

The role of home BP monitoring: Answers to 10 common questions

How does home BP monitoring stack up against clinic and ambulatory measurements for the Dx and management of hypertension? Find out in this review.

National Health and Nutrition Examination Survey (NHANES) data from 2011 to 2014 revealed that 29% of adults in the United States have hypertension.¹ Prevalence increases with age, so that 7% of adults ages 18 to 39 years, 32% of adults ages 40 to 59, and 65% of adults ages ≥60 years have the disease.¹ This national survey data also showed that 53% of those given the diagnosis had uncontrolled hypertension, and that control of hypertension did not change significantly from 2009 to 2014.¹

Elevated blood pressure (BP) has been the leading risk factor for death related to cardiovascular disease globally for the last 3 decades.² Yet in 2 nationally representative samples, only 1 in 6 patients with documented BP ≥140/90 mm Hg received treatment intensification with new medication during primary care visits.³ Uncertainty about the representativeness of any single clinic BP measurement is a prominent reason for health care providers not to intensify therapy.⁴

■ Confirming the Dx outside the office.

The 2015 US Preventive Services Task Force (USPSTF) guidelines on screening for hypertension state that, for most patients, a diagnosis of hypertension should be confirmed with out-of-office BP monitoring before initiating treatment.⁵ The USPSTF states that ambulatory BP monitoring (ABPM) is accurate for hypertension diagnosis and monitoring, and that home BP monitoring (HBPM) is an acceptable alternative, based on good quality evidence.

Access to ABPM, however, is often limited. In a 2015 survey of primary care clinics, only 25% of the 123 clinics that completed the questionnaire reported having access to it.⁶ Conversely, HBPM is widely available and acceptable to most patients. A recent NHANES survey showed that 43.5% of patients who were aware of their hypertension diagnosis engaged in HBPM.⁷

So what, exactly, should the role of HBPM be in the management of patients with hypertension? The evidence-based answers to the 10 questions that follow provide useful insights.

1. Can HBPM be used to confirm a Dx of hypertension?

Yes (Strength of recommendation [SOR] C).

In reviewing the diagnostic accuracy of various methods to confirm the diagnosis of hypertension, the USPSTF identified ABPM as the most accurate, followed by HBPM, with clinic BP measurements bringing up the rear.⁵ In adults ≥18 years of age, the USPSTF recommends obtaining BP measurements outside of the clinical setting for diagnostic confirmation before starting treatment unless the patient's BP is ≥180/110 mm Hg, there is evidence of end-organ damage, or the patient has a diagnosis of secondary hypertension.⁵ The USPSTF recommends HBPM as an acceptable alternative to ABPM based on 6 studies including a total of 1253 participants.⁸ The percentage of patients with elevated office BP confirmed by HBPM to

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Strength of recommendation (SOR)

- A** Good-quality patient-oriented evidence
- B** Inconsistent or limited-quality patient-oriented evidence
- C** Consensus, usual practice, opinion, disease-oriented evidence, case series

have hypertension was 45% to 84% across these 6 studies.

Sixteen studies from another systematic review evaluated the diagnostic accuracy of HBPM while using ABPM as a reference.⁹ This review found that HBPM had high specificity and negative predictive value, but low sensitivity and positive predictive value. There was moderate diagnostic agreement between HBPM and ABPM, with kappa statistic values of 0.37 to 0.73 across all studies.⁹

In yet another study, home BP and ambulatory BP measurements were identical when the same dual-mode device was used to measure both ambulatory and home BP.¹⁰

2. What are the diagnostic and treatment targets for home BP monitoring?

Treat patients if home BP is $\geq 130/80$ mm Hg and categorize patients as normotensive if home BP is $< 125/76$ mm Hg (SOR C). Monitor patients who are in between.

A 2017 joint statement from the American College of Cardiology/American Heart Association (ACC/AHA) Task Force states that the target BP for HBPM should be $< 130/80$ mm Hg.¹¹ The Joint National Commission (JNC) 8 issued BP goals of $< 140/90$ mm Hg for adults < 60 years of age and those with diabetes and/or chronic kidney disease, and a goal of $< 150/90$ mm Hg for adults ≥ 60 years of age with no diabetes or chronic kidney disease,¹² but much debate has recently surrounded these guidelines. JNC 8 does not provide a separate BP goal for HBPM.

Although based solely on evidence (and not patient-oriented outcomes), a home BP threshold of $\geq 135/85$ mm Hg for the diagnosis and treatment of hypertension has been supported by the European Society of Hypertension consensus guidelines,¹³ results of a longitudinal study,¹⁴ meta-analyses of published studies,¹⁴ and a meta-analysis using individual subject data.¹⁵

Support for a home BP measurement of $< 125/76$ mm Hg as normal is limited to a single cross-sectional study of 48 patients with 2 elevated office BP readings where the threshold of 125/76 mm Hg on home BP was

shown to exclude 80% of patients diagnosed with hypertension by ambulatory readings.¹⁶ If home BP measurements are $> 125/76$ mm Hg but $< 135/85$ mm Hg, 24-hour ambulatory BP monitoring is recommended to assess hypertension control.¹⁷

3. Does home BP monitoring improve hypertension control?

Yes, in the short term, but not in the long term (SOR C).

A meta-analysis of 13 comparative studies looking at HBPM alone vs usual care showed a small, but statistically significant, benefit of achieving target BP at 6 months with a relative risk ratio (RRR) of 1.3 (95% confidence interval [CI], 1.00-1.68; $I^2=77\%$).¹⁸ However, the pooled effects from 3 studies that measured the benefit of achieving a predefined BP target at the 12-month follow-up mark were not significant in this review (RRR=1.18; 95% CI, 0.95-1.46, $I^2=86\%$).¹⁸ The pooled effect from 19 studies from the same review showed that there was a statistically significant weighted mean difference of -3.9 mm Hg in systolic BP and a weighted mean difference of -2.4 mm Hg in diastolic BP at 6 months; however, the changes were no longer significant at the 12-month follow-up mark.¹⁸

More than half of the studies included in the meta-analysis were of low quality, and none of the studies recruited patients based on differences in clinic BP and home BP patterns, but rather on controlled or uncontrolled hypertension status. The studies included in this meta-analysis measured final BP outcomes by measuring ambulatory BP or clinic BP.

Another systematic review of 19 studies and 7100 participants looking at how HBPM compared with ABPM as a measurement standard for BP control and patient outcomes found insufficient data to determine the benefit of using HBPM as a measurement standard for BP control.¹⁹

HBPM + added support. There was high-quality evidence from the meta-analysis that HBPM plus additional support vs usual care led to a reduction in BP and a higher



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Do you confirm most diagnoses of hypertension with out-of-office (ambulatory or home) blood pressure monitoring?

Yes

No

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proportion of patients achieving target BP.¹⁸ However, the additional support interventions in the studies were heterogeneous.

4. Should HBPM be used to detect a change in BP associated with medication alterations?

Yes (SOR B).

A 2008 meta-analysis²⁰ and several other studies^{21,22} showed that HBPM has greater accuracy than office BP for identifying drug-induced BP changes. The 2008 meta-analysis looked at changes in office and home BP measurements produced by various antihypertensive drugs. In 7 studies that compared office BP measurements with home and ambulatory BP measurements, the 24-hour ambulatory BP measurements and home BP measurements showed less dramatic BP reductions with medications than clinic BP measurements.²⁰ This meta-analysis included 30 studies with 6794 participants and showed that home BP readings fell 20% less than office BP readings; the difference was statistically significant. These findings suggest that treatment-attributable changes in home BP and clinic BP measurements are linearly related, with the treatment effect on home BP measurements being around 80% of the effect on clinic BP measurements.

5. Do home BP measurements correlate with clinical outcomes?

Yes, and better than office BP measurements do; however, most studies comparing home BP measurements with usual care while looking at clinical outcomes are observational or quasi-experimental (SOR B).

For example, a 2015 systematic review looking at associations between BP measurement type (office, home, and ambulatory) and patient mortality found 5 observational studies that showed that adding home or ambulatory BP information improved cardiovascular risk prediction models. Moreover, all-cause mortality was associated with home BP and ambulatory BP levels only and not with office BP lev-

els.¹⁹ The number of participants in these 5 studies varied between 210 and 2051 with study duration between 2.4 and 12.3 years. Of note, every study had a distinct population, affecting the generalizability of the results.

One quasi-experimental study with 450 participants showed that home BP measurements were at least as good as ambulatory BP measurements at predicting end organ damage related to hypertension when organ damage was measured by cardiac echocardiography, detection of microalbuminuria, and carotid echocardiography.²³ Similarly, a systematic review of 14 studies and 2485 participants comparing home, ambulatory, and office BP readings showed that home BP measurements' association with left ventricular mass index is as good as that of ambulatory BP measurements, and superior to clinic BP readings.²⁴

6. Does HBPM help improve medication adherence?

The jury is still out on this one (SOR B).

A 2006 systematic review of randomized controlled trials (RCTs) incorporating HBPM and evaluating medication adherence outcomes found that in 6 of the 11 studies identified, there was some improvement in medication adherence with HBPM.²⁵ However, only 1 of the 6 studies in this review involved HBPM as the sole intervention; the remaining 5 studies employed additional adherence-enhancing strategies.

Another systematic review looking at HBPM vs usual care included 8 studies (3 of moderate quality and 5 of low quality) that measured medication adherence (using varying measures of adherence) of which only 3 studies showed some improvement in medication adherence with HBPM.¹⁸

7. Does HBPM reduce therapeutic inertia?

Yes (SOR B).

A meta-analysis of 15 studies showed that therapeutic inertia was less common with HBPM than with office BP monitoring alone; the relative risk for unchanged medi-



Home blood pressure monitoring correlates better with clinical outcomes than does office blood pressure monitoring.

cation was 0.82 (95% CI, 0.68 to 0.99) with HBPM.²⁶ However, 10 of the 15 studies were of low quality with a Jadad score ≤ 3 .

8. Does HBPM, along with titration of treatment, improve BP outcomes?

Yes (SOR B).

Two RCTs that looked at self-monitoring of BP and self-titration of hypertensive medications showed significant reductions in BP levels.^{27,28} In a cluster RCT of home BP tele-monitoring, in which the pharmacist adjusted antihypertensives based on transmitted BP measurements, hypertension control was significantly better in the intervention group than in the usual care group (57.2% vs 30%).²⁹

9. What are the recommended techniques for HBPM?

Patients should use a device that is validated, fully automated, and has an upper arm cuff (not a wrist monitor), according to a joint statement from the AHA, the American Society of Hypertension, and the Preventive Cardiovascular Nurses Association.¹⁷ (SOR C). (See validated BP monitor list at http://www.dableducational.org/sphygmo-manometers/devices_2_sbpmm.html.)

Patients should measure their BP in their nondominant arm after 5 minutes of rest with the arm at heart level, back supported, and feet flat on the ground. Patient technique and the accuracy of the home BP monitor should be checked annually. It is also recommended that patients check their BP 2 to 3 times every morning and evening. An average of 12 morning and evening measurements should be used for monitoring and treatment changes. An AHA informational sheet that shows how to measure BP properly can be found on their Web site (https://www.heart.org/-/media/files/health-topics/high-blood-pressure/how-to-measure-blood-pressure-letter-size-ucm_445846.pdf).

Several studies examining the accuracy of measuring BP over clothing did not find significant differences in BP measurements performed on a bare arm vs over a sleeve.³⁰⁻³³

10. What are the predictors of differences between home and office BP measurements?

Gender is one of the biggest predictors (SOR B).

A 2016 meta-analysis reported a total of 60 different hypothesized predictors of differences between home and clinic BP measurements (eg, gender, age, body mass index, systolic BP, diastolic BP). Masked hypertension was defined as a normal clinic BP reading and an elevated home BP reading. White coat hypertension was defined as an elevated clinic BP measurement with an acceptable home BP measurement. The researchers extracted odds ratios (ORs) for each study describing the association between patient characteristics and white coat or masked hypertension.³⁴ Studies of masked hypertension diagnosed from HBPM showed male gender as the most significant predictor of home-clinic BP differences (OR=1.47, 95% CI, 1.18-1.75). In contrast, female gender was the only significant predictor of white coat hypertension (OR=3.38; 95% CI, 1.64-6.96) when comparing home BP with clinic BP measurements.

Literature limitations and barriers to greater implementation

Most studies looking at HBPM outcomes have measured outcomes using ABPM or office BP measurements. The authors of studies using office BP as the outcome measure usually performed multiple BP measurements at often multiple office or clinic visits to calculate the true BP—a procedure that primary care practices rarely follow.³⁵ Additionally, there are significant methodologic differences in HBPM and ABPM; home BP is measured at rest, while ambulatory BP is measured while the patient is mobile and functioning. There are insufficient prospective studies looking at HBPM effects on clinical and patient-oriented outcomes.

The evidence clearly supports using HBPM in the diagnosis of hypertension and suggests its benefit in hypertension management. However, there are significant barriers to incorporating HBPM into practice—barriers that are largely unaddressed in the literature.

For HBPM to be successful, patients need affordable validated home BP monitors cov-

> Several studies examining the accuracy of measuring BP over clothing did not find significant differences in BP measurements performed on a bare arm vs over a sleeve.

ered by insurance that can translate home BP readings into usable information. Additional administrative and/or nursing assistance is required for patient education and support. Uploaded data need to be summarized in a way that is actionable and linked to the electronic health record.

As the volume of patient-generated home data increases, there is a risk of information overload. Thus, meaningful summarization of the data is required to enable the physician, patient, and/or pharmacist to take prompt and effective action. **JFP**

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One of the biggest predictors of differences between home and office blood pressure measurements is gender.