Effect of repeat manual blood pressure measurement on blood pressure and stage of hypertension

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ABSTRACT

Hypertension management guidelines are influenced by clinical trials that utilize automated office blood pressure (BP) to measure BP. Many primary care clinics still use manual office BP, which has been shown to produce significantly higher BP values than automated office BP. In a primary care office, a manual BP was obtained by nursing staff using an aneroid sphygmomanometer. Initial BPs $\geq 120/80$ mm Hg were repeated during the clinical encounter by the physician. A total of 1012 encounters were analyzed, with 1000 meeting inclusion criteria. The median difference between nurse and provider BP was 4 mm Hg in systolic BP and 2 mm Hg in diastolic BP ($P < 0.0001$), with the greatest difference seen in patients with initial BPs > 150 mm Hg systolic (10 mm Hg; $P < 0.0001$). Repeating BP measurements resulted in 34% of patients being reclassified to a lower hypertension stage. Patients with stage 1 and 2 hypertension initially were reclassified as controlled (systolic BP < 130 mm Hg) in 40% and 8% of encounters, respectively, with repeat measurements. In clinics that use manual office BP, repeating a manual BP by the physician may provide a better reflection of adherence to standard hypertension performance measures used in the primary care setting.

KEYWORDS Hypertension; manual office blood pressure; primary care clinic; repeat blood pressure measurement

Measurement of blood pressure (BP) is fundamental in assessing and treating hypertension; however, the method of BP measurement in clinical practice remains heterogeneous. Manual office BP (MOBP) is still frequently used in outpatient primary care clinics despite evidence that MOBP measurements are approximately 8 mm Hg higher than the gold standard method of BP measurement, ambulatory BP monitoring, as well as automated office BP (AOBP).^{1–3} Many of the landmark trials, including SPRINT, that guided the more aggressive hypertension treatment approach of the 2017 American College of Cardiology/American Heart Association (ACC/AHA) hypertension guidelines used AOBP as their method of BP measurement.^{4–6} Patients who have their BP determined by MOBP, with those measures applied to the 2017 ACC/AHA hypertension guidelines, may be at risk for overdiagnosis and overtreatment of hypertension. Because repeat measurements with AOBP have been shown to decrease BP measurements,^{7,8} we hypothesized that

repeating a manual BP after the patient has rested will provide a lower BP that is more consistent with the patient's true BP.

METHODS

In a large academic center primary care office, patients were roomed in the usual fashion. Manual BP was measured by nursing staff using an aneroid sphygmomanometer. Any initial BP that was considered “elevated” by the 2017 ACC/AHA hypertension guidelines (i.e., BP $\geq 120/80$ mm Hg) was repeated with a manual sphygmomanometer during the clinical encounter by the physician before the patient moved to the exam table. Nurses and physicians were instructed to adhere to the ACC/AHA BP measurement methods and guidelines. Inclusion criteria were an initial BP > 120 mm Hg systolic or 80 mm Hg diastolic and age ≥ 18 years. Patients were classified into 2017 ACC/AHA hypertension groups based on their systolic BP.

The mean differences in BP measurements between initial and repeat measurement were compared using the

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Figure 1. (a) Overall difference between physician-measured blood pressure (BP) and nurse-measured BP for diastolic and systolic BP ($P < 0.0001$). (b) Difference between nurse- and physician-measured systolic BP when grouped by initial nurse-measured systolic BP ($P < 0.0001$). (c) Difference between nurse- and physician-measured diastolic BP when grouped by initial nurse-measured systolic BP ($P < 0.0001$).

Wilcoxon signed rank test. The comparisons of mean differences among different age groups, genders, and initial BP measurements were tested by Wilcoxon rank sum test and Kruskal-Wallis test. Statistical tests were two-sided at the $\alpha = 0.05$ significance level, and two-sided 95% confidence intervals were used. All P values were presented as nominal P values. Analyses were carried out with the use of SAS software, version 9.4 (SAS Institute, Cary, NC).

RESULTS

BP was reported for 1012 patients, and 1000 met inclusion criteria; 593 patients were women and 407 were men. The median age of the patients was 64 years (interquartile range, 52 and 74). Overall, the mean difference between initial and repeat measurements was 4 mm Hg (interquartile range, -2 and 12) for systolic BP and 2 mm Hg (interquartile range, -4 and 6) for diastolic BP ($P < 0.0001$) (Figure 1).

When grouped by initial BP measurement, all patients had a significant decrease in BP with the repeated measurement ($P < 0.0001$). The decrease in BP was greatest in patients with higher initial BP, with smaller but significant decreases in BP in the lower initial BP groups. The decrease was observed in both systolic BP and diastolic BP, with the greatest difference seen in systolic BP (Figure 1). There was no significant difference between BP differences based on patient age. Median time between measurements was 32 minutes (interquartile range, 21 and 44). There was no significant correlation of time in between measurements and difference in BP.

Overall, 73% of patients had a BP that was equal to or less than the initial measurement and 27% had a higher measurement. Among all initial ACC/AHA hypertension groups based on systolic BP, reclassifying the patient's hypertension stage based on the practitioner-rechecked BP resulted in 34% of patients having a lower stage and 10% having a higher stage of hypertension. In patients with stage 1 systolic hypertension (systolic BP 130–139 mm Hg) on the initial measured BP, 40% were reclassified as controlled (systolic

BP < 130 mm Hg) and 11% increased their hypertension stage. In patients with stage 2 systolic hypertension (systolic BP > 140 mm Hg), 36% had a lower hypertension stage and 8% of those were controlled upon practitioner recheck of BP (Figure 2).

DISCUSSION

We found that a repeat manual BP measurement prior to the physical exam resulted in a significantly lower BP than the initial measurement. The difference in BP was statistically significant and had a median difference of 4 mm Hg in systolic BP and 2 mm Hg in diastolic BP. Although seemingly inconsequential, a difference of even 2 mm Hg in systolic BP has been shown to decrease stroke mortality by approximately 10% and ischemic heart disease by 7%.⁹ In addition, 34% of patients were reclassified into a lower hypertension stage following the repeat BP measurement: 40% of patients who were initially categorized as stage 1 hypertension had controlled BP with recheck, as did 8% of those with initial stage 2 hypertension. By simply repeating a BP measurement, many patients may avoid being inappropriately diagnosed and overtreated for hypertension.

The ideal method of office BP measurement is clearly AOBP. AOBP has been shown to produce BP measurements similar to those of ambulatory BP monitoring, correlates well with cardiovascular outcomes, and is the method used in most trials that influenced the 2017 ACC/AHA hypertension guidelines.^{2,4,10} Ideally, all outpatient clinics would use AOBP devices, but MOBP is still the norm for many practices. Because MOBP BP measurements are approximately 8 mm Hg higher than AOBP, patients at clinics that use MOBP are at increased risk for overdiagnosis and subsequent adverse events from aggressive treatment.² Considering that recent studies have shown increased adverse events associated with aggressive BP control with little to no offsetting benefit in low-risk and elderly populations, it is imperative that BP not be overestimated.^{11,12} Our data suggest that if MOBP is used in the primary care setting, a repeat measurement should be performed by the physician. Additionally,

Figure 2. Changes in 2017 American College of Cardiology/American Heart Association hypertension groups. **(a)** Hypertension category changes for all patients based on repeat systolic blood pressure (BP) measurement. **(b)** Hypertension category changes for initial systolic stage 1 hypertension. **(c)** Hypertension category changes for initial systolic stage 2 hypertension. Controlled = systolic BP <130 mm Hg.

nursing staff should allow the patient to rest for at least 5 minutes before the first BP measurement and then average three BP measurements obtained 1 minute apart, as is done in research and recommended by the ACC/AHA guidelines. Periodic calibration of all sphygmomanometers should also be performed. These simple steps may result in a lower BP that is similar to the BP that would have been obtained with AOBP and help prevent overdiagnosis and overtreatment of hypertension.

In our study, 27% of the repeat measurements were higher, resulting in 10% of patients having a higher stage of hypertension than with the initial measurement. White coat hypertension is known to have a greater effect when the physician measures the BP, and physicians generally record higher BPs than nurses.^{13,14} Because the repeat measurement was performed by physicians in our study, it is not surprising that there was a group of patients with increased BP. We suspect that for most patients, the additional time between measurements allowed the patient's BP to return to baseline; however, some patients may have had an emotional response to their physician, resulting in higher BP measurements.

There are several limitations to our study. Manual BP measurement is subject to the expertise and bias of the provider performing the measurement. Physicians were not blinded to the initial BP measurement, which may have affected their judgment in measuring BP. Additionally, hypertension control is a quality metric of our physicians, which, despite our confidence in the integrity of our physicians, places the data at risk for observer bias.

In conclusion, we found that when using MOBP, a repeat manual BP measurement will likely be lower and provide a better reflection of true adherence to standard hypertension performance measures used in the primary care setting. Future research is needed to compare MOBP with a repeat measurement to AOBP to validate our method. Because MOBP continues to be used in many primary care clinics, repeating a BP measurement may be critically important in preventing overdiagnosis and overtreatment of hypertension.

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1. Hansen TW, Kikuya M, Thijs L, et al. Prognostic superiority of daytime ambulatory over conventional blood pressure in four populations: a meta-analysis of 7030 individuals. *J Hypertens.* 2007;25:1554–1564. doi:10.1097/HJH.0b013e3281c49da5.
2. Myers MG, Godwin M, Dawes M, Kiss A, Tobe SW, Kaczorowski J. The Conventional versus Automated Measurement of Blood pressure in the Office (CAMBO) trial: masked hypertension sub-study. *J Hypertens.* 2012;30:1937–1941. doi:10.1097/HJH.0b013e328356abd3.
3. Godwin M, Birtwhistle R, Delva D, et al. Manual and automated office measurements in relation to awake ambulatory blood pressure monitoring. *Fam Pract.* 2011;28:110–117. doi:10.1093/fampra/cm067.
4. Wright JT Jr, Williamson JD, Whelton PK, et al. A randomized trial of intensive versus standard blood-pressure control. *N Engl J Med.* 2015;373:2103–2116. doi:10.1056/NEJMoa1511939.
5. Bundy JD, Li C, Stuchlik P, et al. Systolic blood pressure reduction and risk of cardiovascular disease and mortality: a systematic review and network meta-analysis. *JAMA Cardiol.* 2017;2:775–781. doi:10.1001/jamacardio.2017.1421.
6. 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:e127–e248.
7. Einstadter D, Bolen SD, Misak JE, Bar-Shain DS, Cebul RD. Association of repeated measurements with blood pressure control in primary care. *JAMA Intern Med.* 2018;178:858–860. doi:10.1001/jamainternmed.2018.0315.
8. Daimee UA, Done D, Tang W, Tu XM, Bisognano JD, Bayer WH. The utility of repeating automated blood pressure measurements in the primary care office. *J Clin Hypertens.* 2016;18:250–251. doi:10.1111/jch.12657.
9. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R. Age-specific relevance of blood pressure to cause-specific mortality is best assessed by collaborative meta-analysis of individual participant data from the separate prospective studies. *Lancet.* 2002;360:1903–1913. doi:10.1016/S0140-6736(02)11911-8.

10. Myers MG, Kaczorowski J, Dolovich L, Tu K, Paterson JM. Cardiovascular risk in hypertension in relation to achieved blood pressure using automated office blood pressure measurement. *Hypertension*. 2016;68:866–872. doi:[10.1161/HYPERTENSIONAHA.116.07721](https://doi.org/10.1161/HYPERTENSIONAHA.116.07721).
11. Weiss J, Freeman M, Low A, et al. Benefits and harms of intensive blood pressure treatment in adults aged 60 years or older: a systematic review and meta-analysis. *Ann Intern Med*. 2017;166:419–429. doi:[10.7326/M16-1754](https://doi.org/10.7326/M16-1754).
12. Sheppard JP, Stevens S, Stevens R, et al. Benefits and harms of anti-hypertensive treatment in low-risk patients with mild hypertension. *JAMA Intern Med*. 2018;178:1626–1634. doi:[10.1001/jama-intermed.2018.4684](https://doi.org/10.1001/jama-intermed.2018.4684).
13. Pickering TG, James GD, Boddie C, Harshfield GA, Blank S, Laragh JH. How common is white coat hypertension? *JAMA*. 1988;259:225–228.
14. Clark CE, Horvath IA, Taylor RS, Campbell JL. Doctors record higher blood pressures than nurses: systematic review and meta-analysis. *Br J Gen Pract*. 2014;64:e223–e232. doi:[10.3399/bjgp14X677851](https://doi.org/10.3399/bjgp14X677851).