ABC of Blood Pressure Measurement

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FUTURE TRENDS

Semi-automated sphygmomanometers

The auscultatory method of measuring blood pressure is accurate enough for clinical practice if the observer is adequately trained and minimises error by attention to detail. Several semi-automated devices have recently appeared on the market claiming to be more accurate than conventional mercury or aneroid sphygmomanometers.

The basic assumption made by many manufacturers of these machines (and by some of the public who use them) is that automation will improve the accuracy of measurement. Nevertheless, many of these machines, which are much more expensive than a standard mercury manometer, are not as accurate. Most semi-automated devices incorporate some form of audiovisual signalling of end-points and some possess automatic control of inflation or deflation, or both. Some also provide a permanent record of the blood pressure, a facility which may reduce observer bias and error. Nevertheless, technical details on these machines are often lacking and the end-point selected for diastolic pressure may not be clearly defined.

Most semiautomated machines work on one of two principles—the detection of Korotkoff sounds (by human ear or a microphone) or the detection of arterial blood flow by ultrasound. Other techniques being developed include the phase-shift method, which measures pressure changes between two segments of a double cuff; infrasound recording; oscillographic detection of arterial pulsations with double arm cuff; tonometry, which depends on the principle that displacement of a force-sensitive transducer over a superficial artery can be made linearly proportional to the arterial blood pressure; and a technique that measures average pressures from a cuff at constant pressure.

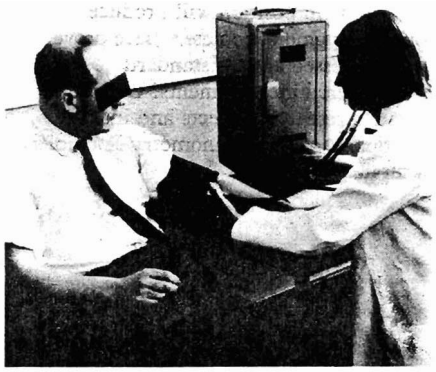
Korotkoff-sound sphygmomanometers

A number of semi-automated devices based on Korotkoff-sound detection are available.

An electronic microphone shielded from extraneous noise in the pressure cuff will detect the Korotkoff sounds and indicate the pressure on a chart or audiovisually by bleeps or blinking lights. The microphones are sensitive to movement and friction, however, and are difficult to place accurately. Manual or automatic inflation and or deflation may be available, and Korotkoff sounds can be recorded intermittently over 24 hours for ambulatory blood-pressure measurement. An example of an ambulatory recorder is the Remler machine.

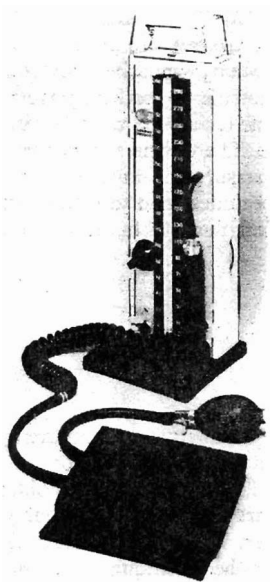
Two semi-automated sphygmomanometers have been designed for clinical trials with the purpose of reducing observer bias and digit preference—the London School of Hygiene Sphygmomanometer and the Hawkesley zero-muddling sphygmomanometer.

London School of Hygiene Sphygmomanometer



The London School of Hygiene instrument has a standard cuff with automatic inflation and deflation at a constant rate. The cuff pressure registers on three mercury-in-glass columns, which are hidden from the operator. The operator auscultates the brachial artery pressure in the conventional way, stopping the descent of each column in turn by pressing buttons on the front of the instrument as Korotkoff phases 1, 4, and 5 are detected. A cursor in front of the mercury columns can be adjusted by a crankhandle to the meniscus of each column and the pressure is then displayed on a digital counter. Both observer bias and digit preference are thus eliminated. The instrument is too cumbersome for routine use, but it is accurate when assessed against direct intra-arterial measurements.

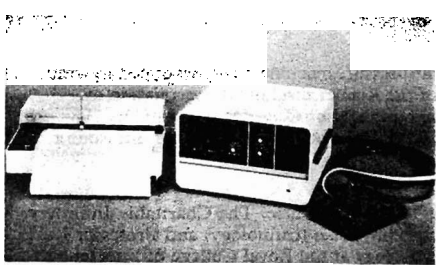
The Hawkesley zero-muddling sphygmomanometer



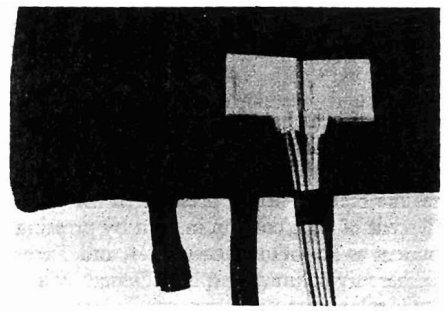
The zero-muddling manometer is only slightly larger than the conventional sphygmomanometer and operates in the same way, except that a wheel is spun before each measurement to adjust the zero to an unknown level. Once the blood pressure has been measured the level of zero may be determined and the pressure reading corrected.

In this way observer bias is reduced but not digit preference. The machine compares favourably with the standard mercury manometer and direct intra-arterial pressure.

Ultrasound sphygmomanometers

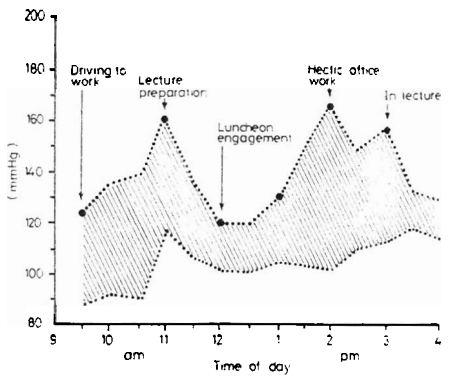


Ultrasound is valuable in measuring blood pressure in children, but ultrasound sphygmomanometers are also useful in adults, particularly those with low output states, such as shock, when the Korotkoff sounds may be difficult to detect. A small transmitting and receiving ultrasound transducer is incorporated in an inflatable cuff, which is wrapped round the arm in the conventional manner so that the transducer overlies the brachial artery. When the cuff is inflated above systolic pressure the artery is occluded and the transmitted ultrasound waves are reflected back without any change in frequency. As the cuff is deflated the vessel opens and closes, producing frequency changes in the reflected ultrasound waves, until the movement of the arterial wall ceases at pressures equal to and lower than diastolic pressure, when the reflected ultrasound will again have a constant frequency. The variations in frequency of reflected ultrasound may be amplified to produce a signal that can be detected by headphones or speakers and recorded or visualised.



Although ultrasound is not influenced by environmental noise, the transmitting and receiving crystals must be accurately fixed and stable over the brachial artery. Even minor shifts in position will produce considerable inaccuracies. Ultrasound sphygmomanometers have proved reasonably reliable and accurate when assessed against standard sphygmomanometers and direct intra-arterial measurements. Even so, their very high cost restricts their use to research projects and intensive care. For normal clinical use conventional sphygmomanometry is simpler, much cheaper, and every bit as accurate.

Continuous blood-pressure recording



Recordings of blood pressure over prolonged periods in ambulatory hypertensive patients and normal subjects have shown striking variations in the individual blood-pressure response to everyday stresses and activity. They have served to emphasise that the casual blood-pressure measurement, representing only 1 1400 of the total day's blood pressure, may be not only unrepresentative but frankly misleading, particularly in patients with borderline or labile hypertension. Unfortunately, methods for continuous ambulatory blood-pressure measurement are invasive and there have been serious complications. Most clinicians would be reluctant to leave an indwelling arterial catheter in situ while the patient performs normal activities outside hospital; hence this technique must be reserved for those few cases with special indications. There is no satisfactory method of continuously recording blood pressure non-invasively in an ambulant patient. Although a device has been designed to record pressures at pre-set intervals, the necessity for cuff inflation makes the subject aware of measurements.

Home recording of blood pressure

Name [redacted]

Drugs INDERAL CENTYL

Date	Blood pressure				Dose	
	am		pm			
	S	D	S	D	am	pm
1.9.79	174	104	210	112	80 2·5	80
2.9.79	200	108	212	110	80 2·5	80
3.9.79	198	104	222	116	80 2·5	80
4.9.79	202	100	206	105	80 2·5	80
5.9.79	186	98	198	100	80 2·5	80
6.9.79	176	94	180	98	80 2·5	80
7.9.79	180	90	180	94	80 2·5	80
8.9.79	190	98	204	104	100 2·5	100
9.9.79	164	92	190	106	100 2·5	100

The casual blood pressure may be unrepresentative of the patient's true blood pressure. Since there is no satisfactory technique for ambulatory measurement of blood pressure, doctors may try to obtain a more representative profile of blood-pressure behaviour by encouraging patients to record their own blood pressures. The patient, or his relative or friend, needs to be adequately trained in the technique. Even so, we believe that home recording of blood pressure is a useful means of obtaining information on the pattern of blood-pressure behaviour in selected patients. The patient should use a relatively cheap mercury or aneroid sphygmomanometer and stethoscope rather than one of the expensive and often inaccurate semi-automatic devices. His technique should be reviewed occasionally.

The photograph of the public blood-pressure machine was reproduced by kind permission of the *Irish Times*, that of the Remler machine by permission of Alphamed, that of the LSH machine by Professor G A Rose, that of the Hawkesley machine by Gelman Hawkesley Ltd, and that of the Arteriosonde ultrasound machine by Koutron.

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This is the sixth of a series of seven papers, and no reprints will be available from the authors.