

Ambulatory blood pressure monitoring: the 'gold standard' for the diagnosis and management of hypertension in general practice

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ABSTRACT

Although ambulatory blood pressure measurement (ABPM) has been available for over 30 years, it has only recently been accepted as the 'gold standard' for blood pressure (BP) measurement by the national and international bodies that make recommendations for the management of hypertension in clinical practice. However, the technique is not widely used in clinical practice for various reasons, and it remains much underused as the state-of-the-art technique for BP measurement. Moreover, whereas there is international agreement that ABPM (especially daytime BP) should be used for the diagnosis of hypertension to identify white coat hypertension and masked hypertension, there is little guidance on the use of ABPM for identifying patterns of 24-hour blood pressure, such as nocturnal dipping and non-dipping, and for using the technique to initiate and monitor the efficacy of blood pressure lowering treatment. This paper will address the general use of ABPM in primary care.

Introduction

Current strategies for managing hypertension have failed to reduce BP in hypertensive patients in most countries of the world. Consequently, cardiovascular disease, for which hypertension is the main underlying cause, has been dubbed "the largest epidemic ever known to mankind"¹. Indeed, at all ages, high BP is the major driver of cardiovascular complications². The Global Burden of Diseases Study 2010 reported that high BP is the leading risk factor for ill health and causes 9.4 million deaths every year—more than half of the estimated 17 million deaths per year attributable to total cardiovascular disease^{3,4}.

A major factor contributing to this global epidemic has been the use of inaccurate and misleading methods of BP measurement that do not give an accurate assessment of BP control⁵.

There is now international acceptance that

ABPM is the method of choice for diagnosing hypertension, especially to identify white coat and masked hypertension⁶. However, recent reviews have begun to draw attention to the role of ABPM in monitoring the efficacy of management strategies and drug treatment in patients with hypertension^{7,8,9}. This wider application of ABPM in clinical practice, apart from having the advantage of improving the management of hypertensive patients, provides primary care physicians with a novel means of monitoring the efficacy of treatment strategies in practice. We are faced, therefore, with a responsibility to use ABPM to achieve the maximum benefit, without applying the technique excessively.

Use of ABPM for the diagnosis of hypertension

The North American^{11,12}, European^{6,13} Japanese¹⁴ and Chinese¹⁵ bodies responsible for international

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and national guidelines, having carefully examined the evidence as to which method of BP measurement is best –office, home or ABPM– have unanimously recommended ABPM as the state-of-the-art technology for BP measurement. To add to this weight of international scientific opinion, the recently published American College of Cardiology and the American Heart Association (ACC/AHA) Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults, has endorsed the use of ABPM in hypertension management, while recognizing that there will be difficulty implementing its use in clinical practice¹⁶. The recommendations from these bodies are based on sound scientific evidence showing that ABPM is most accurate and cost effective method of BP measurement and each has concluded that ABPM (or home measurement if ABPM is declined or not tolerated) should be performed in anyone who has had an elevated BP measurement $\geq 140/90$ mmHg recorded by any method of measurement. The rationale behind this recommendation is basically, to confirm that the elevation of blood pressure noted on the out-of-office measurement is sustained and not due to a white coat reaction, as may occur in some 25% of subjects¹⁷. Therefore, for the diagnosis of hypertension, anyone with a raised BP by any method of measurement – casual, office, home, clinic, pharmacy, or kiosk – should be offered ABPM to confirm hypertension or to identify white coat hypertension, and (with the exception of markedly elevated office BP) treatment should only be prescribed on the basis of an ABPM.

The next diagnostic problem is identifying patients with masked hypertension (i.e. a normal office BP with a raised ABPM) who may be at high risk. Clearly it is not possible to perform ABPM in the entire population, and, in practice, I look for masked hypertension by performing ABPM in patients with normal office BP who have had a previous cardiovascular event (any evidence of cerebrovascular, coronary, vascular, or renovascular disease), patients with concomitant disease (diabetes, metabolic syndrome), and patients with a bad family history of hypertension or cardiovascular disease.

Use of ABPM for detecting patterns of hypertension

BP is a manifestation of a haemodynamic state that varies, often greatly, from moment to moment, and although this variability is subject to many environmental and neuro-humoral influences, certain patterns of behaviour can be discerned that are important in the management of hypertension. There has been a tendency for international guidelines to concentrate on ABPM daytime pressures. However, recently the association of night-time hypertension with the cardiovascular consequences of hypertension, such as stroke, has focussed the scientific literature on nocturnal hypertensive patterns, such as isolated nocturnal hypertension, and a non-dipping pattern of BP^{7,8,9,18,19,20}. On-going research may show that night-time BP is the most sensitive of all BP measurements, but, at present, it is important to be aware that there may be causes for nocturnal hypertension, such as sleep apnoea⁶, and the increased risk of stroke with elevated nocturnal BP, makes it important to assess the response to BP lowering medication during sleep.

Other patterns of hypertension deserving of consideration include the white coat response (often seen in the first hour of an ABPM recording), isolated systolic hypertension (common in the elderly), post-prandial hypotension (again common in the elderly), and drug-induced hypotension.

ABPM to determine efficacy of treatment

We now move into uncharted waters as none of the guidelines make definitive recommendations as to how to use ABPM to initiate and assess the response to antihypertensive drug treatment despite evidence that ABPM can be extremely helpful in this regard. The largest study to date on the use of ABPM to guide treatment in primary care comes from Spain, where a nationwide project to promote the use of ABPM in primary care settings was established a decade ago⁹. This study showed that ABPM identified the patients for whom medication was needed and resulted in an overall reduction in the number of patients treated for hypertension. The conclusion was that ABPM can save much money and the extra costs of providing the technique were more than offset by cost savings from better targeted treatment¹⁰.

Let us now consider the therapeutic possibilities as shown in Figure 1 and summarised in Figure 2.

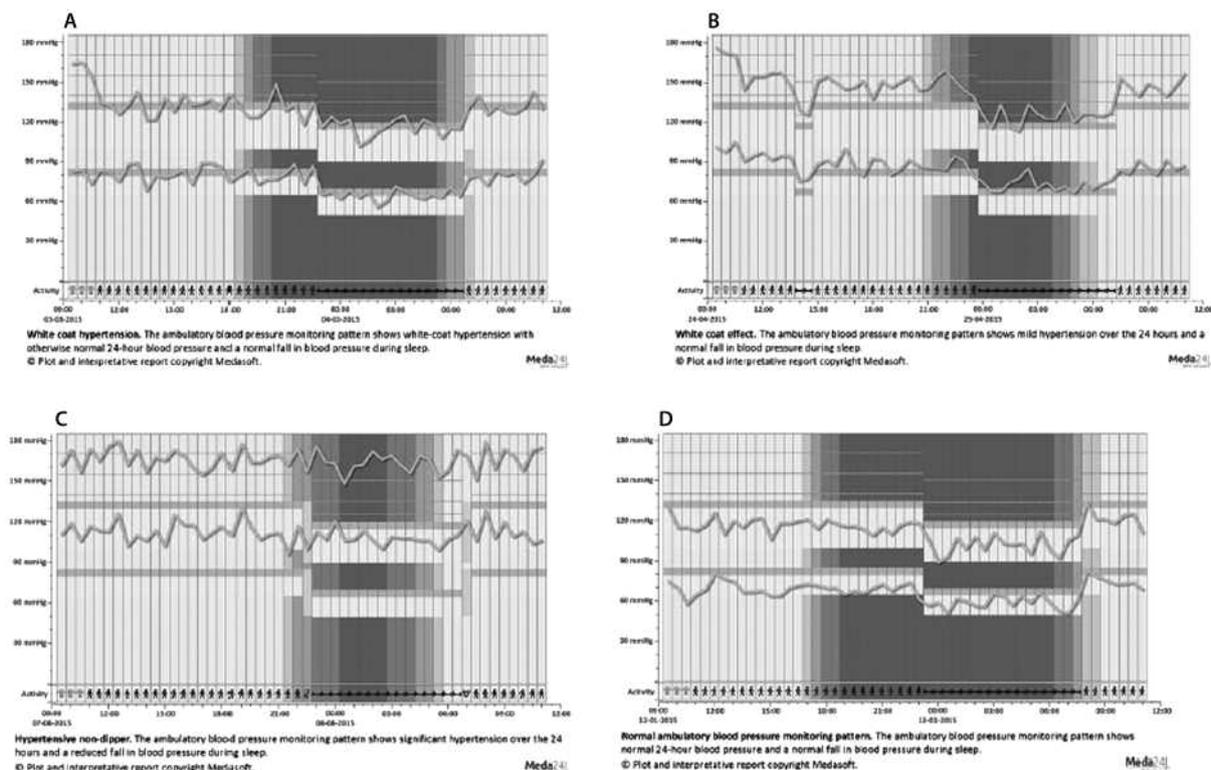


Figure 1. (A) White-coat hypertension: The ambulatory blood pressure (BP) monitoring pattern shows white-coat hypertension with otherwise normal 24-hour BP and a normal fall in BP during sleep. (B) White-coat effect: The ambulatory BP monitoring pattern shows mild hypertension over 24 hours and a normal fall in BP during sleep. (C) Hypertensive nondipping pattern: The ambulatory BP monitoring pattern shows significant hypertension over 24 hours and a reduced fall in BP during sleep. (D) Normal ambulatory BP monitoring pattern: The ambulatory BP monitoring pattern shows normal 24-hour BP and a normal fall in BP during sleep.

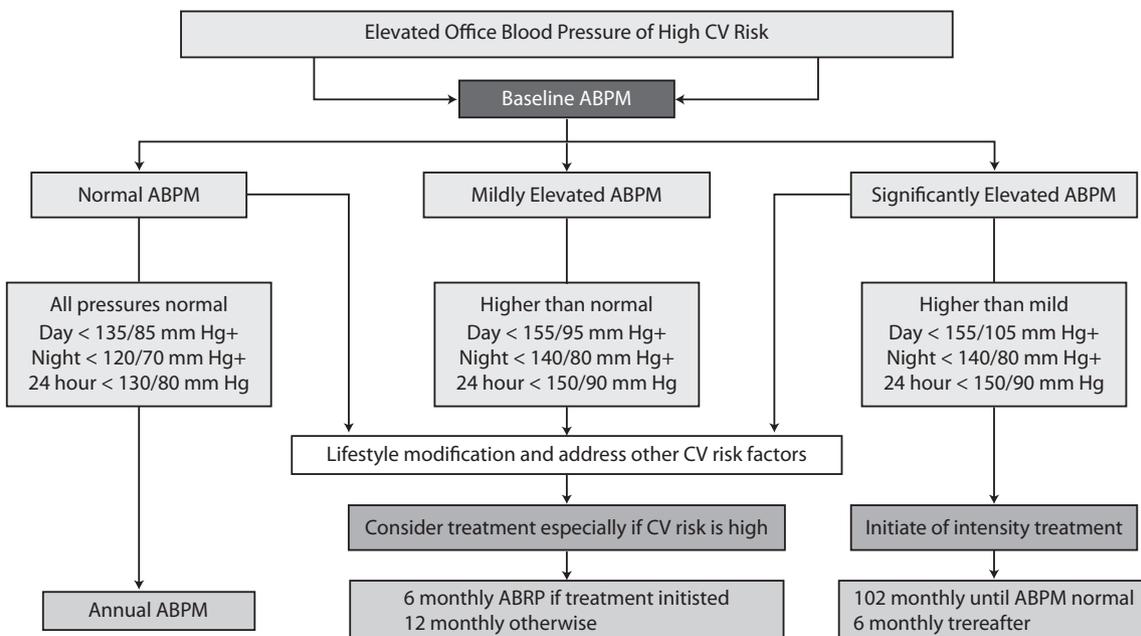


Figure 2. Flow-chart for the use of ABPM in primary care. CV = cardiovascular.

- *Patient with high OBPM and normal ABPM profile* (Fig 1.a.): This patient has white coat hypertension, which may not be a totally benign phenomenon and which may in time progress to sustained hypertension that will require treatment. It is appropriate, therefore, to repeat an ABPM at yearly intervals, which, in practice, will amount to about 25% of patients with an elevated OBPM¹⁰.
- *Patient with high OBPM and mildly elevated ABPM profile* (Fig 1.b): The decision here might be to try life-style modification if the patient is younger than 50 years, and if the overall cardiovascular (CV) risk is low and in such a case ABPM should be repeated in a year; if, on the other hand the CV risk is high (e.g. evidence of target organ damage, previous cardiovascular event, bad family history, obesity, unhealthy life-style, or co-morbidities, such as diabetes) treatment should be initiated with a repeat ABPM in 6 months to assess 24-hour BP control¹⁰.
- *Patient with high OBPM and significantly elevated ABPM profile* (Fig 1.c.): In such a case treatment is clearly indicated and if treatment is already prescribed this should be intensified and consideration given to exclusion of secondary hypertension or non-compliance with therapy. In either event, ABPM should be repeated in one to two months until a normal 24-hour profile is achieved, and if there is a poor response to treatment, referral for further evaluation should be considered. Once 24-hour BP control is obtained (Fig 1.d), it would be reasonable to repeat ABPM every 6 months to ensure optimal 24-hour BP control. Based on Irish data, which should be similar in other countries this level of hypertension on ABPM might be anticipated in only about 13% of patients¹⁰, but in these patients, who are at the highest risk of having a cardiovascular event, such as a stroke, repeated ABPMs are justified to ensure that effective BP control over the 24-hour period is achieved as soon as possible.
- *Excessive BP lowering*: There is another aspect of treatment that merits consideration, namely, excessive lowering of BP, especially nocturnal pressure. Recent evidence suggests that, on the one hand, excessive elevation of nocturnal BP carries an adverse cardiovascular risk, but that, on the other, a group of patients may be adversely affected by excessive lowering of nocturnal BP. In these patients, the vasculature to the heart,

and/or brain, may be compromised by atherosclerotic disease that leaves the patient dependent on a critical level of BP to maintain adequate perfusion. It is important, therefore, to use ABPM to prevent excessive BP lowering with medication, especially at night.

Home blood pressure measurement (HBPM) to assess efficacy of treatment

Self-taken HBPM by patients is recommended as an alternative to ABPM if the latter is not available. However, in substituting HBPM for ABPM it must be emphasised that to obtain a HBPM equivalent to mean daytime ABPM, it is necessary to obtain the mean of 7 days HBPM measurements (duplicate readings twice per day) after discarding the measurements from the first day⁶. This is regarded by many patients (and doctors) as being more onerous than performing ABPM, which, in addition, provides nocturnal BP measurements, which, are increasingly important in assessing BP control.

Conclusion

I have outlined the value of the many applications of ABPM in clinical practice in the hope that primary care physicians will see the technique as having much greater value than merely using ABPM to confirm the diagnosis of hypertension. Although the international guideline recommendations clearly stipulate the diagnostic indication for ABPM (any person who has previously had a BP measurement $\geq 140/90$ mmHg), there are no clear recommendations for the use of ABPM to guide BP lowering therapy. I have made recommendations as to how ABPM might be used to initiate treatment and to assess the efficacy of blood pressure lowering therapy over time. In doing so, I recognise that there will be initially be a high cost, but this should be more than offset by improved BP control and the reduction of cardiovascular consequences of hypertension. However, to achieve this consideration should now be given to the central storage of ABPM data so as to provide national registries of hypertension.

The increasing approval of ABPM for reimbursement in many countries is an overdue and welcome initiative⁷, which although incurring substantial initial short-term costs, will lead to much improved blood pressure control in the longer-term, and substantial savings in the prevention of the cardiovascular con-

sequences of hypertension, most especially the prevention of stroke.

REFERENCES

1. Yusuf S, Wood D, Ralston J, Reddy KS. The World Heart Federation's vision for worldwide cardiovascular disease prevention. *Lancet* 2015; 386: 399-402.
2. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R. Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet* 2002; 360: 1903-1913.
3. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* 2012; 380: 2224-2260.
4. Murray CJ, Ezzati M, Flaxman AD, et al. GBD 2010: design, definitions, and metrics. *Lancet* 2012; 380: 2063-2066.
5. O'Brien E, Stergiou GS. The pursuit of accurate blood pressure measurement: A 35-year Travail. *J Clin Hypertens (Greenwich)*. 2017; *J Clin Hypertens (Greenwich)* 2017; 19: 746-752.
6. O'Brien E, Parati G, Stergiou G, et al. European Society of Hypertension Working Group on Blood Pressure Monitoring. European Society of Hypertension position paper on ambulatory blood pressure monitoring. *J Hypertens* 2013; 31: 1731-1768.
7. Staessen JA, Li Y, Hara A, Asayama K, Dolan E, O'Brien E. Blood Pressure Measurement Anno 2016. *Am J Hypertens* 2017; 30: 453-463.
8. Dolan E, O'Brien E. How should ambulatory blood pressure measurement be used in general practice? *J Clin Hypertens (Greenwich)*. 2017; 19: 218-220.
9. Banegas JR, et al. Impact of ambulatory blood pressure monitoring on reclassification of hypertension prevalence and control in older people in Spain. *J Clin Hypertens* 2015; 17: 453-461.
10. O'Brien E, Dolan E. Ambulatory Blood Pressure Monitoring for the effective management of Antihypertensive Drug Treatment. *Clin Therapeutics* 2016; 38: 2142-2151.
11. Siu AL. U.S. Preventive Services Task Force. Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med* 2015; 163: 778-786.
12. Leung AA, Nerenberg K, Daskalopoulou SS, et al. CHEP Guidelines Task Force. Hypertension Canada's 2016 Canadian Hypertension Education Program Guidelines for Blood Pressure Measurement, Diagnosis, Assessment of Risk, Prevention, and Treatment of Hypertension. *Can J Cardiol* 2016; 32: 569-588.
13. National Institute for Health and Clinical Excellence (NICE). The clinical management of primary hypertension in adults. National Institute for Health and Clinical Excellence: London, UK, 2011.
14. Shimamoto K, Ando K, Fujita T, et al. Japanese Society of Hypertension Committee for Guidelines for the Management of Hypertension. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2014). *Hypertens Res.* 2014; 37: 253-390.
15. Liu LS, Writing Group of 2010 Chinese Guidelines for the Management of Hypertension. 2010 Chinese guidelines for the management of hypertension (in Chinese). *Chin J Hypertens* 2011; 19: 701-742.
16. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines [published online November 13, 2017]. *Hypertension*. doi:10.1161/HYP.0000000000000065
17. Pickering TG, et al. How common is white coat hypertension? *JAMA*. 1988; 259: 225-228.
18. Salles GF, Reboldi G, Fagard RH, et al. Prognostic Effect of the Nocturnal Blood Pressure Fall in Hypertensive Patients: The Ambulatory Blood Pressure Collaboration in Patients With Hypertension (ABC-H) Meta-Analysis. *Hypertension* 2016; 67: 693-700.
19. Kollias A, Ntineri A, Stergiou GS. Association of night-time home blood pressure with night-time ambulatory blood pressure and target organ damage: a systematic review and meta-analysis. *J Hypertens* 2017; 35: 442-452.
20. Cuspidi C, Facchetti R, Bombelli M, Sala C, Tadic M, Grassi G, Mancia G. Is night-time hypertension worse than daytime hypertension? A study on cardiac damage in a general population: the PAMELA study. *J Hypertens* 2017; 35: 506-512.