Management of Hypertensive Outpatients: Clinical Evaluation of Casual and 24-Hour Ambulatory Blood Pressure

Kazuo Sawami

Sawami Medical Office, 1-4, 2 Cho-me, Fukae-Kita, Higashinari-ku, Osaka 573, Japan

Summary Knowledge of daily blood pressure profiles is now an important factor in the management of hypertension. We recently analyzed the relationship of casual blood pressure (CBP) to 24-hour blood pressure (24-h BP) in 9 hypertensive patients and 11 normotensive subjects. A 24-hour ambulatory blood pressure monitoring apparatus (24-h ABPM, A & D Co.) was used to monitor 24-h BP. Data were divided into daytime mean blood pressure (daytime mBP), night mean blood pressure (night mBP), and 24-hour mean blood pressure (24-h mBP). In each subject, the 24-h ABP pattern was highly reproducible. Analysis of CBP disclosed that both the systolic blood pressure (SBP) and diastolic blood pressure (DBP) correlated more closely with 24-h mBP than with any other parameter. In view of the high incidence of cerebral infarction during night time or rest, prior knowledge of a blood pressure change pattern from daytime mBP to night mBP in individual patients is important in the prevention of this condition. The degree of decrease from daytime mBP to night mBP varied greatly among individuals, being higher in hypertensive patients than in normotensive subjects. The degree of this change in blood pressure was difficult to predict based on the CBP change pattern following postural change or 5-min rest. In some cases, 24-h ABPM data were within the hypertensive range (systolic > 160 mmHg, diastolic > 95 mmHg) for many hours, even though CBP was within the normal range. On the other hand, the duration of this sustained hypertensive level during 24-h ABPM was sometimes short, even in subjects with elevated CBP. To deal with such discrepancies between CBP and 24-h ABPM, the duration of the sustained hypertensive level during 24-h ABPM should be given high priority in assessing the severity and prognosis of hypertension. Key Words 24-hour ambulatory blood pressure, hypertension, casual blood pressure, postural change, 24-hour hypertensive level

The prevention of cerebrovascular accidents and myocardial infarction is an important goal in the management of hypertension (1,2). In recent years, it has become easy to perform blood pressure determinations in the home. Although such blood pressure measurements tend to be done at random, it seems to be significant for physicians to
utilize home-measured blood pressure data in the management of hypertension. For this purpose, prior knowledge of 24-hour blood pressure (24-h BP) in individual patients is indispensable. Currently, compact low-cost 24-hour ambulatory blood pressure monitoring apparatuses (24-h ABPM) with low noise are commercially available (3). The present study aimed to examine the reliability and reproducibility (similarities of data between multiple measurements in the same subjects) of the measurements obtained from these apparatuses and to explore the relationship between casual blood pressure (CBP) and 24-h ABPM data. Because night mean blood pressure (night mBP) is closely related to the prevention of cerebrovascular accidents, we also analyzed the degree of fall from daytime mean blood pressure (daytime mBP) to night mBP and examined whether or not CBP could be predicted from this measurement (4). In the present study, some subjects showed a discrepancy between CBP and 24-h ABPM data. This discrepancy cannot be overlooked when addressing the issue of the treatment and prognosis of hypertension. Although frequent CBP checks are important in the management of hypertension, the additional classification of hypertensive patients by taking into consideration duration of high blood pressure levels measured by ABPM would appear to allow more accurate management of hypertension.

METHODS

The subjects of the study were 11 normotensive controls and 9 hypertensive patients (Table 1). The diagnosis of hypertension was based on WHO criteria. The parameter CBP was determined at times of postural change (to standing, sitting, and supine positions) and at 5 min after postural change the supine position. The use of anti-hypertensive drugs was forbidden on CBP check days. Meanwhile, 24-h ABPM, employing the recently commercialized TM2402 recorder/TM2020 processor (A & D Co.), was conducted at 30-min intervals during daytime (7:00 to 22:00) and at 60 min intervals at night (22:00 to 7:00) (Fig. 1). In both time zones, systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were measured. Mean blood pressure (mBP) was automatically calculated. Figure 2 schematically represents the duration of sustained hypertensive levels (systolic > 160 mmHg, diastolic > 95 mmHg) during 24-h ABPM. This duration for systolic pressure and diastolic pressure was expressed as HT-time(S) and HT-time(D), respectively.

Table 1. Numbers of subjects.

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Normotensive subjects</th>
<th>Hypertensive patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 35</td>
<td>4 (2)</td>
<td>1</td>
</tr>
<tr>
<td>35−60</td>
<td>0</td>
<td>2 (1)</td>
</tr>
<tr>
<td>60 &lt;</td>
<td>7 (2)</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Total</td>
<td>11 (4)</td>
<td>9 (5)</td>
</tr>
</tbody>
</table>

Classification according to casual blood pressure; figures in parentheses indicate females.

RESULTS

Reproducibility of 24-h ABPM in 2 normotensive controls

Figure 1 shows the data yielded by the methods outlined above. The right column indicates the first measurement and the left indicates the second. Although the two measurements were conducted on different days, blood pressure patterns were similar on the two occasions in both normotensive subjects. When the data were divided into daytime mBP, night mBP and 24-h mBP, according to the method shown in Fig. 2, the results shown in Fig. 3 were obtained. Mean ± SD agreed well between the two measurements. SD tended to be lower in the second measurement, probably reflecting the examiner having become accustomed to this examination by the second measurement. These results indicate that individuals have specific blood pressure patterns which are important in estimating the age-related changes and assessing the efficacy of treatment in individual patients.

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Fig. 2. Diagram of 24-hour ambulatory blood pressure monitoring

Relationship of standing CBP to the data provided by 24-h ABPM

CBP correlated well with the blood pressure data provided immediately after installment of the 24-h ABPM apparatus (Fig. 4). Although the blood pressure levels, measured by ABPM, were slightly high, satisfactorily close correlations were observed between CBP data and ABPM data in terms of SBP \( (r = 0.79) \), DBP \( (r = 0.85) \), and HR \( (r = 0.81) \).

Relationship of sitting CBP to daytime mBP and 24-h mBP provided by 24-h ABPM

Considering that blood pressure measurement is usually done in the sitting position, we analyzed the relationship of sitting CBP to daytime mBP and 24-h mBP (Figs. 5 and 6). The coefficient of correlation was 0.69 between daytime mBP and systolic CBP and 0.73 between daytime mBP and diastolic CBP. Thus, CBP in the sitting position correlated well with the 24-h mBP.

Fig. 3. Reproducibility of daytime mean blood pressure, night mean blood pressure and 24-hour mean blood pressure during ABPM (Normotensive subjects).

**Decrease of mean BP from daytime to night during ABPM**

Table 2 shows the decrease in mean BP from daytime to night during ABPM. In a majority of subjects, the degree of decrease was 10–20 mmHg for SBP, 10 mmHg or less for DBP, and 10 beat/min or more for HR. Figure 7 shows these data in graph form. The mean decrease in SBP was 14.5 ± 6.8 mmHg, and the mean decrease in DBP was 8.5 ± 7.0 mmHg. The decrease tended to be larger in hypertensive patients than in
Fig. 4. Relationship between casual blood pressure and heart rate measured immediately after installation of ABPM (standing position).

Fig. 5. Relationship between casual blood pressure and heart rate for determination of daytime mean blood pressure obtained by ABPM (sitting position).

Changes in CBP following postural changes (supine → 5-minutes after supine; sitting → 5-minutes after supine) in relation to the decrease in mBP from daytime to night

Figure 9 shows the relationship of CBP changes (between the beginning of supine position and 5 minutes later) to the daytime-night decrease in mBP. As shown here, the correlation between these parameters was low for both SBP (r = 0.15) and DBP (r = −0.11). Also on analysis of the relationship of CBP changes (between the beginning of the sitting position and 5 min after supine), to the daytime-night decrease in mBP, the
Fig. 6. Relationship between casual blood pressure, heart rate, and 24-h mean blood pressure, obtained by ABPM (sitting position).

Fig. 7. Decrease of mean blood pressure and heart rate from daytime to night during ABPM.
correlation was low for both SBP \( (r = -0.05) \) and DBP \( (r = -0.01) \) (Fig. 10). Thus, contrary to our expectation, the changes in SBP following postural change were not useful in predicting the decrease in mBP from daytime to night during 24-h ABPM.

**Duration of hypertensive blood pressure levels during ABPM**

Figure 11 shows HT-time(S) and HT-time(D) for both normotensive and hypertensive subjects.
hypertensive groups. As expected, the HT-time(S) for the normotensive group (1.8 ± 2.4 h) was lower than that for the hypertensive group (6.4 ± 3.9 h), although the classification of hypertension was based on CBP data in these subjects. In 2 subjects who were rated as normotensive, based on CBP data, but who frequently showed high blood pressure, the HT-time was high. In addition, some subjects who were rated as hypertensive, based on CBP data, showed a lower HT-time.

DISCUSSION

Twenty-four-hour ABPM is advantageous in that it discloses a daily blood pressure pattern which cannot be yielded by casual blood pressure monitoring at an outpatient
Despite this monitoring system being convenient, it is difficult to repeat this monitoring many times in the same individual. In addition, the blood pressure patterns yielded by this system may be affected by physical activity and mental condition. For these reasons, we attempted to utilize CBP for the prediction of the 24-h ABPM pattern, with prior knowledge of the relationship between CBP and 24-h ABPM data.

When two measurements were taken on different days in normotensive subjects, high reproducibility was observed. These cases would seem to allow estimation of blood pressure status by comparing the blood pressure data (from home measurement and casual measurement) to known blood pressure patterns. This is difficult, however, when the subjects are active, or if they are mentally unstable.

We then compared errors in blood pressure data collected by CBP and 24-h ABPM. According to Tochikubo et al., the auscultatory method and ABPM provided lower SBP and higher DBP compared to the intravascular SBP and DBP. When we compared the auscultatory method (immediately before installment of the ABPM apparatus) and the ABPM method (immediately after installment of the ABPM apparatus), both SBP and DBP were lower with the auscultatory method than with the ABPM, although the correlation between the two methods was good for both SBP and DBP. The lower SBP and DBP obtained with the auscultatory method seem to reflect the several-minute interval between the two tests.

It is important to know which portion of the 24-h ABPM data is associated with CBP data; however, it is impossible to compare the continuously changing conditions. Therefore, we compared CBP data with daytime mBP, night mBP, and 24-h mBP.
provided by 24-h-ABPM. This comparison disclosed a correlation of CBP to both daytime mBP and 24-h mBP (particularly high with respect to 24-h mBP). This result suggests that although CBP is measured during daytime, CBP data may also reflect the influence of night blood pressure. In the past, it was seemed difficult to estimate changes in 24-h BP based on CBP data. In the present study, we explored the relationship of CBP changes following postural change to daytime, night, and 24-h mean BP provided by ABPM. This attempt, however, yielded no satisfactory results. This is probably because CBP changes associated with postural change were measured for a short time in the daytime, and because measurement during daytime (when the sympathetic system is predominant) does not sufficiently reflect the features of blood pressure at night (when the parasympathetic system is predominant).

In some cases, there were slight discrepancies between CBP data and 24-h ABPM data. That is, the mean blood pressure provided by 24-h ABPM was sometimes elevated in subjects showing normal CBP, and 24-h ABPM sometimes yielded relatively normal blood pressures in those showing elevated CBP. These cases include cases of mild hypertension, transient hypertension caused by seeing the white coat of the examiner, etc.

According to a past report on the relationship between CBP and hypertension-induced influence on organs (5), mean daytime blood pressure was more closely related to organ disturbances. Considering the findings from our present study and previous studies, not only CBP, but also the HT-time in 24-h ABPM, is significant in the treatment of hypertension and the prediction of its prognosis. In other words, knowledge of the relationship between CBP and 24-h ABPM is important in diagnosing mild hypertension or white coat hypertension and in the management of those patients with hypertension who do not require intensive treatment. In the future, ABPM will play a more important roles in the therapy of hypertension and in assessing the prognosis of cerebrovascular and cardiovascular diseases.

REFERENCES