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A Representative Value for 24-Hour Monitored Ambulatory Blood Pressure

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***Several shorter-term** alternatives for whole-day ambulatory monitoring of blood **pressure using** Pressurometer III or conventional sphygmomanometer were evaluated **in 12 male** patients with mild hypertension. Averages of BP reading at 8 AM once, 3 consecutive readings either with Pressurometer or manually, serial readings for 2-hour intervals from 8-10 AM and 2-4 PM were compared with that of 24-hour ambulatory, non-invasive BP readings by Pressurometer. Both systolic and diastolic 2-hour BP averages in the morning (8 to 10 o'clock) correlated more strongly with 24-hour averages (r=0.91 and 0.91) than the 3 consecutive (r=0.88 and 0.66) or single (r=0.49 and −0.35) reading alternatives did. In conclusion, the average of serial readings obtained during 2-hour monitoring period from 8 to 10 AM is a reliable predictor of 24-hour ambulatory BP and represents it more closely than the conventional single or multiple BP readings.*

Key Words: *Blood pressure Ambulatory*

INTRODUCTION

The cardiovascular complications of hypertension are more closely related to the average of multiple blood pressure readings (Sokolow et al., 1966) over 24-hours than to casual single reading.

The average of BP readings for an entire day would provide a more characteristic and reproducible representation of BP than the customarily used single casual readings and would avoid sampling errors caused by circadian variation in the blood pressure.

Whole-day BP measurement could be obtained either by a direct intra-arterial catheter or through an indirect non-invasive, ambulatory automatic technique. (Drayer et al., 1982) Both techniques could be uncomfortable and inconvenient and thus are not practical in every patient.

The purpose of this study is to evaluate a more practical short-term measurement which is more convenient and less expensive, while more closely represents a 24-hour measurement.

In this study, we performed full 24-hour BP monitoring in hypertensive patients with Pressurometer III, which reported on previously at the 8th Asian-Pacific Congress of Cardiology held in Taipei in November 1983 (Yoo et al., 1983), and compared this method with three alternatives; a single BP measurement, the average of three consecutive BP readings measured either instrumentally or manually, and the average of multiple readings obtained during a 2-hour observation with Pressurometer III.

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MATERIALS AND METHODS

Twelve male patients with mild essential hypertension were studied. Casual BP was defined as the average of two readings taken after 5 minutes of rest on more than two occasions, at least one week apart.

The patients were composed of those who had de novo essential hypertension and those who were known hypertensives and free of all antihypertensive medication for at least two weeks before the study. They were all in-patients, although being ambulatory

as in their ordinary life activities.

Automated, ambulatory, non-invasive BP monitoring was done for 24-hours, using Pressurometer III. Readings of SBP, DBP and heart rate were obtained at 15 minutes interval during the day and at 30 minute intevals during the night. After completion of the monitoring, the data were analyzed and printed-out using Pressurometer Data Analysis System, Model 1981 of Del Mar Avionics.

Averages of BP readings for 1) 24-hours, 2) 2-hour period from 8 to 10 AM, 3) 2-hour period from 2-4 PM, 4) 3 consecutive readings at 8 AM by Pressurometer, 5) 3 consecutive readings at 8 AM by sphygmomanometer and 6) a single rading at 8 AM, were analyzed for comparison.

Regression equations between blood pressures measured by each method were obtained and the averages of BP on each occasion were tested by Student's T distribution method, using the average of whole-day BP as a standard.

RESULTS

1. Representative value of systolic blood pressure (Tab. 1, Fig. 1 and 2)
   The nearest value to the average of 24-hour systolic pressure-140 mmHg-was that of single measurement at 8 AM, 141 mmHg, followed by that of multiple measurements in the morning 8-10 AM, 143 mmHg, 3 consecutive measurements with Pressurometer, 145 ing 0.91, and worst in single measurement, scoring 0.49.
2. Representative value of diastolic blood pressure
   The lowest value was 91 mmHg of 24-hours and the nearest was 92 mmHg of manual 3 consecutive (r = 0.87) followed by 93 mmHg in 2-hours multiple readings in the morning (r = 0.91).
3. Representative value for mean arterial pressure

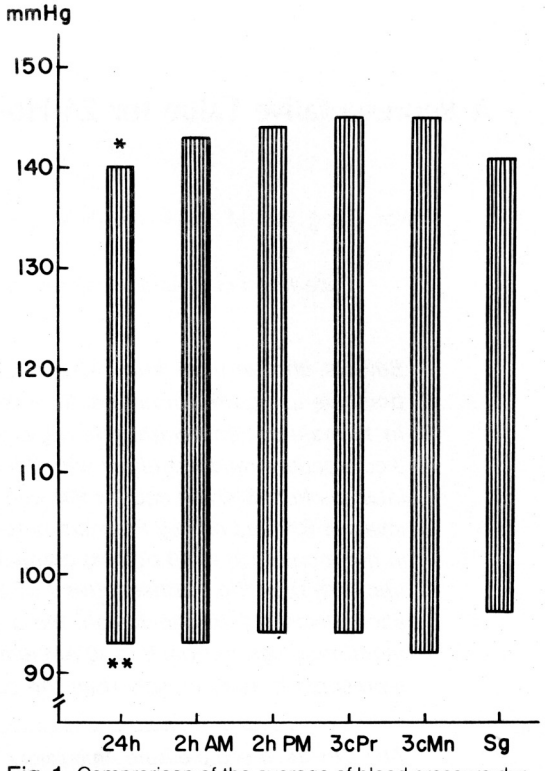

Fig. 1. Comprarison of the average of blood pressure during short-term measurements with that of 24 hours
*The upper end of each bar represents the average of systolic pressure measured by each method
**The lower end represents diastolic pressure

Table 1. Comparison of the averages of several short-term blood pressure measurements (mmHg)

	24h	2h AM	2h PM	3c Pr	3c Mn	Sg	p*
SBP ± SB	140 ± 19	143 ± 18	144 ± 18	145 ± 15	145 ± 20	141 ± 18	n.s
r		.91	.87		.87	.49	
DBP ± SD	91 ± 9	93 ± 9	94 ± 10	94 ± 8	92 ± 13	96 ± 11	n.s
r		.91	.66	.66	.77	-.35	
MAP	107	110	111	111	110	110	n.s
r		.88	.75	.74	.79	-.02	

24h; 24 hour multiple readings with Pressurometer, 2h AM; 8-10 AM multiple readings with Pressurometer, 2h PM; 2-4 multiple readings with Pressurometer, 3c Pr; 3 consecutive measurements with Pressurometer, 3c Mn; 3 consecutive measurements with aneroid sphygmomanometer, Sg; Single reading at 8 AM with aneroid sphygmomanometer
*Differences between the averages of blood pressure measured by each method were not statistically significant in systolic. diastolic and mean arterial pressure, respectively.

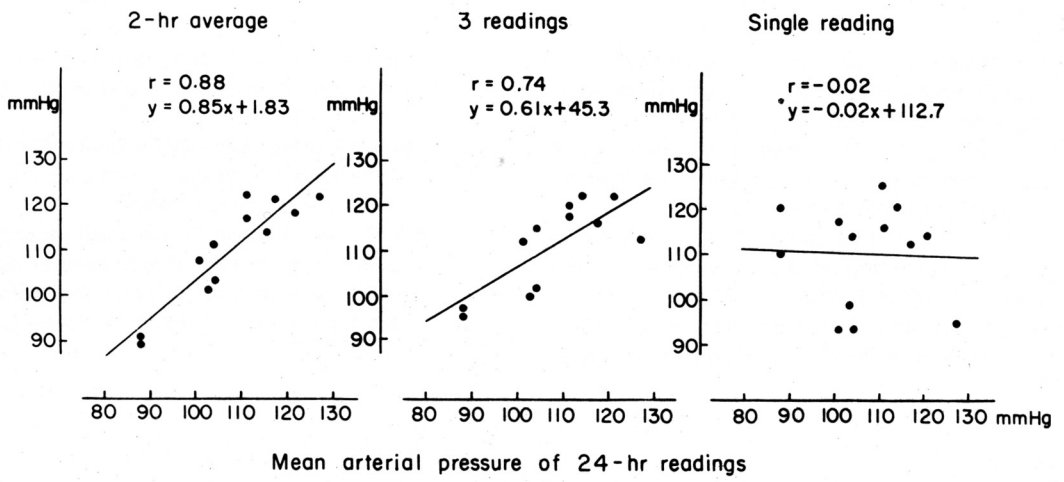

Fig. 2. Scattergram of mean arterial pressure of 2-hour, 3 consecutive and single reading comparing with 24-hour readings

Compared to 107 mmHg of 24-hours average, all the short-term measurements revealed a little higher value of 110 mmHg. However, the value of r was highest in 2-hour morning measurement as 0.88 too.

4. Two-hour morning average as a representative value for 24-hours average
   Although the absolute value was 2.8% in systolic and 2.2% in diastolic pressure higher than the 24-hour average, the coefficients of correlation were very high, being 0.91/0.91 for systolic/diastolic and seemed to be reasonably tolerable for clinical application.

DISCUSSION

Blood pressure is not constant. Its variability is greater in the patients with hypertension than the normotensives. (O'Brien et al., 1979; Mill-Craig et al.,1978) Some authors pointed out that the cardiovascular complication of hypertension is more closely related to the average of blood pressures over 24 hours than a single casual pressure and ambulatory readings more predictive than resting pressures (Perloff and Sokolow, 1978).

Twenty-four hour BP can be measured either directly with an intra-arterial catheter (Bevan et al., 1969; Floras et al., 1981) or indirectly by using automatic BP recording and analysing device e.g. Pressurometer or oscillometric Dinamap (Silas et al., 1980). All these methods could be dangerous, incovenient and expensive. A more convenient, low-cost method is needed for daily practice.

Wever (Wever et al., 1982) developed short-term BP average of 2-hours intervals, 8-10 o'clock in the morning, measuring BP every 7.5 minutes, which resulted in an r of 0.89/0.89. He got 0.62/0.72 and 0.49/0.39 for 3 consecutive measurements starting at 8 AM and a single reading at 8 AM respectively.

Our data were similar to Wever's, revealing 0.91/0.91 for 2-hours with a Pressurometer taking at 15 minutes interval, 0.88/0.66 for 3 consecutive with a Pressurometer, 0.87/0.77 for 3 consecutive BP's taken manually, and 0.49/-0.35 for a single reading.

Representation of blood pressure for 24-hour, ambulatory blood pressure by average of multiple readings of 8 to 10 o'clock in the morning seems to be reasonable not only for clinical usage, but also is more convenient, compliable and reproducible with lower cost.

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