Clinical Significance and Cost-Effectiveness of 24-hour Ambulatory Blood Pressure Monitoring

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IMAI, Y. Clinical Significance and Cost-Effectiveness of 24-hour Ambulatory Blood Pressure Monitoring. Tohoku J. Exp. Med., 1995, 176 (1), 1-15 — Ambulatory blood pressure (BP) monitoring as an adjunct to casual/clinic BP measurements is currently used widely for the diagnosis and treatment of hypertension. It has been established that ambulatory BP monitoring is essential to confirm “white coat” hypertension, drug-resistant hypertension, duration of drug action, short-term BP variation, and nocturnal and on-the-job BP levels. It is estimated that approximately 10,000 ambulatory BP monitoring devices are currently used in Japan. That number would increase if 1) a standard algorithm with a theoretical basis to determine BP levels is introduced for ambulatory BP monitoring devices based on cuff-oscillometric method, 2) the reproducibility of ambulatory BP levels is confirmed, 3) reference values for evaluating ambulatory BP monitoring levels are established, and 4) the clinical significance and prognostic value of ambulatory BP monitoring is established. If such problems are settled, the use of ambulatory BP monitoring in the diagnosis and treatment of hypertension would be national health insurance and would improve the prognostic accuracy of evaluating hypertension as well as the cost-effectiveness of screening, diagnosis and treatment of hypertension. — ambulatory blood pressure monitoring; devices; reproducibility; home blood pressure measurements; white coat hypertension; cost-effectiveness

Ambulatory blood pressure (BP) monitoring as an adjunct to casual/clinic BP measurement is currently used widely for the diagnosis and treatment of hypertension. As estimated 10,000 ambulatory BP monitoring devices are currently used in Japan. That number would increase if the clinical significance of ambulatory BP monitoring was established and if the use in the diagnosis and treatment of hypertension was covered by national health insurance. Currently, the economic burden of ambulatory BP monitoring is carried by medical institutions or individual patients. If ambulatory BP monitoring is to be used for over

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20 million hypertensive patients in Japan, its financial impact on the nation's health insurance program will be severe. However, if the diagnostic and therapeutic relevance as well as cost-effectiveness or cost-benefit of ambulatory BP monitoring are established, a more informed decision can be made. The objective of this article is to assess the clinical significance and cost-effectiveness of ambulatory BP monitoring.

**Current and future status of ambulatory BP monitoring method**

BP monitoring devices employ the Korotkoff-sound (K) and/or cuff-oscillometric (O) method using an arm cuff. The first automatic BP device employing the O-method was introduced in Japan in 1984. Since then, nearly all BP monitoring devices designed in Japan have incorporated the O-method. About one million home BP devices are manufactured every year in Japan, with approximately half of them being exported. Until 1994, 10,000 ambulatory BP monitoring devices were used in clinical practice in Japan. Some of the more recent devices incorporate both the K- and O-methods. Although the O-method was developed to compensate for the shortcomings of the K-method, it also has

<table>
<thead>
<tr>
<th>Table 1. Advantage (+) and disadvantages (-) of K-method vs. O-method</th>
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<tr>
<td><strong>Method</strong></td>
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<tr>
<td><strong>Cost</strong></td>
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<td><strong>Utility</strong></td>
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<td><strong>Reliability</strong></td>
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<td><strong>BP values</strong></td>
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<td><strong>Ambulatory monitoring</strong></td>
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problems that need to be resolved before it can become established as a standard method for BP measuring.

Table 1 shows the advantages and disadvantages of the O- and K-methods. The most serious problem with the O-method is the lack of a theoretical basis for determining systolic (SBP) and diastolic BP (DBP) (Imai and Yamakoshi 1994). The O-method can be used to obtain only the mean BP from the oscillation pattern of the cuff pressure. Some devices estimate SBP at the point at which the oscillation height abruptly increases, the mean BP (MBP) at the point at which the oscillation peak is observed, and the DBP at the point at which the oscillation height shows its first abrupt drop. Other devices estimate the MBP at the point at which the oscillation peak is observed, and estimate the SBP and DBP at the points at which a certain percent of the peak oscillation height is observed. However, most manufacturers of BP measuring devices do not disclose the algorithm for determining SBP and DBP by the O-method. Most of these devices seems to use an empirically derived algorithm to estimate SBP and DBP.

Table 2 shows the laboratory results of validity of the K-method and O-method devices (Imai et al. 1989, 1990, 1992, 1994). The validity of the measured values is generally assessed in the resting condition and assessed as a difference

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Method</th>
<th>Objective</th>
<th>No. of subjects</th>
<th>SBP</th>
<th>DBP</th>
</tr>
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<tr>
<td>UEDA</td>
<td>USM700F</td>
<td>K</td>
<td>Medical use</td>
<td>321</td>
<td>0.8±5.2</td>
<td>−0.5±7.3</td>
</tr>
<tr>
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<td>ESH51</td>
<td>K</td>
<td>Medical use</td>
<td>170</td>
<td>0.7±2.9</td>
<td>−0.3±2.6</td>
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<td>A&amp;D</td>
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<td>K</td>
<td>ABPM</td>
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<td>−1.6±6.3</td>
<td>−1.7±6.5</td>
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<tr>
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<tr>
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<td>BP103NH</td>
<td>O</td>
<td>Medical use</td>
<td>244</td>
<td>−5.3±5.6</td>
<td>3.0±6.8</td>
</tr>
<tr>
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<td>Medical use</td>
<td>170</td>
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<td>A&amp;D</td>
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<td>O</td>
<td>Home use</td>
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<td>−0.4±7.8</td>
</tr>
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</table>

Values are mean±s.d., BP: average value obtained by auscultation by two listeners-value obtained by device.
from the results obtained by the auscultatory method. Both the A&D TM2421 (A & D Incorp., Tokyo) and Colin ABPM630 (Colin Incorp., Komaki), which are widely used for ambulatory BP monitoring in Japan, simultaneously record BP by K- and O-methods (Imai et al. 1989, 1990). Both methods in these devices satisfy the standard of Association for the Advancement of Medical Instrumentation (AAMI) (1987) and were estimated as higher than grade B based on guidelines set by the British Hypertension Society (O'Brien et al. 1990). Since the K- and O-methods of A & D TM2421 used under a bicycle ergometer load also satisfied the AAMI standard, they are accepted as appropriate for use in ambulatory BP monitoring (Imai et al. 1992). However, for accurate blood pressure readings in the ambulatory condition, the subjects must keep the arm still during the actual measurement.

The direction of the mean differences in the values obtained with the O-method and those obtained with the auscultation method in each device differs, indicating the need for standard algorithm for determining the SBP and the DBP by the O-method (Table 2). We developed several BP measuring devices that incorporated the O-method for medical use, home use and ambulatory BP monitoring. During the development of these devices, we repeatedly validate our results by adjusting the BP values so obtained with those obtained by auscultation. The manufacturer easily modifies the algorithm to adjust the values in the device to those seen with by auscultation. It seems obvious that each device based on the O-method has a different algorithm to determine SBP and DBP. It is surprising, however, that each device based on O-method provided a reasonable value for SBP and DBP and that the performance of the ambulatory BP monitoring devices based on this method is apparently superior to that of those based on the K-method. For example, significant measurements accounted for 97.5% of the measurements obtained by O-method incorporated in the recently developed A & D TM 2421, versus 87.0% of the measurements obtained by the K-method also incorporated in the same device (Imai et al. 1992). Therefore, the introduction of a standard algorithm with a theoretical basis should absolutely be introduced for devices based on the O-method. This would result in a standardization and comparableness of the BP measurements. Although several recently designed K-method devices for ambulatory BP monitoring introduced a gating system using R waves (White et al. 1990) or noise signals to secure the K-sound signal (Tochikubo et al. 1988), the performance of these ambulatory BP monitoring devices is poor. Nevertheless, the K-method is the standard for clinical BP measurement. We previously reported that, when both O- and K-methods were incorporated in a single device, differences in DBP measurements obtained by the two methods were greater than we had expected from validation under either static or dynamic conditions (Imai et al. 1992). Therefore, an improved ambulatory BP monitoring device must be developed to measure SBP and DBP more accurately using the K-method, which would be compensated for by the O-method
(Imai and Yamakoshi 1994). Otherwise, a new method of measuring BP, such as the volume oscillometric method, is needed (Yamakoshi et al. 1982; Imai et al. 1987).

The devices for monitoring ambulatory BP currently manufactured in Japan cost between 2,500-3,500 US$. The CO₂ cartridge required for the ABPM630 costs an additional 5-10 US$, but the TM2421 uses rechargeable battery, which requires no maintenance cost. Thus, if one TM2421 device is used for the ambulatory BP monitoring of 1,000 people, the cost for a single ambulatory BP monitoring is 3.5 US$.

Reproducibility of ambulatory blood pressure levels

Clinical BP and/or casual BP are generally obtained at the outpatient clinic once every 2 to 4 weeks. Epidemiological surveys indicate that such casual BP measurement, even a single measurement, including that obtained on physical examination, accurately reflect the prognosis of a population (Kannel et al. 1980; Working Group on Risk and High Blood Pressure 1985). However, casual BP measurements do not always reliably predict individual prognosis. Since casual values include various biases, their reproducibility is poor. Ambulatory BP monitoring, which incorporates a large number of measurements, therefore constitute a more representative estimate of an individuals typical BP levels outside the medical setting, including those reflecting various mental and physical activities. It is thus likely that the reproducibility and reliability of ambulatory BP levels are superior to those of casual BP levels (James et al. 1988). Consequently, ambulatory BP levels are probably better predictor of target organ damage, cardiovascular complication and prognosis than casual BP levels (Sokolow et al. 1966; Perloff et al. 1983; Devereux et al. 1987; White et al. 1989). This favorable reproducibility is highly advantageous for diagnosing hypertension and the evaluating the efficacy of antihypertensive treatment (Gould et al. 1981; Dupont et al. 1987; Parati et al. 1988). However, the values obtained by ambulatory BP monitoring are subject to various uncontrolled mental and physical activities, so that the environment at time of measurement is not uniform. Consequently, the environment as well as mental and physical activities on the day of measurement influences the BP values. In this regard, if the initial average ambulatory BP levels are relatively high, it is likely that the second average ambulatory BP levels become lower than the first levels, or vice versa (i.e. regression to the mean) (Fig. 1) (Yabe et al. 1994). This trend is also observed in hospitalized patients. The decline in their BP upon admission is clearly reflected in their ambulatory BP levels.

When the long-term (apart from one year) reproducibility of ambulatory BP levels is expressed as the mean difference of two ambulatory BP levels and its 2s.d. (confidence limit), the 2s.d. of SBP was about 20 mmHg, which was not much different from the 2s.d. of the mean difference of two casual SBP levels; each of
Fig. 1. Long-term reproducibility of screening blood pressure levels (×1: one measurement vs. one measurement, ×3: average of three measurements obtained at three separate visits vs. average of three measurements obtained at three separate visits), ambulatory blood pressure levels and home blood pressure levels. Vertical axis represents the difference of blood pressure levels between two periods. Horizontal axis represents blood pressure levels at the first measurement.
Ambulatory Blood Pressure Monitoring

those was determined as the average of 3 casual SBP values obtained at 3 separate visits (Fig. 1). Consequently, the reproducibility of ambulatory BP levels was unexpectedly poor (Staessen et al. 1994; Yabe et al. 1994). In contrast, the reproducibility (2s.d.) of 20 measurements of homes BP, which is another BP information obtained outside the clinical setting, was 15 mmHg, a value clearly lower than that obtained with ambulatory BP monitoring (Sakuma, M., Imai, Y., and Satoh, H. unpublished data). Therefore, home BP measurements may be the most reliable ones available. However, home BP measurements are not as usual as ambulatory BP monitoring in that they cannot determine circadian BP variation, BP levels at work or during sleep, or short-term variability of BP. Thus, an optimal BP measurement method must be selected to obtain target blood pressure information.

*Application of ambulatory blood pressure monitoring*

The standard method of measuring BP in the diagnosis of hypertension is based on the Korotkoff sound technique using a mercury sphygmomanometer in the clinical setting. Home BP measurements and ambulatory BP monitoring are only supplementary. This was emphasized by the 5th Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (1993) and the WHO/ISH Guidelines (Zanchetti et al. 1993). The National High Blood Pressure Education Program (1990) recently recommended the use of ambulatory BP monitoring in a variety of clinical settings. For example, it is most effectively applied to the identification of white coat effect and diagnosis of white coat hypertension.

The incidence of white coat hypertension or white coat borderline hypertension is reportedly 10-50% (Ayman and Gouldshine 1940; Floras et al. 1981; Krakoff et al. 1988; Pickering et al. 1988; Lerman et al. 1989; Julius et al. 1990; Imai et al. 1995). Since BP information outside the clinical environment is essential for the evaluation of the white coat effect and the diagnosis of the white coat hypertension, ambulatory BP monitoring or home BP measurements are essentially necessary, except in the diagnosis of severe and accelerated hypertension. White coat effect is occasionally involved in intractable hypertension resistant to antihypertensive drugs and if stepwise dose increments or stepwise combinations of antihypertensive drugs do not lower casual BP, ambulatory BP monitoring or home BP measurements can clarify whether the patient is actually drug-resistant. Antihypertensive drug treatments based on casual BP alone may sometimes lead to hypotensive episodes outside the medical setting and cause cardiovascular complication in patients with white coat hypertension (Fig. 2). Home BP measurements are appropriate for investigating long-term and seasonal BP variations, and thus, for determining long-term effects of antihypertensive drug treatment. Ambulatory BP monitoring can determine short-term BP variability and, thus, rapid and transient BP changes including episodic hypertension.
Y. Imai

and hypotension. Short-term BP variability reportedly reflects target organ
damage and cardiovascular complications (Parati et al. 1987; Frattola et al. 1993).
Furthermore, ambulatory BP monitoring is the sole method of obtaining noctur-
nal and on-the-job BP levels. Many investigators have examined the relation-
ships between nocturnal BP levels or amplitude of the fall in nocturnal BP and
left ventricular hypertrophy (Verdecchia et al. 1990; Kuwajima et al. 1992) or
asymptomatic ischemic cerebrovascular lesions (Shimada et al. 1990; Watanabe et
al. 1994).

Reference values for evaluating ambulatory blood pressure levels

Reference values for ambulatory BP levels based on epidemiological surveys
of hypertensive patients have not been established. Therefore, the diagnostic
criteria of ambulatory BP described here are tentative and based on statistical
analysis of the data obtained from community-based population surveys,
employment-based surveys and studies of subjects whose casual BP levels
classified as normotensive. Two statistical procedures can be used to evaluate
ambulatory BP level. One method is to calculate the 95th percentile value,
mean + s.d. value, and mean + 2s.d. value from the distribution of ambulatory BP
levels in community-based or employment-based population, including those with
hypertension and those receiving antihypertensive drugs (Imai et al. 1993). The
other method is to obtain similar statistical values from the distribution of
ambulatory BP levels in those whose casual BP measurements demonstrated

Fig. 2. White coat hypertension (upper panel) and white coat phenomenon in
hypertensive subjects (lower panel). Since white coat hypertension and white
ccoat phenomenon are little influenced by antihypertensive drugs, hypertension
remains unchanged in the medical setting while hypotension is observed in the
non-medical setting (c).
Ambulatory Blood Pressure Monitoring

normal values without antihypertensive treatment. The reference values may change considerably depending on the cut-off point. Mean + S.D. value corresponds to the 84th percentile of the normal distribution, while mean + 2S.D. value is equivalent to 98th percentile. According to the Ministry of Health and Welfare in Japan (1992), 12% of the values determined by casual BP measurements are higher than 160 and/or 95 mmHg in Japanese population. Since the BP distribution in the population does not necessarily demonstrate a normal pattern but rather a pattern skewed to higher BP levels, the 95th percentile values of a particular population are considerably high, so a person whose value exceeds this level is considered to be definite hypertensive on the basis of ambulatory BP levels. An estimated 67% of Japanese population is normotensive. If the mean + S.D. value of a community-based population or an employment-based population is taken as the upper normal limit, the value is assumed to be rather too high. Therefore, using the mean + S.D. value of ambulatory BP in the subjects estimated as normotensive on the basis of casual BP would prevent overestimation of normotensives. However, if those positioned in between are evaluated as borderline hypertensive, a certain part of those with normotension and definite hypertension may be erroneously classified as borderline hypertensive.

O'Brien et al. (1991) investigated 815 untreated subjects (17-79 years old) at the Allied Irish Bank, and reported that the mean value, mean + 2S.D. value and 95th percentile value of 24-hour average ambulatory BP level were 118/72 mmHg, 140/86 mmHg and 134/84 mmHg, respectively. An epidemiological survey of ambulatory BP levels conducted in northern Japan (Ohasama, Iwate Prefecture) determined the respective values in 474 untreated subjects (20-89 years old) in the first cohort to be 119/70 mmHg, 144/85 mmHg and 144/83 mmHg (Imai et al. 1993). The 24-hour average ambulatory BP levels for the 448 people who were classified as normotensive by casual BP measurement was 118/69 mmHg, and the mean + S.D. was 129/76 mmHg (Imai et al. 1993). Based on the results, it is reasonable to classify 24-hour average ambulatory BP values exceeding 144/85 mmHg as definitely hypertensive, and the values of 129/76 mmHg or less as normotensive. Staessen et al. performed metaanalysis of ambulatory BP levels using data from 4577 subjects throughout the world and reported 24-hour ambulatory BP levels of 116±10/70±7 mmHg and a 95th percentile value of 133/82 mmHg (Staessen et al. 1991).

Reevaluation of casual BP by ambulatory BP

Ambulatory BP monitoring provides multiple BP values obtained from subjects engaged in a variety of physical and mental activities in a nonmedical setting, without observer bias. Averaging the results of repeated or multiple BP measurements provides a reliable estimate of cardiovascular risk and prognosis of hypertension (Sokolow et al. 1966; Perloff et al. 1983; Devereux et al. 1987; White et al. 1989). Highly accurate BP measurements can be obtained with
multiple determinations of ambulatory BP over 24 hours. Therefore, this article tentatively postulates that ambulatory BP is the gold standard of BP measurements. A cross-sectional community survey of ambulatory BP and casual BP level was conducted in a community of northern Japan (Imai et al. 1993, 1995). A total of 969 adults (mean age ± s.d., 59.3 ± 12.1 years, age range: 20–89 years) out of 1575 eligible adult people underwent initial screening of BP and monitoring of ambulatory BP. A total of 285 (66.5 ± 9.2 years old) were taking antihypertensive medication (treated group) versus 684 (56.3 ± 12.0 years old) who were not (untreated). BP screening was performed in accordance with the WHO criteria. Ambulatory BP levels were defined as follows: hypertension: systolic BP ≥ 144 mmHg and/or diastolic BP ≥ 85 mmHg, and normotension: systolic BP ≤ 133 and diastolic BP ≤ 78 mmHg. These values were mean ± 2 s.d. value and mean + SD value of the ambulatory BP, respectively, obtained from the untreated subjects in the first cohort of the community. Of the 717 subjects identified as normotensive on the screening measurements, ambulatory BP monitoring showed 30 (4.2%) to be hypertensive, whereas 594 (82.4%) to be normotensive. Of the 83 subjects identified as hypertensive on screening measurements, ambulatory BP monitoring showed 26 (31.3%) to be hypertensive and 32 (38.6%) to be normotensive. Of the 285 treated subjects, 49 (17.2%) were defined as hypertensive by screening measurements, whereas 36 (12.6%) were defined as hypertensive by ambulatory BP monitoring. Only 12 (24.5%) of the former 49 subjects were also defined as hypertensive, while 20 (40.8%) were defined as normotensive by ambulatory BP monitoring. Of the 684 untreated subjects, 34 (5.0%) were hypertensive by screening measurements and 43 (6.3%) by ambulatory BP monitoring. Only 14 (41.2%) of the former 34 subjects were classified as hypertensive by ambulatory BP monitoring. Of the 34 untreated subjects identified as hypertensive by screening measurements, ambulatory BP monitoring showed 12 (35.3%) to be normotensive, suggesting that they were cases of white coat hypertension. Based on these data obtained from untreated subjects, the screening BP measurements had a specificity of 96.9% but a sensitivity of only 32.6%. Underestimation as well as overestimation of hypertension may result in cardiovascular complications, end-organ damage, inappropriate administration of medications and alterations in the quality of life, as well as imposing unnecessary economic burdens. Accurate determination of BP may help to improve the prognosis of hypertensive patients and to optimize the cost effectiveness of treatment.

Cost-effectiveness of 24-hour ambulatory blood pressure monitoring

According to a report from the Ministry of Health and Welfare (1993a), approximately 10 million of the 71 million people over the age of 30 in Japan are hypertensive with casual BP of 160 and/or 95 mmHg or over, and approximately 16 million are borderline hypertensive with casual BP between 159/94 mmHg and
140/90 mmHg. Untreated hypertensive subjects account for 4.7 million of those 10 million hypertensive people and untreated borderline hypertensive subjects account for 13 million of those 16 million borderline hypertensive people. These values were all based on casual BP measurement. When these data were reevaluated according to rates of hypertension and normotension based on ambulatory BP in Ohasama, 1.8 million of the 4.7 million untreated hypertensives were evaluated as normotensive and thus required no treatment, and 1.4 million classified as borderline hypertensive, and thus having no immediate need for antihypertensive drug treatment. It is estimated that 160 US$ per year is spent on antihypertensive drugs for each hypertensive patients (Ministry of Health and Welfare 1993b). If those diagnosed as hypertensive based on casual BP begin antihypertensive drug treatment, the total cost would be 750 million US$ a year. However, medical costs would be reduced by 510 million US$ if ambulatory BP monitoring is implemented. Approximately 59 million untreated Japanese people aged 30 years or older demonstrate borderline hypertension BP levels or below on the basis of casual BP. If these people are reevaluated by ambulatory BP criteria (Imai et al. 1995), approximately 3.8 million would require antihypertensive drug therapy, which would cost 608 million US$. Currently, those aged 30 years or older who are receiving antihypertensive drug treatment number circa 10.9 million. According to the Ohasama Study, 9.5% (1 million) of them are assessed by ambulatory BP monitoring to be in the hypotensive range, either requiring no antihypertensive drugs or requiring a reduced dosage or temporary discontinuation at antihypertensive drug therapy. Discontinuation of treatment for these people would represent a savings of 165 million US$. Thus, only taking into account cost related to antihypertensive drugs, the medical costs can potentially be reduced by up to 69 million US$ by introducing ambulatory BP monitoring. This is a decrease in direct cost of antihypertensive drug therapy, but an annual cost reduction of 556 million US$ is possible if the annual cost of 1,284 US$ per hypertensive patient is taken into consideration (Ministry of Health and Welfare 1993b). A huge reduction in indirect medical costs can also be anticipated. For example, if those people who are not receiving antihypertensive drug treatment based on their casual BP levels are reevaluated by ambulatory BP monitoring as requiring treatment, the initiation of such treatment can prevent cerebrovascular and cardiovascular complications for which hypertension is the greater risk factor. Medical costs related to cerebrovascular disease in Japan amounted to 14.0 billion US$ in 1990 (Ministry of Health and Welfare 1993b). How much of this was spent on the primary incidence and recurrence of cerebrovascular diseases is unknown, but assuming that the prevalence of cerebrovascular diseases in Japan is 0.4 million and that the incidence of cerebrovascular disease is 0.14 million/year (Kameyama 1990), at least 5 billion US$ was spent on patients with acute phase stroke. Since the ratio of incidence of acute cerebral hemorrhage to cerebral infarction in Japan is 1 to 4 (Ueda 1991), we can estimate
that at least 1 billion US$ a year is spent on the treatment of acute cerebral hemorrhage in Japan. Hypertensive cerebral hemorrhage accounts for 60% of all cerebral hemorrhage cases (Buhemuka 1987). If the incidence of this disease can be reduced by 50% by the introduction of ambulatory BP monitoring, 300 million US$ in medical costs can be saved per year. Furthermore, a 5% decline in the incidence of acute cerebral infarction can reduce the medical costs by 160 million US$. An estimated 5.9 billion US$ a year is spent for the treatment of ischemic heart disease (Ministry of Health and Welfare 1993b). Hypertension is a minor risk factor for ischemic heart disease when compared with stroke, but if the introduction of ambulatory BP monitoring can save 1% of the medical cost spent on ischemic heart disease, savings of 30 million US$ a year would result. Based on the above assumptions, the introduction of ambulatory BP monitoring would reduce medical costs for the treatment of cerebrovascular and cardiovascular disease by 520 million US$ a year. Added to the direct medical costs related to hypertension, the total reduction would be approximately 1 billion US$ a year.

Decreases in indirect medical costs are also expected if ambulatory BP monitoring is implemented. If patients found to be positive on the basis of casual BP measurements are diagnosed accurately as normotensive by ambulatory BP monitoring, the unnecessary intake of antihypertensive drugs is eliminated, the quality of life is improved, and the time and costs of office visits and examinations are saved. Furthermore, prevention of cerebrovascular and cardiovascular complications by the correct diagnosis of hypertension by ambulatory BP monitoring with treatment of the patient with appropriate antihypertensive drugs would result in huge cost savings, and would eliminate medical and nursing costs associated with the chronic stage of stroke. Thus, immeasurable medical cost may be reduced extensively.

CONCLUSION

The decision to treat hypertension may not only be based on BP level. However, the BP level is to be the most important criterion for the diagnosis and treatment of hypertension. As an adjunct to casual BP measurement, the introduction of home BP measurement and ambulatory BP monitoring can improve the prognostic accuracy of evaluating hypertension as well as the cost-effectiveness of screening, diagnosis and treatment of hypertension.

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