

Blood Pressure Measurement

- Everyone over 40 years old should have their BP checked at least every 5 years, certainly up to the age of 80 years.
- BP must be measured in a standardised fashion using a properly validated, well maintained and recently calibrated monitor.
- Use the average BP from several visits when estimating cardiovascular risk in mild hypertension.
- Semi automatic and automatic oscillometric devices are now the commonest method for BP measurement and are suitable for home BP measurement.
- All semi-automatic and automatic devices need separate validation for use in pregnancy.

Introduction

Of all measurements routinely undertaken in clinical practice, BP estimation is one of the most frequently performed yet potentially the most unreliable. The large natural variation in BP that occurs between beats and over minutes to hours, along with measurement errors, makes recording representative BP measurements problematic, although measurement errors can be significantly reduced. Everyone over 40 years old should have their BP checked at least every 5 years up to the age of 80 years. Those with high normal (borderline) levels (SBP 135-139 mmHg and/or DBP 85-89 mmHg) should have the measurement repeated again within the next 12 months (ref 1).

While undergoing evaluation of mild hypertension and assessment of overall cardiovascular (CV) risk, paired BP recordings should be repeated on two or three further visits over the subsequent 2-3 months. For those with moderate or severe hypertension on initial recordings, and/or evidence of target organ damage further assessments should be made over a shorter period e.g. 3 to 4 weeks, as prolonged periods of observation before starting treatment are unnecessary. Measurement of BP is usually undertaken in the clinic/surgery by a doctor or nurse, although increasingly multiple readings obtained by home/self BP monitoring as well as automated 24-hour ambulatory recordings give a reflection of BP measurements away from the clinical environment. However, the benefits of basing the initiation, or alteration, of anti-hypertensive treatment based solely on self or ambulatory BP levels have yet to be firmly established.

Blood pressure measurement

The Methods

BP must be measured as accurately as possible (ref 2,3) in a standardised fashion (see Box 1) using a properly validated, well maintained and recently (within the last 6 months) calibrated monitor.

Box 1: Blood pressure measurement by standard mercury sphygmomanometer or semi-automatic device

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| <ul style="list-style-type: none"> • Remove tight clothing, ensure arm is relaxed and supported at heart level • Use cuff of appropriate size (see Box 2) • Inflate cuff to 20-30 mmHg above palpated SBP • Lower column slowly, by 2 mm per second or per beat • Read BP to the nearest 2 mmHg • Measure diastolic as disappearance of sounds (phase V) | } Only devices using auscultation (mercury/hybrid) |
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Subjects should have the procedure explained and rest sitting or supine for at least 5 minutes in a quiet room at ambient temperature, before measurements are made. Patients should be asked not to talk during measurements.

The brachial artery should be located by palpation and a cuff of the appropriate size applied (see Box 2) ensuring the cuff is at heart level and bladder encircles at least 80% of the upper arm, with the length to width ratio of the bladder being approximately 2:1. Using too large a cuff can result in underestimation of BP levels, similarly too small a cuff will lead to over-estimation. It is important when purchasing any BP monitor to ensure that appropriate size cuffs are available for that particular instrument.

BP should initially be measured in both arms as a significant number of patients, particularly the elderly, have large between arm differences (>10 mmHg) and the arm with the highest value used for subsequent measurements and this recorded. Two measurements (1-2 minutes apart) should be taken on each occasion, the initial value being discarded if there is a large (>10 mmHg) difference between the first and subsequent readings and further measurements made.

To assess orthostatic BP changes, particularly in elderly or diabetic patients and in those with symptoms suggesting postural hypotension, measurements should be repeated after the patient has been standing for 1-3 minutes, again with the arm supported.

If the auscultatory method is used, observers must be properly instructed using BHS training material (www.bhsoc.org) and Korotkoff Phase I and V sounds taken for systolic and diastolic BP levels respectively.

Note the time of measurement, particularly in relation to antihypertensive drug use, meals and smoking and use the average BP for several visits when estimating cardiovascular risk in mild hypertension.

Box 2: BP cuff sizes for mercury sphygmomanometer, semi-automatic and ambulatory monitors

Indication	Width (cm)*#	Length (cm)*#	BHS Guidelines Bladder width & length (cm)	Arm Circumference (cm)
Small Adult/Child	10-12	18-24	12 x 18	<23
Standard Adult	12-13	23-35	12 x 26	<33
Large Adult	12-16	35-40	12 x 40	<50
Adult Thigh Cuff**	20	42	20 x 42	<53

* The range for columns 2 and 3 are derived from recommendations for the British Hypertension Society (BHS), European Hypertension Society (ESH) and the American Heart Association. Columns 4 and 5 are derived from only the BHS Guidelines.

** Large bladders for arm circumferences over 42 cm may be required. # Bladders of varying sizes are available so a range is provided for each indication (applies to columns 2 and 3)

The Devices.

Mercury Sphygmomanometers

Although in the process of being withdrawn from clinical use, the mercury sphygmomanometer remains the gold standard against which new BP monitor accuracy is judged. Like all devices, mercury

sphygmomanometers need regular maintenance with suitable safety procedures adopted regarding mercury use. A good quality stethoscope and a well-trained observer are also vital if accurate measurements are to be made.

Oscillometric devices

Oscillometric devices rely on the detection of pressure oscillations in the cuff during deflation and an algorithm is used to calculate SBP and DBP. This is now the most common method used in semi-automatic and automatic devices. These monitors do not require accurate placement of the cuff over the brachial artery and they do not rely on manual auscultation. They are therefore easy for patients to use during self-monitoring. However because the method relies on brachial artery oscillations, stiff vessels, particularly in older people, may cause inaccuracies. These devices are suitable for home BP measurement and are often combined with an internal memory for recording multiple measurements. Alternatively, the data can be downloaded directly onto a PC, others have built-in printers or can be used in telemonitoring. There are many oscillometric devices that are accurate and validated for both clinic and self-BP measurement use costing from £40 upwards. Regularly updated lists of validated monitors available in the UK are on the BHS (www.bhsoc.org) and other websites (www.dableducational.com)

Hybrid devices

In these monitors the mercury column has been replaced by an electronic gauge, although in some models it still resembles the standard 'mercury' column, and BP is measured manually by auscultation. This type of monitor is particularly useful in patients in whom oscillometric devices cannot be used. Calibration of these devices is also relatively simple although they tend to be more expensive than some of the oscillometric devices.

Aneroid

Because the gauges of these monitors rely on a series of bellows and levers, they tend to lose their accuracy over time and need very regular calibration and maintenance.

Since mercury sphygmomanometers, hybrid and aneroid devices rely on the auscultatory method of measuring BP, training and revalidation of operators is essential. None is recommended for self-measurement of BP.

Other devices

Devices that measure beat to beat BP levels using photoplethysmographic or tonometric techniques are used to track rapid changes in BP, but their accuracy is questionable, as is their ease of use. Other methods, particularly automated auscultatory monitors with in-built cuff microphones to detect Korotkoff sounds are prone to movement artefact and need accurate cuff placement. Wrist monitors in general have not been found to be accurate. None is recommended for routine clinical use.

Validation

It is vital that all devices used in clinical practice have undergone a formal clinical validation process to assess their accuracy. Either the revised BHS (ref 4), or the International Protocol (ref 5) is appropriate for validation. The BHS, after review, accepts as accurate any monitor which has been appropriately validated using these protocols and a current list can be found on the BHS website (www.bhsoc.org). All semi-automatic and automatic devices need separate validation for use in pregnancy.

Special Cases

Rhythm disturbances, especially atrial fibrillation, affect BP measurement using oscillometric techniques which depend on successive pressure waveforms having a similar smooth profile. Regardless of the method of measurement, multiple recordings are required to obtain an accurate estimation of BP levels in atrial fibrillation. When heart rates are below 50 beats/min, even if the rhythm is regular, some of the newer semi-automatic devices are unable to reduce their deflation rate sufficiently so that too rapid a fall in cuff pressure, results in underestimation of SBP and overestimation of DBP. In pregnancy, DBP is best measured as the disappearance of Korotkoff V sounds. However, in some cases the sounds may persist when the cuff is completely deflated, in which case Phase IV should be used.

References

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- 2 O'Brien E, Asmar R, Beilin L, Iami Y, Mallion J-M et al. European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. *J Hypertens* 2003;21:821-848.
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