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Ambulatory blood pressure monitoring in evaluation of hypertensive patients receiving antihypertensive medications in a Nigerian tertiary hospital

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ABSTRACT

Objectives: Hypertension is a major risk factor for cardiovascular morbidity and mortality; thus, proper monitoring of blood pressure (BP) control is essential to reduce the burden of cardiovascular diseases. Despite the advocacy for the use of 24-hour ambulatory BP monitors (ABPMs), their routine use in this environment is still suboptimal. This study, therefore, sets out to determine the proportion of hypertensive patients on therapy who have good BP control with both office BP value and 24-hour ABPM parameters.

Material and Methods: This study was a cross-sectional study of 235 hypertensive subjects on continuous BP medications. They all had their office BP checks done and then had 24-hour ABPM to assess BP control.

Results: The mean age of the study population was 53.61 ± 8.81 with a male-to-female ratio of 146:89. Only 96 patients (40.85%) and 13 (5.5%) of the study population had good BP control using office BP and ABPM values, respectively. The ABPM parameters of the 96 patients with good office BP control showed only 10 (10.4%) of them satisfied the ABPM parameters for good BP control.

Conclusion: Poor BP control was common among hypertensive patients on anti-hypertensive medications. A large percentage of patients with good office BP control had uncontrolled BP when evaluated with a 24-hour ABPM. Therefore, routine use of ABPM is advocated to improve medication dosing and good BP control.

Keywords: Ambulatory blood pressure monitors, Office blood pressure, Hypertension, Hypertension control, Anti-hypertensive

INTRODUCTION

Cardiovascular disease (CVD) remains a leading cause of death globally, and hypertension (HTN) is a major risk factor for cardiovascular morbidity and mortality.[1,2] Proper identification, detection, evaluation, and treatment of HTN are essential to reduce the morbidities and target organ damage associated with HTN.[3-5] These will, therefore, reduce the burden of CVDs.[4,6,7] The practical first step to reducing the burden of HTN will be the proper diagnosis of high blood pressure (BP) and appropriate treatment monitoring.[8] Ambulatory BP monitoring (ABPM) and home BP measurements have been advocated as better alternatives to office BP monitoring in diagnosing HTN, monitoring BP control, and assessing the efficacy of anti-hypertensive therapy.[8-10]

In clinical practice, the definition of BP control is often based on office BP measurements, and most studies relating HTN to cardiovascular morbidity and mortality are derived from office BP measurements.[1,11] However, patients on antihypertensive therapies need round-the-clock BP control, as fluctuation in BP has been linked to increased target organ damage.[12-16]

Recent studies suggest that office BP measurements may not reflect the true BP levels as multiple measurements throughout the day are capable of capturing fluctuations not detected by once-daily BP sampling in the clinic or at home.[8,15] Therefore, 24-h ABPM will provide multiple daytime and nighttime BP measurements and also help in detecting white-coat HTN, white-coat accentuation of BP, as well as masked HTN.[17-20] ABPM can also detect variability in BP during the night and early morning, which could have a considerable influence on cardiovascular outcomes.[13,21] It can also be used to obtain additional information such as diurnal BP variability, circadian changes, and the effects of environmental and emotional conditions on BP levels.[7,8,13] ABPM, therefore, has a greater predictive value than office or home BP for predicting HTN-related target organ damage and morbid events.[3-6] The challenges associated with the use of a single office BP measurement include the white-coat effect contributing to the uncontrolled BP population, while masked HTN may be missed.[8,12,21]

ABPM use is gaining ground worldwide, but the availability in developing countries is still poor.[15] Although home BP checks could also be used, many international guidelines now advocate the use of ABPM for the diagnosis and monitoring of HTN because ABPM is comparable to intra-arterial BP monitoring.[22,23] Despite this, many studies on HTN in this environment still use office BP to monitor BP control with an attendant large number of poorly controlled BP populations.[1] Finally, studies comparing the use of ABPM with office BP to monitor BP control of treated hypertensive patients are few, and this index study was conducted to bridge this knowledge gap.

This study, therefore, sets out to determine the proportion of controlled and uncontrolled hypertensive patients on treatment using both ABPM and office BP monitoring. The result will further deepen the knowledge on the use of ABPM in sub-Saharan Africa.

MATERIAL AND METHODS

Study design and study population

This study was a cross-sectional descriptive study involving 235 adult hypertensive patients (males = 146 and females = 89) on antihypertensive therapies for whom BP medications had not changed over the three preceding months before the study. They were selected using a purposive sampling technique from patients who attended the outpatient cardiology clinic of Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Southwest, Nigeria, from January 2018 to August 2019.

Sample size determination

The Fisher's formula was used to calculate the minimum sample size for this study using a standard normal deviation of 1.96, a confidence level of 95%, a precision of 5%, and a proportion of 20% obtained from a previous study on the prevalence of HTN.[1]

Study procedure

Demographic parameters of subjects were noted and recorded. All subjects were clinically examined to evaluate their body mass index (BMI) and cardiovascular status. They were considered hypertensive if they had a resting systolic BP (SBP) >140 mmHg and diastolic BP (DBP) >90 mmHg measured after at least 15 min of rest in the sitting position with a mercury sphygmomanometer and adapted cuff at the brachial artery and if they are on antihypertensive therapy.[11] Korotkoff phase 1 was used for SBP and phase 5 for DBP. Three consecutive measurements were performed at 5-min intervals and the mean values for SBP and DBP were noted as office SBP and DBP, respectively.

After the initial evaluation, patients were followed up in one of the outpatient clinics by one of the authors. Counseling on lifestyle and non-pharmacological management of HTN was done, and antihypertensive treatment was continued with a BP goal of <140/90 mm Hg. The patient was then put on ABPM monitoring at the same clinic visit.

ABPM

Ambulatory BP was subsequently performed on the patients with the use of an oscillometric monitor Schiller BR 102- Plus. The cuff was fixed on the non-dominant arm and the device was set to obtain automatic BP readings at 15-min intervals during the day time and at 30-min intervals during night-time.[24] The patient was then sent home with instructions to perform their usual activities, to hold the arm immobile at the time of the measurements, note on a diary the occurrence of any unusual events, including times at which they went to bed and woke up, and return 24-h later for device removal. Daytime and night periods were defined individually according to the patient's self-reported data of going to bed and getting up times. Interpretation of the ambulatory BP profile (ABP) profile was done according to the recommendations of the British HTN Society.[12] Mean

24-h, daytime, and night-time values for ambulatory BP were calculated for each subject. Percentage nocturnal BP decline was defined by calculating the percentage of the decline in both SBP and DBP during the night, using the following formula: (Daytime BP–night time BP)/daytime BP × 100. A normal dipping pattern (dipper) was diagnosed when the reduction in the average SBP during the night period was >10% of the mean SBP during the day. An abnormal dipping pattern (non-dipper) was diagnosed when the night average SBP reduction was <10% today values.[13]

SBP and DBP loads in the entire 24-h and separately for the daytime and nighttime were calculated. Daytime and nighttime BP loads were calculated using a threshold of 140/90 mmHg and 120/80 mmHg, respectively.[12] The individual loads are the percentage of elevated readings during each period. SBP and DBP variability was assessed as the standard deviation of the mean (coefficient of variation) of 24-hour ambulatory SBP and DBP recordings.[13]

Exclusion criteria

Excluded were patients with established chronic kidney disease or serum creatinine >1.5 mg% (132 umol/L), ischemic heart disease, congestive heart failure, valvular heart disease, hemoglobinopathy, and diabetes mellitus.

Data analysis

The data were analyzed using Stata version 13.0 for Windows (StataCorp LP, College Station, TX 77845, USA). Continuous variables were described by calculating the means and standard deviation, while categorical variables were analyzed using percentages. The difference between the ABPM parameters of the patients who had good controlled office BP and uncontrolled office BP was tested. Data were presented in tables. $P < 0.05$ was considered statistically significant.

Ethical consideration

Ethical clearance was obtained from the Health Research and Ethics Committee of OAUTHC, Ile-Ife, Nigeria, before the commencement of the study. The respondents were assured of strict confidentiality regarding the information collected from them. All respondents gave informed consent before data collection.

RESULTS

The study population consisted of 235 hypertensive patients who were on treatment. This population was made up of 146 (62.1%) males and 89 (37.9%) females.

The clinical, demographic, office BP and ABPM data of the study population are shown in Table 1. The mean age of the study population was 53.61 ± 8.81 years. The BMI showed that the majority of the patients were overweight.

Table 1: Clinical, demographic, office BP, and ABPM data of the study population.

	HTN patients (*n*=235)		
	Mean±SEM	**Min**	**Max**
Sex (%)			
Male	146 (62.1)		
Female	89 (37.9)		
Age	53.61±0.81	21	84
Body weight	81.47±0.96	46	133
BMI	28.9±0.31	18.87	46.02
Office SBP	143.64±19.07	90.00	210.00
Office DBP	90.40±11.87	62.00	140.00
Mean SBP (awake)	135.84±1.0	107	205
Mean DBP (awake)	83.21±0.7	61	116
Mean SBP (asleep)	127±1.22	0	186
Mean DBP (asleep)	75.43±0.81	0	121
Mean HR (total)	75.97±0.64	43	108
SBP load (awake)	37.69±1.98	0	100
DBP load (awake)	30.42±1.76	0	100
SBP load (asleep)	62.26±2.07	0	100
DBP load (asleep)	37.21±2.08	0	100
Systolic dip	5.27±0.49	−25	24
Diastolic dip	8.38±0.56	−25	33
Morning surge	18.70±1.78	0	61.33

BP: Blood pressure, ABPM: Ambulatory blood pressure monitoring, HTN: Hypertension, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, HR: Heart rate, SEM: Standard error of mean

Table 2 shows the office BP control of the study population. The results showed that only 40.85% (n = 96) of the hypertensive patients were controlled despite antihypertensive medications.

Table 3 shows the various domains of the ABPM parameters and the proportion of patients with good BP control in each domain. Only 5.5% of the study population had good BP control if all ABPM parameters were applied.

Further, an analysis of the 96 patients who were found to have good office BP control was done; only 10.4% (n = 10) of these patients had good BP control with all the domains of ABPM parameters. This is shown in Table 4.

DISCUSSION

This study sets out to determine the proportion of hypertensive patients taking anti-hypertensive medications who had good BP control when the parameters of both office BP measurement and ABPM were applied. We further reanalyzed the ABPM parameters of patients whose BP was hitherto controlled with the office BP parameters to determine their level of BP control using ABPM parameters.

Table 2: BP control with office BP readings (n=235).

	n	%
BP is controlled using office BP		
BP controlled	96	40.85
BP not controlled	139	59.15
	235	100.0

BP: Blood pressure

Table 3: Proportion of good BP control using ABPM profile (n=235).

	n	%	P-value (χ^2)
Awake ABPM	75	31.9	**<0.0001**
Asleep ABPM	58	24.7	**<0.0001**
Total ABPM	58	24.7	**<0.0001**
Awake BP load	74	31.5	0.143
Asleep BP load	64	27.2	**0.011**
Total pressure load	64	27.2	0.081
Systolic dipping	26	11.1	0.385
Diastolic dipping	49	20.9	0.388
Reverse dipping	28	11.9	0.556
All ABPM parameters satisfied	13	5.5	0.006

BP: Blood pressure, ABPM: Ambulatory blood pressure monitoring, P value <0.05 are significant that are highlighted in bold

Table 4: ABPM profile of the 96 patients that had good BP control using office BP check.

	n	%
Awake ABPM	75	78.1
Asleep ABPM	58	60.4
Total ABPM	58	60.4
Awake BP load	74	77.1
Asleep BP load	64	66.7
Total pressure load	64	66.7
Systolic dipping	26	27.1
Diastolic dipping	49	51.0
Reverse dipping	10	10.4
All ABPM parameters satisfied	10	10.4

BP: Blood pressure, ABPM: Ambulatory blood pressure monitoring

This study showed the mean age of the hypertensive population to be in the middle age and also found a male predomination among the hypertensive population. Many of the patients were also overweight and obese. Previous works have documented similar findings.[1,15,18] This may infer that the demographics of hypertensives across various populations are fairly stable. However, Hara *et al*. reported female predomination in a large study involving more than 1000 hypertensive patients aged ≥55 years.[4] This may result from a higher health-seeking behavior among elderly females and, thus, selection bias.

Our finding showed that the proportion of patients with poorly controlled BP, despite being on anti-hypertensive medications, was more than half. This is in agreement with some previous studies that have documented poor BP control among hypertensive patients on medications. Furthermore, the finding of good office BP control and poor ABPM control (40.85% and 5.5%, respectively) is comparable with the findings of Hara *et al*., who found a disparity between the predictive values of ABPM and office BP.[4]

Ambulatory BP showed a wide spectrum of domains not recorded by the office BP measurement, which further emphasizes that good BP control goes beyond mere office systolic and diastolic values. For example, in this study, the prevalence of good BP control (SBP and DBP) recorded with office BP was 40.85%; however, when the same subjects were further analyzed, and all the domains of the ABPM were factored in, the prevalence of good BP control plummeted dangerously to 10.4%. This may explain why target organ damage may still be reported in patients with good office BP control. This was further corroborated by Moran *et al*., who reported progressive albuminuria among type 2 diabetic patients monitored with office and ABPM.[16] ABPM has also been shown to be an independent predictor of prognosis in patients with essential HTN.[21]

In this study, the SBP and DBP loads were also noticed to be higher during nighttime compared to the daytime period. This finding is comparable with the study that showed that cardiovascular events occurred more at night because of poor nocturnal BP control.[25] Office BP, however, cannot assess this. This pattern had been shown by Fagard *et al*. who reported higher nighttime values and showed that nighttime ABP is a better predictor of outcome and mortality than daytime ABP.[25]

From the foregoing, assessment of good BP control seems to be better with ABPM; thus, the efficacy and titration of the antihypertensive medications would be better when BP is assessed using ABPM. Poor BP management has been associated with the development of florid target organ damage; thus, the use of ABPM may help prevent these avoidable organ damage.[25]

Finally, the many domains of ABPM parameters make it a better means of assessing patients' BP control and cardiovascular risks, rather than the one-off office BP measurement, because ABPM has better reproducibility and a higher prognostic value.[26] This study further emphasizes the recommendations of the European Society of HTN on the use of ABPM, in addition to office BP monitoring, to improve cardiovascular risk prediction in hypertensive patients.[26]

Limitation of study

This study did not determine end organ damage among the study population and, thus, cannot compare target organ complications of the patients with good BP control against those with poor control. It would have also been good to follow-up on the study population to determine the cardiovascular outcome of the poorly controlled cohort compared to the population with good BP control.

Areas of future research

A prospective multi-center study on ABPM to determine the effect of tight BP control on cardiovascular outcome is desired.

CONCLUSION

This study concluded that poor BP control is common among hypertensive patients taking BP medications. Furthermore, a large percentage of patients on antihypertensive medications who seemingly had good office BP control had uncontrolled BP when evaluated with 24-hour ABPM.

These apparently controlled BP values may allow progressive end-organ damage and complications of long-standing HTN in these subjects. Therefore, we advocate the routine use of ABPM in monitoring hypertensive subjects on antihypertensive medications.

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Ethical approval

The research/study approved by the Institutional Review Board at Obafemi Awolowo University Teaching Hospital Ile-Ife, Nigeria, number ERC/2013/04/01, dated April 08, 2013.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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