

Ambulatory blood pressure monitoring

This article forms part of our 'Tests and results' series for 2011 which aims to provide information about common tests that general practitioners order regularly. It considers areas such as indications, what to tell the patient, what the test can and cannot tell you, and interpretation of results.

Keywords: ambulatory blood pressure monitoring

Ambulatory blood pressure (ABP) monitoring involves measuring blood pressure (BP) at regular intervals (usually every 20–30 minutes) over a 24 hour period while patients undergo normal daily activities, including sleep. The portable monitor is worn on a belt connected to a standard cuff on the upper arm (Figure 1) and uses an oscillometric technique to detect systolic, diastolic and mean BP as well as heart rate.¹ When complete, the device is connected to a computer that prepares a report of the 24 hour, day time, night time, and sleep and awake (if recorded) average systolic and diastolic BP and heart rate.

The accuracy of ABP monitoring has been validated in a range of patients including young, elderly, pregnant and obese subjects (provided the correct size cuff is used). Ambulatory BP monitoring is safe and is not usually associated with complications. Occasionally oedema or petechiae of the upper arm or bruising under the inflating cuff may occur. Modern ABP devices are quiet, lightweight and easy to wear, but inflation of the cuff may cause some transient discomfort, particularly in people with hypertension or when multiple readings are triggered due to errors in measurement. Ambulatory BP measurements during the night may disturb sleep; potentially requiring retesting if there are poor nocturnal BP measurements.

What are the indications?

- Suspected white-coat hypertension (including in pregnancy)
- Suspected masked hypertension (untreated subject with normal clinic BP and elevated ABP)

- Suspected nocturnal hypertension or no night time reduction in BP (dipping)
- Hypertension despite appropriate treatment
- Patients with a high risk of future cardiovascular events (even if clinic BP is normal)
- Suspected episodic hypertension.

Ambulatory BP monitoring may also be useful for:

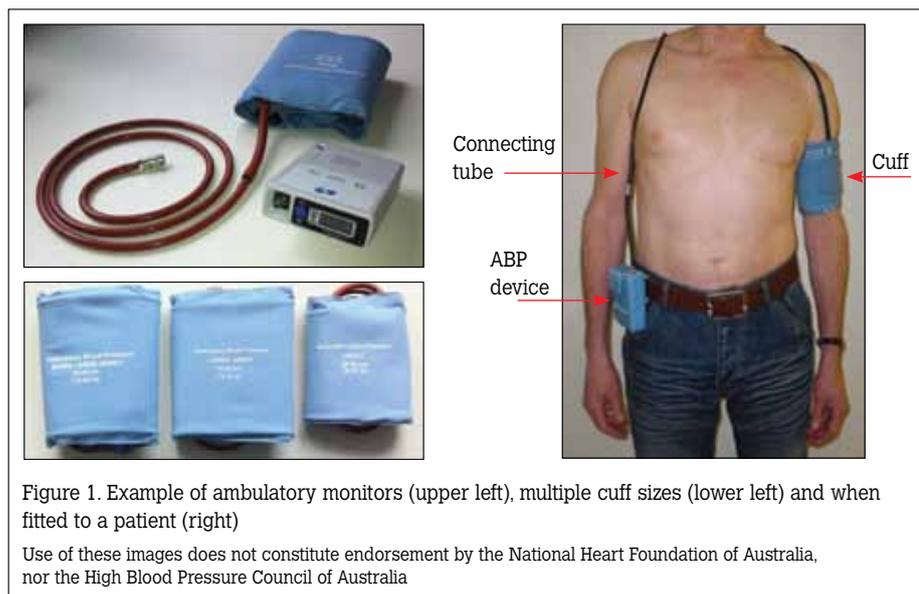
- titrating antihypertensive therapy
- borderline hypertension
- hypertension detected early in pregnancy
- suspected or confirmed sleep apnoea
- syncope or other symptoms suggesting orthostatic hypotension, where this cannot be demonstrated in the clinic.

When is it not recommended?

There are no specific contraindications to ABP monitoring, however, it is important that this test doesn't delay commencing drug therapy in patients with severe hypertension (ie. clinic BP grade 3; defined as systolic BP ≥ 180 mmHg and/or diastolic BP ≥ 110 mmHg) as ABP can be valuable to confirm adequacy of treatment. While not a contraindication, ABP monitoring may be inaccurate in patients with irregular heart rate and arrhythmias.¹

Where does it fit in a diagnostic approach?

Ambulatory BP monitoring provides a more reliable measure of a patient's BP than isolated clinic measures and is not subject to the 'white-coat effect', which can overestimate BP, particularly in susceptible patients. While clinic measurement of BP is useful for screening, and in the management of suspected and true hypertension. Ambulatory BP and home BP measurements add considerably to the accurate diagnosis of hypertension and the provision of optimal care. Recent recommendations from expert groups such as the United Kingdom's National Institute for Health and Clinical Excellence strongly advocate wider use of ABP monitoring in the diagnosis and management of hypertension.



What should I tell my patient?

Patients should be aware that the device will automatically inflate the cuff and measure BP periodically over a 24 hour period. They will need to book to have the monitor fitted and, as they cannot get the device wet, they should attend after bathing. A top with loose sleeves will best accommodate the cuff and a firm waistband will help support the monitor. Patients should continue with their normal daily activities, preferably including a work day rather than a rest day. They should take all their usual medications.

When the cuff starts to inflate the patient should stop moving and talking, keep the arm still and relaxed, and breathe normally. They should avoid activities that may interfere with the device such as vigorous exercise. A brief diary is important to record timing of activities, sleep, taking of medicines, posture and symptoms (eg. dizziness) that may be related to BP.

No Medicare rebate is currently available for ABP monitoring. Costs will vary with provider and need to be discussed with the patient.

How does the monitor work?

Ambulatory BP monitors use cuff oscillometry. The cuff is inflated until the pressure occludes flow within the brachial artery. As the pressure is released, blood begins to flow causing fluctuations (oscillations) in the arterial wall that are detected by the monitor. These oscillations increase in intensity then diminish and cease when blood is

flowing normally. The monitor defines the maximal oscillations as mean arterial BP and then uses an algorithm to calculate systolic and diastolic BP. The correct cuff size is essential and in very large patients, a conical shaped cuff is necessary. Measure BP in both arms and if the SBP difference is less than 10 mmHg, use the nondominant arm. If the SBP difference is greater than 10 mmHg, use the arm with the higher pressure. If there are contraindications to measuring BP in one arm (eg. fistula or previous axillary clearance), the monitor must be fitted on the other arm. To ensure validity, when the ABP monitoring device is fitted, at least three readings should be recorded simultaneously using a calibrated sphygmomanometer connected to the ABP monitoring device by a Y connector. Average readings for ABP and sphygmomanometer should not differ by more than 5 mmHg. Ambulatory BP monitoring devices are usually programmed to take readings at set intervals; 15–30 minutes during the day and every 30–60 minutes at night, to obtain numerous measurements while limiting interference with activity or sleep.

What do the results mean?

Measurements obtained from ABP monitoring must be interpreted carefully with reference to diary information and the timing of medicines. Reference 'normal' ABP values for nonpregnant adults are²:

- 24 hour average <115/75 mmHg (hypertension

threshold 130/80 mmHg)

- Day time (awake) <120/80 mmHg (hypertension threshold 135/85 mmHg)
- Night time (asleep) <105/65 mmHg (hypertension threshold 120/75 mmHg).

Ambulatory BP values above 'normal' and below thresholds for hypertension are considered 'high normal'. Night time (sleeping) average systolic and diastolic BP should both be at least 10% lower than day time (awake) average.¹ Blood pressure load (percentage of time that BP readings exceed hypertension threshold during 24 hours) should be <20%.

Blood pressure variability, maximum systolic BP and morning BP surge should also be taken into account (and targeted by treatment).

Treatment targets based on ABP are lower than the targets for clinic BP readings (eg. for clinic BP of 140/90, day time ABP equivalent is 136/87²) Importantly, ABP monitoring can be effectively used to manage antihypertensive treatment.³ The frequency of ABP assessment can be guided by the changes to therapy as routinely performed using clinic assessments combined with self measurements. An example of an ABP report is shown in *Figure 2*.

What won't the results tell you?

Ambulatory BP monitoring will not provide any information relating to cardiac arrhythmias and may be inaccurate in the setting of irregular heart rate such as in atrial fibrillation. Ambulatory BP is not designed to detect postural hypotension as the measurements occur at a fixed interval and devices do not contain inclinometers that would be required to record a patient's position. However, diary information can provide positional and event data. Ambulatory BP monitoring can be used to assess whether there is high variability of BP which is often associated with orthostatic hypotension.⁴

What are the next steps if the test is negative or inconclusive?

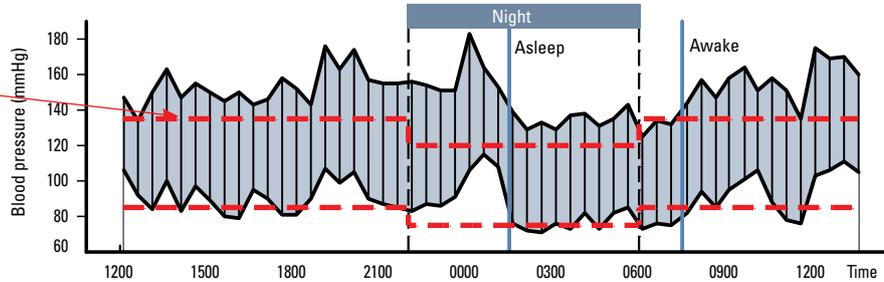
Untreated patients at low risk of cardiovascular disease with elevated clinic BP but a normal ABP (ie. day BP is <135/85 mmHg) may have 'white-coat hypertension'. This should be confirmed with a second ABP. People with white-coat hypertension are at greater risk of developing true hypertension and glucose intolerance. They

Ambulatory blood pressure report			
Patient name:	Mr J Bond	ID:	007
Scan start date	29/08/2011	Clinic SBP/DBP	140/90
Scan start time	12:08	Total readings	56
Scan end date	30/08/2011	Successful readings	52
Scan end time	13:37	Percent successful	93

Clinic BP suggests hypertension

OK if >85%

Grade 1 hypertension threshold



SBP: Grade 2 hypertension ≥148 mmHg

DBP: Grade 1 hypertension ≥84 mmHg

Summary					
	Min	Mean	Max	STD	BP load (<20%)
Systolic	125	151	183	13.4	94%
Diastolic	71	90	115	11.9	67%
Heart rate	54	70	94	9.5	

Day summary 6:00 to 22:00					
	Min	Mean	Max	STD	BP load
Systolic	125	152	176	12.2	91%
Diastolic	73	91	111	10.9	68%
Heart rate	54	71	90	8.7	

Night summary 22:00 to 6:00					
	Min	Mean	Max	STD	BP load
Systolic	129	146	183	14.7	100%
Diastolic	71	86	115	13.5	70%
Heart rate	57	69	94	11.1	
% Night SBP dip (>10%)		3.9%		% Night DBP dip (>10%)	5.5%

Night SBP dipping abnormal

Night DBP dipping abnormal

Awake summary 7:00 to 1:30					
	Min	Mean	Max	STD	BP load
Systolic	132	155	183	11	93%
Diastolic	75	92	115	11	68%
Heart rate	55	73	94	9	

Asleep summary 1:30 to 7:00					
	Min	Mean	Max	STD	BP Load
Systolic	125	134	143	5	100%
Diastolic	71	76	85	5	55%
Heart rate	54	60	67	5	
% Night SBP dip (>10%)		14%		% Night DBP dip (>10%)	28%

Asleep SBP dipping normal

Asleep DBP dipping normal

Interpretation: Patient ABP day, night, awake, asleep BP, BP load values are all above hypertension grade 1 threshold (shown in red). While night summary suggests 'nondipping' (<10%) this is due to very late sleep onset. The nocturnal dipping based on awake and asleep values are satisfactory (>10%)

Conclusion: Confirmed grade 1 hypertension

Recommendation: Commence or increase antihypertensive therapy. Assess cardiovascular risk to determine correct target BP. Reassess after modification

Figure 2. Example of ambulatory blood pressure report. Values in red are above hypertension thresholds based on reference 2

therefore need ongoing assessment of absolute cardiovascular risk and continued monitoring with clinic and home BP measurements. Repeat ABP every 1–2 years.

For patients with high cardiovascular risk or suspected masked hypertension it is appropriate to perform an initial ABP and repeat ABP monitoring in 1–2 years, even if clinic BP remains normal. Repeat ABP and/or home BP monitoring in these patients should be guided by the initial ABP profile and response to treatment.

An inconclusive test can occur if there has been insufficient valid readings (patient removes or inactivates device) or when there has been sleep disturbances which may obscure the correct assessment of night time BP.

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