Ambulatory blood pressure monitoring for hypertension in general practice

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Ambulatory blood pressure monitoring (ABPM) is being increasingly used in general practice. There is at present little published evidence regarding the clinical utility of ABPM in the care of patients with established hypertension in this setting. We examined this issue by undertaking ABPM in a group of patients with established hypertension.

40 patients (aged 33–60 years) currently being treated for hypertension were randomly selected from a general practice list and underwent a single 24-hour ABPM study. ABPM values were compared with clinic blood pressure (CBP) values obtained on the day of monitoring together with previous readings taken by the general practitioner (GP).

In the case of mean arterial pressure, 24-hour, awake and asleep ABPM values were found to underestimate CBP values by 14 mmHg (95% confidence interval 11–16 mmHg), 9 mmHg (95% CI 6–12 mmHg) and 24 mmHg (95% CI 21–27 mmHg), respectively. When used to classify blood pressure control, ABPM values produced equivalent results to CBP except by the criterion of BP load, for which 24-hour ABPM showed a higher rate of unsatisfactory control. 5 patients classified by CBP to have satisfactory BP control according to current international guidelines were found to have unsatisfactory BP control by ABPM.

This study demonstrates the potential value of ABPM in patients with essential hypertension in a general practice setting. ABPM provided information over and above that obtained by CBP in a substantial proportion of patients.

INTRODUCTION

Over the past decade ambulatory blood pressure monitoring (ABPM) has been increasingly used in general practice, where most of the diagnosis and management of hypertension takes place[1,2]. By providing repeated measurements of blood pressure away from the surgery without an observer, ABPM offers several advantages over conventional clinical blood pressure (CBP) measurement—removal of observer bias, improvement in measurement precision and reproducibility and assessment of the blood pressure in different everyday situations[1]. Nevertheless the role of ABPM in general practice remains controversial. An expensive and time-consuming technique, it demands special training both for application and for interpretation[1]. In addition guidelines for the treatment and management of hypertension are currently based on clinic, rather than ambulatory, blood pressure measurements[3,4]. The potential utility of ABPM in general practice has been demonstrated in the diagnosis of new cases of hypertension, when between 20% and 40% of individuals diagnosed as hypertensive by measurement in the surgery have proved to be normotensive when studied by ambulatory monitoring[5,6]. Although 'white coat' hypertension is not a harmless condition, the general view is that these patients do not require treatment with antihypertensive drugs, at least in the early stages[7]. There are therefore benefits from such an approach in terms of avoiding unnecessary treatment and associated side-effects. Moreover, the cost of ABPM is largely met by savings on drugs, and in the long term this technique may reduce the overall cost of management[8].

Little has been published on the role of ABPM in patients with established hypertension undergoing drug treatment in primary care. However, numerous hospital-based pharmacological trials indicate that ABPM can provide important information on the quality of blood pressure control[9]. We have examined this issue by undertaking ABPM in a group of patients with treated established hypertension randomly selected from a primary care practice list.

METHODS

Patients

A computer-based register of a multi-partner practice of 28 000 patients was used to identify all patients between the ages of 18 and 60 years who were currently receiving

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treatment for hypertension. 326 were identified, and the criteria for selection were that their antihypertensive medication had not been changed in the past three months, they had no evidence of secondary hypertension and they were able to give informed consent. Patients were excluded if they had arrhythmias or if they had a dermatological condition that would prevent them wearing the monitor.

Of the patients who met the study criteria and were therefore invited to take part, 8 did not respond, 22 declined and 1 had recently died. A letter, signed by the patient's GP, explaining the object of the study and inviting them to take part, was sent to a computer-generated random sample of patients who fulfilled the above criteria. 40 patients were studied on a single occasion. It was estimated that a sample size of 35 would have 80% power to detect a 5 mmHg paired difference (with standard deviation of 10 mmHg) between ABPM and office BP[10]; a difference that is smaller than that reported by previous workers[5,11].

Blood pressure assessment

The device used for ABPM was Accutracker II (Suntech Medical Instruments, Raleigh, North Carolina, USA), which has been previously validated by this laboratory[12]. On the day of assessment, patients were asked to visit the primary care health centre. Each patient received a detailed explanation of the ABPM procedure from the study research nurse (JS). The non-dominant arm was used for all measurements. Cuff size was selected on the basis of arm circumference. CBP was measured with a calibrated mercury sphygmomanometer by the study research nurse, who was experienced in BP assessment. When the patient had sat quietly for a minimum of 15 minutes, simultaneous assessment of BP (via a T-piece connection) was made by the ABPM unit and by the research nurse using a standard mercury sphygmomanometer. Patients then underwent a 24-hour period of ABPM, blood pressure being measured at 15-minute intervals. Patients were given a contact number for the research nurse and were asked to keep a diary of their activity over the 24 hours. After 24 hours each patient returned to the health centre and the ABPM data were downloaded onto a computer for later analysis. In addition, details of the three previous CBP readings taken by the GP were obtained from the case notes.

Data analysis

Two kinds of measurements were compared by the method of Bland and Altman[13]. Mean arterial pressure (MAP) was calculated for CBP and ABPM values by adding one-third of the pulse pressure to the diastolic pressure. The difference in mean arterial pressure was plotted against the averages of the two methods being compared. The paired t-test was used to assess the diastolic and systolic BP differences between CBP and ABPM values.

Control of BP was specified as satisfactory or unsatisfactory according to recommendations derived from an international database of over 7000 subjects[14]. Satisfactory control was defined as: mean 24-hour ABPM <133/82 mmHg, mean awake ABPM <140/88 mmHg, and mean asleep ABPM <125/76 mm/Hg. Satisfactory ABPM control was also determined from BP load—i.e. <40% of readings in excess of the above thresholds[13]. Satisfactory CBP was determined from the British Hypertension Society recommendation—i.e. pressures exceeding 160/90 mmHg require treatment[3]. McNemar's paired test of proportions was used to assess whether the two techniques gave different assessments of control[15].

RESULTS

Patient characteristics

40 hypertensive patients (21 women) agreed to take part in the study, mean age 53 years (range 33–60). All patients were on antihypertensive medication; 20 were on monotherapy, 19 taking two agents, and 1 on triple therapy. The mean duration of treatment was 9 years (range 1–32). There was no statistically significant difference in mean age, sex distribution, mean blood pressure or range of antihypertensive medication in the 31 eligible patients who did not participate in the study compared with the 40 patients who did.

Assessment of BP methods

There were no significant differences in either systolic or diastolic blood pressures between any two of the three previous CBP readings taken by the GP and BP taken on the day of the 24-hour assessment. CBP significantly overestimated ($P<0.001$) BP when compared with overall 24-hour ABPM, awake ABPM and asleep ABPM (see Table 1).

Table 1 **Mean (and standard deviation) values of clinic blood pressure (BP) and ambulatory blood pressure monitoring (ABPM)**

	Systolic BP (mmHg)	*Diastolic BP (mmHg)*
GP clinic BP 1	148 (16)	98 (7)
GP clinic BP 2	149 (18)	91 (11)
GP clinic BP 3	152 (14)	90 (7)
Study clinic BP	150 (17)	90 (9)
24-hour ABPM	131 (14)*	79 (7)*
Awake ABPM	137 (14)*	83 (7)*
Asleep ABPM	116 (17)*	70 (4)*

*Comparison with clinic BPs, $P<0.001$
GP=General practitioner

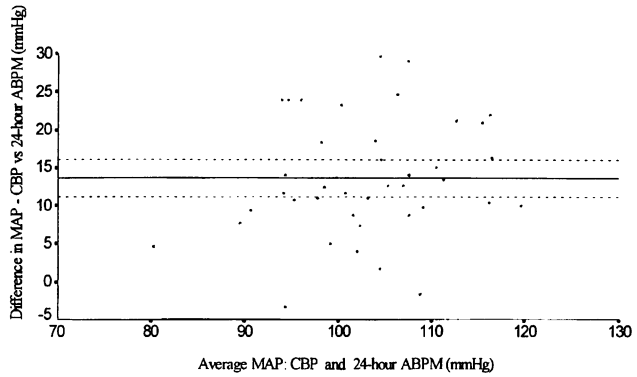

Figure 1 **Plot of difference in mean arterial pressure between CBP and 24-hour ABPM** (mean difference and 95% confidence interval shown). CBP=Clinic blood pressure; ABPM=ambulatory blood pressure monitoring; MAP=mean arterial pressure

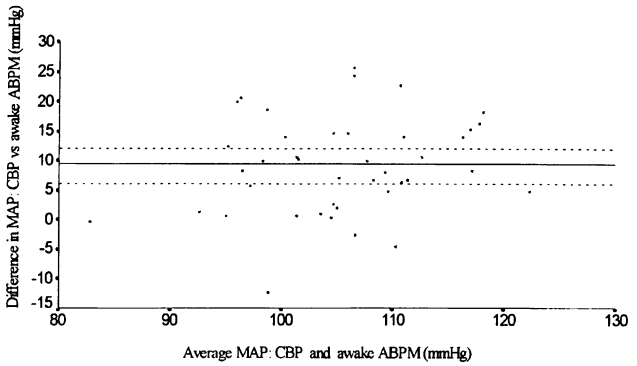

Figure 2 **Plot of difference in MAP between CBP and awake ABPM** (mean difference and 95% confidence intervals shown). See Figure 1 for key to abbreviations

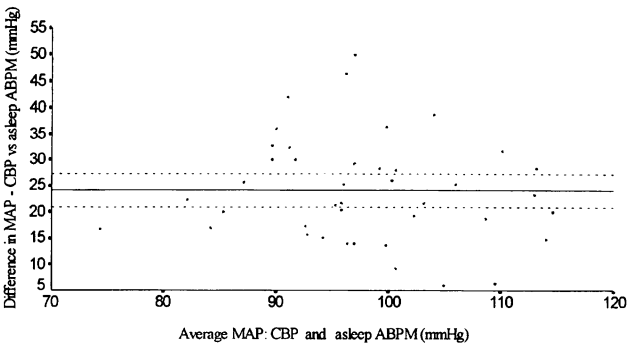

Figure 3 **Plot of difference of MAP between CBP and asleep ABPM** (mean difference and 95% confidence intervals shown). See Figure 1 for key to abbreviations

Table 2 **Blood pressure (BP) control assessed by study clinic BP and ambulatory blood pressure monitoring (ABPM)—number of patients (percentage)**

	BP control	
	Satisfactory	***Unsatisfactory***
Study clinic BP	32 (80%)	8 (20%)
Mean ABPM		
24-hour ABPM	31 (76%)	9 (22%)
Awake ABPM	37 (92%)	3 (8%)
Asleep ABPM	33 (81%)	7 (17%)
ABPM load		
24-hour ABPM	18 (45%)	22 (55%)*
Awake ABPM	32 (80%)	8 (20%)
Asleep ABPM	30 (75%)	10 (25%)

*Comparison with clinic BPs, $P<0.01$

The differences between CBP and 24-hour ABPM, awake ABPM, and asleep ABPM are shown in Figures 1, 2 and 3, respectively. ABPM, in comparison with CBP, consistently underestimated both systolic and diastolic BP. When expressed as MAP, this underestimation was consistent for 24-hour ABPM (mean 14 mmHg, 95% CI 11–16 mmHg), awake ABPM (mean 9 mmHg, 95% CI 6–12 mmHg) and asleep ABPM (mean 24 mmHg, 95% CI 21–27 mmHg).

Assessment of satisfactory BP control

The proportions of patients assessed to have satisfactory BP control as defined by CBP and ABPM are presented in Table 2.

These data indicate that there are no overall group differences between CBP and ABPM in the assessment of satisfactory control except with regard to 24-hour load. However, examination of individual data revealed 5 patients with a normal CBP who had unsatisfactory ABPM control as defined by a failure to meet at least four of the six ABPM criteria (see methods). In these cases the general practitioner was advised to alter BP management (see Table 3).

DISCUSSION

The degree to which ABPM underestimated BP pressure as recorded in the clinic is consistent with findings from previous comparisons in hypertensive patients. The precise level of ABPM at which satisfactory BP control is defined will not be fully resolved until we have the morbidity and mortality results from current prospective studies of ABPM. Here we used ABPM thresholds derived from a substantial international database[14]. In addition to the notion of ABPM threshold cut-offs, and in accordance with

Table 3 **Blood pressure (BP) management recommendations**

Patient	Mean CBP (mmHg)*	ABPM evaluation and recommendation
19	152/82	Sustained periods of raised systolic BP over 24 h. Advise general increase in antihypertensive medication
16	138/90	Sustained periods of raised systolic and diastolic BP during sleep. Suggest introduction of late evening doses of long-acting antihypertensive
7	158/85	Sustained periods of raised daytime systolic BP and no drop in sleep diastolic BP. Recommend general increase in antihypertensive medication
10	136/90	Raised systolic and diastolic BP during the day. Increase dose of antihypertensive medication on rising
17	145/90	Paroxysmal and abrupt rises in both systolic and diastolic BP over 24 hours. Referred for further investigation

Mean of three previous general practitioner clinic readings
CBP=Clinic blood pressure; ABPM=ambulatory blood pressure monitoring

the work of White and colleagues[11], we analysed ABPM values as the proportion of values in excess of these cut-offs—i.e. 'blood pressure load'. When these ABPM criteria were applied to the BP values in our study, there appeared to be good concordance in the assessment of BP control compared with CBP. The agreement is perhaps surprising in view of the large differences between absolute CBP and ABPM values. This finding emphasizes the importance of general practitioners' not interpreting absolute ABPM values without consideration of appropriate reference values.

Although overall there was no statistical difference in the assessment of BP control by CBP and ABPM, there was a small group of patients for whom there were important differences between the two methods. In 5 patients (12%) who were otherwise consistently defined as well controlled in terms of CBP, ABPM yielded clear evidence of periods of inadequate BP control. In addition 8 patients, similarly with well-controlled CBP values, had sustained periods of apparently low BPs (100/65 mmHg during sleep). The clinical relevance of these apparently low BPs during ABPM is unclear, although some of these patients reported light-headedness and fatigue consistent with drug-induced hypotension. Since current ABPM criteria consider only blood pressure values in excess of a particular threshold value (i.e. 'hypertension'), this hypotension is not reflected in Table 2. In addition to ABPM cut-offs to define hypertension, there is therefore a need for ABPM criteria that indicate hypotension.

In conclusion, we have shown that in a sizeable proportion of patients ABPM provides important information to the GP over and above that obtained by CBP. A larger study is indicated, to explore this issue in greater depth.

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