

Striving for accuracy in blood pressure measurement in the clinical setting

All measuring devices which depend on a cuff and bladder are prone to inaccuracy, writes **Prof Eoin O'Brien**

Recently, the European Society of Hypertension published a summary version of its full guidelines for the measurement of blood pressure. The document, which has important relevance for clinical practice, is summarised here.

Blood pressure measurement is the basis for the diagnosis, management, treatment, epidemiology and research of hypertension, and the decisions affecting these aspects of hypertension will be influenced, for better or worse, by the accuracy of measurement. An accurate blood pressure reading is a prerequisite, therefore, regardless of which technique is used, yet all too often the accuracy of measurement is taken for granted or ignored.

Aspects of blood pressure measurement common to all techniques:

Selecting an accurate device: An accurate device is fundamental to all blood pressure measurement techniques. All devices used for blood pressure measurement should be subjected to independent evaluation according to one of the recognised protocols. Details of devices and their validation status can be obtained on <www.dableducational.org>, a website devoted to blood pressure measurement.

Variability of blood pressure: No matter which measurement device is used, blood pressure will always be a variable haemodynamic phenomenon that is influenced by many factors. These include the circumstances of measurement itself, emotion, exercise, meals, tobacco, alcohol, temperature, respiration, bladder distension, and pain. Blood pressure is also influenced by age, race and diurnal variation, usually being lowest during sleep.

White-coat hypertension (isolated clinic hypertension): White-coat hypertension is a condition in which an individual is hypertensive during repeated CBPM, but pressures measured outside the medical environment by ABPM or SBPM techniques are normal.

White-coat effect: This is the term used to describe the phenomenon found in many hypertensive patients whereby CBPM is usually greater than the blood pressure values obtained outside the clinic environment with ABPM or SBPM, the levels of which are nonetheless increased above normal.

Masked hypertension (isolated ambulatory hypertension): This

phenomenon refers to patients in whom CBPM is normal but ABPM or SBPM is increased; in other words, hypertension is hidden until ABPM or SBPM is performed.

The procedure:

Explanation to the patient: The first step in blood pressure measurement is adequate explanation of the procedure in an attempt to allay fear and anxiety, especially in nervous individuals. The patient should be relaxed and the observer unhurried.

Posture of subject: Blood pressure should be measured with the individual sitting with back support, legs uncrossed and the arm supported at heart level. Some patients may exhibit postural hypotension, especially with certain antihypertensive drugs. When this is likely, blood pressure should be measured with the patient standing.

Which arm? Bilateral measurement should be made on first consultation and, if persistent differences greater than 20 mmHg for systolic or 10 mmHg for diastolic pressure are present on consecutive readings, the patient should be referred to a cardiovascular centre for further evaluation.

The cuff and bladder: However sophisticated a blood pressure measuring device may be, if it is dependent on cuff occlusion of the arm (as are the majority of devices), it will then be prone to the inaccuracy induced by mis-cuffing, whereby a cuff containing a bladder that is either too long or too short relative to arm circumference.

Factors common to the patient: Certain groups of people merit special consideration for blood pressure measurement. These include children, the elderly, obese people, patients with arrhythmias, and pregnant women.

Clinical (conventional/office) sphygmomanometry - basic requirements for auscultatory blood pressure measurement:

Basic requirements for auscultatory blood pressure measurement: The accurate measurement of blood pressure in clinical practice by the century-old technique of Riva Rocci/Korotkoff is dependent on the individual, the equipment used and the observer. Errors in measurement can occur at each of these points of interaction of the technique, but by far the most fallible component is the observer.

Mercury and aneroid sphygmomanometers: The mercury sphyg-

momonometer is a reliable device, but all too often its continuing efficiency has been taken for granted, whereas the aneroid manometer is not generally as accurate. Users should be aware of the hazards of mercury, which may soon be banned from use in clinical medicine. Aneroid sphygmomanometers register pressure through a bellows and lever system, which may become inaccurate with everyday use, usually

leading to false low readings with the consequent underestimation of blood pressure. A stethoscope should be of a high quality, with clean, well-fitting earpieces.

Automated devices as alternatives to the mercury sphygmomanometer: An accurate automated sphygmomanometer capable of providing printouts of systolic and diastolic blood pressure, together with heart rate and the time and date of measure-

ment, should eliminate errors of interpretation and abolish observer bias and terminal digit preference.

Performing auscultatory measurement:

• The observer should ensure that the manometer is no more than 1m away, that the mercury column is vertical, that the bladder dimensions are accurate, and that, if the bladder does not com-

pletely encircle the arm, its centre is over the brachial artery.

• The stethoscope should be placed gently over the brachial artery at the point of maximal pulsation.

• The cuff should then be inflated rapidly to about 30mmHg above the palpated systolic pressure and deflated at a rate of 2-3mmHg per pulse beat (or per second), during which the Korotkoff sounds will be heard.

• Systolic blood pressure is the first appearance of faint, repetitive, clear tapping sounds that gradually increase in intensity.

Ambulatory blood pressure measurement:

Advantages of ambulatory blood pressure measurement: ABPM has a number of advantages over other methods of measurement: it provides a profile of blood pressure away from the medical environment, thereby allowing identification of individuals with a white-coat response; it shows blood pressure behaviour over a 24-hour period during usual daily

activities, rather than when the individual is sitting in the artificial circumstances of a clinic or office; it can indicate the duration of decreased blood pressure over a 24-hour period; it can identify patients with blunted or absent blood pressure reduction at night – the non-dippers – who are at greater risk for organ damage and cardiovascular morbidity; it can demonstrate a number of patterns of blood pressure behaviour

that may be relevant to clinical management, such as white-coat hypertension, isolated systolic hypertension, masked hypertension, hypotension, and enhanced blood pressure variability. In long-term outcome studies, ABPM has been shown to be a stronger predictor of cardiovascular morbidity and mortality than is CBPM.

Choosing an ambulatory blood pressure monitoring device: The website <www.dableducation

[al.org](http://www.dableducation.org)> provides up-to-date information on ABPM devices.

Defining daytime and nighttime periods: The software dabl@ABPM program provides a standardised evidence-based method for recording 24-hour ABPM without the user having to become concerned with editing procedures.

Definition of normality:

Normal ranges for ABPM are average daytime ABPM of less than 135/85mmHg and average nighttime ABPM less than 120/70mmHg, but even lower values are advocated, particularly in high-risk groups such as diabetic patients. Normal ranges in pregnancy are also available.

Who should be re-monitored?

In individuals with increased CBPM and normal ABPM – that is, white-coat hypertension – it is advisable to confirm the diagnosis by repeating ABPM within three-to-six months. In individuals with confirmed white-coat hypertension and a normal risk-factor profile, ABPM should be repeated annually, or every two years if the pattern appears to be established and consistent, as is often the case. SBPM may be combined with ABPM to reduce the frequency of ABPM.

Self measurement:

Self blood pressure measurement is popular among patients, as indicated by the huge sales of devices. Although there is a revival of interest in this old methodology, based on evidence suggesting that the regular use of SBPM under medical guidance may help to achieve better control of blood pressure, there is a need for further research to determine the precise role of SBPM in practice.

Devices and validation:

The types of monitor available for SBPM include mercury column sphygmomanometers and aneroid manometers, but electronic devices using oscillometry are becoming more popular and are replacing the auscultatory technique. These devices require less training and are more suitable for patients with infirmities such as arthritis and deafness. Devices that measure blood pressure at the finger are not recommended, because of the inaccuracies arising from distortion of measurements as a result of peripheral vasoconstriction, alterations in blood pressure at more distal sites of recording, and the effect of limb position on blood pressure. Devices that

measure blood pressure at the wrist are subject to the latter two problems and, although they are more accurate than finger measuring devices, there are strong reservations about the correct use of these devices. If the wrist is not held at heart level during measurement, inaccurate measurements will be obtained, and measurement is also influenced by flexion and hyperextension of the wrist. A major advantage of automated devices is a capability to store measurements, to provide hard copy of measurements and to transmit measurements electronically or telephonically.

User procedure:

The recommendations for SBPM do not vary in principle from those that apply for blood pressure measurement in general, but there are some points in need of emphasis. The procedure should be performed under medical supervision; a period of rest should precede each measurement; brachial artery occluding devices are preferred to wrist monitors; memory-equipped devices, which can store or transmit data, have beneficial advantages; in the initial phase of assessment or when treatment is being initiated, two measurements in the morning and two measurements in the evening are recommended each day for one week, and for long-term observation measurements, this routine can be reduced to one week per quarter.

Diagnostic thresholds:

The threshold level of 135/85mmHg (130/80mmHg optimal) for SBPM is the same as that for mean daytime ABPM, and should be the average of several readings taken over several days. SBPM needs to be further evaluated in prospective outcome studies.

Clinical indications:

The clinical applications of SBPM are only beginning to become apparent as the technique becomes more widely used and scientific data is gathered, but these are broadly similar to those for ABPM. There is some evidence that SBPM may improve compliance with antihypertensive medication.

References available on request

Prof Eoin O'Brien, is the Professor of Cardiovascular Pharmacology, ADAPT Centre, Beaumont Hospital, Dublin and the RCSI