Eliminating the Human Factor in Office Blood Pressure Measurement

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Factors related to the physician/nurse and patient and their interaction are potential sources of error in manual office blood pressure (MOBP). The use of automated sphygmomanometers to record blood pressure (BP) with the patient alone reduces measurement error and minimizes anxiety-related increases in BP, thus eliminating the "white-coat" response. Comparative studies have shown the cut-point for a normal automated office BP (AOBP), awake ambulatory BP, and home BP (<135/85 mmHg) to be similar, providing the patient does not rest for a prolonged period before the first AOBP reading, as recommended for MOBP measurement. AOBP should now replace MOBP in routine clinical practice. *J Clin Hypertens (Greenwich).* 2014;16:83–86. ©2014 Wiley Periodicals, Inc.

Manual blood pressure (BP) measurement has always been the standard technique for evaluating the BP status of patients in the office setting. Established guidelines carefully describe the proper methods for recording office BP including 5 minutes of rest before the first reading is taken, at least two BP measurements, no conversation, and no digit preference (rounding off of readings to the nearest zero value). Each of these features requires the cooperation of the patient and /or health professional. Failure to adhere to these guidelines often leads to higher and inaccurate readings. Furthermore, the actual presence of a physician or nurse tends to increase BP by making the patient anxious, resulting in a diagnosis of "white-coat" hypertension.[1,2] When manual BP readings are performed according to guidelines, the mean value is about 5/5 mm Hg higher than the corresponding mean awake ambulatory BP or home BP, thus making a normal office BP of <140/90 mm Hg equivalent to normal home and awake ambulatory BP values of <135/85 mm Hg.[3,4]

Nevertheless, there is little information on how often physicians and nurses record BP according to the guidelines in routine clinical practice, as it is difficult to obtain unbiased data due to the "Hawthorne Effect."[5] This term describes the phenomenon whereby observing the activity of health professionals in itself leads to changes in behavior, in this case more careful recording of BP.[6] A measure of the quality of routine manual office BP (MOBP) may be obtained by looking at BP data recorded in real-life settings. There are now at least 6 studies that report higher MOBP in routine clinical practice compared with manual readings taken according to guidelines as part of a research study.[4] In these studies, the routine MOBP averaged 10/7 mm Hg higher than the manual research BP. Given that treatment decisions are based on manual BP recorded in research studies, it would appear that the true cut-point for a normal BP in the community is about 150/95 mm Hg and not 140/90 mm Hg. Experience acquired from collecting BP data from patient records in primary care practice[3,7] shows that only a single BP reading is usually taken and MOBP is rounded off to the nearest zero value about 50% of the time. Conversation between patients and nurses/physicians is likely very common, especially when many health professionals believe that talking makes the patient less anxious, although it actually provokes the white-coat response.[8] Thus, the elimination of the human factor in BP measurement should result in a more accurate assessment of a patient's true BP status.

AUTOMATED OFFICE BP

New developments in automated sphygmomanometer technology have now made it possible to circumvent many of the shortcomings of MOBP by having validated, fully automated devices that are capable of recording multiple BP readings with the patient resting alone in a quiet room.[9] The resulting mean automated office BP (AOBP) is similar to the mean awake ambulatory BP, which simplifies defining hypertension in that the cut-point for a normal AOBP (<135/85 mm Hg) is the same as the cut-point for normal home and awake ambulatory BP.[4] Studies using AOBP have reported that readings are similar in different settings and can be taken as often as 1 minute apart.[10,11] Three devices for recording AOBP have been validated for accuracy, the BpTRU (BpTRU Medical Devices, Coquitlam, BC, Canada),[12] Omron HEM-907 (Omron Corporation, Kyoto, Japan),[13] and Microlife WatchBP Office (Microlife, Switzerland).[14] Each device takes a mean of several readings during a period of 4 to 5 minutes. For example, the BpTRU automatically records an initial "test" reading and then 5 readings at 1-minute intervals timed from the start of one reading to the start of the next one.[12] Mean AOBP readings are similar with the different devices and/or with the awake ambulatory BP.[4,15,16]

The basic principles of AOBP include multiple readings taken with a fully automated recorder with the

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patient resting alone in a quiet room.[9] A fully automated device is necessary since activation of an automated recorder by the patient in itself tends to increase BP.[17] Being alone in an examining room eliminates the possibility of conversation, although simply sitting apart in the waiting room may be sufficient.[18] Multiple readings satisfy the recommendations in the guidelines and also preclude the need for a period of rest before the first reading is taken. Taking more than a single reading also reduces BP variability if atrial fibrillation is present. Furthermore, AOBP does not exhibit digit preference, which reduces the accuracy of BP measurement.[3,6]

METHODOLOGIC ISSUES IN THE EVALUATION OF AOBP

Patients should not rest for 5 minutes before AOBP is recorded, otherwise the reading may be too low. In one study,[19] mean AOBP was 6.9/1.9 mm Hg lower than the mean awake ambulatory BP when patients rested at least 5 minutes before the first reading was taken. Without a prespecified rest period, the mean AOBP is generally the same as the mean awake ambulatory BP and self-measured BP in the home.[17]

When AOBP and MOBP are compared, readings should not be taken on the same visit, otherwise an "order effect" will be present with the second reading being biased lower.[20] This aspect of AOBP measurement was examined in a population survey[21] involving 2551 patients residing in the community, 238 of whom had both AOBP and manual BP readings taken.[22] Manual BP was recorded in duplicate by research personnel according to guidelines using a mercury sphygmomanometer and was preceded by 5 minutes of rest. AOBP was recorded using the BpTRU without any prescribed rest beforehand and the order of the manual BP and AOBP was randomized. Mean systolic AOBP (113/70 mm Hg) was significantly lower than the manual BP (117/74 mm Hg) when the manual BP was recorded first compared with the manual BP (118/75 mm Hg) when it was recorded after AOBP (116/72 mm Hg). When this order effect occurs in patients with higher mean BP values, the differences are greater and become more clinically relevant, such as occurred in a recently published study.

In this study,[23] Edwards and colleagues compared AOBP and MOBP readings in 329 patients with each other and with the mean awake ambulatory BP. The order of the readings was always MOBP first followed by AOBP. MOBP was obtained in triplicate after the patient had been sitting in a quiet room "for at least 5 minutes." Subsequently, each patient had AOBP recorded using a BpTRU device set to take readings 1 minute apart with the patient resting seated and alone. The article did not state whether the patients also rested for 5 minutes before the AOBP was recorded. The authors reported the AOBP to be a mean of 3.2/2.4 mm Hg lower than the mean awake ambulatory BP (139.4/76.5 mm Hg) and concluded that AOBP is associated with a "systematic downward bias" in determining BP status.

Based on the previously mentioned studies in which patients rested before the AOBP reading,[19,20,22] it is clear that the lower mean AOBP value seen in their patients resulted from the order effect inherent in their study design, which involved sequential BP readings. The proper method for comparing two types of office BP readings is to take measurements on separate days, such as before and after the 24-hour ambulatory BP recording, with the order of the two types of readings being randomized. A review of studies in different settings has shown that the mean AOBP is within 1 to 2 mm Hg of the mean awake ambulatory BP.[4] Based on data from 10 studies,[4] the mean AOBP was 136.5/78.7 mm Hg compared with a mean awake ambulatory BP of 137.3/78.9 mm Hg.

OTHER ASPECTS OF AOBP

AOBP appears to be relatively consistent from visit to visit and when recorded within and outside of the clinical setting.[10] In 62 patients, mean AOBP was almost identical from one office visit to the next and when recorded on a separate visit to the ABPM unit. The intra-class correlation for the 3 sets of readings was very strong (r=0.896/r=0.873) for systolic/diastolic BP.[10]

The main advantage of AOBP is that it virtually eliminates the white-coat effect.[4] To do so, the patient must be hypertensive in the office setting. If an individual's BP is in the lower part of the normal range, AOBP may be somewhat lower than the awake ambulatory BP, whereas, for patients with higher BP readings, AOBP and awake ambulatory BP are similar.[4,17,20]

A somewhat surprising finding in a study comparing routine MOBP with AOBP was that AOBP did not increase the prevalence of masked hypertension even though the readings were significantly lower than the routine MOBP.[24] This observation was true if single AOBP readings were compared with the awake ambulatory BP or if AOBP data recorded on 2 or 3 visits were analyzed.

THE FUTURE OF OFFICE BP MEASUREMENT

The imminent disappearance of the mercury sphygmomanometer from clinical practice as a result of environmental concerns is already changing our approach to BP measurement with new automated and semiautomated ascultatory devices becoming available. Coincidentally, influential guidelines such as the National Institute for Health and Clinical Excellence (NICE) and the European Society of Hypertension[25–27] have shifted the focus away from office BP measurement to 24-hour ambulatory and home BP. These out-of-office BP readings are capable of predicting future cardiovascular risk related to an individual's BP status significantly better than manual BP measurement. The NICE guidelines virtually mandate that 24-hour ambulatory BP monitoring be performed before making a diagnosis of hypertension. As far back as 2005, Canadian guidelines[28] proposed 24-hour ambulatory BP monitoring as the preferred method for diagnosing hypertension. At the present time, the role of office BP in the management of hypertension is somewhat uncertain.

AOBP is now recognized as providing an alternative to MOBP with its readings being similar to awake ambulatory BP and home BP.[26,29] Interest in AOBP has increased dramatically in the past few years as its advantages over routine MOBP have become more evident. To date, there have not been any clinical outcome studies comparing AOBP with other types of BP measurement. However, there is evidence showing AOBP to have a significantly stronger relationship than conventional office BP to intermediate measures of target organ damage such as intima-media thickness of the carotid artery[30] and left ventricular mass.[31] Also, AOBP correlates significantly better than routine MOBP with awake ambulatory BP,[3,6,7] which is now considered to be a gold standard for predicting future cardiovascular risk in relation to BP status. The relatively high price of AOBP devices has been a disincentive for their use, but lower cost units will soon become available.

No method of BP measurement is perfect. Ambulatory BP monitoring entails the least human involvement, which may, in part, be responsible for its pre-eminent position in the guidelines. Self-measurement of BP in the home has documented advantages over office BP but the findings in research studies may not always be transferred to the clinical setting. Home BP in the community is subject to "reporting bias," with patients conveying incorrect or fictitious BP readings to their physicians.[32] Newer home BP recorders generally have a memory for storing BP data but patients still write their readings on to paper instead of taking their recorders to show the actual BP to their physician. BP telemonitoring is one way to eliminate the human factor that causes reporting bias with readings being automatically transmitted to the doctor's office without any chance of the values being altered.[33]

AOBP corrects some of the problems associated with MOBP such as single readings, conversation with patients, and digit preference, which can reduce measurement accuracy and transiently increase BP. However, there are other limitations that are common to all types of office BP measurement, including the need to have the patient seated with the back and arm supported, feet on the floor, and the use of a cuff of proper size for the arm's circumference.

CONCLUSIONS

The disappearance of the mercury sphygmomanometer is forcing a change in how office BP is recorded. The available evidence supports AOBP as the best replacement for MOBP by taking advantage of the advances in automated BP measurement and, at the same time, minimizing the human factor, which has the potential to adversely affect the quality of BP readings.

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