INFORMATION

Ambulatory blood pressure monitoring

Position Statement

Barry P McGrath, and on behalf of the National Blood Pressure Advisory Committee of the National Heart Foundation of Australia

Barry P McGrath, MB BS, MD, FRACP, Head.
Department of Vascular Sciences, Dandenong Hospital, David Street, Dandenong, VIC 3175.

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ABSTRACT

End-organ damage associated with hypertension is more closely related to ambulatory blood pressure (ABP) than clinic or casual blood pressure measurements.

ABP measurements give better prediction of clinical outcome than clinic or casual blood pressure measurements.

The technique of ABP monitoring (ABPM) is specialised; validated monitors and appropriate quality control measures should be used.

Interpretation of ABP profile should include mean daytime, night-time (sleep) and 24-hour measurements, and consideration of diary information and time of drug treatment. Reports may also include ABP "loads" (percentage area under the blood pressure curve above set limits) for daytime and night-time periods.

Normal blood pressure values for adults are <135/ 85 mmHg for daytime, <120/75 mmHg for night-time, and <130/80 mmHg for 24 hours.

ABPM is indicated to exclude "white coat" hypertension and has a role in assessing apparent drug-resistant hypertension, symptomatic hypotension or hypertension, in the elderly, in hypertension in pregnancy, and to assess adequacy of control in patients at high risk of cardiovascular disease.

White coat hypertension requires continued surveillance; patients who display this phenomenon may, in time, develop established hypertension.

Appropriate use of ABPM may result in cost savings.

Randomised controlled trials comparing management based on clinic or casual versus ABP measurements are needed.

The development of non-invasive ambulatory blood pressure monitoring (ABPM) devices has been a great impetus to clinical hypertension research, and ABPM is now widely used in clinical practice. This position statement examines the evidence to support the use of ABPM, and provides guidance on how and when it should be applied in practice and how to interpret an ambulatory blood pressure (ABP) profile.

Rationale for use of ABPM in clinical practice

A range of indicators have been used to examine the relationship between increased 24-hour ABP and end-organ damage. Most studies have shown that the end-organ damage associated with hypertension is more strongly correlated with ABP than with clinic blood pressure measurements. There is a stronger relationship between left ventricular hypertrophy (LVH) and 24-hour ambulatory systolic blood pressure than clinic or casual systolic blood pressure [E3][1] (see box at the end of this article for an

explanation of levels of evidence). In a study of 206 patients with essential hypertension, regression of left ventricular hypertrophy (LVH) was predicted much more closely by changes in ABP than in clinic or home blood pressure measurements [E3].[2] A pivotal study with a mean of eight years follow-up reported a progressive rise in risk of cardiovascular morbidity and mortality (stroke, myocardial infarct) with increasing levels of ABP.[3] A review of published outcome studies conducted in untreated and treated patients with hypertension in the general population concluded that there was good evidence for the clinical usefulness of ABPM for refinement of cardiovascular risk stratification [E3].[4]

Two prospective studies have reported that ABP measurements give better prediction of clinical outcomes compared with conventional clinic or office blood pressure measurements.[5,6] The first involved 1542 subjects of Ohasama, Japan, who were followed up for a mean of 6.2 years. ABP measurements better predicted mortality than did casual blood pressure measurements [E3].[5] More recently, in a study of 808 older participants (aged over 60 years) with isolated systolic hypertension followed up for a mean of 4.4 years, ambulatory systolic blood pressure was a significantly better predictor of cardiovascular events than conventional blood pressure measurement [E3].[6] Although this was a large randomised controlled study, treatment was based on office blood pressure recordings. There is a need for randomised controlled studies which compare outcomes in patients with hypertension who are treated on the basis of ABP versus casual blood pressure measurements.

Technical aspects of non-invasive ambulatory blood pressure monitoring (ABPM)

The first device for non-invasive ambulatory blood pressure monitoring was developed in 1962. It used a microphone taped over the brachial artery, an occlusive cuff inflated by the patient, and a magnetic tape recorder for recording cuff pressures, electrocardiogram and Korotkoff sounds. A modified version was used by Sokolow and colleagues in a classic study published in 1966,7 which showed that end-organ damage was related to average ABP measurements.

New measurement techniques (see Box 1) and the ability to handle large volumes of data with computer-assisted analysis have led to studies that challenge entrenched views on diagnosis, prognosis and management of hypertension. A new language has emerged, with such terms as blood pressure load, nocturnal dipping (a significant day–night difference in blood pressure of more than 10% or more than 10/5 mmHg) and non-dipping, “white-coat” (or “isolated clinic”) hypertension, “white-coat” effect, “reversed white-coat” hypertension, trough-to-peak ratio, and blood pressure variability. Health professionals now have to adjust and incorporate this new knowledge into their practice.

Practical aspects of ABPM

Current ABP monitors are generally lightweight, easy to wear, accurate, quiet, programmable and computer-interactive. Only devices validated to international standards (British Hypertension Society [BHS[8]] or the American Association for the Advancement of Medical Instrumentation [AAMI][9]) should be used. Recent reviews of validation studies have shown that about two-thirds of ABPM devices tested could be recommended, as they fulfilled the AAMI criteria for both systolic and diastolic pressure (denoted as “passed”) and received a grade of A or B under the BHS protocol for measuring both systolic and diastolic blood pressures.[10,11,12]

There are important principles for the application of ABP monitors that are often overlooked in current practice. The British guidelines[8] emphasise observer training and assessment, calibration testing and an ongoing schedule of in-use evaluation of equipment. Patients should be monitored on a normal work day, rather than a rest day, to provide a better predictor of end-organ damage. At least two concomitant sphygmomanometer readings should be recorded at the time the device is fitted; a Y-tube should be used, and average values for ABPM and mercury column readings should not differ by more than 5 mmHg. Each participant should receive verbal and written information on the monitoring procedure and a diary to record times of sleep and medication, posture, activity and symptoms. The arm should be kept immobile at the time of measurements.

Some patients find the cuff pressure intolerable, particularly those with very high blood pressure and who have frequent repeat readings. Patients need to have a mobile phone number or pager number of a nurse or technician who can give advice if there are problems or technical difficulties during the monitoring period. ABPM is uncommonly associated with any complications. Petechiae of the upper arm and sometimes bruising under the inflating cuff may occur, and sleep disturbance is fairly common.

In general, ABP may not be accurate during exercise or when driving, or when the cardiac rate is irregular, as in atrial fibrillation. There may be technical reasons why ambulatory readings fail in some patients (e.g. problems with cuff fitting in patients with conical-shaped arms, movement artefact, tremor, weak or irregular pulse, auscultatory gap). Although movement and physical activity often result in invalid readings, machines that rely on detection of Korotkoff sounds with simultaneous ECG recording to validate the signal ("gating") offer some advantages in detecting movement artifact. Most devices are programmed to take additional readings if a likely erroneous reading is recorded. A generally accepted rule is that an ABPM recording is not acceptable if fewer than 85% of readings are suitable for use in the analysis. The detection of artefactual recordings and handling of outlying values have been debated, but editing should be kept to a minimum.[10]

Studies that have looked at the day-to-day variability in ABP profiles have generally reported good reproducibility, but some have found significant variation. ABP profiles should be interpreted cautiously in relation to activity and sleep patterns.

There is no consensus on the summary measures that should be used in clinical decision making. All experienced monitoring centres report the mean values for daytime, night-time (sleep), and 24 hours. Many also report blood pressure "loads", defined as the percentage area under the blood pressure curve above set limits. This concept was first described by White in 1989, who showed that blood pressure load was a better predictor of cardiac target-organ effects than the corresponding mean ABP values.[13] A careful visual assessment of the ABP profile should also be made in relation to diary information and the timing of drug therapy.

1. Ambulatory blood pressure monitoring devices

A variety of devices are now available for ambulatory blood pressure monitoring (ABPM), and their pressure detection relies on one or more of three principles.

- *Auscultation* with detection of the onset and disappearance of Korotkoff sounds by a microphone placed over an artery distal to a deflating compression cuff.
- *Cuff oscillometry*, which relies on detection of cuff pressure oscillations. Systolic and diastolic pressures correspond to cuff pressures at which oscillations first increase (systolic) and cease to decrease (diastolic). The end-points are approximated by analysis of oscillation amplitudes and cuff pressures. Different algorithms are used by different manufacturers, creating a potential source of variability.
- *Volumetric oscillometry*, usually of a finger, with detection of volume pulsations under a cuff. Systolic and mean pressures are estimated as the cuff pressures at which finger volume oscillations commence and become maximal, respectively, while diastolic pressure is derived.

These three detection methods for ABPM incorporate techniques relying on different vascular phenomena during arterial pressure waveform transmission. Auscultatory methods depend on flow and may underestimate systolic pressure. Oscillometric methods may overestimate systolic pressure because of transmitted cuff pressure oscillations. Finger pressure has a variable relationship to brachial pressure, and there are also problems inherent in assessing diastolic blood pressure by finger oscillometry.

Day–night blood pressure differences

There is now extensive literature on day–night ambulatory blood pressure differences. Some investigators suggest night-time blood pressure is more important than daytime blood pressure in predicting outcome, particularly in individuals whose nocturnal (sleep) blood pressure remains high (i.e. less than 10% lower than the daytime average – "non-dippers").[14] In older patients with isolated systolic hypertension, the Syst-Eur study found that cardiovascular risk increased with a higher night: day ratio of systolic blood pressure (i.e. in patients more likely to be non-dippers) independent of the average 24-hour blood pressure, with a 10% increase in the ratio giving a hazards ratio for cardiovascular end-points of 1.41 (95% CI, 1.03–1.94) [E3].[6] In contrast, in the SAMPLE study, night-time ABP did not improve on the prediction of LVH regression provided by daytime ABP, suggesting that daytime ABP suffices.[2] Moreover, the Ohasama study found that mean daytime ABP is a better predictor of mortality than night-time ABP.[5] Thus, the jury is still out on the relative importance of night-time (sleep) and daytime ABP measurements. A practical problem is that it is very difficult to differentiate "non-dippers" from "non-sleepers" without monitoring brainwave activity.

Is 24-hour control of blood pressure important?

It is a widely held view that optimal BP control requires a smooth reduction in the 24-hour BP profile. In the United States, it is a Food and Drug Administration requirement that a claim for 24-hour efficacy of a drug must be substantiated with 24-hour ABPM studies. However, it has yet to be determined which particular component of the blood pressure profile (24-hour mean, daytime mean, night-time mean, ambulatory blood pressure load,

day–night difference, blood pressure variability) is the best predictor of prognosis. The blood pressure measured during a patient's workday is a good predictor of left ventricular hypertrophy, and there is supporting evidence for a carryover of high daytime ABP into the evening period in patients with "high demand, low control" types of work [E3].[15]

Application of ABPM

The importance of ABPM in managing hypertension has been acknowledged in hypertension guidelines,[16,17] and a number of authoritative bodies have now issued guidelines on the use of ABP.[10,18,19] A taskforce of participants at the 1999 Consensus Conference on ABP monitoring, sponsored by the International Society of Hypertension, suggested that:

> "ABPM should be performed only with properly validated devices as an accessory to conventional measurement of BP [blood pressure]. ABPM requires considerable investment in equipment and training and its use for screening purposes cannot be recommended. ABPM is most useful for identifying patients with white-coat hypertension (WCH), also known as isolated clinic hypertension. ABPM or equivalent methods for tracing the white-coat effect should become part of the routine diagnostic and therapeutic procedures applied to treated and untreated patients with elevated clinic blood pressures. Results of long-term outcome trials should better establish the advantage of further integrating ABPM as an accessory to conventional sphygmomanometry into the routine care of hypertensive patients and should provide more definite information on the long-term cost-effectiveness."[20]

Reasons for using ABPM are summarised in Box 2.

2: Why use ambulatory blood pressure monitoring?

- To exclude "white coat" hypertension.
- End-organ damage is more closely correlated with ambulatory blood pressure (ABP) than with clinic blood pressure readings.
- ABP may be a better predictor of cardiovascular events and mortality than clinic blood pressure readings.
- Patients with hypertension whose nocturnal (sleep) blood pressure remains high (<10% lower than daytime average) may have a worse prognosis.
- ABP provides a 24-hour profile, allowing assessment of clinic effects, drug effects, work influence, etc.

ABPM should be considered in the following scenarios:

- To exclude "white coat" hypertension in patients with newly discovered hypertension with no evidence of end-organ damage;[10,18,19]
- In patients with borderline or labile hypertension;[10,18,19]
- To assist blood pressure management in patients whose blood pressure is apparently poorly controlled, despite using appropriate antihypertensive therapy;[10,18,19]
- In patients with worsening end-organ damage, despite adequate blood pressure control on office blood pressure measurements;[10,18,19]

- To assess adequacy of blood pressure control over 24 hours in patients at particularly high risk of cardiovascular events, in whom rigorous control of blood pressure is essential (e.g. diabetes, past stroke);[10]
- In deciding on treatment for elderly patients with hypertension;[10]
- In patients with suspected syncope or orthostatic hypotension;[10,18,19]
- In patients with symptoms or evidence of episodic hypertension;[18,19] and
- In hypertension in pregnancy.[10,18,19]

The role of ABPM in monitoring antihypertensive therapy

There is fairly good evidence that antihypertensive therapy based on ABPM rather than regular office measurements may be advantageous in that the amount of medication required to achieve the target blood pressure is reduced [E3].[21] ABPM may also be a sensitive indicator of loss of BP control.[22] "White-coat" hypertension does not appear to respond to standard drug therapy, but large-scale controlled trials are needed to examine this issue.[10,23]

Normal values for ABP profiles in adults

There are large studies in normal adult populations which have provided suitable normative data for ambulatory blood pressures. Staessen and colleagues[24] collated data from an international database of 24 research groups, including one Australian centre. The database was drawn from 4577 participants with repeated normal casual blood pressure readings of less than 140/90 mmHg. In these normotensive participants, the 95th centiles for 24-hour ambulatory blood pressure were 133 mmHg systolic and 82 mmHg diastolic. Data from this large, unbiased sample of a general population showed that home and 24-hour or daytime average blood pressures were much lower than clinic blood pressures. The upper limit of "normality" for both home and ambulatory blood pressures was in the range 120–130 mmHg systolic and 78–81 mmHg diastolic, compared with the upper limits for clinic blood pressure of 140/90 mmHg. In the Italian PAMELA study, clinic, home and ambulatory blood pressure measurements were compared in 1438 adults.[25] Data from both the international database and the PAMELA study are shown in Box 3. Ohkubo and colleagues derived reference values for 24-hour ABP based on a prognostic criterion in the Ohasama study, and reported that the optimal blood pressure range predicting the best prognosis for risk of cardiovascular mortality was 120–133 mmHg for systolic ABP and 65–78 mmHg for diastolic ABP.[26]

Deciding what constitutes normal versus abnormal ABP is controversial, but commonly used values for adults are less than 135/85 mmHg during the day, less than 120/75 mmHg during the night, and less than 130/80 for 24 hours.[10,16,18,19] Normative data for children[27] and pregnant women[28] are available from smaller studies. Normal values for adults and information on interpreting an ABPM profile are shown in Box 4.

It should be emphasised that blood pressure values obtained by ABPM or home blood pressure monitoring are several mmHg lower than those obtained by clinic measurements, with a 24-hour ABP of 125/80 mmHg corresponding to a clinic reading of 140/90 mmHg.[25] The difference is even more exaggerated for systolic blood pressure in older patients with isolated systolic hypertension [E2].[29]

3: Comparisons of ambulatory, home and clinic blood pressures (mmHg, mean ± SD)

Blood pressure	International database*	PAMELA study
SYSTOLIC		
24-hour	116±10	118±11
Day	122±11	123±11
Night	106±11	108±16
Home		119±17
Clinic		128±17
DIASTOLIC		
24-hour	70±7	74±7
Day	75±8	79±8
Night	61±8	65±7
Home		75±10
Clinic		82±10

*4577 participants with repeated casual (clinic) blood pressure readings less than 140/90mmHg.
Randomised population sample of 1438 participants aged 2464 years not receiving antihypertensive therapy.

4: How to interpret ambulatory blood pressure (ABP) profile

- ABP profiles should be inspected in relation to diary information and time of drug treatment.
- Normal ABP values for adults (non-pregnant) are <135/85 mmHg during the day, <120/75 mmHg during the night, and <130/ 80 mmHg over 24 hours.
- Daytime and night-time ABP "loads"* should be <20% above normal values.
- Mean day-time and night-time (sleep) ABP measurements should differ by >10%.

* Percentage area under the blood pressure curve above set limits.

"White-coat" ("isolated clinic") hypertension

This is a condition in which blood pressure is persistently elevated in the presence of a doctor, but falls to normal values when the patient leaves the medical environment [E2].[23,30] Measurement of blood pressure by nurses or trained non-medical staff may reduce, but not necessarily abolish, this effect. The condition can only be detected by ABPM or by self-monitoring. There are no known predisposing factors such as personality type, reactivity to stress, biochemical or physiological variables. The definition has been variable in published series and there may be selection bias.[31] Initially thought to be benign, there is increasing evidence that the prognosis for patients with "white-coat" hypertension is intermediate between that of those who have normotension and those with established hypertension.[1,23,32] However, in an older Japanese population followed for an average of 42 months, among those with "white coat" hypertension (defined according to American Society of Hypertension criteria

[clinic blood pressure, >140/90 mmHg; 24 h ABP, <130/80 mmHg]) the incidence of stroke was similar to that of normotensive participants, and the risk of stroke was a quarter that for patients with sustained hypertension.[33] Further large-scale definitive outcome studies are needed. Appropriate management requires careful exclusion of end-organ damage and cardiovascular risk factor management, appropriate lifestyle changes, as well as the introduction of self-monitoring and repeat ABPM at one-year to two-year intervals, or both. Important points about "white coat" hypertension are summarised in Box 5.

The only alternative to ABPM for diagnosing "white-coat" hypertension is home or self-monitoring. However, only about a fifth of self-recording devices evaluated in recent reviews have met acceptable criteria,[11,12] so care should be exercised in choosing the home monitoring device. A recent review of self-monitoring suggests that ABPM may be better for the initial diagnosis of hypertension and for predicting prognosis, but that home blood pressure monitoring may be of more value for long term follow-up.[34] In a separate paper, the National Heart Foundation of Australia outlines the value of blood pressure self-monitoring for promoting patient understanding and improving compliance, and provides guidelines for valid self-measurement of blood pressure.[35]

The mirror image phenomenon of "reversed white-coat" hypertension — when the blood pressure reading is normal when measured in the clinic but raised on ABP — also occurs and is not an uncommon phenomenon.[5] The cause and implications of this are unknown at present.

Cost effectiveness

The evidence on cost effectiveness of ABPM is limited. Appropriate use of ABPM in selected patient groups to improve diagnosis and reduce unnecessary drug therapy may result in significant cost savings [E3].[36]

5: "White-coat" ("isolated clinic") hypertension

- Can only be detected by ambulatory blood pressure monitoring (ABPM) or self-monitoring.
- May not be benign; definitive outcome studies are needed.
- Requires continued surveillance, involving self-monitoring and repeat ABPM at 1 to 2-year intervals.
- Does not respond to standard drug therapy.

Conclusions

The rationale for the use of ABPM in clinical practice is soundly based. The technique is specialised and quality control measures have been defined for service providers. ABPM is indicated to exclude "white coat" hypertension and has a role in assessing apparent drug-resistant hypertension, the elderly, hypertension in pregnancy, during symptomatic episodes of hypotension or hypertension, and in monitoring adequacy of blood pressure control in patients at high risk of cardiovascular disease. Definitive outcome studies are needed in the form of randomised controlled trials comparing management of hypertension based on office blood pressure measurement versus ABPM.

Background and evidence basis of recommendations

This Position Statement on Ambulatory Blood Pressure Monitoring was written by Professor Barry McGrath on behalf of the National Blood Pressure Advisory Committee of the National Heart Foundation of Australia, which comprises Professor L Wing (Chair), Dr A Boyden, Professor A Dart, Associate Professor K Duggan, Professor G Hankey, Dr M Nelson, Professor I Puddey, Dr M Stowasser, and Dr J Vial. The draft Statement was circulated for comment to the above members of the committee, who have clinical and research expertise or interests in hypertension and blood pressure monitoring. All comments were incorporated into the final document, which was ratified by the Heart Foundation's Cardiovascular Health Advisory Committee. All available evidence from controlled observational studies and clinical trials was combined with clinical experience to provide recommendations according to the National Health and Medical Research Council quality-of-evidence ratings.[37]

Levels of evidence:

E1 Level I: Evidence obtained from a systematic review of all relevant randomised controlled trials.

E2 Level II: Evidence obtained from at least one properly designed randomised controlled trial.

E3 Level III: Evidence obtained from all well-designed controlled trials without randomisation, well-designed cohort or case-control analytical studies, preferably from more than one centre or research group, or from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.

E4 Level IV: Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committee.

National Health and Medical Research Council, 1995.

References

1. Verdecchia P, Clement D, Faggard R, et al. Blood Pressure Monitoring. Task force III. Target organ damage, morbidity and mortality. *Blood Press Monit* 1999; 4: 303- 317.
2. Mancia G, Zanchetti A, Agabiti-Rosei E, et al. Ambulatory blood pressure is superior to clinic blood pressure in predicting treatment-induced regression of left ventricular hypertrophy. *Circulation* 1997; 95: 1464-1470.
3. Perloff D, Sokolow M, Cowan R, et al. Prognostic value of ambulatory blood pressure measurements: further analysis. *J Hypertens* 1989; l 7: S3-S10.
4. Verdecchia P. Prognostic value of ambulatory blood pressure. Current evidence and clinical implications. *Hypertension* 2000; 35: 844-851.
5. Imai Y. Prognostic significance of ambulatory blood pressure. *Blood Press Monit* 1999; 4: 249-256.
6. Staessen J, Thijs L, Fagard R, et al. Predicting cardiovascular risk using conventional vs ambulatory blood pressure in older patients with systolic hypertension. *JAMA* 1999; 282: 539-546.
7. Sokolow M, Werdegar D, Kain H, Hinman A. Relationship between level of blood pressure measured casually and by portable recorders and severity of complications in essential hypertension. *Circulation* 1966; 34: 279-298.
8. O'Brien E, Petrie J, Littler WA, et al. The British Hypertension Society protocol for the evaluation of blood pressure measuring devices. *J Hypertens* 1993; 11: S43- S63.

9. Association for the Advancement of Medical Instrumentation. American National Standard. Electronic or automated sphygmomanometer. *ANSI/AAMI* SP 10-1992. Arlington, VA.
10. O'Brien E, Coats A, Owens P, et al. Use and interpretation of ambulatory blood pressure monitoring: recommendations of the British Hypertension Society. *BMJ* 2000; 320: 1128-1134.
11. O'Brien E, Waeber B, Parati G, et al. Blood pressure measuring devices: recommendations of the European Society of Hypertension. *BMJ* 2001; 322: 531- 536.
12. O'Brien E. State of the market for devices for blood pressure measurement. *Blood Press Monit* 2001; 6: 281-286.
13. White WB. Blood pressure load and target organ effects in patients with essential hypertension. *J Hypertens* 1991; 9: S39-S41.
14. Verdecchia P, Porcellati C, Schillaci G, et al. Ambulatory blood pressure. An independent predictor of prognosis in essential hypertension. *Hypertension* 1994; 24: 793-801.
15. Steptoe A, Cropley M, Joekes K. Job strain, blood pressure and response to uncontrollable stress. *J Hypertens* 1999; 17: 193-200.
16. Joint National Committee on Detection, Evaluation and Treatment of Hypertension. The sixth report of the Joint National Committee. *Arch Intern Med* 1997; 157: 2413- 2446.
17. Guidelines Subcommittee. World Health Organization–International Society of Hypertension guidelines for the management of hypertension. *J Hypertens* 1999; 17: 151-183.
18. Pickering T, for the American Society of Hypertension Ad-hoc Panel. Recommendations for the use of home (self) and ambulatory blood pressure monitoring. *Am J Hypertens* 1996; 9: 1-11.
19. Myers MG, Haynes RB, Rabkin SW. Canadian Hypertension Society guidelines for ambulatory blood pressure monitoring. *Am J Hypertens* 1999; 12: 1149-1157.
20. Staessen J, Beilin L, Parati G, et al. Task force IV: Clinical use of ambulatory blood pressure monitoring. *Blood Press Monit* 1999; 4: 319-331.
21. Staessen JA, Bytterbier G, Buntinx F, et al, for the Ambulatory Blood Pressure Monitoring and Treatment of Hypertension Investigators. Antihypertensive treatment based on conventional or ambulatory blood pressure measurement: a randomized controlled trial. *JAMA* 1997; 278: 1065-1072.
22. Beltman F, Hessen W, Kok R, et al. Predictive value of ambulatory blood pressure shortly after withdrawal of antihypertensive drugs in primary care patients. *BMJ* 1996; 313: 404-406.
23. McGrath BP. Is white coat hypertension innocent? *Lancet* 1997; 348: 630.
24. Staessen J, O'Brien E, Atkins N, et al. Ambulatory blood pressure in normotensive compared with hypertensive subjects. *J Hypertens* 1993; 11: 1289-1297.
25. Mancia G, Sega R, Bravi C, et al. Ambulatory blood pressure normality: results from the PAMELA study. *J Hypertens* 1995; 13: 1377-1390.
26. Ohkubo T, Imai Y, Tsuju I, et al. Reference values for 24-hour ambulatory blood pressure monitoring based on a prognostic criterion: the Ohasama Study. *Hypertens* 1998; 32: 255-259.
27. Lurbe E, Redon J, Liao Y, et al. Ambulatory blood pressure monitoring in normotensive children. *J Hypertens* 1994; 12: 1417-1423.
28. Brown MA, Robinson A, Bowyer L, et al. Ambulatory blood pressure monitoring in pregnancy: what is normal ? *Am J Obstet Gynecol* 1998; 178: 836-842.
29. Silagy C, McNeil J, Farish S, McGrath B. Comparison of repeated measures of ambulatory and clinic blood pressure readings in isolated systolic hypertension. *Clin Exp Hypertens* 1993; 15: 895-909.
30. Pickering T, James G, Boddie C, et al. How common is white coat hypertension. *JAMA* 1988; 259: 225-228.
31. Palatini P, Dorigatti F, Roman E, et al. White-coat hypertension: a selection bias? *J Hypertens* 1998; 16: 977-984.
32. Palatini P, Mormino P, Santonastaso M, et al. Target-organ damage in stage I hypertensive subjects with white coat and sustained hypertension: results from the HARVEST study. *Hypertension* 1998; 31: 57-63.
33. Kario K, Shimada K, Schwartz J, et al. Silent and clinically overt stroke in older Japanese subjects with white-coat and sustained hypertension. *J Am Coll Cardiol* 2001; 38: 238-245.
34. Herpin D, Pickering T, Sterglou G, et al. Consensus conference on self-blood pressure measurement. Clinical applications and diagnosis. *Blood Press Monit* 2000; 5: 131-135.

35. Self measurement of blood pressure —- a paper for health professionals. Melbourne: National Heart Foundation of Australia, September 1999.
36. Ewald B, Pekarsky B. Cost analysis of ambulatory blood pressure monitoring in initiating antihypertensive drug treatment in Australian general practice. *Med J Aust* 2002; 176: 580-583.
37. National Health and Medical Research Council. Guidelines for the development and implementation of clinical practice guidelines. Canberra: AGPS, 1995.

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