

ABC of hypertension

Part III Ambulatory blood pressure measurement

Ambulatory blood pressure measurement is used increasingly in clinical practice. The evidence that it gives information over and above measurement of conventional blood pressure has been increasing steadily over the past 25 years. Ambulatory blood pressure measurement is now accepted internationally as an indispensable investigation in patients with established and suspected hypertension.

Choosing devices and software

The first step in adopting ambulatory blood pressure measurement is to select an accurate device (see www.dableducational.org for the latest selection of accurate devices). Ambulatory blood pressure measurement in clinical practice is simplified by a standardised graphical presentation of the recording (much as is the case for electrocardiograph recordings) regardless of the type of monitor used. This saves the user having to become familiar with a variety of programs and simplifies the interchange of recordings between hospitals and primary care practices. Interpretive reports provide help for doctors and nurses unfamiliar with the technique, and the time needed for a doctor to report on each measurement is reduced, which lessens the cost of the technique.

Financial considerations

Analysis of the cost-benefit of ambulatory blood pressure measurement is complex and awaits full study. It is more expensive than measurement of conventional blood pressure, but the evidence strongly suggests benefits to patients justify the additional expense.

Training requirements

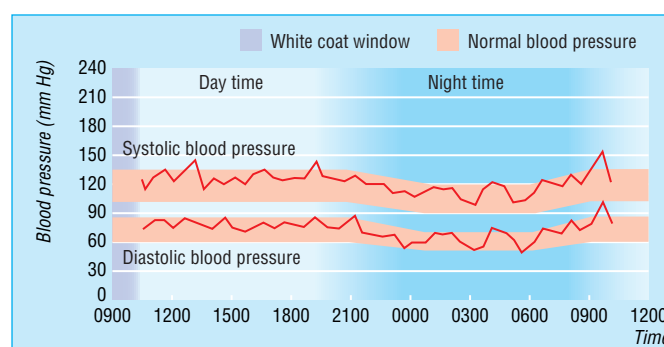
Measurement of ambulatory blood pressure is a specialised technique and should be approached with the care reserved for any such procedure. An understanding of the principles of the measurement of conventional blood pressure, cuff fitting, monitor function, and analysis and interpretation of the data produced is needed. In practice, a nurse with an interest and experience in hypertension can master the use of devices to measure ambulatory blood pressure after relatively little training. Analysis and interpretation of profiles for ambulatory blood pressure, however, need experience in the technique; this is achieved best by the doctor in charge of a service that provides ambulatory blood pressure measurement.

Using a monitor

Time needs to be allowed to fit the monitor and prepare the patient for the monitoring period if good results are to be obtained. The key to successful measurement of ambulatory blood pressure is educating the patient on the process of monitoring, and the instructions should be explained and printed on a diary card. Blood pressures recorded during the 24 hours can be analysed in a number of ways, which can be selected in the software program. One simple and popular method is to assess the time of awakening and sleeping from entries in diary cards. Another method uses fixed times, in which the retiring period (2101 to 0059) and rising period



Devices to measure ambulatory blood pressure



Plot of ambulatory blood pressure. Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)

Financial considerations in measurement of ambulatory blood pressure

Against

- Devices remain expensive but are becoming cheaper
- Staff need to be trained on the use and interpretation of data
- Staff need to fit monitors, instruct patients, and download data from recorders

In favour

- Identifies patients with white coat hypertension and masked hypertension
- Reduces drug prescribing
- Helps decision making for insurance proposals
- Helps decision making for employers
- Shows efficacy of treatment
 - More efficient prescribing of drugs
 - Decreased prescribing of drugs
- Identifies patients with nocturnal hypertension at high risk for stroke
- Predicts outcome more accurately than other blood pressure measurements

Using a monitor to measure ambulatory blood pressure

- 15–30 minutes needed
- Patient should be relaxed in quiet room
- Enter patient details into monitor
- Measure blood pressure in each arm
 - If difference in systolic blood pressure <10 mm Hg, use non-dominant arm
 - If difference in systolic blood pressure ≥10 mm Hg, use higher pressure arm
- Select appropriate cuff
- Select frequency of measurement—usually every 30 minutes day and night
- Inactivate liquid crystal display
- Give patient written instructions and a diary card
- Instruct patient on how to remove and inactivate monitor after 24 hours

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(0601 to 0859; during which blood pressure is subject to considerable variation) are eliminated. The daytime period lasts from 0900 to 2100 and the night-time period from 0100 to 0600. In this way, variations between young and old people and between people of different cultures are eliminated, to some extent, from the analysis.

The reproducibility of measurements of ambulatory blood pressure is improved when the measurements are taken on like days—for example, working days or recreational days. A diary card may be used to record symptoms and events that could influence ambulatory blood pressure measurement.

Editing data

Many statistical techniques exist to describe different aspects of ambulatory records, and no one method is ideal. If sufficient measurements are available, editing is not needed to calculate average values for 24 hours, daytime, and night-time. Only grossly incorrect readings should be deleted from recordings.

Normal levels

As with the measurement of conventional blood pressure, normal ranges for ambulatory blood pressures have been the subject of much debate over the years. General agreement is that levels of ambulatory blood pressure are appreciably lower than normal levels for conventional blood pressure.

Clinical indications

Ambulatory blood pressure measurement provides a large number of measurements over a period of time, usually 24 hours, which can be plotted to give a profile of the behaviour of a person's blood pressure. In practice, although the average daytime or night-time values from ambulatory blood pressure measurement are used to make decisions, the clinical use of ambulatory blood pressure has identified a number of phenomena in hypertension.

Suspected white coat hypertension

White coat hypertension, or isolated office hypertension, is present in people who seem to have hypertension from measurement of conventional blood pressure but have normal ambulatory blood pressure. The most popular definition of white coat hypertension requires:

- blood pressure measured by conventional techniques in the office, clinic, or surgery $>140/90$ mm Hg on at least three occasions
- normal ambulatory blood pressure throughout the 24 hours, except for the first hour, when the patient is under the pressor influence of the medical environment while having the monitor fitted.

White coat hypertension is present in 10–20% of clinic referrals for ambulatory blood pressure measurement; the reported prevalence in the population is around 10%. Patients with high conventional blood pressure and normal average daytime ambulatory pressures have a higher risk of major cardiovascular events than those with clinically normal blood pressure and a lower risk than those with high pressures during the daytime. White coat hypertension may affect young people, elderly people, people with normal blood pressure, those with hypertension, and pregnant women.

White coat effect

White coat hypertension should be distinguished from white coat effect, which is the term used to describe the increase in

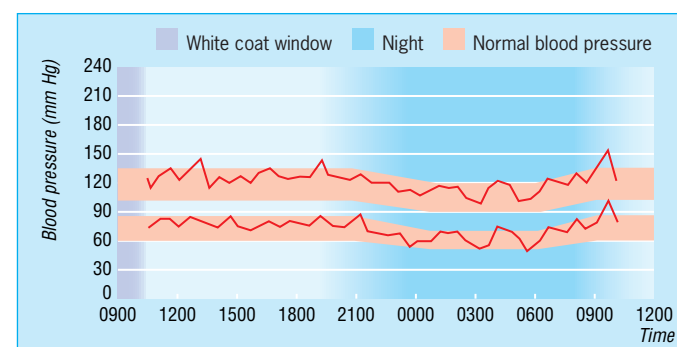
Requirements for satisfactory measurement of ambulatory blood pressure

- Measurements taken every 30 minutes day and night
- Measurements sometimes taken every 15 minutes
 - Can interfere with activity during the day
 - Can interfere with sleep at night
- Daytime minimum—14 measurements of systolic and diastolic blood pressure
- Night-time minimum—seven measurements of systolic and diastolic blood pressure
- If minimum requirement not met, measurement should be repeated

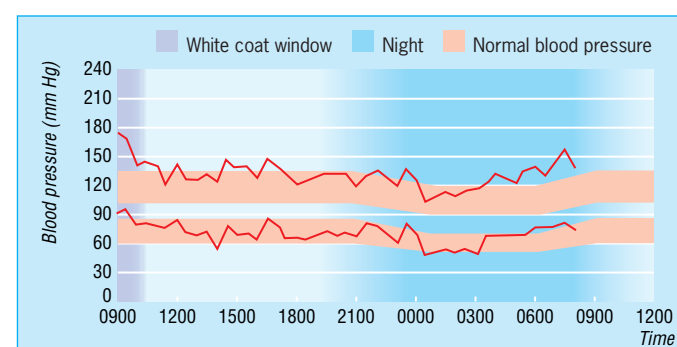
Recommended normal levels for ambulatory blood pressure in adults*

Status	Blood pressure (mm Hg)		
	Optimal	Normal	Abnormal
Awake	$< 130/80$	$< 135/85$	$> 140/90$
Asleep	$< 115/65$	$< 120/70$	$> 125/75$

*Normal and abnormal demarcation levels based on evidence from several studies. Evidence not available to make recommendations for intermediate pressure ranges between normal and abnormal levels or for recommendations lower than those given. The levels are only a guide to normality, and lower optimal levels may be more appropriate in patients whose total profile of cardiovascular risk factors is high, and those with comorbid disease.



Normal ambulatory blood pressure monitoring pattern—On the basis of the data recorded and the available literature, the ambulatory blood pressure monitoring pattern suggests normal 24-hour systolic and diastolic blood pressure (128/78 mm Hg daytime, 110/62 mm Hg night-time). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)



White coat hypertension—On the basis of the data recorded and the available literature, the ambulatory blood pressure monitoring pattern suggests white coat hypertension (175/95 mm Hg) with otherwise normal 24-hour systolic and diastolic blood pressure (133/71 mm Hg daytime, 119/59 mm Hg night-time). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)

Consequences of failing to identify white coat hypertension

- People penalised for insurance and pension policies and employment
- Lifelong treatment prescribed unnecessarily
- Adverse effects of drugs more likely
- Inappropriate use of drugs in elderly people, with possible debilitating consequences

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pressure that occurs in the medical environment regardless of the daytime ambulatory blood pressure. It is present in most patients with hypertension, who usually tend to have conventional blood pressures higher than the average daytime ambulatory blood pressure, which is still higher than normal.

Masked hypertension (isolated ambulatory hypertension)

Recently, patients in whom conventional blood pressure is normal but ambulatory blood pressure is high have been identified. Because ambulatory blood pressure gives a better classification of risk than conventional blood pressure, these people should be regarded genuinely as being hypertensive and at risk. The problem for doctors in clinical practice is how to identify and manage these patients, who may number as many as 10 million people in the United States.

Resistant hypertension

Ambulatory blood pressure may be useful in patients with resistant hypertension (conventional blood pressure consistently >150/90 mm Hg despite treatment with three antihypertensive drugs). It may indicate that the apparent lack of response is the result of the white coat phenomenon.

Elderly patients in whom treatment is being considered

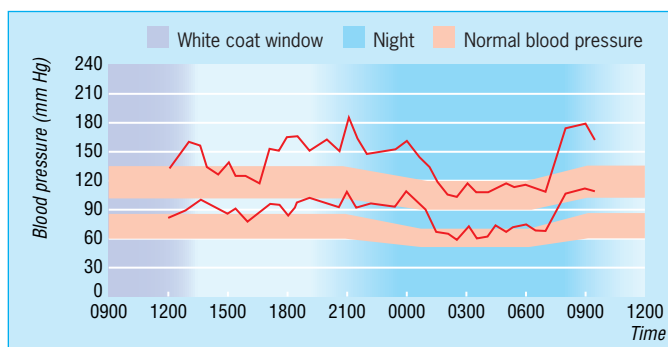
A number of patterns of ambulatory blood pressure may be found in elderly people. Conventional systolic blood pressure in elderly people may be an average of 20 mm Hg higher than daytime ambulatory blood pressure. A number of hypotensive states as a result of baroreceptor or autonomic failure are common in elderly people. As elderly people particularly can be susceptible to the adverse effects of drugs used to reduce blood pressure, identification of hypotension becomes especially important, although its management may present a considerable therapeutic challenge.

Isolated diastolic hypertension

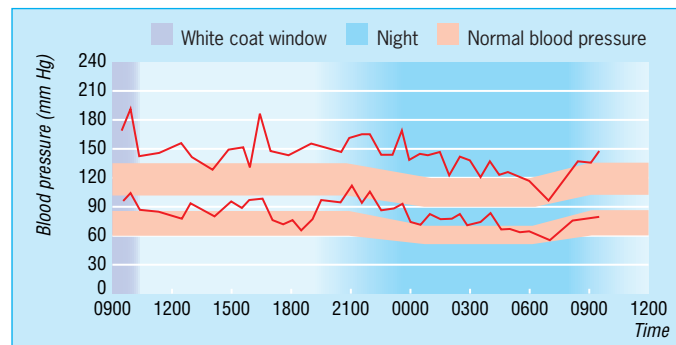
High diastolic blood pressure with normal systolic ambulatory blood pressure increasingly is being recognised. The importance of isolated diastolic hypertension awaits further research.

Suspected nocturnal hypertension

Ambulatory blood pressure measurement allows blood pressure to be measured during sleep. Recent evidence showed that people whose blood pressure remains high at night (non-dippers) rather than falling below daytime levels (as in most people) are at higher risk of stroke, heart attack, and cardiovascular death. The pattern of non-dipping may provide



Hypertensive dipper. On basis of recorded data and available literature, ambulatory blood pressure suggests mild daytime systolic and diastolic hypertension (147/93 mm Hg) and normal night-time systolic and diastolic blood pressure (111/66 mm Hg) with white coat effect (158/90 mm Hg). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)



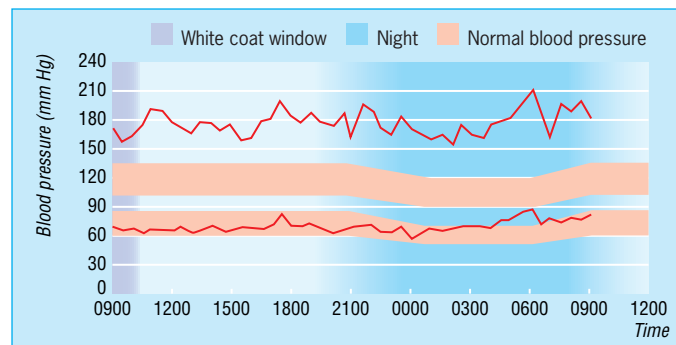
White coat effect—On the basis of the data recorded and the available literature, the pattern suggests mild daytime systolic hypertension (149 mm Hg), borderline daytime diastolic hypertension (87 mm Hg), borderline night-time systolic hypertension (121 mm Hg), and normal night-time diastolic blood pressure (67 mm Hg) with white coat effect (187/104 mm Hg). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)

Factors suspicious for masked hypertension

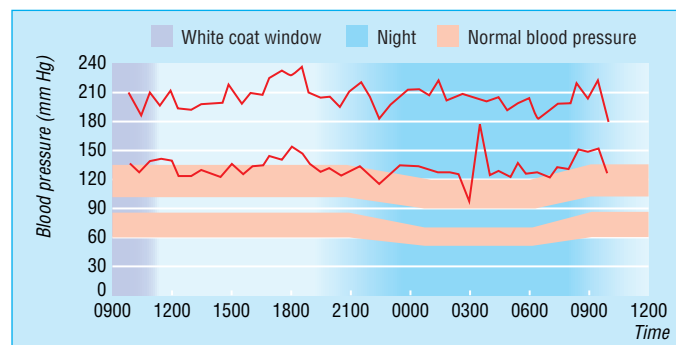
- High conventional blood pressure recorded at some time
- Normal or normal-high conventional blood pressure and early left ventricular hypertrophy in a young patient
- Family history of hypertension in two parents
- Multiple risks for cardiovascular disease
- Diabetes

Patterns of ambulatory blood pressure in elderly people

- White coat hypertension (common)
- Masked hypertension
- Isolated systolic hypertension (most common)
- Nocturnal hypertension
- Autonomic or baroreceptor failure (daytime hypotension or nocturnal hypertension)
- Postural hypotension
- Drug induced hypotension
- Postprandial hypotension



Isolated systolic hypertension—On basis of recorded data and available literature, the pattern suggests severe 24-hour isolated systolic hypertension (176/68 mm Hg daytime, 169/70 mm Hg night-time). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)



Hypertensive non-dipper—On basis of recorded data and available literature, the pattern suggests severe systolic and diastolic hypertension over 24 hours (209/135 mm Hg daytime and 205/130 mm Hg at night). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)

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a useful (although non-specific) clue to the presence of secondary hypertension in a patient.

Pregnancy

As in the non-pregnant state, the main use for ambulatory blood pressure measurement in pregnancy is to identify white coat hypertension, which may occur in nearly 30% of pregnant women. Its recognition is important, so that pregnant women are not admitted to hospital or given antihypertensive drugs unnecessarily or excessively. Normal values for ambulatory blood pressure in the pregnant population are available, and changes in pressure, which occur during the trimesters of pregnancy and the postpartum period, have been defined.

Type I diabetes

In people with type I diabetes, a blunted or absent drop in blood pressure from day to night is an even more serious predictor for increased cardiovascular complications than in patients with hypertension without diabetes. The aim of antihypertensive drugs should be to achieve lower levels of blood pressure in diabetic than in non-diabetic patients.

Ambulatory hypotension

Ambulatory blood pressure measurement is helpful in identifying hypotensive episodes in elderly people, but it also may be used in young patients in whom hypotension is suspected as a cause of symptoms. Ambulatory blood pressure measurement may also show drug induced decreases in blood pressure in patients being treated for hypertension.

Who should be monitored

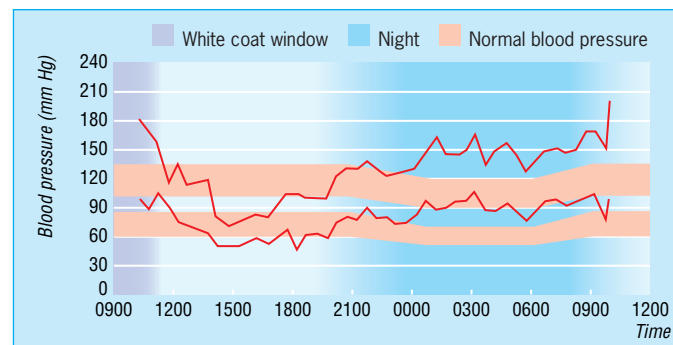
Ambulatory blood pressure measurement may be inconvenient to patients and should be used, therefore, with discretion. The decision as to when to repeat ambulatory blood pressure measurement is largely one of clinical judgment. The frequency of repeat ambulatory blood pressure measurement must be guided by the response to treatment, the stability of blood pressure control, and the overall cardiovascular risk profile. Where the risk for cardiovascular complications is high, the frequency is more than justified by the need for tight blood pressure control, whereas when the risk is low, less frequent measurement is needed. Self-measurement of blood pressure may be combined with ambulatory blood pressure measurement to reduce the frequency of the latter.

Indications for re-monitoring for ambulatory blood pressure measurement

- Subjects with white coat hypertension
- Treated patients with major white coat effect
- Elderly patients with symptoms suggesting orthostatic hypotension
- Patients with nocturnal hypertension
- To compare effect of changes in medication
- High-risk patients
- Diabetic patients

Mean (SD) ambulatory blood pressures during pregnancy

Gestation (weeks)	Blood pressure (mm Hg)			
	Daytime		Night-time	
	Systolic	Diastolic	Systolic	Diastolic
9–16	115 (8)	70 (7)	100 (7)	55 (5)
18–24	115 (8)	69 (6)	99 (8)	54 (6)
26–32	116 (9)	70 (7)	101 (8)	55 (6)
33–40	119 (9)	74 (7)	106 (8)	58 (7)



Ambulatory hypotension—On basis of recorded data and available literature, ambulatory blood pressure monitoring pattern suggests low daytime systolic blood pressure (100 mm Hg) and normal daytime diastolic blood pressure (61 mm Hg) and moderate night-time systolic and diastolic hypertension (146/89 mm Hg) with white coat effect (200/102 mmHg). Plot and report generated by dabl ABPM—© dabl 2006 (www.dabl.ie)

The role of ambulatory blood pressure in guiding drug treatment is the subject of much research, but recent reviews have highlighted the potential of ambulatory blood pressure measurement over 24 hours in guiding the use of antihypertensive drugs

Ambulatory blood pressure measurement as a guide to drug treatment

- Efficacy of treatment in patients with white coat effect
- Efficacy of treatment over 24 hours—especially during the night
- Shows excessive effects of drugs matched to occurrence of symptoms
- Shows drug induced hypotension

Suggested frequency for repeat ambulatory blood pressure measurement

- White coat hypertension pattern—confirm diagnosis in 3–6 months
- White coat pattern and low risk profile—repeat ambulatory blood pressure measurement every 1 to 2 years
- White coat hypertension pattern and high risk profile—repeat ambulatory blood pressure measurement every 6 months to detect possible transition to sustained hypertension requiring treatment
- To determine efficacy of treatment
 - If low risk and controlled without target organ damage—annual ambulatory blood pressure measurement
 - If high risk and/or poorly controlled with target organ damage—more frequent ambulatory blood pressure measurement