough.

Which is the most cost-effective method

The usefulness of ABPM *versus* HBPM depends on the specific clinical scenario and patient population. Both techniques have their advantages and limitations. ABPM provides a continuous measurement of blood pressure over a 24-hour period and can provide valuable information on the variability of blood pressure throughout the day and night, as well as the nocturnal dipping pattern. This can help identify patients who may have masked or white-coat hypertension and can provide a more accurate assessment of blood pressure control compared to clinic measurements. In contrast, HBPM involves patients measuring their own blood pressure at home, which can provide a more convenient and accessible way to monitor blood pressure outside the clinic setting. It may be particularly useful for patients who have difficulty attending frequent clinic appointments or for those who are being treated for hypertension and need to monitor their blood pressure regularly. Both ABPM and HBPM have been shown to be better predictors of cardiovascular risk compared to clinic blood pressure measurements. However, the choice between the two techniques may depend on factors such as patient preference, clinical indications, and availability of monitoring devices.

In summary, both ABPM and HBPM are useful techniques for monitoring blood pressure outside of the clinic setting and can provide valuable information on cardiovascular risk. The choice between the two may depend on the specific clinical scenario and the patient population. Worldwide, HBPM is more widely available and less expensive than ABPM. However, ABPM was endorsed by in 2015 as the reference standard for out-of-office blood pressure monitoring [27]. More studies have examined the associations of out-of-office blood pressure with target organ damage using ABPM and HBPM. HBPM has consistently been recommended as an alternative approach if ABPM is unavailable or poorly tolerated by the patient.

The problem of not validated devices

In a 2020 research paper, the unspoken truth about the validity of the devices was captured very well. Non-validated BP devices dominate the online marketplace and are sold at a lower cost than validated ones, which is a major barrier to accurate home BP monitoring and cardiovascular risk management. Non-validated devices may provide dubious results for the measurement of home BP. This may cause a “garbage in, garbage out” situation, where the physician acts upon fallible measurements. Before purchasing a BP device, people should check it has been validated at <https://www.stridebp.org> [28]. Of course, ABPM is also sometimes measured by non-validated devices and this also should be addressed. However, the mass usage of HBPM devices makes them a priority for imposing strict regulations from governments and policymakers for their distribution and circulation.

The verdict

Although ABPM has been the preferred method for out-of-office measurement since its introduction in research and clinical practice, recent guidelines suggest that HBPM is a more practical approach in clinical practice than ABPM, particularly for individuals taking antihypertensive medication. The combined use of office and out-of-office BP evaluation can improve the accuracy of hypertension diagnosis and BP control status classification [18]. In conclusion, these two methods are complementary and interchangeable. The major issue with home BP measurements is that there is still no policy concerning the distribution of unvalidated devices in the marketplace. This could be a major public health issue because the prevalence of hypertension remains high and is a major cardiovascular risk factor. Out-of-office measurements are neither infallible nor perfect. Democracy could parallel this. As Churchill said decades ago, no one pretends that democracy is perfect or all-wise. Indeed, it has been said that democracy is the worst form of government, except for all forms that have been tried from time to time. This is somewhat the case for both ABPM and home BP measurements. None is perfect, but they are both extremely useful in diagnosing and following up high blood pressure. To date, the complete accuracy of BP measurements is a requisite for both clinical practice and research. Organizations such as Stride BP provide information to physicians and the public regarding validated devices. The right methodology for home blood pressure measurement should be provided through media, videos, and public awareness strategies. Unfortunately, the daily burden of the physician does not allow for an elaborate

description of the measurements most of the time. Hypertension societies should also promote the use of validated devices and correct measurements.

Conclusions

It is long overdue for policymakers to establish strict regulations for the distribution of any device meant for use in cardiovascular prevention. Since hypertension is the number one cardiovascular risk factor, it is imperative to withdraw all non-validated devices from the marketplace so that they will no longer threaten public health and prevent cardiovascular diseases. In addition, the public should be aware that many devices are not appropriate for the measurement of blood pressure, which should be communicated by doctors and scientific societies. As we see in recent years, when blood pressure is measured at home with validated devices and with the correct protocol, this could be modestly superior to ABPM. However, this is rarely the case. Until we achieve this, ABPM will remain the most valuable and cost-effective method for measuring blood pressure out-of-office.

Conflict of interest

The authors declare no conflict of interest.

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