British Hypertension Society

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RECOMMENDATIONS ON BLOOD PRESSURE MEASUREMENT

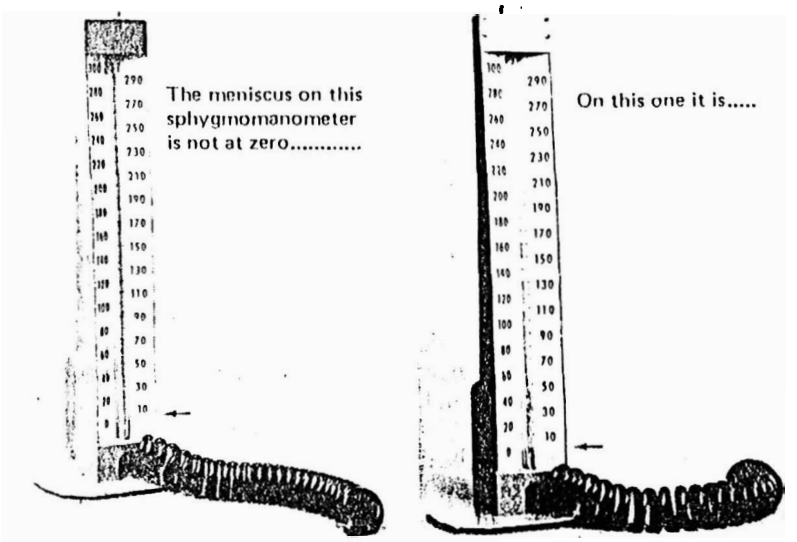
Incorrect technique → False readings

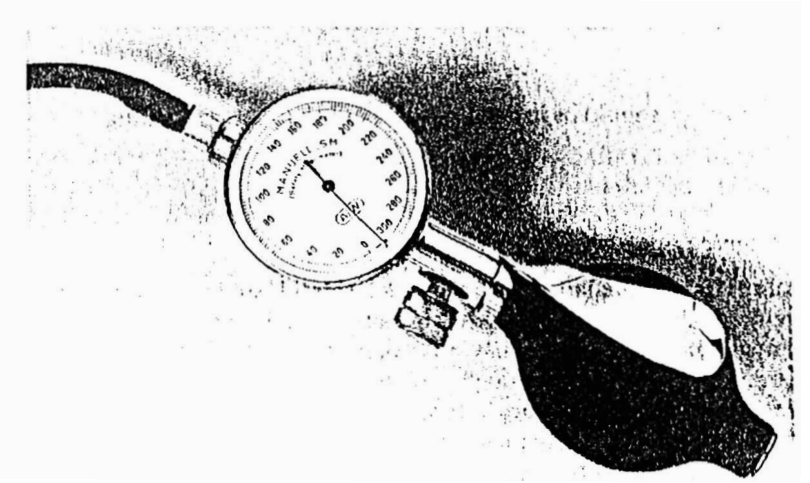
→ Unnecessary treatment, inappropriate treatment and follow up

Only an observer who is aware of the factors that lead to false readings should measure blood pressure. Wrong readings obtained through failure to use the proper technique often lead to the wrong diagnosis, which may result in unnecessary or inappropriate treatment and follow up.

The aim of these recommendations is to provide simple guidelines for the indirect measurement of blood pressure.

Equipment





Points to check in assessing equipment

- *Manometer*—visibility of meniscus; calibration
- *Cuff*—condition; length and width of inflatable bladder
- *Inflation-deflation device*—possible malfunction; control valve
- *Stethoscope*—condition
- *Maintenance*—regularity; responsibility

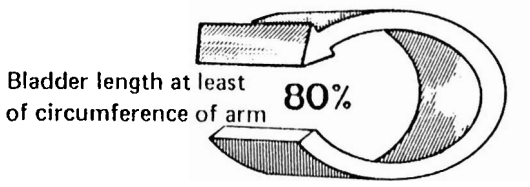
Two instruments are required for measuring blood pressure: a sphygmomanometer and a stethoscope.

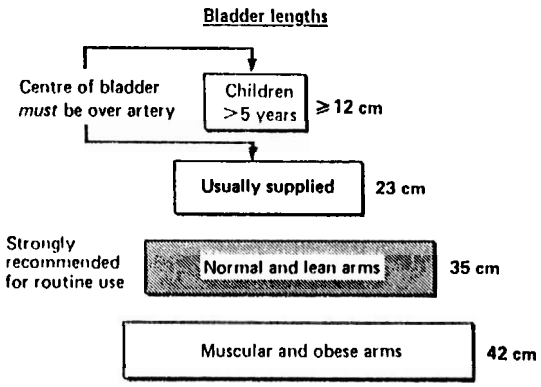
The sphygmomanometer consists of a manometer, an inflatable bladder in a cuff, and an inflation-deflation device. Before any measurement is attempted the equipment must be checked to make sure that it is appropriate and in good order. If any part of the apparatus is defective or unsuitable alternative equipment must be used.

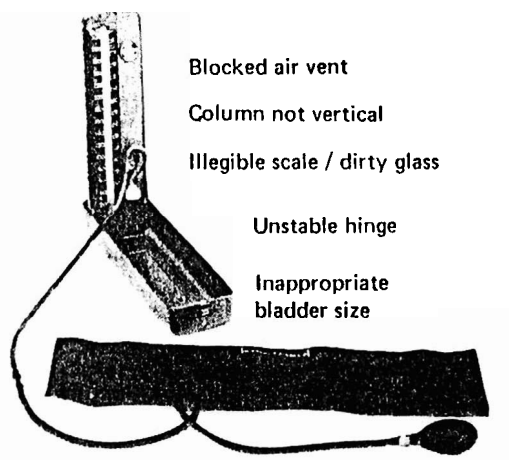
● *Manometer*

Mercury column—The meniscus should be clearly visible, not obscured by oxidised mercury on the inside of the glass. Before inflation it must be at zero.

Aneroid—This type loses its accuracy over time, leading usually to falsely low readings and a consequent underestimation of blood pressure. The accuracy of the instrument may be checked at different pressure levels by connecting it with a Y piece to the tubing of a standardised mercury column manometer. If recalibration is necessary, this must be done by the manufacturer—though some pharmaceutical companies will arrange recalibration.







Hospital sphygmomanometers

Responsibility for maintenance clearly defined

Date for routine 6 monthly service marked on unit

Defective equipment reported to member of staff responsible

Replacement parts and instruction booklet available in clinical area

Sphygmomanometers in surgeries

Check once a year

● *Cuff*

The cuff consists of an inflatable bladder within a restrictive cloth sheath. The bladder, tubing, connections, inflation bulb, and valves should all be sound. The sheath containing the bladder should also be in good condition and have a secure fastening. Provided it is long enough to wrap round the arm and be easily secured, the length of the sheath is not important.

Both the length and width of the inflatable bladder are critical.

The length of the bladder is one determinant of the area of pressure applied to the artery. If the bladder is too short the blood pressure will be overestimated, since the pressure is not fully transmitted to the artery. The bladder should nearly or completely encircle the patient's arm, and the length should be at least 80% of the circumference of the arm. For normal or lean arms a 35 cm bladder is strongly recommended; but for heavily muscled or obese arms longer bladders—up to 42 cm—are necessary. Most commercially available bladders are only 23 cm long. With such shorter cuffs the centre of the bladder must be positioned directly over the artery. In children similar considerations apply, and in those over 5 years of age the bladder should normally be at least 12 cm long.

The width of the bladder determines the length of the segment of artery to be occluded. Too narrow a bladder leads again to overestimation of blood pressure for the same reason that too short a one does; but the error is not likely to be as great as that resulting from the use of bladders that are too short. In adults the recommended widths for lean, normal, obese, or heavily muscled arms are from 12 to 15 cm; in fact, the width should be at least 40% of the circumference. In children over 5 years of age the bladder should be at least 8 cm wide.

The dimensions of the bladder should be clearly shown on each cuff, together with a prominent marker indicating the centre of the bladder.

● *Inflation-deflation device*

Failure to achieve a pressure of 40 mm Hg above the estimated systolic blood pressure or 200 mm Hg after 3-5 seconds of rapid inflation is a sign of equipment malfunction. So too is the inability of the equipment to deflate smoothly when the controlling release valve is operated at 2-3 mm/s or at each pulse beat. When such problems occur the unit should be set aside and clearly marked with instructions for defective parts to be repaired or replaced. Faulty control valves, leaks, dirty vents, and perished tubing are simple to repair. The commonest source of error in the inflation-deflation system is the control release valve, which can easily be replaced.

Deflation that is either jerky or too rapid may result in the systolic pressure being underestimated and the diastolic pressure overestimated. If, on the other hand, deflation is too slow the patient may suffer pain, even bruising, and blood pressure may be overestimated.

● *Stethoscope*

The stethoscope should be in good condition with clean, well fitting earpieces.

● *Maintenance*

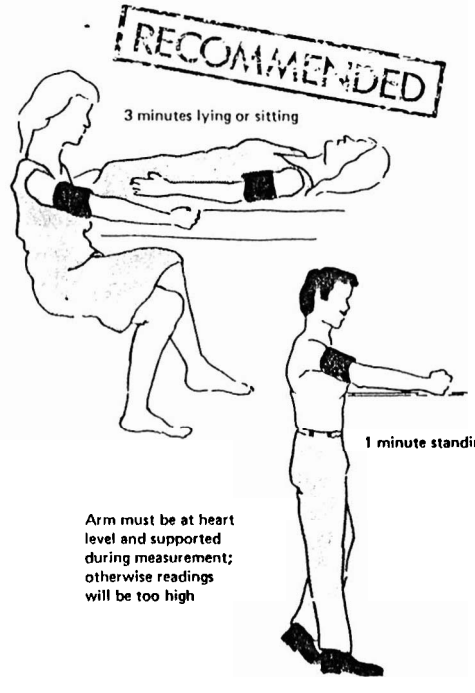
The date of last maintenance or recalibration should be clearly marked on the sphygmomanometer, together with the date when the next is due. Sphygmomanometers used regularly in hospitals should be routinely serviced every six months. Those in less frequent use should be checked once a year. Replacement parts are cheap and should be readily available in the clinical area, together with a maintenance instruction booklet.

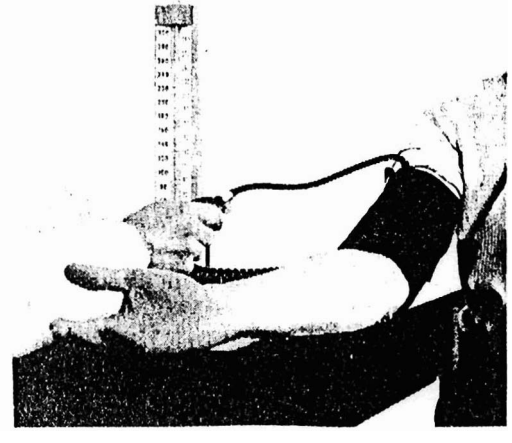
The responsibility for reporting faulty equipment or the lack of appropriate cuffs lies with the observer, who should always refuse to use defective or inappropriate equipment. The responsibility for arranging regular maintenance should be clearly defined for each clinical area.

Procedure

Practical points

- Explanation to patient
- Defence reaction
- Variability in blood pressure
- Posture of patient
- Position of arm
- Application of cuff
- Position of manometer
- Estimation of systolic pressure
- Auscultatory measurement of systolic and diastolic pressure
- Number of measurements
- Indications for measurement in both arms
- Times of measurement
- Measurement in children
- Follow up measurements





Those who measure blood pressure should be familiar with the practical points listed on the left and discussed below.

● *Explanation to patient*

The observer should outline the procedure briefly. In particular, he or she should warn the patient of the minor discomfort caused by inflation and deflation of the cuff and tell the patient that the measurement may be repeated several times.

● *Defence reaction*

The defence reaction, causing an increase in blood pressure, tends to subside once the patient becomes accustomed to the procedure and the observer. Readings are likely to be lower when they are taken in the home. Except in patients with severe hypertension, repeated measurements to assess the severity of raised blood pressure should be made every one or two weeks for at least a month. In many patients blood pressure falls without treatment.

● *Variability in blood pressure*

Blood pressure varies in individuals according to both the time of day, meals, smoking, anxiety, temperature, and the season of the year. It is usually at its lowest during sleep.

● *Posture of patient*

Whether the patient is sitting or lying (supine) makes no difference to the blood pressure readings. Pressure should also be measured in the standing position in patients whose symptoms or drug regimen may be associated with a disproportionate postural fall. Pregnant patients too may suffer a profound fall in blood pressure when lying supine; therefore in pregnancy all measurements should be performed with the patient either sitting or in the left lateral position. No information is available on the optimal time in the position before the measurement, but we suggest three minutes lying or sitting and one minute standing.

● *Position of arm*

The arm should be horizontal and supported at the level of the mid-sternum because dependency of the arm below heart level leads to an overestimation of systolic and diastolic pressures of about 10 mm Hg. Correspondingly, raising the arm above heart level leads to underestimation of these pressures.

● *Application of cuff*

The patient should be in a warm environment. Tight or restrictive clothing should be removed from the arm. The position of maximal pulsation of the brachial artery in the arm, just above the antecubital fossa may be marked lightly with a pen. A cuff with a long enough and wide enough bladder should then be applied to the upper arm, with the tubing placed superiorly so that it does not interfere with auscultation. The centre of bladders less than 35 cm long must be positioned over the line of the artery. The lower edge of the bladder should be 2-3 cm above the marked point. The cuff should fit firmly and comfortably and be well secured.

● *Position of manometer*

In the mercury column manometer the column must be vertical (unless designed with a tilt), at eye level, and not more than three feet from the observer. Stand mounted manometers are recommended, largely because they are mobile. Box and desk models are more easily damaged and less convenient to use.

Systolic pressure estimation

(1) Palpate brachial artery pulsation

(2) Inflate cuff until pulsation vanishes

(3) Deflate cuff

(4) Take reading

Estimation of systolic pressure

The systolic pressure should be estimated before the operator uses the stethoscope. He should palpate the brachial artery pulse and inflate the cuff for 3-5 seconds until the pulsation disappears. The point of disappearance represents the systolic pressure. Then he should deflate the cuff. This technique is especially useful in patients in whom auscultatory end points may be difficult to judge accurately—for example, pregnant women, patients in shock, or those taking exercise.

Systolic and diastolic pressure measurements

(5) Place stethoscope gently over point of maximal pulsation of brachial artery

(6) Inflate cuff to 30 mm Hg above estimated systolic pressure

(7) Reduce pressure at rate of 2-3 mm Hg per second

(8) Take reading of systolic pressure when repetitive, clear tapping sounds appear for two consecutive beats

(9) Take reading of diastolic pressure when repetitive sounds disappear

● *Auscultatory measurement of systolic and diastolic pressures*

The stethoscope is placed gently over the artery at the point marked with a pen. The instrument must not be pressed too firmly or touch the cuff, or the diastolic pressure may be grossly underestimated. The pressure is then raised by inflating the bladder to 30 mm Hg above the previously estimated systolic blood pressure. Next, the pressure is reduced at 2-3 mm Hg per second, or pulse beat. The point at which repetitive, clear tapping sounds first appear for at least two consecutive beats gives the *systolic blood pressure*. The point where the repetitive sounds finally disappear gives the *diastolic blood pressure* (phase 5). Both measurements should be taken to the nearest 2 mm Hg.

In some groups—for example, children and pregnant, anaemic, or elderly patients—sounds may continue until the zero point. In such patients the final, distinct muffling of the repetitive sounds (phase 4) is taken as the diastolic pressure. The point of muffling is usually higher than the true arterial diastolic pressure. If phase 4 is used this should be clearly recorded (200/90 mm Hg-phase 4). Phase 4 should be used routinely in pregnant patients.

Digit preference, whereby observers choose to record, say, only to the nearest 0 to 5 mm Hg, is another source of bias. Such bias is best avoided by recording to the nearest 2 mm Hg.

The silent or auscultatory gap occurs when the sounds disappear between the systolic and diastolic pressures. Its importance is that unless the systolic pressure is palpated first this pressure may be underestimated. The presence of a silent gap should be recorded on the case sheet or blood pressure chart.

Sustained blood pressure elevation

Make minimum of two measurements
Repeat if agreement not to within 10-15 mm Hg
Allow 1 minute between measurements

● *Number of measurements*

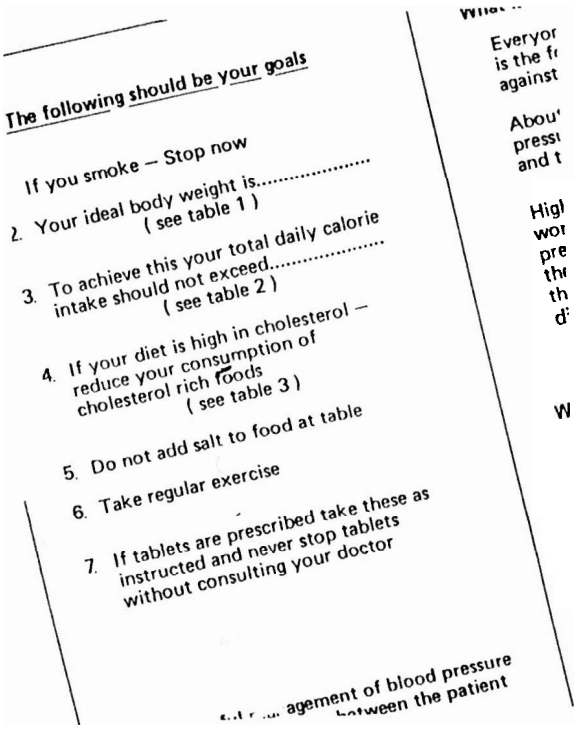
For patients in whom sustained increases of blood pressure are being assessed at least two auscultatory measurements in each position should be made at each visit. If these readings do not agree to within 10-15 mm Hg a further reading should be taken. At least one minute should elapse between measurements.

Coarctation or aorta or suspected anatomical abnormalities

Measure simultaneously in both arms

● *Indications for measurement in both arms*

Blood pressure should be measured in both arms in all patients with raised blood pressure at the initial assessment, and if there is a reproducible difference of 20 mm Hg for systolic pressure and 10 mm Hg for diastolic pressure simultaneous measurement should be performed. Simultaneous measurement in both arms is also indicated in patients with suspected coarctation of the aorta or where local anatomical abnormalities are suspected.



● *Times of measurement for patients taking drugs that lower blood pressure*

In patients taking drugs that lower blood pressure the optimum time for control measurements will depend on the time of day at which the drugs are taken. For instance, for patients receiving once daily treatment blood pressure is best measured just before the patient takes his daily dose.

● *Measurement in children*

The blood pressure of children under 5 years old cannot be measured clinically with a conventional sphygmomanometer, and even in children over 5 measurements are susceptible to cuff artefact. There may be an error of 10-15 mm Hg. Furthermore, there is considerable variability in children's blood pressure when measured on different occasions. Thus measurements in children should be attempted only when clinically indicated, and little attention should be paid to moderate deviation from the mean. The equipment necessary for measuring blood pressure in children will be discussed in a future report.

● *Follow up measurements*

When the initial assessment of blood pressure suggests that further measurements are needed it is important to standardise the conditions surrounding these subsequent assessments. The patient should therefore be given written instructions to avoid smoking, drinking alcohol, eating, bladder distension, and undue exercise for at least 30 to 60 minutes before each measurement because such factors complicate the interpretation of the readings. It is useful to have a leaflet on these points available to give to the patient.

Conclusions

- The measurement of blood pressure is one of the most commonly performed procedures in clinical medicine and should not be done carelessly.
- Defective or inappropriate equipment must not be used. A phased maintenance programme is not only essential but also inexpensive.
- A maintenance programme should be defined for each clinical area where blood pressure measurements are made.
- The main causes of misleading readings should be highlighted in training.
- All those who measure blood pressure should be assessed on the practical aspects of the procedure.

These recommendations of the British Hypertension Society were prepared by a working party of the society: Professor J C Petrie, University of Aberdeen; Dr E T O'Brien, The Charitable Infirmary, Dublin; Professor W A Littler, University of Birmingham; and Dr M de Swiet, Cardiothoracic Institute, Brompton Hospital, London.