

# Assessment of Automated vs Conventional Blood Pressure Measurements in a Veterans Affairs Clinical Practice Setting

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**Background:** Automated office blood pressure (AOBP) measurement devices that generate multiple measurements of an unattended patient are increasingly common but their efficacy in a veteran population has not been determined. This study evaluated the difference between automated and conventional BP measurements obtained during cardiology clinic visits at the West Palm Beach VA Medical Center (WPBVAMC).

**Methods:** This retrospective review compared BP measurements taken in the WPBVAMC cardiology clinic between May 2017 and February 2019. Data were evaluated with descriptive statistics. Where appropriate, paired comparisons of continuous and binary variables were evaluated with the paired *t* test and McNemar test for change, respectively.

**Results:** AOBP and conventional office BP measurements for 95 patients were included. AOBP measurements were

taken with the patient sitting alone in a clinic office or in the nursing triage area. The mean values of systolic BP (SBP) and diastolic BP (DBP) were lower for the AOBP method vs the conventional office measurement method, with a difference of 14.6 mm Hg ( $P < .001$ ) and 3.5 mm Hg ( $P = .0002$ ), respectively. A white coat effect was suggested based on an SBP reduction of  $> 20$  mm Hg from conventional to AOBP measurements in 22 patients (23%) and a DBP reduction of  $> 10$  mm Hg in 21 patients (22%). The percentage of patients with controlled BP ( $< 130/80$  mm Hg) was higher in the AOBP group than in the conventional measurement group (22% vs 7%, respectively;  $P = .001$ ).

**Conclusions:** This analysis suggests that the use of AOBP may reduce misclassification of patients with hypertension, prevent unnecessary therapeutic interventions, and mitigate the white coat effect.

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Hypertension remains one of the most important modifiable risk factors for the prevention of cardiovascular (CV) events. According to a population-based study, 25% of CV events (CV death, heart disease, coronary revascularization, stroke, or heart failure) are attributable to hypertension.<sup>1</sup> Recent guidelines have emphasized the importance of accurate blood pressure (BP) measurement in facilitating appropriate hypertension diagnosis and management.<sup>2-4</sup>

Currently, there are different BP measurement methods endorsed by practice guidelines. These include conventional in-office measurement, 24-hour ambulatory BP monitoring (ABPM), home BP monitoring (HBPM), and automated office BP (AOBP) measurement.<sup>2-4</sup> AOBP device protocols vary but generally involve devices automatically taking multiple BP measurements while the patient is unattended. These measurements are then presented as a single averaged reading, with individual BP values available for review by the clinician.

Researchers have found that AOBP measurements have a greater association with ABPM values and can mitigate the white coat effect observed in a substantial proportion of patients during in-clinic

BP measurement.<sup>5</sup> A meta-analysis found that the use of AOBP was associated with a 10.5 mm Hg reduction in systolic BP (SBP) compared with traditional office-based BP assessments.<sup>5</sup> Similarly, a separate meta-analysis found that AOBP SBP measures were on average 14.5 mm Hg lower than routine office or research setting values.<sup>6</sup> In addition, CV risk outcomes data support the use of AOBP to screen and manage patients with hypertension. The Cardiovascular Health Awareness Program (CHAP) study used AOBP values to determine the risk for CV events (myocardial infarction, congestive heart failure, and stroke) in community-based patients aged  $\geq 65$  years.<sup>7</sup> The study showed a significantly higher risk of CV events in patients with an SBP of 135 to 144 mm Hg and a diastolic BP (DBP) of 80 to 89 mm Hg. Therefore, the CHAP study researchers suggested an AOBP target of  $< 135/85$  mm Hg to decrease the risk of CV events.<sup>7</sup>

The landmark SPRINT trial, which was a major contributor to the development of BP target recommendations in guidelines, utilized AOBP to classify hypertension and guide management.<sup>2-4,8</sup> SPRINT ultimately showed that intensive BP-lowering treatment

(to SBP < 120 mm Hg) was associated with a 25% reduction in major CV events and a 27% reduction in all-cause mortality.<sup>8</sup> Other evaluations found a close association between AOBP values and left ventricular mass index and carotid artery wall thickness as surrogate markers for end-organ damage.<sup>9,10</sup> These data show AOBP as a reliable method to guide antihypertensive therapy interventions in the clinical setting.

Considering these proposed advantages, the 2017 Canadian guidelines for hypertension management recommend AOBP as the preferred method for clinic-based BP measurement, and the 2018 European Society of Cardiology/European Society of Hypertension blood pressure guidelines recommend the use of AOBP when feasible.<sup>3,4</sup> The 2017 American College of Cardiology/American Heart Association Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults also discusses AOBP as a method to minimize potential confounders in BP values.<sup>2</sup>

This study evaluated the difference between AOBP and conventional in-office BP measurements obtained during cardiology clinic visits at the West Palm Beach Veterans Affairs Medical Center (WPBVAMC).

## METHODS

A retrospective review of AOBP measurements was performed at the WPBVAMC cardiology clinic between May 26, 2017, and February 19, 2019. These AOBP measurements were taken at the discretion of a nurse or other clinician after initial, conventional BP measurements had been taken as part of clinic check-in procedures. No formal protocols dictated the use or timing of AOBP measurements. Similarly, the AOBP results were factored into clinical care decisions.

Clinicians at the cardiology clinic used AOBP averages that were derived using the BpTRU BPM-100 (BpTRU Medical Devices) meter, which averaged 5 BP readings taken at 1-minute intervals. Clinicians selected cuff size based on manufacturer recommendations. The testing was done with the patient seated alone in either a nursing triage area or a clinic office.

Data collected during the retrospective review included the clinician associated

**TABLE. Clinic-Based Blood Pressure Measurements**

Measure	Conventional office	AOBP	Difference	P value
SBP, mean, mm Hg	157.5	142.9	14.6	< .001
DBP, mean, mm Hg	82.7	79.2	3.5	.0002
Pulse, mean, beats/min	69	68.1	0.9	.20

Abbreviations: AOBP, automated office blood pressure; BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure.

with the visit, the patient's physical location and accompaniment status during AOBP measurement, conventionally measured BP and heart rates, and AOBP-derived BP and heart rate averages. Differences in BP values were compared with the paired *t* test, while binary comparisons were conducted through the McNemar test. Data collection and analysis were performed using Microsoft Excel.

During data collection, all information was stored in a secure drive accessible only to the investigators. The project was approved by the West Palm Beach Veterans Affairs Healthcare System Research and Development Committee as a nonresearch activity in accordance with Veterans Health Administration Handbook 1058.05; thus, institutional review board approval was not required.

## RESULTS

Ninety-five nonconsecutive patients were included in the analysis. AOBP measurements were taken with the patient sitting alone in either a clinic office (*n* = 83) or nursing triage area (*n* = 12). Most patients were coming in for follow-up appointments; 13 patients (14%) had appointments related to a 24-hour ABPM session.

The mean SBP and DBP values were lower for the AOBP measurements vs the conventional BP measurements (mean SBP difference, 14.6 mm Hg; *P* < .001; mean DBP difference, 3.5 mm Hg; *P* = .0002) (Table). There were no appreciable differences in heart rates. The white coat effect was suggested based on an SBP reduction of > 20 mm Hg from conventional to AOBP measurements in 22 patients (23%), a DBP reduction of > 10 mm Hg in 21 patients (22%), and a reduction in both values in 8 patients (8%).

A controlled BP (< 130/80 mm Hg) was more common in the AOBP group than in

the conventional group (22% vs 7%, respectively;  $P = .001$ ).<sup>2</sup> Review of conventional BP measurements indicated that 11 patients had systolic readings  $\geq 180$  mm Hg, 2 had diastolic readings  $\geq 110$  mm Hg, and 1 had a reading that was  $\geq 180/110$  mm Hg. AOBP measurements indicated that these 14 patients had SBP readings  $< 180$  mm Hg and DBP readings  $< 110$  mm Hg. The use of AOBP measurements may have mitigated unnecessary emergency room visits for these patients.

On review of clinic notes and actions associated with episodes of AOBP testing during routine follow-up clinic appointments, AOBP was determined to be useful with regard to clinical decision-making for 65 (79%) patients. Impacts of AOBP inclusion vs conventional BP assessments included clinician notation of AOBP, support for making changes that would have been considered based on conventional BP assessment. AOBP results gave support to forgoing a therapeutic intervention (ie, therapy addition or intensification) that may have been pursued based on conventional BP measurements in 25 of 82 patients (30%). These data suggest that AOBP readings can be useful and actionable by clinicians.

## DISCUSSION

The findings of this study add to the growing evidence regarding AOBP use, application, and advantages in clinical practice. In this evaluation, the mean difference in SBP and DBP was 14.6 mm Hg and 3.5 mm Hg, respectively, from the conventional office measurements to the AOBP measurements. This difference is similar to that reported by the CAMBO trial and other evaluations, where the use of AOBP measurements corresponded to a reduction in SBP of between 10 and 20 mm Hg vs conventional measures.<sup>5,11-18</sup>

These findings showed a significantly higher percentage of controlled BP values ( $< 130/80$  mm Hg) with AOBP values compared with conventional office measurements. The data supported the decision to defer antihypertensive therapy intervention in 30% of patients. Without AOBP data, patients may have been classified as uncontrolled, prompting therapy addition or intensification that could increase the risk of adverse events. Additionally, 14 patients

would have met the criteria for hypertensive urgency under the guidelines at that time.<sup>2</sup> With the use of AOBP readings, none of these patients were identified as having a hypertensive urgency, and they avoided an acute care referral or urgent intervention.

The discrepancy between AOBP and conventional office BP measurements suggested a white coat effect based on SBP and DBP readings in 22 (23%) and 21 (22%) patients, respectively. Practice guidelines recommend ABPM to mitigate a potential white coat effect.<sup>2-4</sup> However, ABPM can be inconvenient for patients, as they need to travel to and from the clinic for fitting and removal (assuming that a facility has the device available for patient use). In addition, some patients may find it uncomfortable. Based on the correlation between AOBP and awake ABPM values, AOBP represents a feasible way to identify a white coat effect.

AOBP monitoring does not appear to be affected by the type of practice setting, as it has been evaluated in a variety of locations, including community-based pharmacies, primary care offices, and waiting rooms.<sup>12,19-22</sup> However, potential AOBP implementation challenges may include office space constraints, clinician perception that it will delay workflow, and device cost. Costs associated with an AOBP meter vary widely based on device and procurement source, but have been estimated to range from \$650 to  $> \$2000$ .<sup>23</sup> Published reports have described how to overcome AOBP implementation barriers.<sup>24,25</sup>

## Limitations

The results of this evaluation should be interpreted cautiously due to several limitations. First, the retrospective study was conducted at a single clinic that may not be representative of other Veterans Health Administration or community-based populations. In addition, patient data such as age, sex, and body mass index were not available. AOBP measurements were obtained at the discretion of the clinician and not according to a prespecified protocol.

## CONCLUSIONS

This analysis showed AOBP measurement leads to a greater percentage of controlled

BP values compared with conventional office BP measurement, positioning it as a way to reduce BP misclassification, prevent potentially unnecessary therapeutic interventions, and mitigate the white coat effect.

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### Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner*, Frontline Medical Communications Inc., the US government, or any of its agencies.

### Ethics and consent

This project was overseen by the West Palm Beach Veterans Affairs Medical Center Research and Development Committee which determined that the quality analysis project was exempt from institutional review board evaluation.

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