Relevance to Home Blood Pressure Monitoring Protocol of Blood Pressure Measurements Taken Before First-Morning Micturition and in the Afternoon

Antonio Eduardo Monteiro de Almeida1,2, Ricardo Stein3,4, Miguel Gus3, João Agnaldo Nascimento5, Karlyse Claudino Belli3, Jorge Rene Garcia Arévalo6, Flávio Dani Fuchs3,4, Jorge Pinto Ribeiro (in memoriam)3,4
Cardiology Division - Hospital Universitário Lauro Wanderley - Universidade Federal da Paraíba1; Physical Education Department - Universidade Federal da Paraíba2; Cardiology Division - Hospital de Clínicas de Porto Alegre3, Porto Alegre, RS; Internal Medicine Department - Faculdade de Medicina - Universidade Federal do Rio Grande do Sul3, Porto Alegre, RS – Brasil; Statistic Departament - Universidade Federal da Paraíba – UFPB4, João Pessoa, PB; Cardiology Departament - Faculdade de Medicina Nova Esperança5, João Pessoa, PB - Brazil

Abstract

Background: The importance of measuring blood pressure before morning micturition and in the afternoon, while working, is yet to be established in relation to the accuracy of home blood pressure monitoring (HBPM).

Objective: To compare two HBPM protocols, considering 24-hour ambulatory blood pressure monitoring (wakefulness ABPM) as gold-standard and measurements taken before morning micturition (BM) and in the afternoon (AM), for the best diagnosis of systemic arterial hypertension (SAH), and their association with prognostic markers.

Methods: After undergoing 24-hour wakefulness ABPM, 158 participants (84 women) were randomized for 3- or 5-day HBPM. Two variations of the 3-day protocol were considered: with measurements taken before morning micturition and in the afternoon (BM+AM); and with post-morning-micturition and evening measurements (PM+EM). All patients underwent echocardiography (for left ventricular hypertrophy - LVH) and urinary albumin measurement (for microalbuminuria - MAU).

Result: Kappa statistic for the diagnosis of SAH between wakefulness-ABPM and standard 3-day HBPM, 3-day HBPM (BM+AM) and (PM+EM), and 5-day HBPM were 0.660, 0.638, 0.348 and 0.387, respectively. The values of sensitivity of (BM+AM) versus (PM+EM) were 82.6% × 71%, respectively, and of specificity, 84.8% × 74%, respectively. The positive and negative predictive values were 69.1% × 40% and 92.2% × 91.2%, respectively. The comparisons of intraclass correlations for the diagnosis of LVH and MAU between (BM+AM) and (PM+EM) were 0.782 × 0.474 and 0.511 × 0.276, respectively.

Conclusions: The 3 day-HBPM protocol including measurements taken before morning micturition and during work in the afternoon showed the best agreement with SAH diagnosis and the best association with prognostic markers.

Keywords: Arterial Pressure; Mass Screening; Predictive Value of Tests; Ambulatory Blood Pressure Monitoring; Cardiovascular Diseases/urine; Hypertension.

Introduction

Ambulatory blood pressure monitoring (ABPM) has been recognized as the reference method to predict the cardiovascular risk associated with increased blood pressure (BP). Longitudinal studies with population samples1-3 and hypertensive individuals4,5 have reported the better ability of ABPM to stratify risk as compared with measurements taken at the office. More recently, home blood pressure monitoring (HBPM) has been accepted in different guidelines as an effective method to measure usual BP and as a useful tool to stratify cardiovascular risk6-11. This low-cost method has potential clinical use in different scenarios, such as in establishing the diagnosis and prognosis of systemic arterial hypertension (SAH), in ‘white coat hypertension’ and ‘masked hypertension’, in assessing BP levels of the elderly and hypertensive individuals with diabetes, in resistant hypertension, and in assessing adherence to anti-hypertensive treatment, as a guide for pharmacological interventions6-9,12-14.

Home blood pressure monitoring is defined as the systematized out-of-office BP measurement by the patient or any skilled person, during wakefulness, following a specific and standardized protocol, which is different from self-blood pressure measurement (SBPM), which is the non-systematized reading performed according to doctor’s guidance or patient’s decision'. European and
North-American guidelines lack accuracy regarding protocol systematization and control, which can be mistaken for SBPM.\(^9,15,16\). However, inconsistencies in protocol recommendations regarding hours, number of days and measurements taken during HBPM are still observed.\(^17-20\) The HBPM protocols of the Brazilian Society of Cardiology (SBC)\(^7\) and of the Japanese Society of Hypertension\(^8\) recommend BP measuring in the morning after micturition, avoiding urinary bladder distension and consequent BP elevation. The influence of BP measurements taken in the afternoon during work on the estimation of usual BP is still arguable.\(^9\) The European Society of Hypertension\(^15,16\) recommends BP measurement for seven days, two taken in the morning and two in the evening, the means of the first day being discarded for the purpose of diagnosis and therapeutic decisions. It is worth noting the lack of major recommendations on the influence of micturition or other conditions on the accuracy of HBPM.

The objective of the present study was to assess the influence on the SAH diagnosis of BP measurements taken immediately after waking up (before micturition) and in the afternoon, considering ABPM during wakefulness as gold-standard. In addition, the secondary objective was to assess the association of prognostic markers, such as microalbuminuria (MAU) and left ventricular hypertrophy (LVH), with HBPM protocols that differ about the inclusion or exclusion of measurements taken before and after morning micturition or in the afternoon.

**Methods**

**Population**

Individuals referred for assessment of ABPM at a private clinic specialized in cardiology in the city of João Pessoa, Paraíba state, were eligible for this study. They were consecutively assessed at medical office, and, after anamnesis and physical examination, the individuals meeting the inclusion criteria were invited to participate in the study and to sign the written informed consent previously approved by the ethics committee of the institution. Patients with the following characteristics were excluded from the study: cardiac arrhythmia; cognitive deficit; and visual deficit hindering the measurements. In addition, exams that did not reach the required number of measurements were excluded from the analysis: < 16 validated measurements during wakefulness and/or < 8 measurements during sleep on ABPM or < 14 validated measurements on HBPM\(^7\).

**Study design**

This is a diagnostic cross-sectional study to compare different HBPM protocols, considering 24-hour ABPM as gold-standard, for the diagnosis of SAH. All diagnostic tests were performed between February 2009 and April 2010.

**Study protocol**

The analyses of this investigation complement previously published data. The recruiting flowchart (Figure 1) and the assessment protocols have been previously described (Figure 2)\(^22\). Briefly, after personal data collection, patients underwent 24-hour ABPM, after which, all were randomized to one of the HBPM protocols (three or five days) and later crossover with a five-day interval between protocols. All patients completing the study underwent both HBPM protocols. For BP measurements, both protocols followed the SBC recommendations, as previously described\(^15,22\).

**ABPM protocol**: the recommendations for ABPM were in accordance with those of the SBC V guidelines for ABPM\(^7\), with SBP and DBP measurements taken every 15 minutes during wakefulness and every 20 minutes during sleep.

**HBPM protocol**: for both protocols, in the morning of the first day, patients underwent the first three BP measurements with a trained nurse, and received all instructions about the protocols to be followed at home. The numbers and times of measurements are shown in Figure 2. On the three-day HBPM protocol, up to 33 BP measurements could be obtained, and, on the five-day HBPM protocol, up to 27 measurements. In both protocols, participants were instructed to take three measurements in the presence of any sign or symptom, at any time of the day, and record them on the diary.

To assess the impact of micturition and afternoon measurements on the accuracy of the three-day protocol as compared with that of the five-day protocol, the following sets of measurements were considered:

- three-day HBPM with all measurements (standard three-day HBPM);
- three-day HBPM with measurements taken before morning micturition and in the afternoon (HBPM-AM);
- three-day HBPM with post-morning-micturition and evening measurements (HBPM-PM+EM).

**Devices**

ABPM: the Spacelabs 90207 monitor (Spacelabs, Washington, DC, United States) validated by the British Hypertension Society was used\(^23\).

HBPM: the validated Microlife BP A 100 Plus device (Microlife, Heerbrugg, Switzerland) was used\(^24\).

**Definitions and measurements of major variables**

Systemic arterial hypertension assessed with ABPM was defined as systolic blood pressure (SBP) > 130 mmHg and diastolic blood pressure (DBP) > 80 mmHg in 24 hours. For ABPM during wakefulness, those values were SBP > 135 mmHg and DBP > 85 mmHg. For HBPM, the criterion adopted for the diagnosis of SAH was SBP at home > 135 mmHg and DBP at home > 85 mmHg\(^7\). For ABPM, wakefulness was defined as the time interval between waking up and going to bed, according to records documented in the diary.

**Urinary albumin**

On the initial exam, urinary albumin concentration, MAU, was measured in a urine sample by using immunoturbidimetric
Eligible n = 204

Refused to participate n = 35

n = 169

Excluded
- arrhythmia n = 1
- CI n = 3

n = 165

WIC

ABPM

Randomization n = 163

Gave it up n = 2

IM n = 2

5 day HBPM

Gave it up n = 2

3 day HBPM

Completed the study
n = 158

Figure 1 – Flowchart of population recruitment. IM: insufficient measurements; CI: cognitive impairment; WIC: written informed consent; HBPM: home blood pressure monitoring; ABPM: ambulatory blood pressure monitoring.
Figure 2 – Diagram of the protocols of 3-day and 5-day home blood pressure monitoring (HBPM).
and, on the five-day HBPM protocol, one patient was excluded because of insufficient measurements (forgot to take BP measurements on the last two days), and two patients were excluded due to a trip. Regarding the patients who concluded all protocols, no change was observed in their lifestyle, medications and usual hours during the study. In the three-day protocol, 24 BP measurements were taken, and, in the five-day protocol, 19 measurements.

Table 1 shows the major characteristics of the population comprised of overweight middle-aged patients with slight predominance of the female sex. Half of them were on anti-hypertensive drugs, ABPM being mainly indicated for SAH diagnosis and treatment. The final diagnoses of ‘white coat hypertension’ and ‘masked hypertension’ were established in 18.3% and 3.1% of the patients, respectively. Assessment by using hierarchical log-linear model with multinomial distribution showed no difference regarding the use of drugs (p = 0.221). No significant difference in MAU between men and women was found (16 ± 11 mg/L; 14 ± 10 mg/L; p = 0.121). The mean LVM values were 112 ± 15 g/m² and 88 ± 9 g/m² for men and women, respectively (p = 0.001).

Table 2 shows the means of ABPM during wakefulness, standard three-day HBPM, three-day HBPM-BM+AM, three-day HBPM-PM+EM, and five-day HBPM, with significant differences between them for SBP and DBP. Figure 3 shows the dispersion and Bland-Altman plots for SBP and DBP, with smaller dispersion and better agreement of the BM+AM protocol as compared with the PM+EM protocol of the three-day HBPM obtained by associating with ABPM during wakefulness.

Table 3 shows a difference in kappa values between the three-day HBPM protocols when the micturition subject is considered in the analysis. Table 4 shows better diagnosis accuracy for the standard three-day HBPM and three-day HBPM-BM+AM protocols, considering ABPM during wakefulness as gold-standard. Table 5 shows that, using the cutoff points previously defined for the diagnosis of SAH and considering all forms of ambulatory measurements, the standard three-day HBPM protocol, the three-day HBPM-BM+AM protocol and the ABPM during wakefulness protocol had the best agreement and correlated better with the diagnosis of MAU and LVH.

Discussion

The major finding in this study was that, considering ABPM during wakefulness as gold-standard for the diagnosis of SAH, the HBPM protocol including BP measurements taken before the first morning micturition and in the afternoon had the best accuracy to diagnose SAH as compared with the other protocols assessed. In addition, that three-day HBPM protocol performed better than the longer five-day protocol, thus being useful and having a practical potential to the routine assessment of hypertensive individuals. Furthermore, that strategy correlates better with prognostic markers, such as MAU and LVH. Because of the clinical relevance of that finding, three-day HBPM protocols should include measurements taken before morning micturition and in the afternoon.
Studies considering the importance of micturition for HBPM accuracy lack in the literature. The SBC guidelines\(^7,15\) on that investigation method recommend BP measurement in the morning after micturition. However, such recommendation is not supported by any scientific reference, being thus empirical. The Japanese Society of Hypertension guideline\(^6\) makes the same recommendation, based on one single Japanese study published as an abstract and showing BP elevation associated with morning urinary bladder distension. In defining the HBPM protocol, the European\(^15,30\) and North-American\(^8\) guidelines make no reference to that subject.

In addition, the circadian variation of BP depends on three major factors: physical activity, autonomic function and sodium sensitivity\(^31\). Fagius and Karhuvaaara\(^12\) have shown an association between BP elevation and urinary bladder distension in 16 healthy individuals after fluid ingestion. That finding has been justified by the vesicovascular stimulus related to an increase in sympathetic flow, which is mediated by vasoconstrictor neurons, thus increasing BP. Scott et al\(^13\) have shown that, in healthy individuals, the BP elevation that follows water ingestion is associated with increases in serum norepinephrine levels, in sympathetic activity and in peripheral vascular resistance. Callegaro et al\(^14\), studying normotensive and hypertensive individuals, have reported that the BP increase after acute water ingestion could be explained by an increased vasoconstrictor sympathetic activity. Studies assessing cold exposure\(^15\) and mental stress exposure\(^16\) have also reported BP elevation due to sympathetic activity. All those factors can be considered as part of the BP circadian cycle complex, and there is convincing evidence that it plays an important role in BP variability regulation\(^7\). Thus, those questions should be assessed at the time the accuracy of BP measuring tests is assessed for a prolonged time or of proposed HBPM protocols. Thus, by discriminating BP in a more reliable way, the diagnosis and treatment of SAH can be better established, and target-organ lesions prevented in the long run. In that scenario, adding measurements to the standard HBPM, considering first-morning micturition and stress at workplace, can influence the accuracy of the method for SAH diagnosis.

The number of measurements of HBPM should be considered, although the optimal number to be used remains controversial in the different guidelines\(^5,9,11,15,16\). Garcia-Vera and Sanz\(^23\) have assessed HBPM in 43 treated hypertensive patients. In their study, two BP measurements were taken in the morning, in the afternoon during work, and in the evening. That procedure was repeated after one and six months. The results have shown that two measurements would suffice, one at the workplace and the other at home, on three consecutive days, to obtain reliable BP estimates. Another finding from that study is that BP measurements at the workplace were consistently higher than those obtained at home. Kario et al\(^18\) have assessed the influence of work-and home-related stress on sympathetic activation and BP in 134 women. Those authors have shown that work-related stress increased BP levels throughout the day, and the home-related stress induced an additional sympathetic activation. Those data corroborate our protocol, which includes one measurement in the afternoon during work, which better correlated with the diagnosis of SAH.

Den Hond et al\(^19\), studying 247 patients, have compared HBPM with ABPM during wakefulness (SAH \(\geq 135/85\) mmHg) by using a protocol with three measurements taken in the morning and evening for seven days. They have found sensitivity,

### Table 1 – Characteristics of the population (n = 158)

| Parameters assessed       | Total sample n = 158 |
|---------------------------|-----------------------|
| Age (years)               | 50.6 ± 13.5           |
| Male sex                  | 74 (46.6)             |
| BMI (kg/m\(^2\))          | 28.3 ± 4.9            |
| Use of anti-hypertensive drugs | 80 (50.6)       |
| Office measurement SBP (mmHg) | 130 ± 14.0    |
| Office measurement DBP (mmHg) | 80.7 ± 10.1 |
| Indication for BP monitoring  |                       |
| Hypertension              | 117 (74.1)            |
| White-coat hypertension   | 32 (20.3)             |
| Masked hypertension       | 9 (5.7)               |

Results shown as mean ± SD or n (%).

| SBP  | ANOVA p | DBP    | ANOVA p |
|------|---------|--------|---------|
| 128.5 ± 14.1 |            | 79.7 ± 10.4 |         |
| 126.1 ± 13.8 |            | 78.2 ± 9.8  |         |
| 127.4 ± 14.1 | 0.001     | 79.5 ± 10.2 | 0.001   |
| 124.8 ± 13.6 |            | 76.8 ± 9.7  |         |
| 126.1 ± 13.3 |            | 78.3 ± 10.4 |         |

HBPM: home blood pressure monitoring; BM+AM: measurements taken before morning micturition and in the afternoon; PM+EM: measurements taken post morning micturition and in the evening.
Figure 3 – Dispersion and Bland-Altman plots of blood pressure measurements comparing 3-day home blood pressure monitoring (HBPM) with ambulatory blood pressure monitoring (ABPM).

BM+AM: measurements taken before morning micturition and in the afternoon; PM+EM: measurements taken post morning micturition and in the evening; DBP: diastolic blood pressure; SBP: systolic blood pressure.
**Table 3** – Kappa statistic for the diagnosis of hypertension considering ambulatory blood pressure monitoring (ABPM) during wakefulness as gold-standard

| HBPM          | Hypertension | 3-day BM+AM | 3-day PM+EM | Standard 3-day | 5-day HBPM |
|---------------|--------------|-------------|-------------|----------------|-----------|
|               |              | No          | Yes         | No             | Yes       | No          | Yes         |
| Wakefulness ABPM | No       | 95          | 8           | 94             | 9         | 93          | 10          | 84          | 19         |
|               | Yes        | 17          | 38          | 33             | 22        | 14          | 41          | 24          | 31         |
| Kappa         |             | 0.638       | 0.348       | 0.660          | 0.387     |

HBPM: home blood pressure monitoring; BM+AM: measurements taken before morning micturition and in the afternoon; PM+EM: measurements taken post morning micturition and in the evening. p < 0.001 for comparison between each protocol and the gold-standard protocol.

**Table 4** – Accuracy of home blood pressure monitoring (HBPM) protocols considering ambulatory blood pressure monitoring (ABPM) during wakefulness as gold-standard

| HBPM          | Sensitivity (%) (95% CI) | Specificity (%) (95% CI) | Positive predictive value (%) (95% CI) | Negative predictive value (%) (95% CI) | Positive likelihood ratio (95% CI) | Negative likelihood ratio (95% CI) | Area under the ROC curve (95% CI) |
|---------------|--------------------------|--------------------------|----------------------------------------|----------------------------------------|------------------------------------|------------------------------------|----------------------------------|
| 3-day HBPM BM+AM | 82.6 (76.5-88.6)         | 84.8 (79.1-90.5)         | 69.1 (61.7-76.4)                      | 92.2 (87.9-96.5)                      | 5.44 (2.79-10.6)                   | 0.20 (0.13-0.32)                   | 0.87 (0.72-0.98)                  |
| 3-day HBPM PM+EM | 71.0 (63.7-78.1)         | 74.0 (67.0-81.0)         | 40.0 (32.2-47.7)                      | 91.2 (86.7-95.7)                      | 2.73 (1.47-5.28)                   | 0.39 (0.28-0.53)                   | 0.72 (0.62-0.83)                  |
| Standard 3-day HBPM | 80.4 (74.1-86.7)        | 86.9 (81.6-92.3)         | 74.5 (67.6-81.5)                      | 90.3 (85.6-95.0)                      | 6.14 (3.35-7.95)                   | 0.23 (0.14-0.36)                   | 0.82 (0.75-0.90)                  |
| 5-day HBPM     | 62.0 (54.3-69.7)         | 77.8 (71.2-84.4)         | 56.4 (48.5-64.2)                      | 81.6 (75.4-87.7)                      | 2.79 (1.75-2.80)                   | 0.52 (0.38-0.71)                   | 0.69 (0.60-0.78)                  |

BM+AM: measurements taken before morning micturition and in the afternoon; PM+EM: measurements taken post morning micturition and in the evening; CI: confidence interval.

**Table 5** – Agreement and correlation between the diagnosis of hypertension and the diagnosis of microalbuminuria and left ventricular hypertrophy

| Diagnosis | Measurements | Standard 3-day HBPM | 3-day HBPM BM+AM | 3-day HBPM PM+EM | 5-day HBPM | Wakefulness ABPM |
|-----------|--------------|---------------------|------------------|------------------|------------|------------------|
|           | Kappa        | 0.352               | 0.342            | 0.199            | 0.207      | 0.372            |
|           | ROC curve    | 0.694               | 0.681            | 0.574            | 0.613      | 0.711            |
| MAU       | Intraclass correlation | 0.526 | 0.511 | 0.276 | 0.346 | 0.552 |
|           |              | 0.352-0.654         | 0.331-0.643      | 0.009-0.471      | 0.105-0.523 | 0.386-0.673 |
| LVH       | Kappa        | 0.636               | 0.641            | 0.299            | 0.298      | 0.587            |
|           | ROC curve    | 0.820               | 0.814            | 0.634            | 0.649      | 0.801            |
|           | Intraclass correlation | 0.778 | 0.782 | 0.474 | 0.459 | 0.741 |
|           |              | 0.696-0.838         | 0.702-0.841      | 0.281-0.616      | 0.259-0.605 | 0.645-0.811 |

HBPM: home blood pressure monitoring; ABPM: ambulatory blood pressure monitoring; BM+AM: measurements taken before morning micturition and in the afternoon; PM+EM: measurements taken post morning micturition and in the evening; MAU: microalbuminuria; LVH: left ventricular hypertrophy; CI: confidence interval.

Limitations

First, ABPM during wakefulness was considered gold-standard for the diagnosis of SAH. It is worth noting that the standard reference to define the best HBPM protocol should be the occurrence of clinical outcomes assessed on longitudinal studies. However, some studies, such as the PAMELA study and FINN-Home studies, have also used ABPM as gold-standard. Second, our three-day HBPM protocol had a higher number of measurements.
per day as compared with the five-day HBPM protocol. Thus, our results may be a mere consequence of approximation bias. Nevertheless, data clearly showed that the three-day HBPM protocol was better than the five-day HBPM protocol, and that measurements taken at different times had a significant importance to the result, suggesting it should be preferred in clinical practice. The feasibility and efficacy of a HBPM protocol with a greater number of measurements require better assessment in longitudinal studies.

Conclusion

The three-day HBPM protocol comprising measurements taken before first-morning micturition and in the afternoon has better agreement with the diagnosis of SAH, considering 24-hour ABPM as gold-standard, and associates better with prognostic markers as compared with the five-day HBPM protocol.

Author contributions

Conception and design of the research: Almeida AEM, Stein R, Gus M, Fuchs FD, Ribeiro JP; Acquisition of data: Almeida AEM, Arévalo JRG; Analysis and interpretation of the data: Almeida AEM, Stein R, Gus M, Nascimento JA, Belli KC, Arévalo JRG, Ribeiro JP; Statistical analysis: Almeida AEM, Stein R, Nascimento JA, Ribeiro JP; Obtaining financing: Stein R, Gus M, Fuchs FD; Writing of the manuscript: Almeida AEM, Stein R, Gus M, Nascimento JA, Belli KC, Fuchs FD, Ribeiro JP; Critical revision of the manuscript for intellectual content: Almeida AEM, Stein R, Gus M, Belli KC, Arévalo JRG, Fuchs FD, Ribeiro JP.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

This study was partially funded by CNPq.

Ricardo Stein and Miguel Gus are Level 2 CNPq investigators. Flávio Dani Fuchs is Level 1A CNPq investigator.

Study Association

This article is part of the thesis of Doctoral submitted by Antonio Eduardo Monteiro de Almeida, from Universidade Federal do Rio Grande do Sul.

References

1. Mancia G, Sega R, Bravi C, De Vito G, Valagussa F, Cesana G, et al. Ambulatory blood pressure normality: results from the PAMELA study. J Hypertens. 1999;13(12 Pt 1):1377-90.
2. Ohkubo T, Imai Y, Tsuji I, Nagai K, Ito S, Satoh H, et al. Reference values for 24-hour ambulatory blood pressure monitoring based on a prognostic criterion: the Ohasama Study. Hypertension. 1998;32(2):255-9.
3. Bombelli M, Sega R, Facchetti R, Corrao G, Polo Friz H, Vertemati AM, et al. Prevalence and clinical significance of a greater ambulatory versus office blood pressure ‘reversed white coat’ condition in a general population. J Hypertens. 2005;23(3):513-20.
4. Clement DL, De Buyzere ML, De Bacquer DA, de Leeuw PW, Duprez DA, Fagard RH, et al; Office versus Ambulatory Pressure Study Investigators. Prognostic value of ambulatory blood-pressure recordings in patients with treated hypertension. N Engl J Med. 2003;348(24):2407-15.
5. Staessen JA, Thijs L, Fagard R, O’Brien ET, Clement D, de Leeuw PW, et al. Predicting cardiovascular risk using conventional vs ambulatory blood pressure in older patients with systolic hypertension. Systolic Hypertension in Europe Trial Investigators. JAMA. 1999;282(6):539-46.
6. Imai Y, Otsuka K, Kawano Y, Shimada K, Hayashi H, Tochikubo O, et al; Japanese Society of Hypertension, Japanese Society of Hypertension (JSH) guidelines for self-monitoring of blood pressure at home. Hypertens Res. 2003;26(10):771-82.
7. Sociedade Brasileira de Cardiologia, Sociedade Brasileira de Hipertensão, Sociedade Brasileira de Nefrologia, V Diretoria Brasileira de Monitorização Ambulatorial da Pressão Arterial (MAPA V) e III Diretoria de Monitorização Residencial da Pressão Arterial (MRPA III). Arq Bras Cardiol. 2011;97(3 suppl.3):1-24.
8. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Bohm M, et al; Task Force Members. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). J Hypertens. 2013;31(7):1281-357.
9. Pickering TG, Miller NH, Ogedeghe G, Krakoff LR, Artinian NT, Goff D; American Heart Association, American Society of Hypertension, Preventive Cardiovascular Nurses Association. Call to action on use and reimbursement for home blood pressure monitoring: A joint scientific statement from the American Heart Association, American Society of Hypertension, and Preventive Cardiovascular Nurses Association. Hypertension. 2008;52(1):1-9.
10. Pickering TG, Hall JE, Appel LJ, Falkner B, Graves J, Hill MN, et al; Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. 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 American Heart Association Council on high blood pressure research. Hypertension. 2005;45(1):142-61.
11. Oghara T, Kikuchi K, Matsuoka H, Fujita T, Higaki J, Horiuchi M, et al; Japanese Society of Hypertension Committee. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2009). Hypertens Res. 2009;32:3-107. Erratum in: Hypertens Res. 2009;32(4):318.
12. Verberk WJ, Kroon AA, Jongsma Van Craybayns HA, de Leeuw PW. The applicability of home blood pressure measurement in clinical practice: a review of literature. Vasc Health Risk Manag. 2007;3(6):959-66.
13. Celis H, Den Hond E, Staessen JA. Self-measurement of blood pressure at home in the management of hypertension. Clin Med Res. 2005;3(1):19-26.
14. Staessen JA, Den Hond E, Celis H, Fagard R, Keary L, Vandenhoven G, et al; Treatment of Hypertension Based on Home or Office Blood Pressure (THOP) Trial Investigators. Antihypertensive treatment based on ambulatory blood pressure measurement in hypertensive patients: a randomized controlled trial. JAMA. 2004;291(8):955-64.
15. O’Brien E, Patash G, Stengou G, Asmar R, Bellin L, Bilo G, et al; European Society of Hypertension Working Group on Blood Pressure Monitoring, European Society of Hypertension position paper on ambulatory blood pressure monitoring. J Hypertens. 2013;31(9):1731-68. Erratum in Hypertens. 2013;31(12):2467.
16. Parati G, Stergiou GS, Asmar R, Bilò G, Leeuw P, Inai Y, et al; ESH Working Group on Blood Pressure Monitoring. European Society of Hypertension practice guideline for home blood pressure monitoring. J Hum Hypertens. 2010;24(12):779-85.

17. Verberk WJ, Koon AA, Kessels AG, Lenders JW, Thien T, van Montfrans GA, et al. The optimal scheme of self blood pressure measurement as determined from ambulatory blood pressure recordings. J Hypertens. 2006;24(8):1541-8.

18. Celis H, Cort PDe, Fagard R, Thijs L, Staessen JA. For how many days should blood pressure be measured at home in older patients before steady levels are obtained? J Hum Hypertens. 1997;11(10):673-7.

19. Okhobo T, Asayama K, Kikuya M, Hoshi H, Hashimoto J, et al. How many times should blood pressure be measured at home for better prediction of stroke risk? Ten-year follow-up results from the Ohshima study. J Hypertens. 2004;22(6):1099-104.

20. Brook RD. Home blood pressure: accuracy is independent of monitoring schedules. Am J Hypertens. 2000;13(6 Pt 1):625-31.

21. García-Vera MP, Sanz J. How many self-measured blood pressure readings are needed to estimate hypertensive patients ‘true’ blood pressure? J Behav Med. 1999;22(1):93-113.

22. Almeida AE, Stein R, Gus M, Nascimento JA, Arevalo JR, Fuchs FD, et al. Improved diagnostic accuracy of a three-day protocol of home blood pressure monitoring for the diagnosis of arterial hypertension. Blood Press Monit. 2013;18(2):119-26.

23. British Hypertension Society (BHS) Ambulatory blood pressure measuring devices oscilometric mode and automatic digital blood pressure devices for clinical use and also suitable for home self-assessment. [Accessed in 2012 Jun 21]. Available from: http://www.bhsoc.org/bp-monitors/bp-monitors/

24. Stergiou GS, Giusas PP, Neofytou MS, Adamopoulos DN. Validation of the Microlife BP A 100 Plus device for self-home blood pressure measurement according to the International Protocol. Blood Press Monit. 2006;11(3):157-60.

25. Zelmanovitz T, Gross JL, Oliveira JR, Paggi A, Tatsch M, Arevedo-MJ, et al. The receiver operating characteristics curve in the evaluation of a random urine specimen as a screening test for diabetic nephropathy. Diabetes Care. 1997;20(4):516-9.

26. Dyer AR, Greenland P, Elliott P, Daviugis ML, Claeyys G, Kesteloot H, et al; INTERMAP Research Group. Evaluation of measures of urinary albumin excretion in epidemiologic studies. Am J Epidemiol. 2004;160(11):1122-31.

27. Lambers Heerspink HJ, Brantsma AH, de Zeeuw D, Bakker SJ, de Jong PE, Gramevoort RT; PREVEND Study Group. Albuminuria assessed from first-morning void urine samples versus 24-hour urine collections as a predictor of cardiovascular morbidity and mortality. Am J Epidemiol. 2008;168(8):979-905.

28. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA, et al; Chamber Quantification Writing Group. American Society of Echocardiography’s Guidelines and Standards Committee; European Association of Echocardiography. Recommendations for chamber quantification: a report from the American Society of Echocardiography’s guidelines and standards committee and the chamber quantification writing group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. J Am Soc Echocardiogr. 2005;18(12):1440-63.

29. Devereux RB, Reichek N. Echocardiographic determination of left ventricular mass in man: anatomic validation of the method. Circulation. 1977;55(4):613-8.

30. Parati G, Stergiou GS, Asmar R, Bilò G, de Leeuw P, Inai Y, et al; ESH Working Group on Blood Pressure Monitoring. European Society of Hypertension practice guidelines for home blood pressure monitoring. J Hum Hypertens. 2010;24(12):779-85.

31. Agarwal R. Regulation of circadian blood pressure: from mice to astronauts. Curr Opin Nephrol Hypertens. 2010;19(1):51-8.

32. Fagius J, Karhusaaara S. Sympathetic activity and blood pressure increases with bladder distension in humans. Hypertension. 1989;14(5):511-51.

33. Scott EM, Greenwood JP, Gilbye SG, Stoker JB, Mary DA. Water ingestion increases sympathetic vasoconstrictor discharge in normal human subjects. Clin Sci (Lond). 2001;100(3):335-42.

34. Callegaro CC, Moraes RS, Negão CE, Trombetta IC, Rondon MU, Teixeira MS, et al. Acute water ingestion increases arterial blood pressure in hypertensive and normotensive subjects. J Hum Hypertens. 2007;21(7):564-70.

35. Hintsala H, Kandelberg A, Herzig KH, Rintamäki H, Mäntysaari M, Rantala A, et al. Central aortic blood pressure of hypertensive men during short-term cold exposure. Am J Hypertens. 2014;27(5):656-64.

36. Sadano I, Speiker L, Bingelli C, Ruschitzka F, Lüscher TF, Noll G, et al. Coffee blunts mental stress-induced blood pressure increase in habitual but not in nonhabitual coffee drinkers. Hypertension. 2005;46(3):521-6.

37. Rudic RD. Time is of the essence: vascular implications of the circadian clock. Circulation. 2009;120(17):1714-21.

38. Kario K, James GD, Marlon R, Ahmed M, Pickering TG. The influence of work- and home-related stress on the levels and diurnal variation of ambulatory blood pressure and neurohumoral factors in employed women. Hypertens Res. 2002;25(4):499-506.

39. Hond ED, Celis H, Fagard R, Keary L, Leerman M, O’Brien E, et al. Self-measured versus ambulatory blood pressure in the diagnosis of hypertension. J Hypertens. 2003;21(4):717-22.

40. Sega R, Faccetti R, Bombelli M, Cesana G, Corrao G, Grassi G, et al. Prognostic value of ambulatory and home blood pressure compared with office blood pressure in the general population: follow-up results from the Presioni-Arteriosi Monitorate e Loro Associazioni (PAMELA) study. Circulation. 2005;111(14):1777-83.

41. Niiranen TJ, Hänninen MR, Johansson J, Reunanen A, Jula AM. Home-measured blood pressure is a stronger predictor of cardiovascular risk than office blood pressure: the Finn-Home study. Hypertension. 2010;55(6):1346-51.