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Setting and Method of Measurement Affect Blood Pressure Readings in Older Veterans

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The present study demonstrated that standardized measurements of blood pressure were lower than the routine method used in most office settings.

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Seventy-five percent of adults aged >75 years have hypertension.¹⁻³ According to the Joint National Commission 8 (JNC 8), the recommended target blood pressure (BP) is < 150/80 mm Hg for adults aged > 60 years.⁴ In 2016 the Systolic Blood Pressure Intervention Trial (SPRINT) suggested that more aggressive BP control with a goal of < 120/80 mm Hg reduced rates of cardiovascular disease and lowered the risk of death in adults aged > 50 years with hypertension.⁵ It is anticipated that as a result of the landmark SPRINT results, clinicians may attempt to treat hypertension more intensely in older patients with an increased risk of adverse consequences if BPs are not appropriately measured.

There is a standardized protocol for BP measurement, but these recommendations typically are not followed in routine office visits.^{6,7} Some studies have noted that home BP measurement may be more accurate than office measurement.⁸ However, clinicians may not always trust the accuracy of home BP readings, and many patients are not adherent with home measurement. As a result, physicians usually manage hypertension in older patients based on office readings, though it is likely that most office measurements do not follow protocol on proper measurement. Office measurements have been noted to be inaccurate with high likelihood of overestimating or underestimating BP control.⁹

Office BP measurements demonstrate poor correlation with home measurements and have not been shown to be as good of a predictor for target organ damage or long-

term cardiovascular outcomes compared with that of home measurements.^{10,11} Although there have been studies comparing home and office BP measurements and comparing office and ambulatory BP measurement, no literature has been found that reports on the difference between routine office and standardized measurement of BP.^{9,12-14}

This study seeks to identify the magnitude of difference among BP measured according to a standardized protocol, routine clinical, and home BP. The authors hypothesized that there would be a significant, clinically relevant difference among the 3 BP measurement methods, especially between the routine office and standardized office measurements. This study has implications for implementing intensive treatment of hypertension based on office measurements.

METHODS

Participants included 30 male veterans aged > 65 years who were actively participating in the Gerofit program at the VA Greater Los Angeles Healthcare System (VAGLAHS). The Gerofit program is a model clinical demonstration exercise and health promotion program targeting older and veterans at risk for falls or institutionalization. Gerofit was established in 1987 at the Durham VA Health System and successfully implemented in 2014 at VAGLAHS. Supervised exercise is offered 3 times per week and consists of individually tailored exercises aimed at reducing functional deficits that are identified and monitored by an initial and quarterly functional assessment.

Blood pressures are checked routinely once a week as a part of the program. Gerofit was reviewed and approved by the institutional review board at VAGLAHS as a quality improvement/quality assurance project.

Data

Routine office and standardized protocol measurements were obtained by a single CasMED 740 (Branford, CT) automated BP machine and were conducted separately on different days. The CasMED 740 machine was not otherwise calibrated; however, a one-time correlation was performed between the CasMED 740 and the home BP monitor for each participant, when it was brought to VAGLAHS. Two measurements were made with the CasMed 740 automated BP machine on the arm that gave the higher BP reading throughout the standardized and routine protocol. Two subsequent measurements were made with the participant's home automated BP cuff. Averages for the CasMED 740 and the home BP monitoring device were compared and assessed for significance by paired *t* test. No rest was scheduled prior to the first measurement, but there was a 1-minute rest after each subsequent measurement.

Mean values (SD) were used for participant characteristics and mean values (standard error [SE]) were used for BP measurements. Data were analyzed using Microsoft Excel (Redmond, WA) and GraphPad Prism version 7.03 (San Diego, CA). *T* tests were used for analysis of home BP measurements due to low sample size. Values of $P < .05$ were considered to be statistically significant.

Routine office protocol. Automated BP was measured to mimic routine office visits. Upon arrival, participants sat down, and the BP cuff was placed around their arm. Any rest before a measurement was incidental and not intentionally structured. Appropriate cuff size was determined by visual estimation of arm circumference. Only 1 measurement was made unless BP was $> 150/90$ mm Hg, in which case a repeat measurement was made after 2 to 4 minutes of rest. The BP was then determined based on the average of 2 or more readings. The BPs were recorded by hand in a weekly log. Participants had

at least 12 weeks of BP readings measured by the routine method, and these BPs were averaged over 12 weeks to yield their average routine measured BP.

Standardized protocol. Automated BP was measured according to the 2015 USPSTF Guidelines and Look AHEAD trial protocol.^{7,15} A participant's arm circumference was measured, and appropriate cuff size was determined. The participant rested quietly in a chair for at least 5 minutes with feet flat on the floor and back supported. The cuff was snugly placed 2 to 3 cm above the antecubital fossa, and the arm was supported at the level of the right atrium during the measurement. Blood pressure was determined using the mean of 4 automated cuff readings, 2 on each arm, taken 1 minute apart. Participants did not necessarily have their BP measured by the standardized method immediately following the routine method but all measurements were performed during the same 12-week time period.

Home blood pressure protocol. Participants were given instructions according to the American Heart Association (AHA) recommendations for measuring home BP. Patients were instructed to use a calibrated, automated arm BP cuff. Home BP machines were not provided in advance, and each individual's BP machine was not calibrated. They also were instructed to rest at least 5 minutes before measuring their BP. The mean home BP was determined by the cumulative average of 3 readings in the morning and evening, taken 1 minute between each reading, for a total of 6 readings/d. Participants recorded home BPs for 2 weeks before submitting their readings. Each participant affirmed

TABLE 1 Participant Characteristics

Characteristics (n = 30)	Mean ± SD (range)
Age, y	82.7 ± 9.3 (67-97)
Body mass index, kg/m ²	29.7 ± 5.7 (22.8-45.0)
No. of antihypertensive medications	1.3 ± 1.2 (0-4)
No. of other blood pressure-affecting medications	0.8 ± 0.7 (0-2)

TABLE 2 Comparison of Different Blood Pressure Methods

	Method of Measurement		
	Routine (n = 30)	Standardized (n = 30)	Home (n = 13)
Mean SBP (SE), mm Hg	135 (2.4)	115 (3.1)	129 (4.7)
Mean DBP (SE), mm Hg	73 (1.6)	62 (1.9)	69 (3.8)

Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure.

clear understanding of how to measure BP by correctly demonstrating placement of the cuff 1 time under supervision.

RESULTS

Thirty veterans aged > 65 years participated in the study. The average age (SD) was 82.7 (9.3) years. The average BMI (SD) was overweight at 29.7 kg/m² (5.7). Most (87.6%) of the study participants had been diagnosed with hypertension prior to the study, and no new diagnoses were made as a result of the study. Participants were prescribed an average of 1.3 antihypertensive medications and 0.8 medications that had BP effects (Table 1).

Both systolic BP (SBP) and diastolic BPs (DBP) measured by the standardized method were significantly lower than those by the routine method (*P* < .01 and *P* < .01, respectively) (Figure 1). The average SBP measured by routine method was 135 mm Hg compared with 115 mm Hg for the standardized method (Table 2). The average routine method DBP was 73 mm Hg vs 62 mm Hg by the standardized method (Table 2). Home BPs approximated routine BPs more closely with an average SBP of 129 mm Hg and DBP of 69 mm Hg. All participants were given instructions about how to monitor BP, but

only 13 out of 30 returned completed home BP logs. There was no statistically significant difference between home and routine or between home and standardized BP readings.

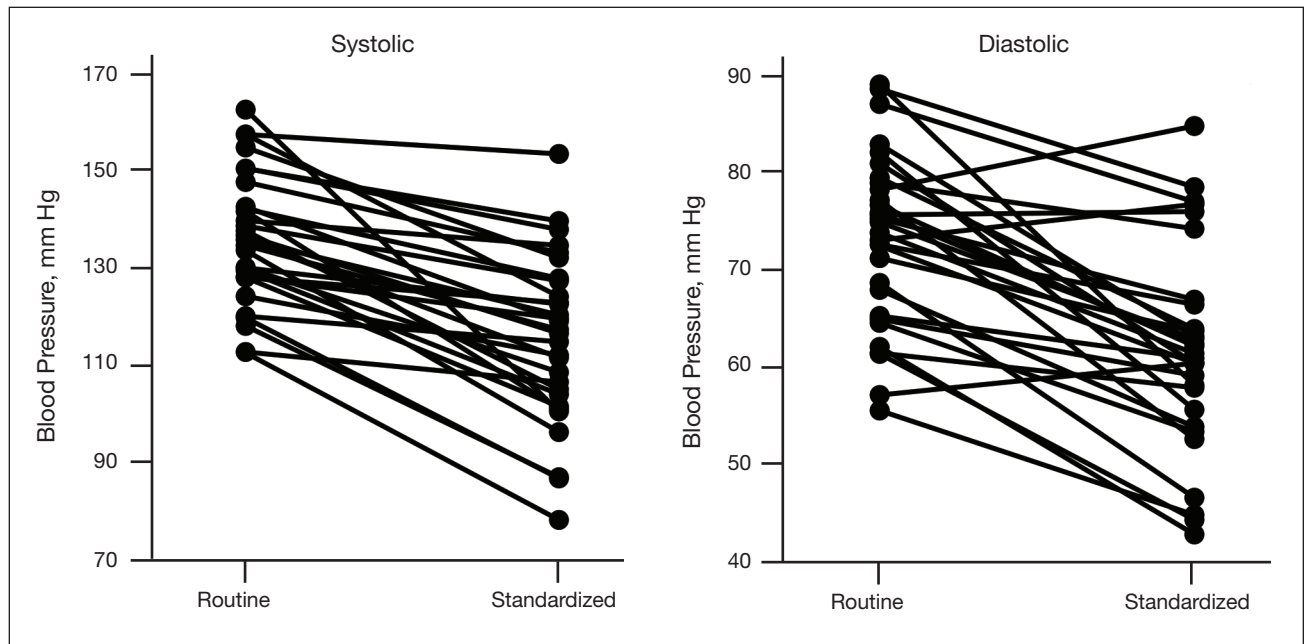
To determine the accuracy of the home BP monitors, the average routine VAGLAHS BP measure was compared with home BP results. For SBPs, there was a significant correlation coefficient of 0.91 (*P* < .01). For DBPs, the correlation coefficient was 0.97 and were also significant (*P* < .01) (Figure 2).

DISCUSSION

The present study demonstrated that standardized measurements of BP were lower than that of the routine method used in most office settings. These results suggest that there could be a risk of overtreatment for some patients those of whose results are higher than the SPRINT BP target of < 120/80 mm Hg. Clinicians might be treating BPs that are elevated due to improper measurement, which can lead to deleterious consequences in older adults, such as syncope and falls.¹⁶

Each participant exhibited a significantly lower BP reading with the standardized method than the routine method. The 20-point decrease in SBP and 10-point decrease in DBP are clinically significant. The routine method of measurement was intended to simulate BP measurement in outpatient settings. There is usually little time structured for rest, and because the protocol established by the AHA and other professional organizations is time consuming, it usually is not strictly followed. With guidelines proposed by JNC 8 and new findings from SPRINT, the method of BP readings should be reviewed in all clinical settings.

While changes in BP management are not necessarily immediate, the differences in recommendations proposed by SPRINT and JNC 8 can lead to confusion regarding how intensely to treat BP. These recommendations guide clinical practice, but clinicians' best judgment ultimately determines BP management. Physicians who utilize routine office measurements likely

FIGURE 1 Routine vs Standardized Blood Pressure Measurements (n = 30)^a

^aThere were significant differences in systolic blood pressure and diastolic blood pressure checked via routine vs standardized methods, $P < .001$.

rely on BP readings that are higher on average than are readings done under proper conditions. This leads to the prospect of overtreatment, where physicians attempt to control hypertension too aggressively, potentially leading to orthostatic hypotension, syncope, and increased risk for falls.¹⁶ With findings from SPRINT recommending even lower BPs than that by JNC 8, overtreatment risk becomes especially relevant. While BP protocol was strictly followed in SPRINT, some clinicians may not necessarily follow the same fastidious protocol.

The average differences between the home and standardized BPs were not statistically significant possibly due to the small sample size in the home BP measurements; however, the difference might represent some clinical relevance. There was a 15-point difference in SBP results between home (129 mm Hg) and standardized (115 mm Hg) measures. There also was a difference in DBP between home (69 mm Hg) and standardized (62 mm Hg) results. The close correlation between both home and BPs measured in VAGLAHS demonstrated that any difference was not due to variability in the measurement devices. Previous studies have demonstrated that home

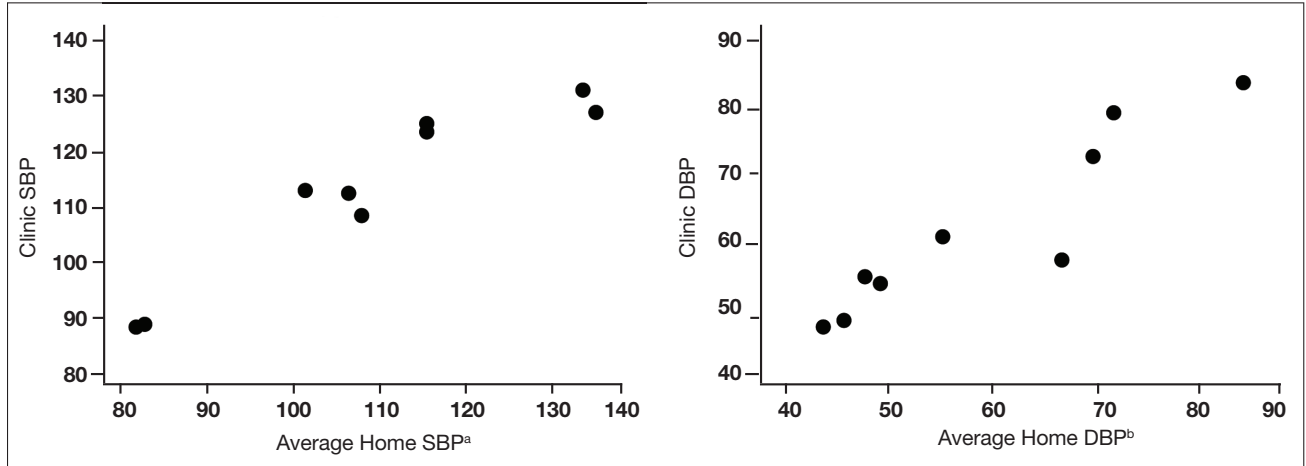
BPs are better indicators of cardiovascular risk than office BP.⁸

Despite lack of statistical significance, home BPs were lower than routine, which suggests that they still may be more reliable than routine office measurements. Definitive conclusions regarding the accuracy of the home BPs in the present study cannot be drawn due to the small sample size (n = 13). Further exploration with comparisons to ambulatory BP monitoring could yield more information on accuracy of home BP monitoring.

In this study's cohort of older veterans, the average BMI was between 25 and 30 (overweight), which is a risk factor for hypertension.¹⁷ Every participant with hypertension was taking at least 1 antihypertensive medication and being actively managed. In this study, the authors accounted for other medications that may affect BP, such as α blockers used in patients with benign prostatic hyperplasia.¹⁸ These could have potential elevating or lowering effects on BP measurements.

An issue in this study was the lack of adherence to home BP monitoring. Many patients forgot to bring in their records or to

FIGURE 2 Significant Correlations Between Average Home and Office Blood Pressure Readings



Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure.

^a $r = 0.91$; $P = .001$.

^b $r = 0.97$; $P < .001$.

measure their BPs at home. The difficulties highlight real-life issues. Clinicians often request that patients monitor their BP at home, but few may actually remember, let alone keep diligent records. There are many barriers between measuring and reporting home BPs, which may prevent the usefulness of monitoring BP at home.

Limitations

There were several limitations to the study. There was no specific protocol for the routine method of BP measurement, as it was intended to simulate the haphazard nature of office measurements. However, this approach limits its reproducibility. For home BP monitoring, it would have been ideal to provide the same calibrated, automated BP device to each participant. This study of older veterans may not be applicable to the general population. Finally, the relatively small number of participants in the study ($n = 30$) may have limited power in drawing definitive conclusions.

Future Directions

For future studies, comparing the standardized method to ambulatory BP monitoring would provide more information on accuracy. In addition, the authors would like to evaluate the effect of exercise on BP measurements in the different settings: home, standardized, and routine methods.

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

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.

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