Clinical Usefulness of Ambulatory Blood Pressure Monitoring

PAOLO VERDECCHIA, FABIO ANGELI, and ROBERTO GATTOBIGIO
Department of Cardiovascular Disease, University of Perugia, Hospital R. Silvestrini, Località S. Andrea delle Fratte, Perugia, Italy

Abstract. During the past decade, several prospective studies showed that ambulatory BP (ABP) measurements provide a better prediction of major cardiovascular events when compared with clinic BP measurements. This review summarizes the available evidence supporting the use of ABP monitoring to refine prognostic stratification in hypertension. On the basis of available evidence, an operational flowchart is suggested to interpret results of ABP for better treatment of patients with elevated BP.

The first device for noninvasive ambulatory BP (ABP) monitoring (ABPM) was developed in 1962 and subsequently modified by Sokolow et al. in 1966 (1). It used a microphone taped over the brachial artery, a cuff inflated by the patient, and a magnetic tape recorder for storing cuff pressure (1). During the past 20 yr, new devices have been developed and ABPM is now widely used for research and clinical purposes. Evidence is accumulating that ABP measurements provide a better prediction of clinical outcome as compared with conventional clinic BP measurements (2–19). This review examines the evidence supporting the use of ABPM, discusses the advantages of ABPM over clinic BP to predict clinical outcome, and provides information on how to interpret ABPM profile and on when it should be used in clinical practice.

Which Is the Rationale for Use of ABPM in Clinical Practice?

Association between ABPM and Target Organ Damage

Most studies have shown that end-organ damages associated with hypertension, including left ventricular (LV) hypertrophy, proteinuria, serum creatinine, atherosclerotic plaque, narrowing of the retinal arteries, and impaired arterial distensibility and compliance, are more strongly correlated with ABPM than with clinic BP measurements (2–16). The association between clinic BP and hypertension-related organ damage is relatively poor because the main limitations of clinic BP are those referred to the marked variability of BP measurements and the white-coat effect.

ABPM and Prediction of Clinical Outcome

In treated or untreated patients with hypertension, ABP is a significantly better predictor of cardiovascular (CV) and cerebrovascular events than clinic BP measurements (2–19). Table 1 provides an overview of event-based prognostic studies on ABP published in full-length papers by several independent groups. Each group is represented in Table 1 with its largest contribution (2–19). Even if most of the available evidence on the prognostic value of ambulatory BP relies on subjects who were untreated at the time of ABPM, a recent study from our group provided substantial evidence that achieved ambulatory BP during treatment is a potent determinant of the subsequent events and that its potency is superior to both pretreatment ABP and pretreatment and in-treatment clinic BP (17).

How to Interpret ABP Profile

An average daytime ABP <135 mmHg systolic and 85 mmHg diastolic is generally considered normal for adults; levels <130/80 mmHg may be considered optimal (20–23).

White-Coat Hypertension

White-coat hypertension (WCH), also referred to as office hypertension or isolated clinic hypertension (21), is generally defined by a persistently elevated clinic BP in the presence of a normal BP outside the hospital or doctor’s office (3). In the PIUMA study (3), we showed that CV morbidity is lesser in subjects with WCH than in those with ambulatory hypertension and not dissimilar between WCH and clinically normotensive subjects. In a subsequent analysis (19), we found that a daytime ABP <130 mmHg systolic and 80 mmHg diastolic may be considered optimal to identify WCH subjects at very low CV risk.

White-Coat Effect

The measurement of BP in the physician’s office may trigger an alerting reaction and a rise in BP (24–26). The transient rise in BP from before to during the visit is usually defined and measured as “white-coat effect” or “white-coat phenomenon,” whereas the clinical situation in which persistently high office BP and normal ABP coexist (regardless of the degree of the “white-coat effect”) is referred to as WCH. From a practical standpoint, the white-coat effect is a measure of BP change from before to during the visit (24,25), whereas WCH is an operative definition of a stratum of clinically hypertensive subjects who are potentially at low risk because of normal BP levels during usual daily life. In the setting of the PIUMA
study, the rate of total and fatal CV disease events did not show any independent association with the office-ambulatory BP difference, taken as a measure of the white-coat effect (6).

Day-Night BP Changes

BP usually follows a circadian pattern with values peaking during the daytime hours falling to a nadir after midnight (27,28). From an operational standpoint, hypertensive subjects are divided, on the basis of their BP dip, or change, from day to night, into "dippers" and "nondippers" (reduction in BP >10%) (29). Several studies carried out in independent centers showed that not only LV hypertrophy (30–32) but also the risk of CV mortality (15,18), silent cerebrovascular disease (33,34), microalbuminuria (35,36), and progression of renal damage (37) were greater in subjects with blunted or abolished fall in BP from day to night than in those with normal day-night BP difference.

In the PIUMA study, a greater LV mass in nondippers than in dippers was found only in subjects with abnormally increased ABP values but not in the normotensive subjects or in subjects with WCH (38). Thus, a blunted day-night BP fall may be expected to be harmful only when the average level of ABP is abnormal. Considering the night/day ratio, a continuous measure of the BP reduction from day to night (4), we found that the rate of CV events significantly increased in both genders with the night/day ratio of systolic BP even after adjustment for age, diabetes, and 24-h systolic ABP.

BP Variability

Twenty-four-hour noninvasive ABPM monitoring allows some estimate of random BP variability (i.e., that as a result of occasional stressors during day or night). In the PIUMA study, for any level of 24-h systolic BP, hypertensive subjects were classified at low or high BP variability according to their SD of daytime and nighttime systolic BP below or above the median. LV mass at echocardiography did not differ between the groups at low versus high systolic BP variability (39). Then we showed that the variability score for daytime and nighttime systolic pressure failed to enter in a model that included age, diabetes, previous CV events, and average nighttime systolic BP (5). Thus, the adverse impact of increased BP variability seemed to be spurious and resulting from the confounding effect of age, BP, diabetes, and previous CV morbid events, all potential markers of increased vascular damage and reduced baroceptor sensitivity (40).

Ambulatory Heart Rate

Several studies showed a direct association between resting heart rate and risk of mortality in essential hypertension (41,42). Clinic, average 24-h, daytime and nighttime heart rates exhibited no association with total mortality (7). However, hypertensive subjects with a blunted reduction of heart rate from day to night exhibit, for each 10% less reduction in the heart rate from day to night, a relative risk of mortality equal to 1.30 (95% confidence interval, 1.02 to 1.65).

Ambulatory Pulse Pressure

A significant association has been noted in several studies between pulse pressure (PP) and subsequent rate of CV morbid events, and such association was independent of systolic and diastolic BP (3,43–46). In the setting of the PIUMA study (3,8), we showed that CV morbidity and mortality markedly increased with average 24-h ambulatory PP. More recently (48), we found that 24-h PP was an independent predictor of fatal cardiac events, and 24-h mean BP was an independent predictor of fatal cerebrovascular events. These findings suggest that in subjects with predominantly systolic and diastolic hypertension, ambulatory mean BP and PP exert a different predictive effect on the cardiac and cerebrovascular complications.
Why and When ABPM Should Be Considered

According to the JNC VI Committee (20) and the World Health Organization/International Society of Hypertension Committee (21), ABPM should be considered in the following situations:

1. Suspected WCH
2. Excessive BP variability over the same or different clinical visits
3. Symptoms suggesting hypotensive episodes in the presence or absence of antihypertensive treatment
4. Apparent resistance to multiple drug treatment

However, as shown in Table 1, the available evidence supporting the prognostic value of ambulatory BP is now remarkable and based mostly on outcome cohort studies in which the qualifying BP monitoring had been carried out in untreated subjects with essential hypertension (2–12,14,19). Therefore, a grade B recommendation with a 2b level of evidence (47) would be that of considering the clinical utility of ABPM for refinement of CV risk stratification above and beyond traditional risk markers in all untreated subjects with essential hypertension as well as in those with resistant hypertension despite three or more drugs. In contrast, there is still limited evidence (13,16,17) that ABP refines CV risk stratification in treated hypertensive subjects, particularly in those well controlled by therapy. From an operational standpoint (49), ABP could first identify a low-risk stratum of untreated hypertensive subjects with “normal” mean levels of ABP (WCH). In the subjects with more elevated ABP (ambulatory hypertension), a nondipping pattern, as well as an elevated 24-h PP (8), would identify a high-risk category. The remaining subjects would belong to an intermediate risk category (Figure 1).

The Centers for Medicare and Medicaid Services in the United States recently approved ABPM for reimbursement in “patients with suspected WCH” because the information deriving from the technique “is necessary to determine the appropriate management of the patient” (50). This decision is likely to exert a significant impact on the clinical use of ABPM in the United States.

References


Figure 1. Operational approach for cardiovascular risk stratification based on ambulatory BP in untreated subjects with essential hypertension. Modified from (49).


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