Blood pressure measurement: why, how, when, and where?

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Keywords: ambulatory blood pressure measurement, clinic or office blood pressure measurement, self-blood pressure measurement

 S Afr Fam Pract 2012;54(2)(Suppl 1):S9-S11

Introduction

With the publication of the recommendations of the National Institute for Health and Clinical Excellence (NICE), ambulatory blood pressure measurement (ABPM) must be seen as an indispensible investigation for good clinical practice. The technique provides a means of achieving blood pressure (BP) control in clinical practice, which is essential if the epidemic of the cardiovascular consequences of hypertension is to be halted. However, if ABPM is to be implemented for these purposes, certain requirements need to be fulfilled. These include the availability of accurate, patient-friendly and inexpensive devices, standardisation of the presentation and plotting of data with summary statistics for day-to-day practice, provision of comprehensive data analysis for research, an interpretative report to facilitate use in busy clinical practice, a trend report to demonstrate efficacy or otherwise of treatment in clinical practice, and online transmission of data to provide immediate real-time data analysis.

Out-of-office measurement

Traditionally, BP has been assessed, and continues to be measured, with the auscultatory technique introduced into clinical medicine at the end of the 19th century. Despite being inaccurate and misleading, this technique has survived, largely unchanged, for over 100 years. Quite apart from the inaccuracy of the auscultatory technique, one of its major limitations is that it can only provide a "snapshot" of BP behavior, usually under circumstances that may adversely affect the level of BP.[1] To overcome these serious methodological shortcomings, out-of-office techniques for obtaining BP measurements away from the medical environment have been developed. It is generally accepted that traditional clinic or office BP measurement (OBPM) is limited in the amount of information that it can provide for the adequate management of hypertension, and that contemporary practice must turn to out-of-office measurement to obtain additional information to guide the diagnosis and management of hypertension. The available methods for out-of-office measurement are ABPM and self-BP measurement (SBPM).

There can be little argument about ABPM and SBPM being superior to OBPM, if for no other reason than they are free of the white-coat reaction that gives OBPM levels considerably higher than those measured away from the medical environment in as many as 20% of individuals with suspected hypertension, and in most patients with hypertension. However, there has been debate, as to whether SBPM or ABPM is the preferred out-of-office measurement. Rather than arguing for one technique over the other, both techniques, as with OBPM, give differing information about BP behaviour that may assist in understanding and managing hypertension.

It is often wrongly assumed that SBPM can provide an assessment of a patient's true BP approximating to daytime ABPM, whereas the reality is that to obtain a BP profile that equates to ABPM, it is necessary to adhere to a comprehensive schedule of SBPM, requiring the patient to perform SBPM over several days. Although there have been calls to limit the number of SBPM readings in clinical practice, there is general support for the recommendation of the European Society of Hypertension Working Party on Blood Pressure Monitoring for daily duplicate morning and evening SBPM measurements for seven days, with the first-day readings being discarded, and the remaining measurements averaged.[2] From the convenience viewpoint, the two methodologies for providing out-of-office BP make distinctly different demands on the patient. To obtain meaningful SBPM, the patient must be prepared to make multiple measurements over seven days, whereas with ABPM, the patient is required to have multiple measurements over one day, with the added advantage of the nocturnal BP being available for analysis. Another fundamental difference between SBPM and ABPM is that the physician must trust patient compliance to the SBPM regimen, whereas with ABPM, the physician controls the procedure, and the 50 or so BP measurements obtained over the 24-hour period are recorded and stored. Importantly, ABPM provides a wealth of information that cannot be derived from SBPM, and although much of these data may only be required for research, the provision of daytime and nighttime BP with ABPM is generally considered to make ABPM indispensable to good clinical practice.[1]

Advantages of ambulatory BP measurement

The advantages of ABPM have influenced recommendations for the technique to be a mandatory investigation in clinical practice. These advantages may be briefly summarised as follows. First and foremost, ABPM simply gives more measurements than conventional BP measurement, and real BP is reflected more accurately by repeated measurements. ABPM provides a profile of BP away from the medical environment. This allows identification of individuals with a white-coat response or masked hypertension; many of the former with white-coat hypertension would have been prescribed BP-lowering drugs on the basis that conventional measurement may not require medication, whereas the latter are in need of efficacious 24-hour BP control. By showing BP behaviour in the window of a 24-hour period, such as the white-coat and nocturnal periods, it is possible to assess the efficacy of antihypertensive medication throughout the day and night, rather than relying on a casual BP, measured with an inaccurate technique under artificial circumstances. The demonstration of the 24-hour effect of BP-lowering drugs has implications for both clinical practice and pharmacological research. ABPM can demonstrate a number of patterns of BP behavior that may be relevant to clinical practice, such as nocturnal hypertension (Figures 1 and 2). ABPM is a much stronger predictor of cardiovascular (CV) morbidity and mortality than conventional measurement, and evidence is growing that nocturnal BP measured by ABPM may be the most sensitive predictor of CV outcome, from which it follows that the measurement of nighttime BP should be an important part of clinical practice.[2] Importantly, ABPM provides a means of improving the diagnosis and management of hypertension, and also for ensuring that effective control of hypertension is implemented at community level.[1-3]

The indications for ABPM are shown in Table I.

Over the years, there has been much discussion on the cost-effectiveness of ABPM, but the recent NICE recommendations have shown beyond doubt that ABPM is more cost-effective than other measurement techniques, including SBPM.[4]

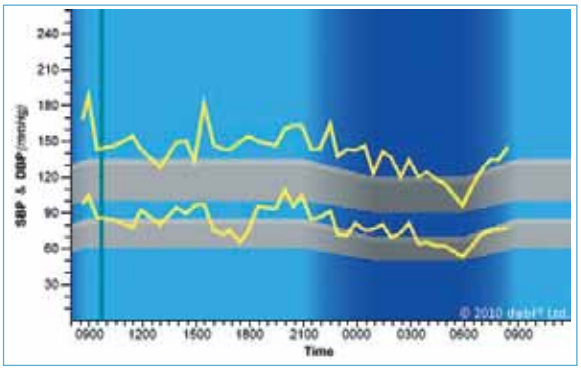

Figure 1: White-coat effect. The ambulatory blood pressure measurement shows mild daytime systolic hypertension (150 mmHg), borderline daytime diastolic hypertension (87 mmHg), borderline nighttime systolic hypertension (123 mmHg), and normal nighttime diastolic blood pressure (68 mmHg), with a white-coat effect (187 mmHg/104 mmHg). Normal dipping pattern. Source: Plots and reports generated by dabl®ABPM© dabl 2010 (www.dabl.ie)

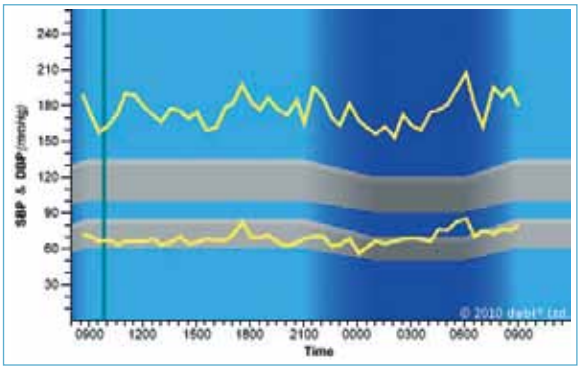

Figure 2: Isolated systolic hypertension. The ambulatory blood pressure measurement shows severe daytime isolated systolic hypertension (176 mmHg/68 mmHg), severe nighttime systolic hypertension (169 mmHg), and borderline nighttime masked diastolic hypertension (70 mmHg). Non-dipping pattern. Source: Plots and reports generated by dabl®ABPM© dabl 2010 (www.dabl.ie)

Table I: The indications for ambulatory BP measurement

Confirmation of diagnosis of hypertension
Suspected white-coat hypertension
White-coat effect
Masked hypertension
Resistant hypertension
Hypertension in children and adolescents
Hypertension in the elderly
Hypertension in pregnancy
Suspected sleep apnoea
Hypertension in diabetes
High cardiovascular risk
Evaluation of hypotension
Assessing efficacy of treatment over 24 hours
Increased blood pressure variability
Suspected nocturnal hypertension
Parkinson's disease and other neurological disorders

Requirements for ambulatory BP measurement

Ambulatory BP measurement devices

ABPM devices differ from other automated devices on the market, for example, devices for SBPM, in that virtually all have been subjected to independent validation. Most of these are accurate, although this often depends on the circumstances pertaining to use.[2] It is important for physicians and patients who are using ABPM to ensure that the device being used has been recommended for clinical use by checking the website http://www.dableducational.org, which provides the latest accuracy data on all BP-measuring devices.

Ambulatory BP measurement software

Whereas the current generation of devices for ABPM, the hardware, is generally acceptable to patients, the same cannot be said for the software accompanying

ABPM devices. In other words, the patient, as one category of user, may be reasonably served by the ABPM devices on offer. However, the physician, who has to make sense of the considerable data provided by ABPM, is often faced with a bewildering report, with reams of paper containing plots, histograms and data analysis that has no relevance to clinical practice. Much more information may be gleaned from the 24-hour BP cycle.[1,2] Therefore, it has been necessary to direct attention to designing software that can provide the basic information in a user-friendly format for clinical practice, while being able to store and retrieve the data required for the sophisticated needs of clinical research.

The dabl® ABPM system has been developed to fulfill these requirements. Its features may be summarised as follows:

Clinical report

The report for clinical use has been designed to be comprehensive and concise, so that all the data are easily read on one page with a standardised plot format with BP levels on the vertical axis, and time of day on the horizontal axis. Windows of the 24-hour period and normal bands are clearly demarcated. It includes a plot of systolic and diastolic BP throughout the 24-hour period, with a facility to plot heart rate and mean BP. Summary statistics for systolic and diastolic BP and heart rate in the windows of the 24-hour period are a feature; as is an interpretative report, indicating the normal or abnormal patterns. Information is provided as to whether or not the required measurements for a valid recording have been met. The clinical report includes medication details too, and has a facility that shows error readings, if required.

Interpretative report

The interpretative report, which has been validated by expert observers, has a number of other advantages. It serves as an educational process for users of ABPM who are not familiar with the technique. It can be provided to patients, so as to allow for their participation in management, and it removes the need for a physician report, with consequent financial savings (Figures 1 and 2).

Circadian patterns of ambulatory BP measurement

In clinical practice, there is a tendency to concentrate on the mean day- and nighttime BP levels without giving consideration to the information that can be obtained from studying and interpreting the circadian patterns that can add greatly to the clinical management of hypertension. The common patterns of ABPM include white-coat hypertension, white-coat effect, systo-diastolic hypertension, isolated systolic hypertension, isolated diastolic hypertension, nocturnal dipping and non-dipping, reverse dipping, extreme dipping, siesta dipping, isolated nocturnal hypertension, the morning surge, masked hypertension and ambulatory hypotension.[1,2]

Trend report

The provision of a trend report allows ABPMs to be compared over time, and clearly demonstrates the efficacy, or otherwise, of treatment strategies. If ABPM is to be used to achieve better BP control, it is essential for prescribing doctors and patients to be able to see whether medication is achieving control throughout the day- and nighttime periods.

Research report

The dabl® system allows for the storage of data for detailed analysis for research and audit. This is achieved according to evidence-based definitions for time-weighted arithmetic and mean values for measures of BP level. Recent evidence has shown that BP variability may give information over and above BP mean levels, and that reduction in BP variability may be beneficial. Time-weighted measures of variability, such as standard deviations and coefficient of variation, and measures of white-coat hypertension, white-coat effect, nocturnal dip and morning surge are also provided. The dabl® system also provides informative indices associated with outcome, such as the ambulatory arterial stiffness index, which has been shown to predict cardiovascular mortality, particularly from stroke.

Central hosting and electronic transfer of data

If ABPM is to realise its full potential, it is essential that the generated data generated can be transmitted electronically for central hosting, so as to be able to provide real-time data to system users. National ABPM registries are being established, which allow for accurate demographic categorisation of BP characteristics, so that intervention strategies to achieve BP control and prevent the CV consequences of hypertension can be initiated.[3]

Conflict of interest

The author is a shareholder and a member of the board of dabl®, Dublin, Ireland.

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