Education and debate

Use and interpretation of ambulatory blood pressure monitoring: recommendations of the British Hypertension Society

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Over the past 20 years or so, the accuracy of using the conventional Riva-Rocci sphygmomanometer and Korotkoff's sounds to measure blood pressure has been questioned, and efforts have been made to improve measurements with automated devices.[1,2] In the same period, the phenomenon of white coat hypertension has been recognised—whereby some patients who apparently have raised blood pressure actually have normal blood pressure when the measurement is repeated away from the medical environment; this has focused attention on methods of measurement that provide profiles of blood pressure rather than rely on isolated measurements made under circumstances that may influence blood pressure.[3] These methods have included repeated measurements of blood pressure using the traditional technique, self measurement of blood pressure in the home or workplace, and ambulatory blood pressure measurement using automated devices.[2] Ambulatory monitoring is advantageous because it gives multiple measurements throughout the day and night

This paper considers only the ambulatory measurement of blood pressure in adults. Its purpose is not to make a case for or against ambulatory measurement; others have already done so.[4,5] Although the results of a number of ongoing, longitudinal studies are forthcoming, there is now firm evidence that ambulatory blood pressure measurement is a more sensitive predictor of cardiovascular outcome than conventional measurement.[6] We have not considered the complex issues of health economics that the increasing use of ambulatory measurement raises.[7] We realise that this technique is being used more often and that doctors who find ambulatory measurement useful in the day to day management of patients with high blood pressure need recommendations from those who have experience. However, regardless of the technique used to diagnose hypertension it is only one factor in determining a patient's risk profile and must be assessed in relation to concomitant disease, such as diabetes mellitus, and in relation to the degree of target organ involvement as recommended in the British Hypertension Society's guidelines on the management of hypertension.[8,9]

Summary points

One of the most important indications for ambulatory monitoring is to exclude white coat hypertension

The technique is also valuable in diagnosing and treating elderly patients and is used increasingly in pregnancy

Practices should consider carefully which monitor to buy, taking into account whether it has been independently validated, and should also consider how the data are analysed and presented

Methods

Recommendations on the use of ambulatory measurement have tended to be ambivalent, although firmer proposals are now being made.[10,11] Such ambivalence has not assisted doctors wishing to use the technique; however, making recommendations on the basis of incomplete evidence may lead to charges of advocating a technique that is not supported by the evidence. Recognising this, we have based our recommendations on evidence when it is available, and in cases in which it is not we have given advice on the basis of our collective experience of using ambulatory measurement over many years. What seems reasonable today may have to be modified as additional evidence becomes available: such is the essence of scientific reasoning. Where possible we have graded the strength of the evidence on which we have based our recommendations according to the scheme discussed by Shekelle et al.[12]

Setting up an ambulatory blood pressure measurement service

Which monitor?

A large variety of devices for ambulatory measurement are available, and the number will increase as the technique becomes more widespread.[11] A number of factors influence the choice of monitor (box); the most important factor is whether the device has been

Table 1 Results of independent evaluation of 23 ambulatory blood pressure measuring devices.[15] Devices were evaluated using the protocols of the British Hypertension Society[12] and the US Association for the Advancement of Medical Instrumentation[13]

Device (manufacturer)	Protocol used: Association for the Advancement of Medical Instrumentation*	Protocol used: British Hypertension Society (Systolic/diastolic pressure)†	Validated
Accutracker II (Suntech)	Passed	A/C	At rest
CH-DRUCK (Disetronic)	Passed	A/A	At rest‡
Daypress 500 (Neural Instruments)	Passed	A/B	At rest
DIASYS 200 (Novacor)	Passed	C/C	At rest
DIASYS Integra (Novacor)	Passed	B/A, B/B	At rest‡
ES-H531(Terumo)	Passed	A/A, B/B	At rest§
Meditech ABPM-04 (Meditech)	Passed	B/B	At rest‡
Nissei DS-240 (IDT France)	Passed	B/A	At rest
OSCILL-iT (FIGI)	Passed	C/B	At rest
Profilomat (Disetronic)	Passed	B/A	At rest‡
	Passed	B/C	In pregnancy
Profilomat II (Disetronic)	SBP Fail/DBP Pass	C/B	At rest‡
QuietTrak (Tycos Instruments)	Passed	A/A, B/B	At rest
	Failed	B/B	In pregnancy
Save 33, model 2 (Save 33:2)	Passed	B/B	At rest
Schiller BR-102 (Schiller)	Passed	B/B	At rest‡
SpaceLabs 90202 (SpaceLabs)	Passed	B/B	At rest
SpaceLabs 90207 (SpaceLabs)	Passed	B/B	At rest‡
	Passed	A/C, B/B, B/C, C/C	In pregnancy
	SBP Pass/DBP Fail	C/D	In children
	Passed	A/C	In elderly patients with postural effect
SpaceLabs 90217 (SpaceLabs)	Passed	A/A	At rest‡
TM-2420, model 5 (A and G Engineering)	Passed	C/C	At rest
TM-2420, model 6 (A and D Engineering)	Passed	B/B	At rest
TM-2420, model 7 (A and D Engineering)	Passed	B/B	At rest
TM-2421 (A and D Engineering)	Passed	B/A	At rest
Takeda 2421 (A and D Engineering)	N/A	C/C, A/B	In children with postural effect
Takeda 2430 (A and D Engineering)	Passed	A/A	At rest§

NA=not available; SBP=systolic blood pressure; DBP=diastolic blood pressure.
*Criteria for fulfilling protocol are that the mean difference between the standard sphygmomanometer and the device being validated should be within ≤5 mm Hg (SD ≤8 mm Hg).
†Grades denote agreement with mercury standard: A=best agreement (recommended for clinical use); B=good agreement (recommended); C=poor agreement (not recommended); D=worst agreement (not recommended). Devices must achieve rating of at least B/B to be recommended. For some devices more than one validation study was conducted and the grades for each validation are shown.
‡Validated for high, medium, and low pressure ranges. §Validated during exercise and for standing and lying positions.

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validated independently according to either the protocol of the British Hypertension Society[15] or that of the US Association for the Advancement of Medical Instrumentation,[14] or both. Table 1 shows the results of independent evaluations of devices using these protocols. (A list of the manufacturers of ambulatory systems can be found on the *BMJ*'s website.)

What type of service is most appropriate?

Doctors may establish their own service to provide ambulatory measurement, refer patients to a hospital service with open access to ambulatory measurement, or refer patients to a blood pressure clinic for full evaluation, which would include ambulatory measurement. Often an open access referral service is used and difficult cases are referred for fuller evaluation to a blood pressure clinic.

Training

The technique of ambulatory blood pressure measurement is specialised and should be approached with care. An understanding of the principles of traditional blood pressure measurement, cuff fitting, monitor functioning, and interpretation of the data from ambulatory measurement is recommended.[16] In practice, a nurse who is interested and has experience in caring for patients with hypertension can use the devices after a comparatively brief training. However, the analysis and interpretation of the ambulatory profiles require experience, and this is best learnt from the doctor in charge of the service offering ambulatory measurement.

Using an ambulatory monitor

About 15 to 30 minutes need to be allotted to fitting the monitor and preparing the patient if good results are to be obtained (box). Recommendations for cuff dimensions are shown in table 2.[9 17] Whichever cuff is

Factors to consider when choosing a monitor

Has the device been validated by the British Hypertension Society or the US Association for the Advancement of Medical Instrumentation?
How much does it cost?
How expensive is the software?
Does the software offer the information that you need?
Are the operating instructions adequate?
How much will maintenance cost?
How expensive are consumables, such as batteries?
Does the practice have adequate computer facilities to support the data analysis?
Is support available from technical or nursing staff within the practice?
Are training facilities available from the manufacturer or supplier?
Is the warranty adequate?
Does the manufacturer or supplier have servicing facilities that are easily accessible?