World Health Organization

# AFFORDABLE TECHNOLOGY

## BLOOD PRESSURE MEASURING DEVICES FOR LOW RESOURCE SETTINGS

CVD
CARDIOVASCULAR DISEASES

# Annex 1: Blood Pressure Measurement Procedures



The following summary of blood pressure measurement procedures is based on the European Society for Hypertension guidelines for blood pressure measurement (10).

## General advice for all techniques/settings

- Explanation to subject: The first step in blood pressure measurement is an adequate explanation of the procedure in an attempt to allay fear and anxiety, especially in nervous subjects.
- Attitude of observer: Before taking the blood pressure, the observer should be in a comfortable and relaxed position. The observer should not rush the procedure otherwise the cuff may be deflated too rapidly, resulting in underestimation of systolic pressures and overestimation of diastolic pressures.
- Attitude of subject: Subjects should be encouraged to relax and should be advised that neither they nor the observer should talk for the few minutes before or during the blood pressure measurement.
- Posture of subject: Blood pressure should be measured with the subject sitting and the arm supported at heart level. Some subjects may exhibit postural hypotension, especially with certain antihypertensive drugs. When this is likely, blood pressure should be measured lying and standing.
- Choice of arm: Bilateral measurements should be made at the first consultation, and if differences greater than 20 mmHg for systolic pressure or 10 mmHg for diastolic pressure are observed for consecutive readings, the subject should be referred to a cardiovascular centre to be further evaluated in order to exclude arterial disease.

## Auscultatory measurement in the office/clinic setting

- The following points should be recorded by the observer: subject position – lying, sitting or standing; subject state – anxious, relaxed; time of drug ingestion; arm – right or left; bladder size.
- The observer should ensure that the manometer is no more than three feet away so that the scale can be read easily, that the mercury column is vertical, and that the bladder dimensions are accurate. If the bladder does not completely encircle the arm, its centre must be 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 30 mm Hg above the palpated systolic pressure and deflated at a rate of 2 to 3 mm Hg per pulse beat (or per second), during which the auscultatory phenomena described in Table I will be heard.



TABLE I: AUSCULTATORY SOUNDS

| | |
|---|---|
| **Phase I** | The first appearance of faint, repetitive, clear tapping sounds which gradually increase in intensity for at least two consecutive beats is the systolic blood pressure. |
| **Phase II** | A brief period may follow during which the sounds soften and acquire a swishing quality.<br>Auscultatory gap – In some patients sounds may disappear altogether for a short time. |
| **Phase III** | The return of sharper sounds, which become crisper to regain, or even exceed the intensity of phase I sounds. The clinical significance, if any, to phases II and III has not been established. |
| **Phase IV** | The distinct abrupt muffling of sounds, which become soft and blowing in quality. |
| **Phase V** | The point at which all sounds finally disappear completely is the diastolic pressure. |

- Disappearance of sounds (phase V) should be taken as diastolic pressure except when sounds persist down to zero, when muffling of sounds (phase IV) should be recorded for diastolic pressure. Measurements should be made to the nearest 2 mm Hg (blood pressure should not be rounded off to the nearest 5 or 10 mm Hg – digit preference). At least 2 measurements, taken at 1 minute intervals, should be recorded. Blood pressure should be written down as soon as it has been recorded.

## Ambulatory blood pressure measurement

Ambulatory blood pressure measurement (ABPM) is increasingly being used in clinical practice (7). A detailed discussion of the advantages and disadvantages of this technique is beyond the scope of this document, in which ABPM is quoted only for general information purposes. For more information on ABPM the reader should refer to the European Society for Hypertension Guidelines for blood pressure measurement (10).

## Self blood pressure measurement



As with ABPM, a detailed discussion of self blood pressure measurement (SBPM) is outside the scope of this document. Some general considerations regarding SBPM devices are provided, however it should be noted that there is a need for further research to determine the precise role of SBPM in practice.

Devices for SBPM include upper arm devices, wrist devices, and finger devices. SBPM devices that measure blood pressure at the finger are not recommended because of the inaccuracies of measurement distortion with peripheral vasoconstriction, the alteration in blood pressure the more distal the site of recording, and the effect of limb position on blood pressure. Devices that measure blood pressure at the wrist, although subject to the latter two problems, are more accurate than finger measuring devices. However, there are strong reservations about the correct use of wrist devices. Inaccurate measurements can be obtained if the wrist is not held at heart level during measurement, as well as if there is flexion and/or hyperextension of the wrist.

Electronic devices using oscillometry are becoming more popular and are replacing the auscultatory technique for SBPM. These devices require less training and are more suitable for subjects with infirmities such as arthritis and deafness. A vast array of automated devices for SBPM are being manufactured and promoted, but few have been evaluated according to the procedures considered necessary for blood pressure measuring equipment used in clinical practice.

Considering that the number of SBPM devices which have fulfilled independent validation criteria is small, the state of the market

needs to be assessed regularly, with results made easily accessible to prospective purchasers. The web site devoted to blood pressure measurement –www.dableducational.com – can be consulted to determine which devices have been validated.

## Factors affecting blood pressure readings

- Variability of blood pressure: Regardless of the measurement device used, blood pressure will always be a variable haemodynamic phenomenon that is influenced by many factors, including the circumstances of measurement itself, respiration, emotion, exercise, meals, tobacco, alcohol, temperature, bladder distension, and pain. Blood pressure is also influenced by age, race and diurnal variation, usually being lowest during sleep.
- White coat hypertension: White coat hypertension (WCH) is a condition in which a normotensive subject is hypertensive during repeated clinic blood pressure measurements, but pressures measured outside the medical environment by ambulatory or self measurement techniques, are normal. WHC can lead to an overestimation of initial blood pressure, as well as an underestimation of the effect of treatment (21,22).
- Special Populations: Certain groups of people merit special consideration for blood pressure measurement. These include children; the elderly, who often have isolated systolic hypertension or autonomic failure with postural hypotension; obese people in whom 'cuff hypertension' is common; subjects with arrhythmias in whom the mean of a number of measurements may have to be estimated; pregnant women in whom the disappearance of sounds (fifth phase) is the most accurate measurement of diastolic pressure except when sounds persist to zero, when the fourth phase of muffling of sounds should be used; and subjects during exercise.

## Factors affecting the accuracy of blood pressure measurement

- Observer error: Observer error, which can greatly affect accuracy of measurement, can include systematic error, such as intra- and inter-observer error; terminal digit preference or rounding to a preferred

digit (often zero); and observer prejudice or bias, where pressure is adjusted to suit the observer.

- 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 be prone to the inaccuracy induced by miscuffing whereby a cuff contains a bladder that is either too long or too short relative to arm circumference (Table II). The British Hypertension Society and the American Heart Association recommendations for bladder dimensions are shown in Table III.



| TABLE II: MISMATCHING OF BLADDER AND ARM | |
|---|---|
| Bladder too narrow or too short | Overestimation of blood pressure – 'cuff hypertension' |
| Undercuffing | range of error – 3.2/2.4 to 12/8 mmHg<br>as much as 30 mmHg in obesity |
| Bladder too wide or too long | Underestimation of BP blood pressure |
| Overcuffing | range of error – 10 to 30 mmHg<br>Undercuffing is more common than Overcuffing |

| TABLE III: RECOMMENDED BLADDER DIMENSIONS FOR ADULTS | |
|---|---|
| **British Hypertension Society** | |
| Standard cuff | Bladder 12 x 26 cm for the majority of adult arms |
| Large cuff | Bladder 12 x 40 cm for obese arms |
| Small cuff | Bladder 12 x 18 cm for lean adult arms and children |
| **American Heart Association** | |
| **Small adult cuff** | Bladder 10 x 24 for arm circumference 22 – 26 cm |
| Adult cuff Bladder | Bladder 13 x 30 for arm circumference 27 – 34 cm |
| Large adult cuff Bladder | Bladder 16 x 38 for arm circumference 35 – 44 cm |
| Adult thigh cuff Bladder | Bladder 20 x 42 for arm circumference 45 – 52 cm |