

## Using 15-Minute Serial Blood Pressures as an Alternative to Measuring a Single Blood Pressure

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### Abstract

Thirty-minute office blood pressure (OBP-30) is an alternative to ambulatory blood pressure (BP) measurement, yet is impractical to implement. This study aimed to determine whether unattended BP readings over 15 minutes would result in a similar probability of obtaining a BP of <140/90. Sixty-seven adults self-described as having high BP were analyzed. BP was measured at baseline and every 5 minutes for 15 minutes with the initial reading compared to the average of the last three readings (OBP-15). Compared to baseline, there was a decline in both average systolic (4.2 points) and diastolic (2.8 points) BP. The probability of BP control predicted by multivariate model was 71.6% at baseline and 78.0% using OBP-15 ( $p=0.011$ ). The increase in BP control from initial to OBP-15 measurement was significant for indigenous or persons of color compared to whites, and men compared to women. OBP-15 is convenient and results in lower BP readings and higher probability of BP control compared to the initial reading.

**Keywords:** unattended blood pressure, OBP-15, hypertension, serial blood pressure measurement

### Introduction

An accurate measurement of blood pressure (BP) is critical for the diagnosis of hypertension, yet difficult to attain in clinical settings.<sup>1</sup> Routine office BP measurement may be subject to the white coat effect or masked hypertension.<sup>2</sup> Although 24-hour ambulatory BP monitoring (ABPM) is the most accurate method to diagnose hypertension and can often identify white coat hypertension or masked hypertension,<sup>3</sup> it is used infrequently in the United States due to inconvenience, patient intolerance, availability, and lack of reimbursement. Automated office BP (AOBP) monitors, which reduce human error, have mostly replaced the manual auscultatory method in clinical practice. They can record multiple BP readings after activation, be left unattended, and provide an average of the readings taken.<sup>1</sup> In the absence of ABPM, the American Heart Association's (AHA) preferred measurement is a validated AOBP device that can take an average of 3 or more BP readings, with unattended AOBP preferred over attended AOBP.<sup>1</sup>

Thirty-minute office blood pressure measurement (OBP-30), a form of AOBP, has also compared favorably to daytime ABPM<sup>4</sup> and resulted in lower BP readings than AOBP.<sup>5-7</sup> For OBP-30, a patient is seated in an exam room by themselves and automated blood pressure measurements are obtained every five minutes for a total of seven readings over 30 minutes. The final five or six readings are averaged for a final 'OBP-30 reading.' In one study, the use of OBP-30 showed an average

systolic blood pressure (SBP) decrease of -22.8 mmHg and diastolic blood pressure (DBP) decrease of -11.6 mmHg from office blood pressure.<sup>6</sup> A second study showed a decrease in SBP of -7.6 and -4.6 mmHg and decrease in DBP of -2.5 and -1.2 mmHg over two visits, respectively.<sup>5</sup> Yet another study found that compared with standard AOBP, OBP-30 resulted in an increased adjusted probability of having a blood pressure measurement of <140/90. Furthermore, the study found females (compared to males) and Black patients (compared to white patients) were more likely to reach a blood pressure goal of <140/90 using OBP-30 compared to their counterparts.<sup>7</sup>

While OBP-30 is easier to incorporate into a clinical setting than 24-hour ABPM, it still may be difficult to implement in an outpatient practice as it entails sitting for 30 minutes while serial BPs are checked. If accurate readings similar to OBP-30 could be achieved in less time (e.g., 15 minutes), it would be easier to incorporate routinely into a clinical setting.

The purpose of this study was to assess whether an unattended 15-minute blood pressure measurement (OBP-15) would increase the probability of meeting a blood pressure goal of less than 140/90 mmHg ("<140/90") from baseline. Fifteen minutes was chosen based on previous OBP-30 research that showed blood pressure dropped in the first 15 minutes then plateaued.<sup>7</sup>

### Methods

#### Population

Subjects were recruited at the Minnesota State Fair on August 28 and 29, 2021 through the University of Minnesota's "Driven to Discover" program; a building dedicated to research studies. Inclusion criteria were non-pregnant adults over the age of 18 who had been told by a medical provider they have high BP. Demographic information collected included age, sex, race, ethnicity, number of current BP medications, presence of chronic kidney disease, number of hours at the fair, and number

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of alcoholic beverages in the past two hours. Subjects visibly intoxicated were unable to consent and were excluded.

### Study Design

Subjects were consented to the process by research staff, completed a questionnaire, and were seated in a backed chair with armrests. An appropriate-sized automated BP cuff was placed on the arm of their choosing. Subjects were instructed to sit quietly with their feet on the floor and their arms on the chair's armrest and not to drink caffeinated beverages during the study. The automated BP cuff measured BP at baseline and every five minutes for fifteen minutes. Four BPs were recorded with the last three averaged for the OBP-15 measurement. Results were given to the subjects and they were compensated with a drawstring backpack. BP measurements were obtained on a validated Welch-Allyn Connex<sup>®</sup> Spot Monitor. All data was stored in Research Electronic Data Capture (REDCap), a database system that provides a secure, central, web-based, Health Insurance Portability and Accountability Act-compliant environment.<sup>8</sup> This study was approved by the University of Minnesota Institutional Review Board.

### Statistical Analysis

BP control in the OBP-15 measurement was defined as having the average of the last three BP measurements <140/90. A BP goal of <140/90 was chosen based on recommendations from the American Academy of Family Physicians,<sup>9,10</sup> as well as state-based quality measures. The authors acknowledge this may not be an appropriate individual goal for each patient. The probability of having BP control was modeled as a logit regression, controlling for age, sex, race, number of BP medicines, number of alcoholic drinks consumed in the past two hours, and number of hours spent at the fair that day as of the time of BP measurement. The presence of chronic kidney disease was not included because the low occurrence (4 of 67) meant we did not have enough sample size to detect its effect. The differences in probability of achieving BP control, comparing the initial measurement to the OBP-15 measurement, was measured using a paired t-test.

### Results

Sixty-seven of the original 72 volunteers who had complete data were included in the analysis. Five of the participants were excluded; four because of difficulties in the measurement process, and one due to visible intoxication. Thirty-four percent of the subjects were under 55, with the majority of participants between the ages of 55 and 74 (58%). Slightly more males than females participated (54% and 46%). The study population was primarily white (87%), with no Black participants. The most common race represented in the "Other Indigenous or Person of Color (IPOC)" category was Asian. Two-thirds of the participants were on at least one BP medication (Table 1).

Overall, the population had well controlled BP, with 71.6% and 80.6% of participants having a BP <140/90 on initial and

OBP-15 reading, respectively. Between initial and OBP-15 measurements, the average systolic BP measure declined by 4.2 points (128.5 mmHg to 124.3 mmHg), and the average diastolic BP measure declined by 2.8 points (82.5 mmHg to 79.7mmHg). Overall, the average probability of BP control predicted by multivariate model was 71.6% at the initial measurement, and 78.0% using OBP-15 ( $p=0.011$ ).

Two populations saw significant improvement in BP control from initial to OBP-15 measurement. IPOC participants had a significant increase in BP control from 66.5% to 80.2% ( $p<0.001$ ), whereas white participants had a marginal but non-significant increase in BP control from 74.8% to 77.5% ( $p=0.114$ ). Similarly, the improvement in BP control in men was statistically significant, with a percentage-point increase from 58.5% to 66.1% ( $p<0.001$ ), whereas the change for women was non-significant, increasing from 88.3% to 89.8% ( $p=0.083$ ).

Figure 1 documents the patterns in unadjusted BP control over time, by race and sex. Across all population groups, similar patterns emerged of improving or stable BP control from the initial through the second of the OBP-15 measurements, however a slight difference emerged in the final measurement in the OBP-15 process. White and female participants continued the favorable trend, while IPOC and male participants saw a slight rebound to lower rates of BP control.

### Discussion

The results of this study show that BP declined over the period of 15 minutes although to a lesser extent than studies on OBP30. Still, OBP-15 may be a suitable option for serial blood pressure measurement, as recommended by the AHA. Pharmacists in ambulatory care or community-based settings could easily implement OBP-15 and utilize the results to manage blood pressure.

One of the key findings in this study was that males showed a greater increase in achieving a BP <140/90 than female participants. This is in direct contrast to this team's previous research.<sup>7</sup> A hypothesized reason for this could be the lack of presence of a white coat effect in female subjects in a non-clinic environment, as has been proposed in the literature.<sup>11</sup> Additionally, despite a low enrollment of IPOC subjects, this study seems to confirm this research team's previous discovery of the benefits of unattended AOBP in an IPOC population.<sup>6</sup> Caution should be used in applying this assessment broadly as non-white individuals made up a small portion of this study and there were no Black participants.

Another key result from this study was the evidence of a slight increase in BP upon the final reading for some groups. This is a similar phenomenon this research team found in the original OBP-30 study (results unpublished), which was thought to be overcome with a shorter time frame. Anecdotally, it seemed that participants were anxious for the study to end, and

therefore, a slight increase in BP could have occurred. It is also possible that no matter what time frame is used, subjects will anticipate the end of the measurement period and subsequently see an increase in BP at the end of the study. Additional research is needed in a more controlled environment to determine the exact cause of this phenomenon.

There were several limitations to this study. The major limitation to this study is that it was not located in a clinic setting, and therefore comparisons to clinic-obtained BPs are limited. This is illustrated by the fact that on average, most subjects were at a goal BP of <140/90 at baseline. White coat hypertension is unlikely in a state fair setting, and patients may be more relaxed given the fun nature of a fair environment. Additionally, by the nature of the setting, being located in a building only conducting research, it is possible that more health-conscious subjects chose to participate in the study. It is also possible this study included some patients that did not have hypertension. By using the phrasing 'been told by a physician that they have high blood pressure', the door was opened to potentially including subjects without a diagnosis of hypertension. Demographic data showed that approximately one-third of subjects were not on a BP medication, and therefore this portion could either have untreated hypertension or not have a diagnosis of hypertension. However, a sub-analysis of participants on one or more medications produced similar results to those described here. Additionally, a standard 5-minute rest was not used prior to obtaining the initial serial blood pressure reading, as is recommended in the AHA guidelines.<sup>1</sup> Finally, another limitation is that a broad BP goal of <140/90 was used, which may not have represented a subject's individual BP goal.

### Conclusion

OBP-15 may be a suitable alternative to OBP-30, although there were some key differences that may have occurred due to the setting being outside of a medical office. Unattended AOBP remains the best way to diagnose hypertension in IPOC patients. This study showed a slight increase in BP towards the end of the study that may indicate fifteen minutes is still too long of a time frame for unattended BP measurements. Some studies seem to indicate the best method of obtaining AOBP measurements in a patient with hypertension may be averaging the last two of three readings over 6 minutes after 5 minutes rest. More research in this area is needed to determine the most appropriate length and interval for unattended AOBPs.

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**Ethics Approval:** This study was approved by the University of Minnesota Institutional Review Board.

**Patient Consent:** All patients opted into this research study via informed consent.

### Abbreviations:

ABPM: 24 hour ambulatory blood pressure measurement  
 AHA: American Heart Association  
 AOBP: automated office blood pressure  
 BIPOC: Black, indigenous, or persons of color  
 BP: blood pressure  
 BPM: blood pressure measurement  
 IPOC: indigenous, or persons of color  
 OBP-30: 30 minute office blood pressure  
 OBP-15: 15 minute office blood pressure

**Disclaimer:** The statements, opinions, and data contained in all publications are those of the authors.

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**Table 1 - Summary of Population Characteristics**

Number of patients	67
Average Blood Pressure - Initial Measurement (mm Hg)	
Systolic	128.5
Diastolic	82.5
Average OBP-15 Measurement (mm HG)	
Systolic	124.3
Diastolic	79.7
Patient Age	
Under 55	34.3%
55-64	43.3%
65-74	14.9%
75 or older	7.5%
Patient Sex	
Male	53.7%
Female	46.3%
Patient Race	
White	86.6%
Black	0.0%
Other	13.4%
Number of Blood Pressure Medications	
0	32.8%
1	49.3%
2	10.4%
3 or more	7.5%
Number of Alcoholic Drinks in Prior 2 Hours	
0	80.6%
1	13.4%
2 or more	6.0%
Amount of Time at Fair	
0-1 hours	14.9%
2-3 hours	32.8%
4-5 hours	26.9%
6-7 hours	14.9%
8 or more hours	10.5%

Figure 1 – Rates of Blood Pressure Control over Time

