Measurement of Blood Pressure in the Office
Recognizing the Problem and Proposing the Solution

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The widely accepted cut-point for normal blood pressure (BP) in the office setting evolved over several decades, based on data derived from a variety of sources. The Actuarial Society of America was one of the first organizations to publish BP data on thousands of community residents, followed by other classic studies such as Framingham, Western Electric Company, Kaiser Permanente, and the Multiple Risk Factor Intervention Trial.[1,2] In every instance, BP readings were based on measurements taken by specially trained health professionals following guidelines for proper BP measurement. As a result of these and other population studies examining the association between different BP levels and cardiovascular outcomes, the importance of systolic and diastolic hypertension was recognized and an office BP of 140/90 mm Hg became the universally established cut-point for separating normal BP from hypertension.

Hypertension Is Not Defined by 140/90 in the "Real World"

There are robust scientific data to support the use of 140/90 mm Hg to define hypertension in clinical practice guidelines. However, the guidelines do not take into account widely recognized problems associated with the quality of manual BP measurement in routine clinical practice.[3] More recent recommendations[4] for diagnosing hypertension clearly acknowledge that an increase in BP attributable to the "white coat response" is frequently associated with manual BP recordings performed in community-based practice. In recognizing this limitation of manual office BP, some guidelines have gone so far as to recommend that home BP and 24-hour ambulatory BP monitoring (ABPM) may need to be performed to obtain an accurate measure of a patient's BP status. The greater reliance on 24-hour ABPM and home BP in the diagnosis and management of hypertension is the result of numerous clinical outcome studies[5,6] that show that these measurement techniques are better predictors of cardiovascular events when compared to manual BP readings, even when manual readings are taken carefully in accordance with guidelines.

However, most guidelines do not seem to have fully considered the impact conventional routine office BP might have on both the cut-point and ongoing management of hypertension as experienced by primary care physicians. In most instances, an office BP of 140/90 mm Hg is equated to a mean home BP or mean awake ambulatory BP of 135/85 mm Hg. However, this relationship has been based on BP readings carefully recorded in accordance with guidelines[4] for proper BP measurement (research-quality office BP readings) and may not reflect the BP obtained by doctors, nurses, and other health professionals in routine office practice.

Comparison of Casual and Research-Quality Manual BP Measurement

When the primary care physician records BP using a mercury or aneroid device, the resulting value frequently tends to be higher than what it would be if measurement guidelines were strictly adhered to. In a 1995 report from one of our centers,[7] BP data were obtained from 147 hypertensive patients being treated by family physicians in a large urban community (Table). Several different BP measurements obtained under different circumstances and for different purposes were available, including the last routine reading taken by the patient's family physician before the patient was identified as a potential research subject, a mean of 2 or 3 BP readings taken for the research study by the same physician in accordance with existing guidelines, a BP reading taken by a research nurse using the same guidelines, and a 24-hour ambulatory BP recording. The physician's mean BP obtained during a routine visit (146/87 mm Hg) was higher than the same physician's mean BP reading taken for research purposes (140/83 mm Hg), or when BP was measured by a research nurse (137/78 mm Hg) in accordance with the guidelines.

These differences in BP measurement may also have implications for detecting possible target organ damage. In this study, increases in left ventricular mass index correlated significantly (all $P<0.01$) with the mean awake systolic ambulatory BP ($r=0.24$), research nurse BP ($r=0.23$) and physician's special research BP ($r=0.27$), but not with the

Table.   Mean BP Readings Taken Manually in Routine Clinical Practice by the Patient's Own Physician, Readings Taken as Part of a Research Study Using a Mercury Sphygmomanometer or Automated Office Device (BpTRU) and the Mean Awake Ambulatory BP

Study, First Author	N	Routine Clinical Practice	Research Quality Office	Automated Office	Mean Awake Ambulatory
Myers[7]	147	146/87	140/83	…	132/78
Brown[8]	611	161/95	152/85	…	139/82
Myers[9]	309	152/87	140/80	132/75	134/77
Graves[10]	104	152/84	138/74	136/79	…
Gustavsen[11]	420	165/104	156/100	…	147/96
Beckett[12]	481	151/83	…	140/80	142/80
Dawes[13]	5918	164/96	…	…	149/90

Table header spanning columns: Type of Blood Pressure Measurement (mm Hg)

physician's routine BP taken as part of usual clinical practice ($r=0.06$). Thus, the patients' own family physicians were able to take research quality BP readings as part of a study that correlated with target organ damage (left ventricular mass index) in a similar manner to readings taken by the research nurse or with ABPM. However, the routine manual BP reading taken in clinical practice upon which most decisions on diagnosis and treatment are based not only produced the greatest white coat response but also did not correlate with target organ damage as determined by left ventricular mass.

These observations are consistent with a report on BP readings in 611 patients referred by family physicians or specialists for 24-hour ABPM.[8] The awake ambulatory BP was on average 22/13 mm Hg lower than the BP reading noted by the referring physicians. A nurse's reading taken in the ABPM unit using a standard protocol was 9/10 mm Hg lower than the routine BP recording in the physician's office.

Similar findings have been observed in a more recent study from one of our centers. In this instance,[9] BP data were collected from 309 patients referred by their family physicians in the community for 24-hour ABPM (Table). At the time of referral, the physicians were asked to provide the last BP recorded in the patient's chart by either the physician or nurse as part of routine clinical practice. In the ABPM unit, the technician performed 2 research-quality readings on these patients using a mercury sphygmomanometer with a T-tube connected to the ambulatory BP recorder as part of the standardized protocol to verify the accuracy of the device in the individual patient. The mean BP taken in the office of the patient's own physician (152/87 mm Hg) was significantly higher ($P<0.001$) than the manual BP taken by the technician in the ABPM unit (140/80 mm Hg). It should be noted that the technician's reading was still higher than the mean awake ambulatory BP of 134/77 mm Hg.

In both of these studies involving patients referred for 24-hour ABPM, the substantial difference between the routine and research quality readings can be partly attributed to a referral bias, in that many of the patients were likely referred for ABPM because they had a suspected white coat effect.

Graves et al[10] obtained routine BP measurements in 104 patients who were referred by their physicians for 24-hour ABPM (Table). A research-quality BP performed by a specially trained nurse was also recorded. The mean manual BP taken in routine practice (152/84 mm Hg) was significantly higher than the research-quality manual BP (138/74). Data on 24-hour ABPM were not reported. Similar findings were observed by Gustavsen et al[11] in 420 patients with newly diagnosed hypertension referred for 24-hour ABPM. BP readings taken in routine clinical practice were compared to research quality BP measurements obtained in the ABPM unit. The routine physician BP (165/104 mm Hg) was significantly higher than the research quality BP (156/100 mm Hg), with the mean awake ambulatory BP being 147/96 mm Hg.

Thus, the numeric BP value obtained in the office is generally higher than a research-quality BP reading from which the normal/hypertension cut-point of 140/90 mm Hg was originally derived. From these data, a routine office BP of 150/95 mm Hg seems to be more comparable to a research-quality BP of 140/90 mm Hg.

Routine Manual Office BP versus Mean Awake Ambulatory BP

Further evidence to support the existence of a higher cut-point for diagnosing hypertension in routine clinical practice can be seen in studies comparing office BP with ABPM. Comparative data derived from several large series of subjects have equated a manual (research quality) office BP of 140/90 mm Hg with a mean awake ambulatory BP of 135/85 mm Hg.[4] Recent studies also have reported comparative data from routine manual BP obtained from the offices of family physicians in the community (Table).

Beckett and Godwin[12] obtained an average of the last 3 manual BP readings taken in the offices of family physicians of 481 hypertensive patients. The mean routine office BP (151/83 mm Hg) was significantly ($P<0.001$) higher than the mean awake ambulatory BP (142/80 mm Hg). Differences of a similar magnitude between routine office BP and mean awake ambulatory BP were reported by Dawes et al[13] in almost 6000 patients under the care of family physicians in the community. Physicians were encouraged to perform 24-hour ABPM on as many of their patients as possible as part of a research study. The mean of the previous 3 BP readings recorded manually in the office before the ABPM was 164/96 mm Hg compared to the mean awake ambulatory BP of 149/90 mm Hg, a difference of 15/6 mm Hg. In another series[9] of 309 patients referred for 24-hour ABPM, the last routine manual BP taken in the office of

the patients' own family physician (152/87 mm Hg) was significantly (P<0.001) higher than the mean awake ambulatory BP (134/77 mm Hg). In this study, a manual research quality office BP was also taken and gave a mean value of 140/80 mm Hg.

Data from these studies (Table) show a consistent difference between the mean awake ambulatory BP and the routine office BP greater than the usually recognized 5 mm Hg (140/90 mm Hg for office BP vs 135/85 mm Hg for mean awake ambulatory BP). Thus, BP measured in routine clinical practice seems to be at least 10/5 mm Hg higher than a research-quality office BP leading to the conclusion that the cut-point for a normal BP in the "real world" should be <150/95 mm Hg and not the value of <140/90 mm Hg derived from readings taken in carefully conducted research studies.

Automated BP Measurement in the Office Setting

Despite numerous attempts by a variety of agencies, including the American Heart Association, to improve the quality of manual BP measurement in clinical practice, concerns remain about the validity of readings generated by physicians and other health professionals as part of routine patient care.[4] Moreover, the time required for a health professional to obtain a valid and reliable manual BP in the office has been estimated at 16 minutes,[14] making it difficult for BP measurement guidelines to be followed in routine clinical practice. Some hypertension specialists have even gone as far as suggesting that office BP be replaced by out-of-office BP measurement in the home or with 24-hour ABPM.[15] Fortunately, new developments in automated office BP technology may yet rehabilitate office BP measurement as part of routine clinical practice.

It is now possible to record the BP of a patient in the office using validated devices in such a way that the mean office BP is comparable to the mean awake ambulatory BP. In the aforementioned study by Beckett and Godwin,[12] in 481 patients mean awake ambulatory BP (142/80 mm Hg) was similar to the mean of 5 readings taken with the fully automated BpTRU device (140/80 mm Hg) with the patients resting alone in a quiet examining room. Similar findings were noted in a report[9] from another one of our centers with the mean awake ambulatory BP in 309 patients (134/77 mm Hg) being similar to the mean of 5 automated office BP (AOBP) readings (132/75 mm Hg), once again, taken with the patients resting alone in a quiet examining room.

In these studies, the correlation between the routine manual BP and awake ambulatory BP was significantly weaker than for the AOBP. In the study of Beckett and Godwin,[12] the coefficient of correlation between the mean awake ambulatory systolic/diastolic BP and the family physician's routine BP was ($r=0.15$/$r=0.32$) compared to ($r=0.57$/$r=0.61$) for readings taken with the automated BpTRU device. Similarly, Myers et al[9] reported a higher correlation ($r=0.62$/$r=0.72$) between the mean awake ambulatory systolic/diastolic BP and the automatic office BP compared to the routine family physician readings ($r=0.32$/$r=0.48$).

To date, guidelines have focused on patients with BP readings in the hypertensive range, recommending 24-hour ABPM or home BP to identify those individuals suspected of having a white coat response in the office setting. Recent data from one of our centers[9] showed that the routine office BP
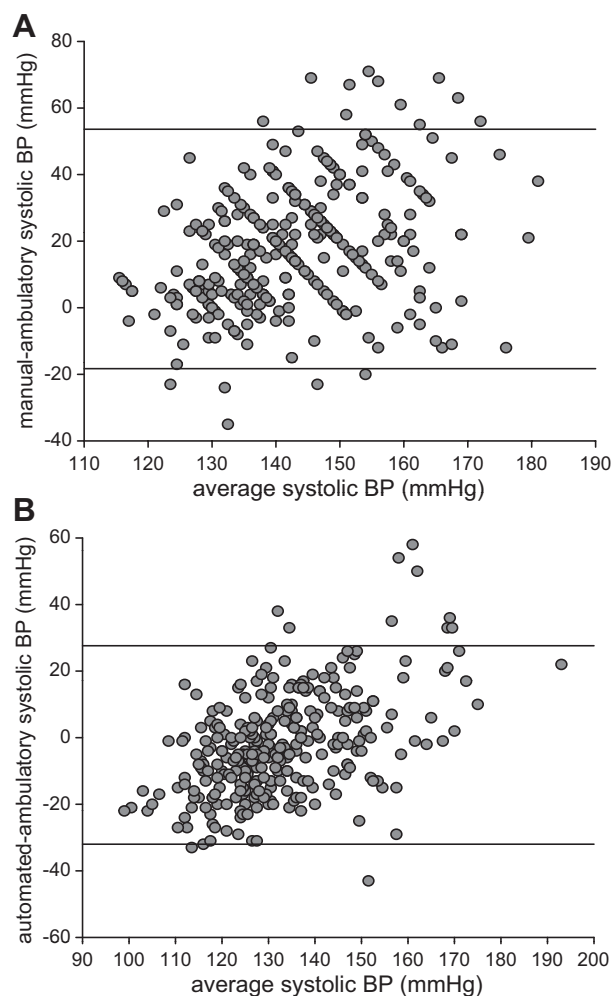

Figure 1. Bland-Altman[16] plots are displayed for awake ambulatory systolic BP vs routine manual physicians' systolic BP (A) and for awake ambulatory systolic BP vs automated office systolic BP (B). The average of the ambulatory BP and either manual BP (A) or automated BP (B) is plotted on the x-axis with the difference between the readings plotted on the y-axis. Upper and lower limits of 2 standard deviations around the mean difference are indicated on each graph.

tends to be higher at all levels of readings when compared with the awake ambulatory BP as displayed in a Bland-Altman[16] plot in Figure 1. There was a positive bias (95% confidence interval [CI]) for routine manual systolic BP (mm Hg) of 14.4 (12.5–16.3), but the plot for AOBP readings showed minimal bias with mean values for systolic BP being −2.8 (−4.4−−1.1). Similar findings were noted with Bland-Altman plots for diastolic BP (data not shown), with the positive bias for manual readings being 8.3 (7.0–9.5) compared to −1.1 (−0.1−−2.0) for AOBP.

Available Devices for AOBP Measurement

The BpTRU is designed to reduce the white coat response associated with manual office BP measurement by allowing the observer to be absent from the room when the readings are taken, thus eliminating observer–patient interaction and minimizing the anxiety experienced by many patients in this situation. This device is programmed to take the first reading with the physician or other health professional in the room to

verify that the cuff is in the correct position and that the device is obtaining a valid BP reading. This first reading is automatically discarded. The BpTRU can be set to take 5 consecutive readings at 1- or 2-minute intervals with the observer leaving the patient to be alone in the room. The observer is then free to attend to other duties while the BP is being recorded. The display automatically shows the mean of the last 5 readings and all individual readings are stored electronically and can be retrieved from its memory.

In a study[17] involving 50 patients attending the office of a hypertension specialist, a mean of 2 manual BP readings (162/85 mm Hg) was similar to the initial AOBP taken with the BpTRU recorder (163/86 mm Hg). Thus, simply having the observer use an automated BP recording device instead of a mercury sphygmomanometer does not in itself lead to lower BP readings. However, leaving the patient alone does reduce BP with the mean of the next 5 readings in these 50 patients being 142/80 mm Hg. A manual BP was taken after the AOBP readings. The mean value still remained higher (157/88 mm Hg) than the mean AOBP value (142/80 mm Hg), confirming that the decline in BP was not simply attributable to repeated BP measurements.

Previous AOBP studies using the BpTRU device recorded readings at either 1- or 2-minute intervals, timed from the start of one reading to the start of the next one. However, a recent study[18] has shown that intervals of 1 and 2 minutes produce similar BP readings, thus precluding the need for a more prolonged period for AOBP measurement. Readings taken at 1 minute intervals require only several minutes of physician/nurse time and 5 additional minutes of the patient's time to record the BP.

The difference between the routine manual BP and the mean awake ambulatory BP in the relatively unselected population of Beckett and Godwin[12] was 9.3/3.2 mm Hg. Patients referred for 24-hour ABPM exhibited a difference of 22/13 and 20/12 mm Hg between the routine manual BP and the mean awake ambulatory BP.[8,9] Judging by the similarity between the automated office BP readings and the mean awake ambulatory BP values in these different patient populations, it would appear that the BpTRU used in accordance with the manufacturer's guidelines virtually eliminates the white coat response. Having the mean AOBP comparable to the mean awake ambulatory BP (and probably also the home BP) simplifies comparisons between BP measurements taken within and outside the office setting.

In Canada, the BpTRU has been marketed specifically for the measurement of BP in the office with the patient resting quietly alone in an examining room. Approximately 10 000 BpTRU devices have been sold (US $700–$900), with many currently being used in routine clinical practice (personal communication, BpTRU Medical Devices, Ltd., Coquitlam, BC, Canada). Two similar devices costing about the same are also available commercially, the Omron HEM 907[19] and the Microlife WatchBP Office.[20] Although, the Omron HEM 907 has been promoted for office BP measurement it has not specifically been recommended for use with patients resting alone in an examining room despite 14 000 devices being in use in countries such as Australia (personal communication, Mark Nelson). Several studies[21–24] have used the Omron HEM 907 to record BP, but in each instance readings were taken in the presence of a health professional. Other automated BP recorders such as the Omron HEM 705 have been used in clinical trials such as the ASCOT study,[25] but the observer was present when the readings were being taken. Thus, the practice of recording BP with automated devices with the patient alone in the examining room has not been universally adopted despite having validated, fully automated BP recorders specifically designed to take readings without health professionals present.

The Microlife WatchBP Office recorder has only recently become available and there is limited clinical experience with this device. In a preliminary report from Ishikawa et al,[26] 52 subjects had AOBP measured while they were resting quietly alone in a room using the Microlife WatchBP Office device. Manual research quality readings were also taken and 24-hour ABPM was performed. The authors noted a stronger correlation between the mean awake ambulatory BP and the AOBP readings compared to the manual BP. They concluded that the AOBP measurements were independently related to the awake ambulatory BP after controlling for the manual office BP.

There are several reasons why the patient should be left alone in the examining room for AOBP readings. Patients tend to be more anxious if a health professional is present. Conversation, which tends to increase BP,[27,28] can only occur if another individual is in the room. Simply having a physician enter the room can also cause a patient's BP to increase.[29] Similarly, AOBP declines when the physician leaves the room with 75% of the decline in BP occurring within <2 minutes.[17,30] These findings also suggest that repeated automated BP readings per se are not responsible for lowering office BP to awake ambulatory BP levels when the AOBP approach is used. Furthermore, the goal of eliminating patient–observer interaction, minimizing patient anxiety, and reducing the observer error associated with manual BP measurement would seem to be best-achieved by obtaining multiple AOBP readings in the absence of an observer. Thus, concerns regarding conventional BP measurement using manual devices such as the mercury sphygmomanometer are not based solely on poor technique on the part of the physician or health professional. A variety of factors influence BP readings, not the least of which is patient anxiety, which may be increased if readings are taken in the presence of a health professional.

Recent Research Involving AOBP

Unlike conventional manual BP, readings taken by AOBP measurement have been shown to be unaffected by the setting of the doctor's office. A recent study found no difference between AOBP obtained during a visit to the physician compared to readings taken in a nontreatment setting.[31] More than 14 000 individuals whose BP was recorded using the BpTRU device are currently being followed-up for cardiovascular morbidity and mortality to relate their BP levels to clinical endpoints.[32] A recent Canadian BP survey[33] of >2500 residents in the Province of Ontario successfully used the BpTRU to record BP. The AOBP readings were compared to BP recorded using a standard mercury sphygmomanometer in a 10% sample of subjects, with the devices showing a close correlation between individual readings aside from the mean manual BP being several mm Hg higher.[34] A national Canadian hypertension survey involving ≈6000

individuals has recently been completed using the BpTRU device (personal communication, N. Campbell). The National Health and Nutrition Examination Survey (NHANES) update currently being conducted in the United States is using the Omron HEM 907 for recording BP, although manual BP readings are also being performed with a mercury sphygmomanometer to allow for comparison with other BP survey data (personal communication, Y. Ostchega). Before undertaking this survey, Ostchega et al[35] conducted a validation study in 509 individuals comparing BP readings taken with the Omron HEM 907 to readings obtained using a mercury sphygmomanometer. There was excellent agreement between the 2 sets of BP measurements, supporting the use of the Omron device for AOBP in routine clinical practice.

The Future of AOBP

It is somewhat surprising that there have not been very many studies which compare BP readings obtained in routine office practice in the "real world" with either research-quality manual BP or ABPM. Recent research into AOBP has shown that this approach to recording BP in the office virtually eliminates the white coat response, results in mean BP readings similar to the awake ambulatory BP (and consequently home BP), and correlates much better with the ambulatory BP than do routine manual BP readings obtained in the community. It should be noted that AOBP is no different from manual BP when it comes to obtaining readings in patients who have an irregular heart rhythm. The presence of atrial fibrillation and frequent ectopic complexes can also affect the AOBP even though readings are taken using an oscillometric technique and not with Korotkoff sounds. Otherwise, the same general guidelines should be followed for both manual BP and AOBP, including the use of an arm cuff appropriate for the patient's arm circumference.

At the present time, there are no specific guidelines for interpreting AOBP. An algorithm for using AOBP as an alternative to manual BP to diagnose hypertension is currently being considered for inclusion in the next update of the Canadian Hypertension Education Program guidelines (Figure 2). The proposed algorithm is based on the American Heart Association's classification[4] for daytime ambulatory BP readings: optimum <130/80, normal 135/85, and abnormal >140/90. This algorithm has been validated in 254 untreated patients referred to an ABPM unit for diagnosis of hypertension.[36] In these patients, only 7% with an AOBP ≥140/90 mm Hg had a mean awake ambulatory BP less than the optimum BP of 130/80 mm Hg. Thus, patients with hypertension based on AOBP rarely have optimum mean awake ambulatory BP. Patients with borderline AOBP readings should have 24-hour ABPM performed, if available; otherwise, 7 days of home BP readings should be performed to clarify the patient's status. At the present time, 24-hour ABPM has advantages over home BP[6,7] because it provides more readings during usual daily activities including nocturnal BP[37] and can identify patients with masked hypertension, both of which might be particularly helpful in the evaluation of patients with borderline office BP readings.

The proliferation of devices such as the BpTRU, Omron HEM 907, and Microlife WatchBP Office into routine clini-

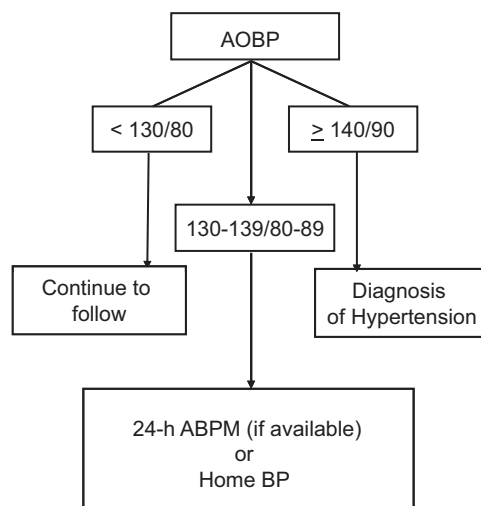### Proposed Algorithm for AOBP in Clinical Practice

Figure 2. Proposed algorithm for diagnosing hypertension using AOBP as an alternative to manual BP in clinical practice.[36]

cal practice is already occurring. There are several reasons why the use of these devices should be encouraged. AOBP with the patient left alone virtually eliminates white coat hypertension and reduces white coat effect in patients already receiving antihypertensive drug therapy. The net result should be more appropriate use of drug therapy in the individual patient and less overtreatment of hypertension. AOBP also allows for direct input of BP data into computerized medical records, thus eliminating potential errors in data transfer and the possibility of readings being rounded-off or otherwise changed by the observer. AOBP is also cost-effective in that readings can be taken in the absence of the health professional who is free to perform other duties while the patient is resting alone in the examining room. Finally, the potential for having a similar cut-point for normal BP vs hypertension using AOBP, home BP, and awake ambulatory BP would simplify guidelines for interpreting BP readings in clinical practice resulting in improved care for hypertensive patients.

Perspectives

Comparisons between manual BP readings performed in research studies and measurements taken in routine clinical practice suggest that the latter technique may result in readings that are 10/5 mm Hg higher. Thus, the cut-point for defining hypertension in routine clinical practice with devices such as the mercury sphygmomanometer may be 150/95 and not the research-based 140/90. Educational efforts aimed at improving the quality of routine manual office BP measurement have met with limited success. Out-of-office BP such as 24-hour ambulatory BP monitoring and home BP have been proposed as possible solutions to problems associated with routine manual BP readings. Recent studies on AOBP offer a third option that would maintain the role of BP measurement in the physician's office. AOBP involves taking multiple readings using an automated sphygmomanometer with the patient resting alone in a quiet room. AOBP virtually elimi-

nates the white coat response exhibited by many patients resulting in readings comparable to the awake ambulatory BP. The imminent disappearance of mercury from the workplace because of environmental concerns creates an opportune moment to consider alternatives to manual BP measurement in the office such as AOBP. This article reviews evidence supporting a shift away from the mercury sphygmomanometer and proposes an algorithm for incorporating AOBP into routine clinical practice. The days of a health professional diagnosing hypertension by manually recording a patient's BP with a mercury sphygmomanometer soon may be over.

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Disclosures

None.

References

1. Pickering G. *High blood pressure*. London: J&A Churchill Ltd; 1968:229.
2. Rutan GH, Kuller LH, Neaton JD, Wentworth DN, McDonald RH, Smith WM. Mortality associated with diastolic hypertension and isolated systolic hypertension among men screened for the Multiple Risk Factor Intervention Trial. *Circulation*. 1988;77:504–514.
3. Pickering TG, Gerin W, Schwartz JE, Spruill TM, Davidson KW. Should doctors still measure blood pressure? The missing patients with masked hypertension. *J Hypertens*. 2008;26:2259–2267.
4. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, Jones DW, Kurtz T, Sheps SG, Roccella EJ. Recommendations for blood pressure measurement in humans and experimental animals Part 1: blood pressure measurement in humans a statement for professionals from the subcommittee of Professional and Public Education of the Am Heart Association Council on High Blood Pressure Research. *Hypertension*. 2005;45:142–161.
5. Parati G, Omboni S, Bilo G. Why is out-of-office blood pressure measurement needed? *Hypertension*. 2009;54:181–187.
6. Verdecchia P, Angeli F, Mazzota G, Gentile G, Reboldi G. Home blood pressure measurements will not replace 24-hour ambulatory blood pressure monitoring. *Hypertension*. 2009;54:188–195.
7. Myers MG, Oh P, Reeves RA, Joyner CD. Prevalence of white coat effect in treated hypertensive patients in the community. *Am J Hypertens*. 1995;8:591–597.
8. Brown MA, Buddle ML, Martin A Is resistant hypertension really resistant? *Am J Hypertens*. 2001;14:1263–1269.
9. Myers MG, Valdivieso M, Kiss A. Use of automated office blood pressure measurement to reduce the white coat response. *J Hypertens*. 2009;27:280–286.
10. Graves JW, Nash C, Burger K, Bailey K, Sheps SG. Clinical decision-making in hypertension using an automated (BpTRU) measurement device. *J Hum Hypertens*. 2003;17:823–827.
11. Gustavsen PH, Hoegholm A, Bang LE, Kristensen KS. White coat hypertension is a cardiovascular risk factor: a 10-year follow-up study. *J Hum Hypertens*. 2003;17:811–817.
12. Beckett L, Godwin M. The BpTRU automatic blood pressure monitor compared to 24-h ambulatory blood pressure monitoring in the assessment of blood pressure in patients with hypertension. *BMC Cardiovasc Disord*. 2005;5:18.
13. Dawes MG, Coats AJ, Juszczak E. Daytime ambulatory systolic blood pressure is more effective at predicting mortality than clinic blood pressure. *Blood Pressure Monitoring*. 2006;11:111–118.
14. Sala C, Santin A, Rescaldani M, Magrini F. How long shall the patient rest before clinic blood pressure measurement? *Am J Hypertens*. 2006;19:713–717.
15. O'Brien E. Ambulatory blood pressure measurement: the case for implementation in primary care. *Hypertension*. 2008;51:1435–1441.
16. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet*. 1986;1:307–310.
17. Myers MG. Automated blood pressure measurement in routine clinical practice. *Blood Pressure Monitoring*. 2006;11:59–62.
18. Myers MG, Valdivieso M, Kiss A. Optimum frequency of automated blood pressure measurements using an automated sphygmomanometer. *Blood Press Monit*. 2008;13:333–338.
19. White WG, Anwar YA. Evaluation of the overall efficacy of the Omron office digital blood pressure HEM-907 monitor in adults. *Blood Press Monit*. 2001;6:107–110.
20. Stergiou GS, Tzamouranis D, Protogerou A, Nasothimiou E, Kapralos C. Validation of the Microlife WatchBP Office professional device for office blood pressure measurement according to the International Protocol. *Blood Press Monit*. 2008;13:299–303.
21. White WB, Cleveland JM, Rolleri RL, for the Ramipril-Hydrochlorothiazide Study Group. Utility of semiautomatic clinic and 24-h ambulatory blood pressure measurements to evaluate combination therapy: the Ramipril-Hydrochlorothiazide Hypertension Trial. *J Human Hypertens*. 2008;22:559–568.
22. Mazze RS, Simonson GD, Robinson RL, Kendall DM, Idrogo MA, Adlis SA, Boyce KS, Dunne CJ, Anderson RL, Bergenstal RM. Characterizing blood pressure control in individuals with Type 2 diabetes: The relationship between clinic and self-monitored blood pressure. *Diabet Med*. 2003;20:752–757.
23. Mazze RS, Robinson R, Simonson G, Idrogo M, Simpson B, Kendall D, Bergenstal R. Undetected, uncontrolled blood pressure in Type 2 Diabetes: Self-monitored blood pressure profiles. *Blood Pressure*. 2004;13:335–342.
24. Nelson MR, Quinn S, Bowers-Ingram L, Nelson JM, Winzenberg TM. Cluster-randomized controlled trial of oscillometric vs. manual sphygmomanometer for blood pressure management in primary care (CRAB). *Am J Hypertens*. 2009;22:598–603.
25. Dahlöf B, Sever PS, PoulterNR, Wedel H, Beevers DG, Caulfield M, Collins R, Kjeldsen SE, Kristinsson A, McInnes GT, Mehlsen J, Nieminen M, O'Brien E, Östergren J, for the ASCOT investigators. Prevention of cardiovascular events with an antihypertensive regimen of amlodipine adding perindopril as required versus atenolol adding bendroflumethiazide as required, in the Anglo-Scandinavian Cardiac Outcomes Trial-Blood Pressure Lowering Arm (ASCOT-BPLA): a multicenter randomized controlled trial. *Lancet*. 2005;366:907–913.
26. Ishikawa J. Nasothimiou E, Karpettas N, Feltheimer S, McDoniel S, Schwartz J Stergiou G, Pickering T. Automatic office blood pressure measurement without doctors or nurses present is more predictive of ambulatory blood pressure than is office blood pressure by mercury sphygmomanometer. *J Hypertens*. 2009;27(Suppl 4):S170.
27. Bailey RH, Bauer JH. A review of common errors in the indirect measurement of blood pressure. *Arch Int Med*. 1993;153:2741–2748.
28. Le Pailleur C, Helft G, Landais P, Montgermont P, Feder JM, Metzger JP, Vacheron A. The effects of talking, reading, and silence on the 'white coat' phenomenon in hypertensive patients. *Am J Hypertens*. 1998;11:203–207.
29. Mancia G, Parati G, Pomidossi G, Grassi G, Casadei R, Zanchetti A. Alerting reaction and rise in blood pressure during measurement by physician and nurse. *Hypertension*. 1987;9:209–215.
30. Myers MG, Dawes M, Godwin M, Kaczorowski J, Kiss A, Tobe SW Minimum number of readings for automated office blood pressure measurement. *J Hypertens*. 2009;27(Suppl 4):S197.
31. Myers MG, Valdivieso M, Kiss A. Consistent relationship between automated office blood pressure recorded in different settings. *Blood Press Monit*. 2009;14:108–111.
32. Kaczorowski J, Chambers LW, Karwalajtys T, Dolovich L, Farrell B, McDonough B, Sebaldt R, Levitt C, Hogg W, Thabane L, Tu K, Goeree R, Paterson JM, Shubair M, Gierman T, Sullivan S, Carter M. Cardiovascular health awareness program (CHAP): A community cluster-randomised trial among elderly Canadians. *Prevent Med*. 2008;46:537–544.
33. Leenen FHH, Dumais J, McInnis N, Turton P, Stratychuk L, Nemeth K, Lum-Kwong Mm, Fodor G. 2006 Ontario survey on the prevalence and control of hypertension (ON BP). *CMAJ*. 2008;178:1441–1449.
34. Myers MG, McInnis NH, Fodor GJ, Leenen FH. Comparison between an automated and manual sphygmomanometer in a population survey. *Am J Hypertens*. 2008;21:280–283.
35. Ostchega Y, Nwankwo T, Sorlie PD, Wolz M, Zipf G. Assessing the validity of the Omron HEM-907XL oscillometric blood pressure measurement device in a national survey environment. *J Clin Hypertens*. In press.
36. Myers MG. A proposed algorithm for diagnosing hypertension using automated office blood pressure measurement. *J Hypertens*. In press.
37. Fagard RH, Celis H, Thijs L, Staessen JA, Clement DL, De Buyzere ML, De Bacquer DA. Daytime and nighttime blood pressure as predictors of death and cause-specific cardiovascular events in hypertension. *Hypertension*. 2008;51:55–61.