A Method for Better Estimating Blood Pressure in Hypertensive Patients

M. Moazenzadeh, MD; and A. Mirzazadeh

Abstract

Background- An elevated arterial pressure is probably the most important public health problem in developed countries. Although the measurement of blood pressure in the clinic has been the cornerstone of the diagnosis and management of hypertension, it has some limitations. Ambulatory blood pressure monitoring (ABPM) is a method of blood pressure assessment which compensates for some of the limitations and errors of clinical values such as the "white coat phenomenon".

Mathods- In this cross sectional study, we enrolled 42 (20 male, 22 female) hypertensive patients who were under treatment. Each patient's BP was measured in clinic twice at 5-minute intervals. ABPM having been set up, each patient's blood pressure was measured at 30- minute intervals during the day and 60- minute intervals during the night. The patients were advised to do regular daytime activities and record unusual activities.

Results- The mean clinic BP 137.95±14.28/88.66±9.53 (mmHg) compared with a mean awake ambulatory BP (ABP) of 132.90±12.27/80.51±7.39 (mmHg). A white coat effect (Clinic–Ambulatory BP > 20/15mmHg) was present in 33.3% (19.15%-47.55%, CI 95%) of the individuals. The correlation coefficient of systolic pressure, diastolic pressure and heart rate between clinic and awake ambulatory measurements was 0.55, 0.48 and 0.57, which indicated a linear relationship (P<0.001). Multiple regression models showed that age, gender, occupation and the duration of hypertension (by year) after diagnosis have no significant effects on estimating awake ABP by clinical measurements but could lead to a better estimation.

Conclusion- The frequent occurrence of white coat phenomenon in these patients suggests that clinic BP assessment may not always represent usual awake ambulatory BP in patients receiving antihypertensive therapy. We also suggest that physicians who do not have the availability of ABPM use this model to estimate average awake BP by clinic BP measurements: awake systolic BP (mmHg)=0.52 x clinic systolic BP + 66; awake diastolic BP (mmHg) = 0.46 x clinic diastolic BP + 42; and awake heart rate (p/min) = 0.33 x clinic heart rate + 52 ***(Iranian Heart Journal 2003; 4 (4):25-30).***

Key words: Hypertension ■White coat effect ■ Mercury sphygmomanometer■Ambulatory blood pressure monitoring (ABPM)

Increased arterial blood pressure (BP) is one of the most important life threatening factors in industrial countries.[1,2] Hypertension is a risk factor for important diseases such as cardiocerebrovascular accidents, renal failure and diabetes. It often has no sign and the only way to diagnose it is getting several reliable measurements.[3,4,5] Using mercurial manometer is common for managing BP; however, it has some limitations and errors. [6,7,8,9]

Changes of BP in some patients in clinic or offices compared with their diurnal

From the Research Center of Medical Sciences, Cardiovascular Research Committee, Jomhuri Islami Blvd., Kerman, Iran
Correspondence to: M. Moazenzadeh, MD, Assistant Professor of Cardiology, Cardiovascular Research Committee, Jomhuri Islami Blvd., Kerman, Iran
E-mail:kmsrc@yahoo.com Tel: (0341) 2110744 Fax: (0341) 2112794

measurement at home, which is known as "white coat phenomenon", can lead to misdiagnosis and treatment of hypertension.[10,11] It seems that ambulatory blood pressure monitoring (ABPM) is the only reliable device to evaluate BP in patients during a 24- hour period.[8,11-13]

In a study performed in Athens, with CBP technique (5 visits/month), 70.4% of all the patients had hypertension, but with ABPM technique the hypertensive subjects were only 56%. Correlation coefficient of systolic/diastolic hypertension measurements by ABPM with CBP technique was 0.34/0.86.[14] Gender, psychiatric and cultural problems had effects on white coat phenomenon.[15]

Many studies indicated that in order to avoid misdiagnosis in healthy individuals, we should measure BP several times a month.[14] Follow-up of patients for months is difficult and in our society almost impossible.

In this study, we compared the BP of hypertensive patients in clinic with their mean BPs at home. An estimation method was devised for averaging the patient's awake BP, based on measurements obtained in clinic. This could help the physicians who do not have this valuable device (ABPM) to evaluate the diurnal BP of patients in their normal life style.

Methods

Sampling

The subjects who had the inclusion criteria were referred from the office to the blood pressure clinic. This study is a cross-sectional study. The subjects selected were 18-70 years old, living in Kerman. All of them were known cases of hypertension (based on multiple measurements over a 3-6-month period). The patients whose past medical history and physical examination showed no history of target organ damage, diabetes and cardiomegaly were included in our study.

Measurements

Each individual's blood pressure was measured in clinic. In this method, we first measured blood pressure twice in 5 minutes with a mercurial manometer. To ascertain whether there were differences in blood pressures measured in clinic with the mercurial manometer and with ABPM, we also measured the blood pressure twice in 5 minutes with ABPM. Next, the individuals were evaluated for BP and pulse with ABPM in a 24-hour period. BP was measured at intervals of 30 minutes during the day and 60 minutes during the night.

The information about each individual's active hours (during sleep or wakefulness) was recorded in separate forms, and the information gathered by ABPM was automatically transferred (using the appropriate software) to a computer.

All individuals were evaluated by a trained nurse with a mercurial manometer, which was calibrated each month. The technique of measurement was based on Korotkof sounds. ABPM (Model DS-250, USA) was set according to its catalogue and was calibrated for each person.

Analysis

At the end of the 24-hr measurement, if the measurements were not recorded for more than 2.5 hours (10% of total hours), the person was excluded. The BPs of ABPM were divided into different groups: (1) 6-11:59 as morning, (2) 12-19:59 as noon + afternoon, (3) 20-5:59 as night, and (4)6-19:59 as day. All the measurements recorded in situations like running, eating and other stressful moments, were deleted.

For statistical accounting, confidence interval and power were considered 95% and 80%. The analysis tests which we used were paired sample t-test and repeated measurement of ANOVA (post HOC Bounferroni), and multiple regression was performed in SPSS V.10.

Results

Fifty individuals were included in the study. Four diabetics, 3 individuals with incomplete forms and one patient having missed BP measurement over 3h were excluded from the study.

Information related to 20 men and 22 women was analyzed with a mean of 46.10±13.15 years. There was no significant difference between men and women's ages. Duration of hypertension was 3.64±3.42 years. The patients used the following drugs: 54.8% beta blockers, 14.3% calcium blockers, 26.2% ACEI, 9.5% diuretics, 7.1% alpha blockers, 9.5% nitrates and 9.5% aspirin. The average of BMI (kg/m^2) was 25.69 ±3.43.

Blood pressure measurements

Before analysis, the outliers (more than 2.5 SD) were balanced, and artificial quantities were deleted. Each individual's BP was measured 42±2 times. During this period in clinic, there were no significant differences between mercurial methods and ABPM: the average systolic/diastolic BP with the mercurial method was 137.95±14.28/80.66±9.53 mmHg and with ambulatory method was 133.20±12.27/ 83.82±9.00 mmHg.

Clinical systolic blood pressure (CSBP) was 5.04 mmHg (CI 95%, 8.75-1.34) more than that of ABPM. Clinical diastolic blood pressure (CDBP) was 8.15mmHg (CI 95%, 10.92-5.37) more than that of ABP (P<0.01, Figs.1, 2). The average of heart rate per minute with the mercurial technique was 78.26±16.77 and with ABPM was 75.54±9.25. This difference (2.71) was not significant (Fig. 3).

The differences between first and second CSBP were significant in women (P<0.05, Figs. 1, 2, 3).

In men, significant differences (4.84) were observed only between CDBP and awake ABPs (CI 95%, 7.74-1.94).

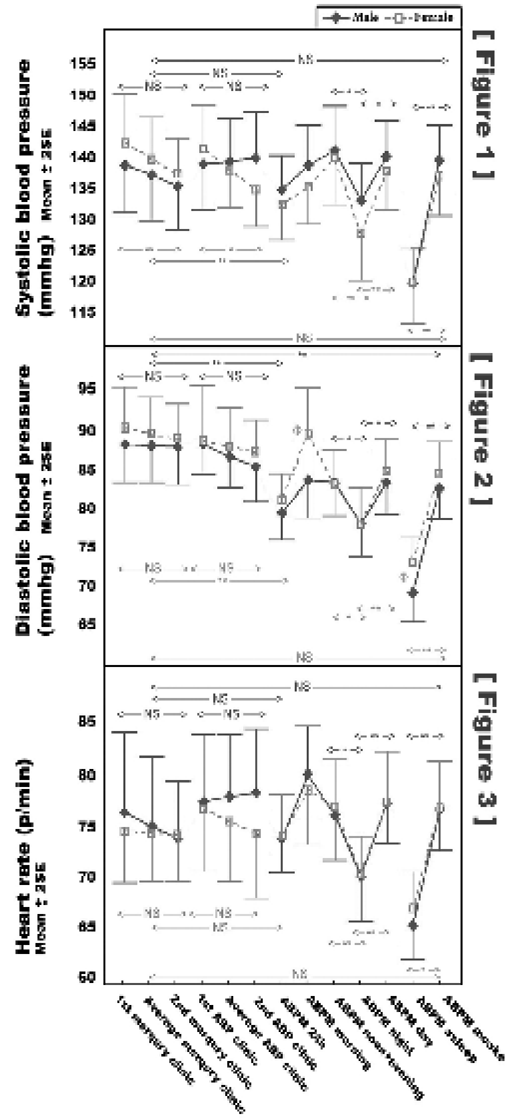

Figure 1,2,3 - Mean and standard error of systolic , diastolic and heart rate in clinic and 24h monitoring. 1st merqury BP was measured in clinic and the 2nd merqury was measured 5min after the first. You could see the average point between them. 1st and 2nd ABP are the same but were measured by ambulatory method in clinic. The others are average of categorical times in day and night which have measured by ambulatory blood pressure monitoring.

* P<0.05 ** P<0.01 NS not significant

White coat phenomenon

The differences of more than 15/20mmHg in clinical systolic/diastolic blood pressures by daily ABP are considered as white coat phenomenon. The prevalence of this phenomenon is estimated at 33.3% (CI

95%, 47.55-19.15%); however, in our comparison between CBP and awake ABP, white coat phenomenon was observed in only 19% (CI 95%, 30.86-7.14%) of the patients.

Diurnal blood pressure estimation

Scatter plots show a linear correlation between CBP and awake ABP. The correlation coefficient of CSBP and awake ABP was calculated as 0.557: 0.489 for DSBP and 0.575 (p<0.001) for pulse (Fig. 4).

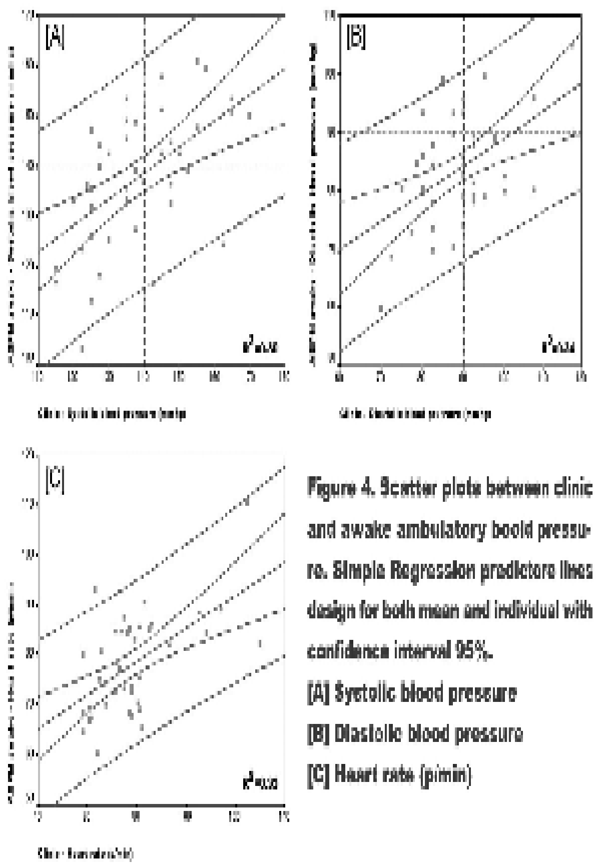

Figure 4. Scatter plots between clinic and awake ambulatory boold pressure. Simple Regression predictors lines design for both mean and individual with confidence interval 95%.
[A] Systolic blood pressure
[B] Diastolic blood pressure
[C] Heart rate (p/min)

Individual predicted lines and mean predicted lines for the groups are drawn with 95% CI for average systolic, diastolic BPs and pulse rate in awake situation. Multiple regressions as shown in Table I indicated that age, gender, occupation and period of hypertension had some effects on awake ABP modeling (Table I).

Table 1. Forward multiple regression of awake ambulatory blood pressure and heart rate.

Variable	β	SE	t	P
Model for awake ambulatory systolic blood pressure (mmhg)				
Clinic SBP	0.547	0.126	4.357	<0.001
Age	-0.003	------	-0.019	0.98
Gender	-0.172	-----	-1.252	0.219
Work	-0.132	------	-0.948	0.350
Time of HTN	0.176	-----	1.227	0.229
Constant	62.958	17.442	3.610	<0.001
R^2=0.365 , P<0.001				
Model for awake ambulatory diastolic blood pressure (mmhg)				
Clinic DBP	0.540	0.137	3.945	<0.001
Age	-0.045	-----	-0.280	0.782
Gender	0.169	------	1.186	0.244
Work	-0.141	-----	-0.979	0.335
Time of HTN	0.077	------	0.530	0.599
Constant	39.212	12.186	2.872	<0.001
R^2=0.220 , P<0.001				
Model for awake ambulatory heart rate (p/min)				
Clinic HR	0.424	0.087	4.866	<0.001
Age	-0.085	-----	-0.704	0.486
Gender	-0.107	-----	-0.797	0.431
Work	-0.248	------	-1.917	0.064
Time of HTN	-0.011	-----	-0.060	0.636
Constant	44.400	6.868	6.474	<0.001
R^2=0.418 , P<0.001				

β indicated multiple linear regression coefficient;SE, standard error of the coefficient;t, t value of the coefficient ;BP, blood pressure;Time of HTN, number of years after diagnosis of hypertension; Work, medical=1 / non-medical=2; Gender, male=1 / female=2.

Conclusion

The results show that despite the fact that we not only provide standards to measure BP in clinic but also inform the patients about the devices and the method, white coat phenomenon affects the evaluation of patients with high BP. According to these results, the prevalence of white coat phenomenon in hypertensive patients is estimated at 33.3%.

Many studies have estimated the white coat phenomenon at between 18-60% in patients with normal BP.[14,16,17,18] The results of this study also show this phenomenon in hypertensive patients.[19] Myers and Reeves in 1995 showed that the prevalence of this phenomenon in hypertensive patients is about 31-33%, which is approximately similar to that in our study. In Myers' study, sex was known as an effective factor.[20] In our study, however, women had obvious signs based upon white coat phenomenon, but the study did not show significant differences between sexes. It seems that the evaluation of more individuals and also the selection of 10mmHg differences for diastolic pressure are the reasons for the variation between these two studies. As shown in other studies, there is a significant linear correlation between CBP and the average of waking hours for SBP, DBP and pulse. We show appropriate correspondence between them in this study. In most studies, the BP of individuals was normal, and it was evaluated several times in clinic. It seems that the results are applicable to hypertensive patients who are under treatment.

The analysis shows that none of these variables (age, sex, number of years after the diagnosis of hypertension) have any significant effects in predicting BP and pulse, although they can lead to measurements close to reality (Table I).

It seems if we use the following formulation, we can precisely estimate the BP of patients for whom the mercurial monometer is used: Awake SBP = 0.52 x clinic SBP + 66: Awake DBP = 0.46 x clinic DBP + 42: Awake HR=0.33 x Clinic HR + 52.

Acknowledgments

We thank Mr. Y. Nikian, our statistical assistant, and Mrs. Abolhasani for gathering patients' information. With special thanks to Dr. Arabzadeh and Miss Talebizadeh.

References

1. Gordan H: Harrison’s Principles of Internal Medicine, 15th ed., New York, McGraw-Hill, 2001, Vol. 2, pp. 1414 -16

2. Oparil S: Cecil Textbook of Medicine, 21th ed. , Philadelphia, W. B. Saunders Co., 2000, Vol. 1, pp. 258-9.

3. Sutton GC, Chatterjee K: Clinical Cardiology: an illustrated text. London, Churchill-Livingstone, 1998, pp. 130-4.

4. Gordan H: Harrison’s Principles of Internal Medicine, 15th Ed., 2001, New York, McGraw-Hill, Vol 2, pp. 1418-20.

5. Isso JL: Hypertension primer-the essential at high blood pressure. American Heart Association 1998, chapter 104, pp. 295-98.

6. Guideline Subcommittee, 1999 World Health Organization, Internal Society of Hypertension Guidelines for the Management of Hypertension. J Hypertens 1999 (17): 151-183.

7. Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure, the Sit Report (JNCVI), Arch Intern Med 1997 (24): 2413-1446.

8. Ramsay LE: Guidelines for Management Of Hypertension: Report At Third Working Party of British Hypertension Society. J Hypertens 1999; (13): 269-592.

9. Rugnath T, Dilly BJ, CassimJee MH: Twenty-four ambulatory blood pressure monitoring in general practice. S Afr Med J 2000 Sep, 90(9): 898-904.

10. Gibbs CR, Murray S, Beevers DG: The clinical value of ambulatory blood pressure monitoring. Heart 1998 February 79(2): 115-117.

11. Owens P, Atkins N, O'Brien E: Diagnosis of white coat hypertension by ambulatory blood pressure monitoring. Hypertension August 1999 34(2) : 267-272.

12. Neutel Joel M: The importance of 24-h blood pressure control. Blood Press Monit, February 2001 6(1): 9-16.

13. Palatini P: Limitations of ambulatory blood pressure monitoring. Blood Press Monit August 2001 Vol 6(4): 221-224

14. Stergiou GS, Skeva II, Biabas NM, et al: Diagnosis of hypertension using home or

ambulatory blood pressure monitoring: comparison with the conventional strategy based on repeated clinic blood pressure measurements. J Hypertens 2000, 18: 1745-51.

15. MacDonald MB, Laing GP, Wilson MP, Wilson TW: Prevalence and predictors of white-coat response in patients with treated hypertension, CMAJ 1999 Aug 161: 265-9.

16. Antti J: Multiple clinic and home blood pressure measurements versus ambulatory blood pressure monitoring. Hypertension 1999 34: 261-266

17. Gardner S, Stephanie F, et al: 24-hour ambulatory blood pressure monitoring in primary care, J Am Board Fam Pract. May/June 2001, Vol 14(8): 166-171.

18. Hoegholm A: White coat hypertension diagnosed by 24-h ambulatory monitoring. Examination of 159 newly diagnosed hypertensive patients, American Journal of Hypertension, 1992 Feb. 5(2): 64-70.

19. Myers MG, Reeves RA: White coat phenomenon in patients receiving ntihypertensive therapy. Am J Hypertens 1991 4: 844-9.

20. Myers MG, Reeves RA: White coat effect in treated hypertensive patients: sex differences. J Hum Hypertens 1995 9: 729-33.