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Research Article

Utility of ambulatory blood pressure monitoring in the evaluation of elevated clinic blood pressures in children

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Abstract

Although ambulatory blood pressure monitoring (ABPM) is recognized for its role in assessing white coat hypertension, other uses include evaluation of treatment adequacy, nocturnal hypertension, dipping status, and hypertension severity. We performed a retrospective study of ABPMs completed at a single center from November 2007 to October 2011 to determine the frequency of white coat hypertension, prehypertension, and hypertension in children and the correlation of these findings with office BPs. A total of 247 ABPMs were performed in 206 children, ages 4–20 years, including 48 recordings in 39 diabetic patients and 64 recordings in treated hypertensive patients. We found a poor correlation between hypertensive status based on clinic BP and diagnosis on ABPM, and evidence for a white coat effect. Among treated patients, ABPM results resulted in medication changes in 63%. We conclude that ABPM is a useful tool for characterizing hypertensive status and treatment adequacy in children. J Am Soc Hypertens 2016;10(5):406–412.

Keywords: ABPM; Blood pressure; child; hypertension.

Introduction

Studies have shown that hypertension (HTN) in childhood and adolescence predisposes to HTN in adulthood, thus early identification and treatment of HTN has become an important aspect of pediatric preventive care.[1–3] In the past, clinicians have relied on office readings to diagnose HTN, but this method can incorrectly classify children with elevated blood pressures (BPs). Home BP machines have also been used, but this method has drawbacks as well. Twenty-four–hour ambulatory BP monitoring (ABPM) has become increasingly used in evaluating pediatric patients with elevated BPs, in particular ruling out white coat hypertension (WCH) and evaluating nocturnal BPs. Blunted nocturnal dipping, an early manifestation of altered hemodynamics in diabetics, and masked hypertension, in which the BP is normal in the office, but elevated in an ambulatory setting, can only be demonstrated with ABPM. Although current consensus guidelines do not directly specify the routine use of ABPM, many pediatric practitioners consider it to be the gold standard for evaluating elevated BPs in children.[4]

Our nephrology clinic has been using 24-hour ABPM for the past several years to diagnose hypertension and assess degree of BP control in known hypertensives. The present study has several goals. First, we sought to determine the incidence of WCH, prehypertension, and hypertension among patients not on antihypertensive medications who underwent ABPM in our clinic and how this compared with a diagnosis based on office BP. We also wanted to determine the predictive value of an office BP classified as Stage 2 hypertension in correctly identifying severe

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ambulatory hypertension on ABPM and to characterize recordings with isolated elevations in diastolic pressures. Finally, we assessed the utility of ABPM in determining degree of BP control among patients on antihypertensive medication(s).

Methods

We performed a retrospective review of all ambulatory BP recordings performed at our center between November 2007 and October 2011. The Space Labs 90217 monitor, validated in children, was used for all ABPM.[5] The nondominant arm was used and patients were encouraged to attend school but avoid vigorous activity. Awake and sleep times were set according to patient diaries. Office records were reviewed to determine the reason for ABPM recording. In untreated patients, ABPM was performed to: rule out WCH, evaluate severity of hypertension (HTN), evaluate for masked HTN, or assess nocturnal dipping. The general practice of our clinic is to perform ABPM in every patient referred for elevated BP. Exceptions to this practice are made for patients unable to tolerate the procedure for developmental or behavioral reasons (typically this includes patient under 7 years of age) and, occasionally, for reimbursement issues. In those on antihypertensive therapy, ABPM was performed to assess for white coat effect (WCE; BP more elevated in office than at home) or to assess the adequacy of antihypertensive therapy. Office records were reviewed to ascertain whether antihypertensive therapy had been altered as a result of ABPM findings.

ABPM were interpreted using American Heart Association (AHA) guidelines at the time of interpretation, with mean BPs >95th percentile for sex and height classified as hypertensive.[6] In patients who were ≥18 years of age, adult thresholds were used: 140/85 (awake) and 120/70 (asleep).[7] Recordings were classified as normal, prehypertensive, or hypertensive as defined in the AHA guidelines.[6] The AHA guidelines from 2008 only considered systolic BP (SBP) in classification of BPs. In contrast, we categorized ABPMs on the basis of either SBP or diastolic blood pressure (DBP). Recordings were classified as normal if the mean awake and sleeping SBP and DBP were below threshold and BP loads were <25%. Recordings were classified as prehypertensive if the mean BPs were under threshold but BP loads fell between 25%–50%. Recordings were classified as hypertensive if the mean BP was above threshold (either >95th percentile) and BP load was elevated to 25%–50%, or severe ambulatory hypertension if the mean BP was above threshold and the BP loads were above 50%. Blunted dipping was defined as <10% drop in mean BP with sleep. The nephrologist interpreting the ABPM determined the adequacy of each recording, in accordance with 2008 AHA criteria.[6] The mean of the mean arterial pressure (MAP) was compared with published thresholds in a subgroup of patients who had isolated diastolic abnormalities on ABPM.[6] With regard to 24-hour monitoring, nocturnal dipping status was noted but not factored into the ultimate diagnosis.

Our study population included patients with chronic kidney disease (CKD) and diabetes mellitus (DM). Given the elevated risk of cardiovascular disease in these groups, lower thresholds were used in classifying patients as normotensive, prehypertensive, or hypertensive on ABPM. For patients <18 years of age, the 90th percentile for sex and height was used, while for those >18 years of age, the adult thresholds of 130/85 (awake) and 110/70 (asleep) were used.[7] Using these thresholds, the same AHA diagnostic criteria for prehypertension, hypertension, and severe ambulatory hypertension were applied.

All patients included in the study had elevated clinic BPs documented on at least three occasions, either in our clinic or at the primary care provider, before placement of ABPM. Casual BP (cBP) readings obtained at the time of placement, or at the preceding office visit when ABPM was ordered, were compared with findings on ABPM. A minimum of three cBP readings was obtained by Dinamap and/or auscultation at each visit, per our clinic protocol. Oscillometric readings were obtained using the Dinamap ProCare Auscultatory 300 or 400. The first reading was discarded and subsequent readings were averaged. For the purposes of this study, cBP was classified using this average as follows[8,9]: normal—BP < 90th percentile for age, sex, and height or <120/80 for those ≥18 years of age; prehypertensive—BP between 90th–95th percentile or between 120/80 and 140/90 for those ≥18 years of age; hypertension Stage 1—BP > 95th–99th percentile + 5 mm Hg or >140/90 to 160/100 for those ≥18 years of age; and hypertension Stage 2—BP > 99th percentile + 5 mm Hg or >160/100 for those ≥18 years of age.

To compare BP readings across all patients, including those with CKD and DM, indices were calculated by dividing the SBP by the 95th percentile BP. This was done for both cBP and mean awake BP on ABPM. Data were analyzed and figures created using Microsoft Excel and Stata 12.1 (Stata Corp., College Station, TX).

Results

This study included 247 ABPM recordings in 206 individual children and adolescents. Thirty-six patients had two or more recordings. Patient characteristics based on BP classification using cBPs (or "treated" if the patient was already on medication at the time of the test) are shown in Table 1. The ages of the patients ranged from 4–20 years, with the mean ages for all groups between 11 and 15 years. Most patients in each group were white, reflecting the demographics of the patients seen in our center. More than half of the patients in all groups were male. There were 47 recordings on a total of 39 diabetic patients, the majority