

# Out-of-Office Blood Pressure Monitoring in 2018

Sarah Melville, BSc, CRA; James Brian Byrd, MD, MS

**Out-of-office blood pressure (BP)** monitoring has proven essential for establishing new diagnoses of hypertension and facilitating its treatment, and its use is detailed in the 2017 ACC/AHA hypertension guidelines.<sup>1</sup> There are 2 main approaches to out-of-office BP monitoring: ambulatory BP monitoring (ABPM), which involves a patient wearing a device much like a Holter monitor that is connected to an automated upper-arm cuff and measures BP every 15 or 30 minutes during daily activities and every 15 to 60 minutes during a predesignated sleep period; and home BP monitoring (HBPM), which involves the use of commercially available, automated devices that patients use on their own to measure BP. Ideally, patients will measure their BP in the morning and evening over the course of several days, averaging at least 2 readings taken in the same time period.<sup>2</sup>

## ACC/AHA Guidelines for Out-of-Office BP Monitoring

The 2017 ACC/AHA hypertension guidelines recommend ABPM or HBPM to evaluate patients with suspected "white coat" hypertension, which is diagnosed when there is an elevated office BP measurement of at least 130/80 mm Hg but less than 160/100 mm Hg, the patient has tried 3 months of lifestyle modification, and the patient has an ABPM or HBPM averaging below 130/80 mm Hg. Establishing a diagnosis of white coat hypertension is important because there is no strong evidence to treat it with medications. ABPM or HBPM is also recommended for screening selected patients for "masked" hypertension, defined as having BP that is normal in the office but is elevated when measured at home. Patients not being treated for hypertension who have an office BP of 120 to 129/<80 mm Hg should be advised to pursue 3 months of lifestyle modification. Upon return if they still have a reading of 120 to 129/<80 mm Hg, they should pursue HBPM and if the daytime home BP is 130/80 or higher then a diagnosis of masked hypertension is made and they should continue with lifestyle modification and antihypertensive medications. For patients already taking hypertension medications who have an office BP that has achieved the goal for therapy and have an increased risk for CVD or target organ damage, HBPM should be pursued to screen for masked uncontrolled hypertension. Masked hypertension is a significant clinical problem with a prevalence of 15% to 30% among normotensive clinic patients.<sup>3</sup>

The exact relationship between office BP, HBPM, and ABPM values is not well known. However, office BP is usually higher than out-of-office measurements, which could lead to overtreatment if office measurements are not confirmed via HBPM or ABPM.<sup>1</sup> The ACC/AHA 2017 guidelines have lower BP targets than before, increasing the need for ABPM or HBPM to avoid overestimating BP and overtreating hypertension.

## Evidence Supporting the Use of Out-of-Office BP Monitoring

ABPM is valuable for differentiating hypertension from white coat hypertension and establishing a diagnosis of masked hyperten-

sion. A recent 10-year registry study of 63 910 participants confirmed earlier findings that ABPM is a stronger predictor of cardiovascular events than office BP measurements.<sup>4</sup> ABPM facilitated recognition of white coat and masked hypertension and of the BP categories, masked hypertension was most strongly associated with an increased risk of all-cause mortality (hazard ratio, 2.83; 95% CI, 2.12-3.79 vs 1.80; 95% CI, 1.41-2.31). That risk was even higher than for sustained hypertension (hazard ratio, 1.80; 95% CI, 1.41-2.31). White coat hypertension had a similar risk for all-cause mortality vs sustained hypertension (hazard ratio, 1.79; 95% CI, 1.38-2.32 vs 1.80; 95% CI, 1.41-2.31).<sup>4</sup>

Beyond serving as an alternative to ABPM for confirming the diagnosis of hypertension, HBPM is a valuable adjunct in the chronic management of hypertension. The recent TASMING trial<sup>5</sup> compared office BP monitoring with office BP plus HBPM, either with or without telemonitoring. Clinicians were free to titrate medications as they wished. In this study of 1182 participants, addition of either HBPM method resulted in significantly lower systolic BP after 12 months (3.5 mm Hg [95% CI, 5.8-1.2] lower with self-monitoring alone and 4.7 mm Hg [95% CI, 7.0-2.4] lower with self-monitoring plus telemonitoring) compared with office BP. HBPM with telemonitoring resulted in significantly lower systolic BP within only 6 months. Individual patient data meta-analysis supports the idea that HBPM in conjunction with co-interventions such as systematic medication titration or lifestyle counseling is more effective for BP lowering vs no self-monitoring.<sup>6</sup> The reasons co-intervention plus HBPM is effective are not fully known but could include overcoming clinical inertia, increased adherence to medication, or improved adherence with lifestyle modifications.<sup>6</sup>

## Educating Patients

Physicians ordering ABPM should ensure a validated device is used and help patients identify appropriate HBPM devices. Several validated ABPM and HBPM technologies available for purchase in the United States are reviewed in the **Figure**.

Explaining how ABPM works can help patients feel comfortable with the device. The importance of continuing regular daily activities during the 24-hour monitoring period should be explained. Patients should be given written instructions; a log for recording daily activities that includes sleep, wake, and medication times; and contact information for the clinicians in case questions or concerns arise.

Although HBPM is more practical and might be more convenient for the patient than ABPM, the success of HBPM depends on patient training in proper measurement technique<sup>2</sup> and on patient motivation. HBPM should be done in the morning and evening before taking medication. An average of at least 2 measurements should be taken about 1 minute apart on at least 2 occasions.<sup>1</sup> Patients need written instructions<sup>2</sup> and a log sheet for recording dates and times of BP measurements and medication doses.

Figure. Selection of Ambulatory and Home Blood Pressure Measuring Devices

	Device	Validation protocol	Upper arm cuff sizes	Features	Software and technological features	Device cost
ABPM upper arm devices for clinical use	SpaceLabs Healthcare <sup>a</sup> 90227 OnTrak	BHS: A/A ESH: Pass (2010)	Child, 12-20 cm Adult (small), 17-26 cm Adult (standard), 24-32 cm Adult (large), 32-42 cm Adult (extra-large), 38-50 cm, includes cuff support harness	300 readings; 2 AA batteries; developed for use in pediatric patients aged 3-12 y; inflation pressure can be set to 110, 130, 150, or 170 mm Hg	\$850, single computer license \$3500-\$4000, 2 network licenses and training	\$2400
	SpaceLabs Healthcare <sup>a</sup> 90217A Ultralite	AAMI: Pass BHS: A/A		270 readings; 3 AA batteries; developed for use in pediatric patients aged ≥6 y	\$850, single computer license \$3500-\$4000, 2 network licenses and training	\$2400 + \$117 for cable
	Microlife WatchBP O3	ESH: Pass (2002)	Medium, 22-32 cm Large, 32-42 cm	Programmable measurement modes for ambulatory, home, and clinic; programmable time intervals of 15, 20, 30, and 60 min for ambulatory monitoring; automatic recording button for time medication is taken	Free software download from company website	\$1995
HBPM upper arm devices	Omron Healthcare Evolv BP7000	ESH: Pass (2010)	Adjustable, 22.9-43.2 cm	No averaging of BP measurements; no internal device memory for BP measurements	Wireless monitor attached to cuff; Bluetooth connection to free mobile app via smartphone or tablet; spreadsheet feature to email BP measurements to user or physician	\$99.99
	Omron Healthcare BP786N	ESH: Pass (2010)	Adjustable, 22.9-43.2 cm	Feature for averaging 3 readings with set rest time between readings; internal device memory saves 200 readings	Wireless with device monitor and cuff separated by air tube; Bluetooth connection to free mobile app via smartphone or tablet	\$64.99 to \$69.99
	A&D Medical UA-651BLE	ESH: Pass (2010)	Standard, 22.9-37.1 cm Large, 31.0-45.0 cm	No averaging of BP measurements; no automatic series of measurements; internal device memory saves 30 readings with date and time stamps	Free download of A&D Connect mobile app software; wireless device to send and store unlimited measurements on Bluetooth-enabled phone or tablet	\$49.99
	Panasonic Ew3109	ESH: Pass (2002)	Standard, 19.7-40.0 cm Large, 34.9-43.8 cm	Single measurements only	Automatic memory of 90 readings	\$49.76 to \$52.00

Abbreviations: AAMI, Association for the Advancement of Medical Instrumentation; ABPM, ambulatory blood pressure monitoring; BHS, British Hypertension Society; BP, blood pressure; ESH, European Society of Hypertension; HBPM, home blood pressure monitoring.

<sup>a</sup>The SpaceLabs Healthcare 90207 ABPM device, as used in the registry-based study by Banegas et al,<sup>4</sup> is no longer available for purchase in the United States.

### How Physicians Should Use the Results of Out-of-Office BP Monitoring

Clinicians should consider using HBPM for medication titration and with other interventions such as individual lifestyle guidance. This useful co-intervention approach is exemplified by the TASMINH4 study protocol,<sup>7</sup> in which participants in the self-monitoring groups were instructed how to monitor their BP with an automated device and how to send the readings to the clinic. Participants monitored

their BP daily (twice in both the morning and evening) for 1 week at the beginning of the month and then sent the readings to the clinic. The physician or nurse reviewed the readings each month to actively titrate medication, as needed. By actively engaging patients in their hypertension management by having them perform HBPM and share those results with the clinician along with other interventions (eg, lifestyle guidance), their awareness of their condition is increased, which may result in better treatment adherence.

#### ARTICLE INFORMATION

**Author Affiliations:** CardioVascular Research New Brunswick, Saint John Regional Hospital, HHN, New Brunswick, Canada (Melville); IMPART Investigator Team Canada, Saint John, New Brunswick, Canada (Melville); Department of Medicine, University of Michigan Medical School, Ann Arbor (Byrd).

**Corresponding Author:** James Brian Byrd, MD, MS, Department of Medicine, University of Michigan Medical School, 5570C MSRB II, 1150 W Medical Center Dr, SPC 5678, Ann Arbor, MI 48109-5678 (jbyrd@med.umich.edu).

**Conflict of Interest Disclosures:** Ms Melville reports funding support from the New Brunswick Health Research Foundation (operating grant: Health Research Value Demonstration Initiative) provided directly to her professional supervisors, Keith R. Brunt, PhD (IMPART investigator team Canada) and Sohrab Lutchmedial, MD, FRCPC (CardioVascular Research New Brunswick, Saint John Regional Hospital, Horizon Health Network).

Dr Byrd reported receiving funding from the National Heart, Lung, and Blood Institute.

**Additional Contributions:** We thank Julie Vicente, RDCS, CRCS, and Kathy Walker, RCT, Saint John Regional Hospital, New Brunswick Heart Centre, for providing access to a 24-hour ABPM device so we could experience what patients should expect during ABPM.

#### REFERENCES

- Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol.* 2018;71(19):e127-e248.
- Jin J. Checking blood pressure at home. *JAMA.* 2017;318(3):310. doi:10.1001/jama.2017.6670
- de la Sierra A, Banegas JR, Vinyoles E, et al. Prevalence of masked hypertension in untreated and treated patients with office blood pressure

below 130/80 mm Hg. *Circulation.* 2018;137(24):2651-2653. doi:10.1161/CIRCULATIONAHA.118.034619

- Banegas JR, Ruilope LM, de la Sierra A, et al. Relationship between clinic and ambulatory blood-pressure measurements and mortality. *N Engl J Med.* 2018;378(16):1509-1520.
- McManus RJ, Mant J, Franssen M, et al; TASMINH4 investigators. Efficacy of self-monitored blood pressure, with or without telemonitoring, for titration of antihypertensive medication (TASMINH4): an unmasked randomised controlled trial. *Lancet.* 2018;391(10124):949-959.
- Tucker KL, Sheppard JP, Stevens R, et al. Self-monitoring of blood pressure in hypertension: a systematic review and individual patient data meta-analysis. *PLoS Med.* 2017;14(9):e1002389.
- Franssen M, Farmer A, Grant S, et al. Telemonitoring and/or self-monitoring of blood pressure in hypertension (TASMINH4): protocol for a randomised controlled trial. *BMC Cardiovasc Disord.* 2017;17(1):58. doi:10.1186/s12872-017-0494-5