DETERMINANTS OF SUBOPTIMAL BLOOD PRESSURE CONTROL IN HYPERTENSIVE PATIENTS: 24-HOUR AMBULATORY BLOOD PRESSURE MONITORING

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Abstract

INTRODUCTION: The study was conducted to define the determinants of suboptimal blood pressure (BP) control among hypertensive patients under treatment and explore a predictive model for detecting the patients at risk for increased BP.

METHODS: We enrolled 97 patients (40 males, 57 females) under treatment for hypertension between June 2006 and May 2007 in Shafa hospital, Kerman, Iran. BP was measured at clinic twice within 5-minute intervals. After setting up ambulatory blood pressure monitoring (ABPM), BP was measured at 30-minute intervals during the day and 60-minute intervals during the night. The frequency of increased BP (more than 140/90 mmHg) was included in a regression model as dependent variable and all the others such as age, sex, body mass index (BMI), drugs and baseline clinical measurements as the predictors.

RESULTS: Increased BP was detected in 44% (95% CI: 38.79%-49.65%) of all measurements during 24-hour monitoring. The frequency of increased BP had a significant relationship with BMI (β=0.35, P=0.001). Clinic's pulse pressure was a significant predicting factor for BP increase (P=0.02).

CONCLUSION: BMI and pulse pressure are the best predictors for being hypertensive during lifetime. Ineffective treatment of hypertension is frequent among the hypertensive patients.

Keywords: Blood pressure control, Pulse pressure, Ambulatory blood pressure monitoring (ABPM), BMI.

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Introduction

Increased arterial blood pressure (BP) and hypertension are among the most important life-threatening factors in both industrial and developing countries.[1] Epidemiological studies conducted in the USA as well as in Europe show that about 65 to 70% of subjects with hypertension were aware of it.[2] Among them, 60% were receiving treatment and less than 30% had their hypertension controlled and reached the recommended target blood pressure of 140 mm Hg for systolic blood pressure (SBP) and 90 mm Hg for diastolic blood pressure (DBP). These data are worrying as the positive effects of lowering blood pressure on mortality and morbidity from cardiovascular disease have been demonstrated in randomized controlled trials for patients with essential mild to moderate hypertension.[2,3] Hypertensive patients are usually asymptomatic and the only way to diagnose is getting several reliable measurements of theirs blood pressure.[4] Using mercurial manometer is common for managing blood pressure, however, it has some disadvantages and errors.[5,6] The patients' BP variation in clinic or office versus their diurnal measurements at home can lead to misdiagnosis and under-treatments of hypertension.[7,8] It seems that ambulatory blood

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pressure monitoring (ABPM) is the only reliable way to evaluate BP, especially increased BP during 24 hours.[7]

All physicians want to prescribe effective therapy cable of controlling hypertension by keeping blood pressure in the safe range for 24 hours a day. Although, most of the patients prefer to get drugs only one time a day, previous studies have indicated that this cannot reduce BP for the entire day and night effectively.[4] Almost always when hypertensive patients were monitored by ABPM, several episodes of BP increase were seen during diurnal activities. These crises of hypertension threaten the health of hypertensive patients under treatment.[1]

We checked the effectiveness of antihypertensive drugs by one clinical measurement with a standard method. This study was designed to assess the percentage of uncontrolled BP in normal life and determine the predictors of increased BP in hypertensive patients under treatment. We set out to explore a predictive model for detecting the patients at risk for increased blood pressure.

Materials and Methods

In this cross-sectional study, we enrolled 99 hypertensive patients under treatment (42 male and 57 female) between June 2006 and May 2007 in Shafa Hospital (a teaching hospital of Kerman University), Kerman, Iran. Subjects were referred from cardiologists to hypertension clinic. Patients 18-70 years old living in Kerman who were known as cases of hypertension (based on several visits in 3-6 months) were included. After taking history and physical examination, others who had a positive medical history of target organ damage (such as cardiomegaly and renal failure) were excluded.

Using a mercury sphygmomanometer, each patient's BP was measured twice in clinic at 5-minute intervals. To recognize whether mercury sphygmomanometer had differences with ABPM, the BP was also measured twice at clinic at 5-minute intervals by ABPM. BP and pulse rate were measured with ABPM in a 24-hour period. BP was measured every 30 minutes during the day and 60 minutes in the night (Figure 1).

Data (hours awake or asleep) were recorded in specific forms. The information collected by ABPM, was automatically transferred to a personal computer.

All individuals were evaluated by a trained nurse with a mercury sphygmomanometer which was calibrated monthly. Measurement technique was based on Kortokof sounds. Ambulatory blood pressure monitor (Model DS_250, USA) was calibrated for each person according to the manufacturer's instruction.

The subject would be excluded from the study at the end of 24 hours of ABPM, if measurements were not recorded for more than 2.5 hours (almost 10% of 24h). Based on the recall checklists, measurements recorded in running, eating, unusual activities and stressful conditions were omitted. In order to exclude the extreme outliers, only measurements which had difference of less than 2.5 from standard deviation were accepted.[5,9]

The distribution of the variables in men and women were compared by t-student and chi-square tests. The frequency of increased BP (more than 140/90 mmHg) was included in a multivariate regression model as the dependent variable, and all other variables such as age, sex, BMI, drugs and baseline clinical measurements as the predictors. All the calculations were conducted by Stata V.8.

Results

Eventually, 97 individuals remained in the analysis. The mean age of men and women were 46.48±15.78 and 51.98±10.89 years, respectively (P=0.06). Men's body mass index (BMI) (25.16±3.64) was significantly lower than women's (28.09±4.04) [t(74)=3.289, P=.002] (Table 1). The most frequent drugs used by patients were beta-blockers (55.7%), calcium-blockers (15.5%), ACE Inhibitors (35.1%), nitrocantin (9.3%), and diuretics (8.2%). The mean number of years past hypertension diagnosis was 4.71±4.1. Mean systolic/diastolic BP measured using mercury sphygmomanometer in clinic was 140.73±18.20/87.75±11.11 mmHg. Meanwhile, measurements by ABPM for systolic and diastolic BP were 140.15±19.45 and 87.45±12.96 mmHg, respectively. Statistical comparison indicated no significant difference between the methods used for the two measurements in clinic (P>0.05) (Table 1). Average systolic/diastolic BP in awake time were 3.6±15.61/4.25±9.57 mmHg, less than those measured in clinic (P=0.02). Abovementioned difference for systolic/diastolic BP was 21.45±16.58/15.59±10.38 when sleeping time was determined (P=0.001). White coat hypertension was detected in 25 individuals (28.8%). The frequency of white coat hypertension in men (17.5%) had no significant difference with women (31.58%) [χ 2(1) =2.435, P=0.119] (Table 1).

Increased BP was detected in 44.22% (95% CI: 38.79-49.65%) of all measurements during 24-hour monitoring. The percentage of BP more than 210/120 mmHg was 2.63% (95%CI: 0.52-4.74%) (Figure 2).

Multivariate regression analysis indicated that increased BP had a significant association with BMI (β=0.35, P=0.001). Moreover, pulse pressure at clinic was a significant predicting factor for BP increase (P=0.02). The frequency of increased BP had no relationship with other variables such as age, gender, duration of hypertension, cigarette smoking, and hypertension treatment.

As seen in Figure 3, most cases of the increased BP were detected between 5 and 9 pm. The frequency of increased BP peaked between 6 and 8 p.m. about more than 60% of the all measured BP. The same patterns were seen in different BP categories, more than 160/90, 180/100, and 210/110 mmHg (Figure 3).

Discussion

Suboptimal treatment of hypertension is frequent among known hypertensive patients. BMI and clinic base pulse pressure were the most predictive factors for the increased BP in such patients. Surprisingly, beside the insufficient control, we saw white coat hypertension in about one-forth of the subjects.

The goal of treatment is below 140/90 mm Hg according to published guidelines.[2,10] Our study shows that only 55% of treated subjects have satisfactory home blood pressure control. This finding is consistent with poor blood pressure control observed in treated hypertensive patients in other studies.[11-13]

Human BP follows a natural cycle during 24 hours. It increases quickly as we wake up and reaches a plateau at 11 a.m. Then BP decreases gradually to reach a minimum at 12 midnight.[6] This cycle was detected in most hypertensive patients; consequently, the increased BP becomes frequent in the afternoon and during the night. The assessment of increased BP according to diurnal time indicated that high BP occurs mostly during 5-9 p.m. This period is considered to be the same as busiest period in diurnal activities.

TABLE 1. Mean and standard deviation of the principle variables by gender.

Variables	Male (n=40)	Female (n=57)	P value
Age (year)	46.48±15.78	51.98±10.89	0.48
BMI (kg/m^2)	25.16±3.64	28.09±4.04	0.002
Systolic BP (mmHg)			
Mercurial in the clinic	140.33±20.37	141.01±16.7	0.04
ABPM in clinic	140.33±20.96	140.03±20.37	0.03
Awake ABPM at home	139.88±16.22	135.19±18.54	0.26
Sleep ABPM at home	121.64±13.76	118.43±17.24	0.17
Diastolic BP (mmHg)			
Mercurial in clinic	88.67±10.13	87.11±11.8	0.10
ABPM in clinic	88.78±12.25	86.52±13.47	0.14
Awake ABPM at home	84.56±8.94	82.76±12.48	0.13
Sleep ABPM at home	73.01±9.14	71.88±11.77	0.08
White coat Hypertension (%)	7 (17.5)	18 (31.58)	0.25

P: P value, BMI: Body mass index, BP: Blood pressure
ABPM: Ambulatory blood pressure monitoring

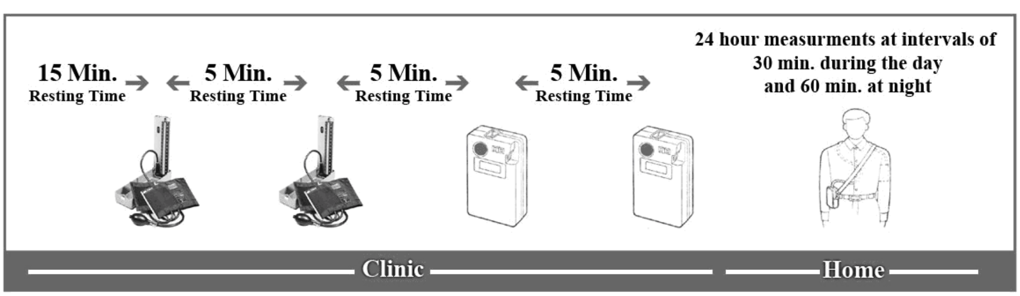

FIGURE 1. The diagram of blood pressure measurements in both clinic and home.

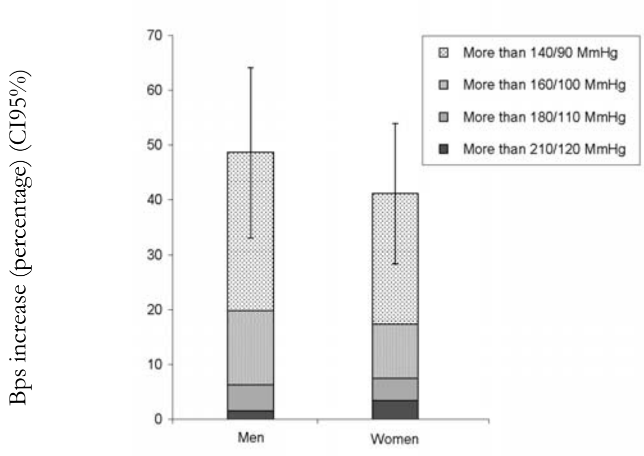

FIGURE 2. The communicative percentage of increased BP in 24-hour ABPM according to different BP categories and sex.

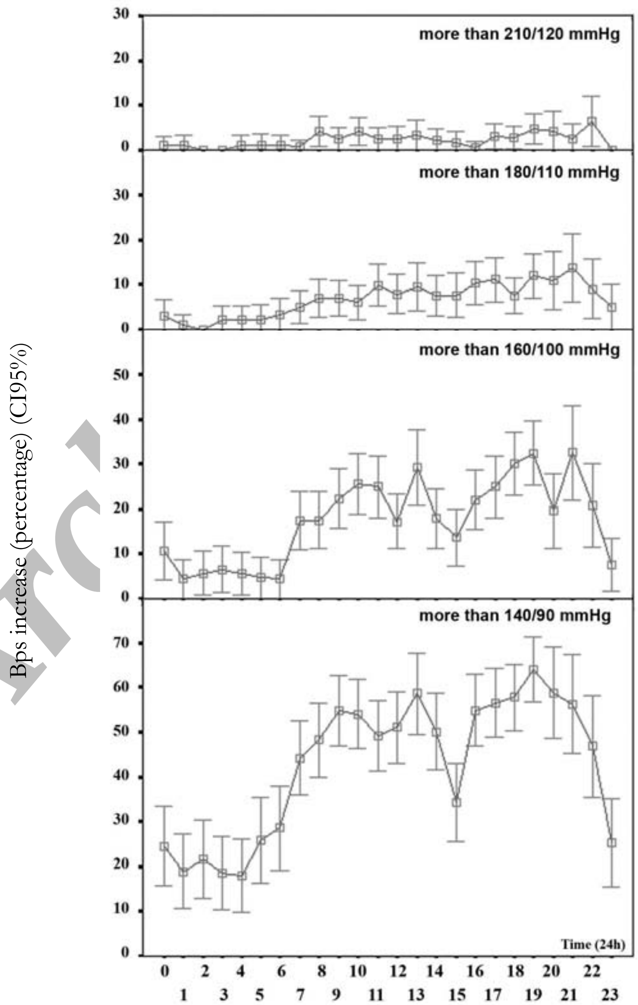

FIGURE 3. Percentage of increased BP in 24-hour ABPM according to points in time.

Most of the people in our society have a stressful life at these times. Also, our biologic clock (interaction of sympathetic and parasympathetic systems) accelerates the occurrence of hypertension crisis/increased BP at these time periods. Most of the patients prefer a single dose of hypertensive drugs, especially in the morning. Maybe this unique prescription of hypertensive drugs could not reduce BP effectively during the day and night. As previous studies reported, BMI play an important role in management of uncontrolled BP.[14,15] A study of 4551 subjects in Italy indicated that the probability of uncontrolled blood pressure was 43% higher in patients with the metabolic syndrome than in those without. They concluded that insufficient control of blood pressure is independently associated with the presence of the metabolic syndrome. Blood pressure control worsens with increased number of metabolic risk factors associated with hypertension.[15] The BMI as an index of obesity and overweight is closely related with metabolic syndrome[16] and that may be why we found BMI to be an important predictive factor for increased BP.

Pulse pressure is not only an important factor for the prognosis of hypertensive patients,[17] but also helps physicians determine the ones who do not respond properly to antihypertensive drugs and will likely experience hypertensive crisis.[18] Moreover, based on our findings, pulse pressure could be an important predictive factor for determining those at risk of uncontrolled hypertension.

The frequency of increased BP in men was slightly higher than in women; however, in women the increase was more marked than in men. These opposite patterns influence the gender differences in cardiovascular risks and should be studied prospectively.

Although all subjects were known hypertensive patients and were familiar with blood pressure measurement techniques, the results indicated that white coat hypertension is a frequent phenomenon. This informed us of a mixed situation. The clinicians should consider not only the uncontrolled BP, but also the misdiagnosis of hypertension due to white coat phenomenon.

Finally, we should acknowledge some errors and biases in this survey. Based on literature review,[5,9] we excluded the measurements with 2 SD far from the mean. These are mostly due to technical errors in measurement, but some may have really been extreme data. The activities, sleeping time and what patients did in their 24-hour ABPM were subjective information that could not be firmly controlled by authors. To decrease observer bias, all subjects were educated by a short program in clinic and a user-friendly pamphlet before the start of measurements. Increased BP among patients under treatment for hypertension is a frequent condition; BMI and pulse pressure are the best factors for detecting patients susceptible to uncontrolled hypertension.

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