Use of an Automated Blood Pressure Recording Device, the BpTRU, to Reduce the “White Coat Effect” in Routine Practice

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Background: Patients often exhibit higher blood pressure (BP) readings in the doctor’s office, a phenomenon known as the white coat effect. This study examines the presence of a physician in the examining room as a possible factor in provoking a white coat effect.

Methods: Blood pressure measurements taken by an automated BP recording device, the BpTRU (VSM MedTech Ltd., Vancouver, BC, Canada) with the patient alone in the examining room, were compared with the following: 1) BP taken by the patient’s family physician; 2) BP taken on the first visit to a hypertension specialist; 3) BP measured by a trained research technician and 4) the mean awake ambulatory BP (ABP). The BpTRU and trained research technician readings were taken outside of the office (treatment) setting in an ABP research unit.

Results: Blood pressure readings (mm Hg, mean ± SEM) taken by the BpTRU (155 ± 5/88 ± 2) tended to be lower than for the family physician (166 ± 4/89 ± 3) and the hypertension specialist (174 ± 5/92 ± 2; P < .001). However, BP taken by the trained research technician (158 ± 4/90 ± 2) was similar to the value obtained by the BpTRU. The mean awake ABP was lower (P < 0.01) than the other four BP values.

Conclusions: Use of an automated BP recording device outside of the office (treatment) setting can partly eliminate the white coat effect. A similar finding was observed with readings taken by a trained research technician under similar conditions. Referral of patients to nonoffice settings for automated BP recordings may provide a more accurate estimate of a patient’s BP status, with partial elimination of the white coat effect associated with readings taken by a physician. Am J Hypertens 2003;16:494–497 © 2003 American Journal of Hypertension, Ltd.

Key Words: Blood pressure measurement, hypertension diagnosis.
Method

Patient Population

A total of 22 consecutive patients referred from a hypertension specialist’s office for 24-h ABP monitoring were enrolled into the study. All patients had been referred for the first time for diagnosis or management from primary care physicians in the community. A 24-h ABP recording was ordered because the initial visit led to a suspicion of a possible white coat effect increasing office BP readings. Patients who were not suitable for ABP recordings (eg, those with atrial fibrillation, frequent ectopic complexes, or suspected poor compliance) were not considered for entry.

The study population included seven men and 15 women with a mean (± SEM) age of 61 ± 3 years. Eight patients were seen for diagnosis of possible hypertension and were untreated. Antihypertensive drug therapy in the remaining patients consisted of diuretics (n = 12), β blockers (n = 8), angiotensin converting enzyme inhibitors (n = 4), or other (n = 10), with one, two, and three or more drugs being taken by one, six, and seven patients, respectively. The mean duration of hypertension was 14 years (range, 0.1 to 41 years), and the mean period of antihypertensive therapy in treated patients was 11.6 years (range, 2 to 31 years). All patients were seeing their primary care physicians on a regular basis but were making their first visit to the hypertension specialist. Informed consent was obtained from all participants and the study was approved by the Institutional Research Ethics Board.

Procedures

Several measures of each patient’s BP status were obtained. After referral of the patient to the hypertension specialist, the last routine reading taken by the patient’s family physician was noted. The specialist’s reading consisted of two measurements taken with the patient in the sitting position in accordance with national recommendations for manual mercury sphygmomanometry. A mean of the two readings was used to designate the specialist’s BP to be higher than the last reading taken by the patient’s family physician.

After enrollment in the study, BP was recorded using two different methods on two separate visits to the ABP monitoring research unit, which was separate from the office of the specialist. One method involved manual recordings by an experienced hypertension research technician using a standard mercury sphygmomanometer, with two measurements being taken on each of the two visits according to national guidelines and the mean of the four readings calculated. The patient was also left in a quiet room with the cuff from the BpTRU device attached to the upper arm. The device was programmed to take three readings at 2-min intervals after an initial 3-min period of rest without anyone else being present in the room. The mean of the second and third readings was calculated for the two visits to derive the BpTRU reading for study purposes. The automated BP measurements were not visible to the patient. Both manual and BpTRU readings were taken under identical conditions.

Each patient then had a 24-h ABP recording performed after the first visit to the research unit using a SpaceLabs model 90207 device (SpaceLabs, Redmond, WA) on a weekday, with readings taken at 15-min intervals during the day and every 30 min at night. Each patient returned about 2 weeks later for a second set of manual and BpTRU readings with the order of the readings being randomized for the two visits. The mean BP taken by the research technician and BpTRU readings were calculated based upon the values obtained on the visits before and after the ABP recording. The mean daytime (7 AM to 11 PM) ABP value was also calculated. All valid ABP readings were included in the analysis except clearly artifactual numbers.

Data are presented as mean ± SEM. Differences among the four sets of BP measurements were evaluated statistically by analysis of variance. The minimum level for statistical significance was set at P < .05.

Results

Systolic readings (mm Hg) taken by the BpTRU device (155 ± 5/88 ± 2) were significantly (P < .001) lower than the mean value recorded on the first visit to a hypertension specialist (174 ± 5/92 ± 2) in the office setting (Fig. 1). The mean manual BP value taken by the research technician (158 ± 4/90 ± 2) was similar to the mean reading taken using the BpTRU device on the two visits before and after the 24-h ABP recording (Fig. 1). There was also a trend for the specialist’s BP to be higher than the last reading taken by the patient’s family physician (166 ± 4/89 ± 3) which was, in turn, higher than the BpTRU and research technician’s readings. The mean awake ABP (146 ± 3/82 ± 2) was significantly lower (P < .01) than all other values.

Familiarity with the automated device did not appear to influence BP measurements. Mean values for the BpTRU
device were similar for the first (157 ± 5/89 ± 2) and second (152 ± 4/88 ± 2) visits. Also, mean manual readings taken by the research technician were similar for the first (160 ± 5/89 ± 2) and second (156 ± 4/89 ± 2) measurements.

A white coat effect, defined as a difference in systolic BP of ≥ 20 mm Hg or diastolic BP of ≥ 10 mm Hg between the mean awake ABP and the other readings was determined. A white coat effect was seen in 14, 18, nine, and 10 patients using the family physician, specialist, technician, and BpTRU readings, respectively.

Discussion
This study highlights several aspects of BP measurement in the office setting. The impact on BP readings of a patient seeing a hypertension specialist for the first time can be seen with the highest values being recorded under these conditions, despite the specialist’s adherence to standard BP measurement techniques. The BP values taken from the patients’ last visit to their primary care physicians were slightly lower, presumably because of the patients’ familiarity with their own physicians and office environment.

The apparent pressor effect noted upon seeing the hypertension specialist for the first time can be partly eliminated if readings are also taken on a separate occasion, either by an experienced research technician using standard BP recording techniques or by a validated, automated BP recording device, the BpTRU. An interesting observation was the similarity in readings taken by the research technician and the BpTRU device with both being significantly greater than the mean awake ABP. Previous studies suggest that these findings are consistent with etiologic factors suspected of contributing to the white coat effect.

Patients’ readings tend to be higher during the first visit to a new setting and then to decrease over subsequent visits, even if BP is measured under identical conditions on each occasion. This phenomenon has been reported in several large studies including the Australian National Blood Pressure Study7 and the British Medical Research Council Trial,8 and it occurred when either a nurse or physician was measuring BP. Thus, it is not surprising that the highest mean BP value in the present study occurred with the first visit to the specialist.

The absence of a significant difference between readings taken by the automated BpTRU device and the research technician is also consistent with an earlier study from our center.9 In this instance, mean office BP was similar to readings taken using an automated device with a memory, the Omron HEM 705CP (AMG Medical Inc., Montreal, PQ, Canada), without anyone else being present in the examining room, when compared with readings taken by the patient’s own family physician on the same visit. Both sets of readings showed a significantly greater systolic BP than the mean awake ABP, confirming that the white coat component of the office visit was still present.

A confounding factor in this study was the physician being aware that he or she was participating in a research study, so that readings were likely taken with greater care than in routine clinical practice. In a previous study, we noted statistically significant correlations between readings taken by the patients’ own family physicians and left ventricular mass, but only for readings taken in the context of a research study.2 No significant correlation was present when routine office readings were correlated with left ventricular mass.

The well-documented difference between mean awake ABP readings and routine office BP readings is likely due to a number of factors related to the patient, the observer recording the BP, and the environment.2 The ABP represents the gold standard in terms of being the most accurate predictor of clinical outcomes compared with office readings or BP self-measurement. Thus, it is important to eliminate as much of the white coat effect as possible to avoid “dilution bias,” in which the relationship between the BP and clinical outcomes is reduced (or “watered down”) because of factors affecting readings, such as the white coat effect.10

The highest readings in this study were seen with the first visit to a hypertension specialist even though careful measurements were taken according to national guidelines. One can speculate that the readings on a first visit in routine clinical practice would have been even higher outside of the context of a research study.

Indeed, the so-called “Hawthorne effect”11 likely plays a major role in any attempt to study physician behavior in BP measurement. Simply being aware of participation in a research study tends to change the behavior of the observer, in this instance leading to the BP being taken more carefully than otherwise would have been done in routine clinical practice. At least for the specialist’s reading, the patients’ white coat effect would seem to have been sufficiently present to give higher readings, even when extra care was taken to minimize unnecessary stimulation.

What has been learned so far from efforts to minimize the white coat effect in the office setting? Clearly, the observer must adhere to standardized guidelines, including no conversation with the patient, either immediately before or during the measurement. First visits to a new physician will likely give higher than usual readings despite the use of careful measurement techniques. Physicians should be aware of this likelihood and arrange to see patients on several occasions before making a diagnosis of hypertension in accordance with current national guidelines. Alternatively, one could use a 24-h ABP recording to eliminate the white coat effect and to obtain a measurement of BP that most accurately predicts future clinical outcomes.

However, ABP recordings are relatively expensive and not widely available. Based upon the findings in the present study, much of the white coat effect can be reduced if the BP is taken outside of the treatment setting, either by specially trained personnel or by an automated recording
device such as the BpTRU. An alternative would be to perform BP self-measurement with validated devices having a memory or a hard copy printout to minimize “reporting bias,” as noted when patients do not report all self-measured BP readings as taken.\textsuperscript{12}

Ideally, it would be useful to compare the BpTRU device to readings taken by a physician in routine clinical practice. Unfortunately, the Hawthorne effect would almost certainly bias the results, making the physicians’ readings “special” and not routine, which would tend to minimize the benefits of using the automated device. There is little doubt that the routine office BP is a weak link in the management of care for the hypertensive patient. Unless special precautions are taken to obtain accurate and reliable manual office readings, it might be preferable to record the routine office BP with a validated, automated BP device such as the BpTRU used in this study.

References