Title: Automated Ambulatory Blood Pressure Monitoring for the Diagnosis of Hypertension in Patients with Elevated Office Blood Pressure

Professional
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Institutional
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September 15, 2016; July 11, 2017
Current Effective Date: December 7, 2012

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<th>Populations</th>
<th>Interventions</th>
<th>Comparators</th>
<th>Outcomes</th>
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<tr>
<td>Individuals: • With elevated office blood pressure</td>
<td>Interventions of interest are: • 24-hour automated ambulatory blood pressure monitoring</td>
<td>Comparators of interest are: • Office blood pressure measurement • Home blood pressure measurement</td>
<td>Relevant outcomes include: • Test accuracy • Other test performance measures • Morbid events • Medication use</td>
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DESCRIPTION
Ambulatory blood pressure (BP) monitors (24-hour sphygmomanometers) are portable devices that continually record BP while the patient is involved in daily activities. There are various types of ambulatory monitors; this policy addresses fully automated monitors, which inflate and record BP at pre-programmed intervals. Ambulatory blood pressure monitoring (ABPM) has the potential to improve the accuracy of diagnosing hypertension and thus improve the appropriateness of medication treatment.

OBJECTIVE
The objective of this policy is to evaluate the accuracy and clinical utility of ambulatory blood pressure monitors to assess individuals with elevated office blood pressure.

BACKGROUND
Typically done over a 24-hour period with a fully automated device, ambulatory blood pressure monitoring (ABPM) provides more detailed blood pressure (BP) information than readings typically obtained during office visits. The greater number of readings with ABPM ameliorates the variability of single BP measurements and is more representative of the circadian rhythm of BP.

There are a number of potential applications of ABPM. One of the most common is evaluating suspected white coat hypertension (WCH), which is defined as an elevated office BP with normal BP readings outside the physician’s office. The etiology of WCH is poorly understood but may be related to an “alerting” or anxiety reaction associated with visiting the physician’s office.

In assessing patients with elevated office BP, ABPM is often intended to identify those with normal ambulatory readings who do not have sustained hypertension. Because this group of patients would otherwise be treated based on office BP readings alone, ABPM could improve outcomes by allowing these patients to avoid unnecessary treatment. However, this assumes patients with WCH are not at increased risk for cardiovascular events and would not benefit from antihypertensive treatment.

This policy does not directly address other uses of ABPM, including its use for the evaluation of “masked” hypertension. Masked hypertension refers to normal BP readings in the office and elevated BP readings outside of the office. This phenomenon has recently received greater attention, with estimates that up to 10% to 20% of individuals may exhibit this pattern. Other uses of ABPM include monitoring patients with established hypertension under treatment; evaluating refractory or resistant BP; evaluating whether symptoms such as lightheadedness correspond with BP changes; evaluating night-time BP; examining diurnal patterns of BP; and other potential uses.
REGULATORY STATUS

Many ambulatory blood pressure monitors have received clearance to market through the U.S. Food and Drug Administration (FDA) 510(k) marketing clearance process. As an example of an FDA indication for use, the Welch Allyn ABPM 6100 is indicated “as an aid or adjunct to diagnosis and treatment when it is necessary to measure adult or pediatric patients’ systolic and diastolic blood pressures over an extended period of time.”

POLICY

A. Automated ambulatory blood pressure monitoring (ABPM) performed one time over a 24 hour period with FDA approved devices may be considered medically necessary, for the evaluation of individuals with any of the following:

1. Suspected "White Coat Hypertension" (WCH) defined as:
   - In-office BP >140/90 mmHg on at least three separate clinic/office visits with two separate measurements taken at each visit; and
   - At least two documented separate BP measurements taken outside the office setting which are <140/90 mmHg: and
   - No evidence of end-organ damage

2. Resistant hypertension being treated with three or more antihypertensive medications at therapeutic doses.

3. Hypertensive individuals with hypotensive symptoms and/or syncopal events thought to be related to antihypertensive medications or neurological syndromes, including autonomic dysfunction.

4. Episodic hypertension suspected when office BP measurements are normal and associated symptoms (eg, excessive sweating, palpitations, pallor) suggest episodic hypertension secondary to an existing condition.

5. Suspected autonomic dysfunction.

Policy Guidelines

1. For pediatric patients, the principles of ABPM use to confirm a diagnosis of hypertension are the same as in adults, but there are special considerations as follows (Flynn et al, 2014):
   a. A device should be selected that is appropriate for use in pediatric patients, including use of a cuff size appropriate to the child’s size.
   b. Threshold levels for the diagnosis of hypertension should be based on pediatric normative data, which use gender- and height-specific values derived from large pediatric populations.
c. Recommendations from the American Heart Association concerning classification of hypertension in pediatric patients using clinic and ambulatory BP are given in Table 1:

Table PG1. American Heart Association Classification of Ambulatory BP Levels in Children (Flynn et al, 2014)

<table>
<thead>
<tr>
<th>Classification</th>
<th>Clinic BP</th>
<th>Mean Ambulatory SBP</th>
<th>SBP Loada</th>
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</thead>
<tbody>
<tr>
<td>Normal BP</td>
<td>&lt;95th percentile</td>
<td>&lt;95th percentile</td>
<td>&lt;25%</td>
</tr>
<tr>
<td>WC HTN</td>
<td>&gt;95th percentile</td>
<td>&lt;95th percentile</td>
<td>&lt;25%</td>
</tr>
<tr>
<td>Masked HTN</td>
<td>&lt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>&gt;25%</td>
</tr>
<tr>
<td>Pre-HTN</td>
<td>&gt;95th percentile</td>
<td>&lt;95th percentile</td>
<td>25-50%</td>
</tr>
<tr>
<td>Ambulatory HTN</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>25-50%</td>
</tr>
<tr>
<td>Severe Ambulatory HTN</td>
<td>&gt;95th percentile</td>
<td>&gt;95th percentile</td>
<td>&gt;50%</td>
</tr>
</tbody>
</table>

BP: blood pressure; HTN: hypertension; SBP: systolic blood pressure; WC: white coat

*Percent of SBP readings that are above 95th percentile for gender and height

**RATIONALE**

The evidence for this policy has been updated periodically with literature reviews of the MEDLINE database. The most recent update with literature review covered the period through May 10, 2017.

The evidence base for this review was informed by a 1999 TEC Assessment and a subsequent 2001 reanalysis of this report conducted by the Centers for Medicare and Medicaid Services. The focus the current review is on the use of ambulatory blood pressure monitoring (ABPM) in previously untreated patients with elevated office blood pressure (BP). In this situation, ABPM is primarily intended to evaluate white coat hypertension (WCH), or “isolated clinic hypertension.” This entity is defined as an elevated office BP with normal BP readings outside the physician’s office. It is diagnosed by obtaining multiple out-of-office BP measurements and comparing them with office readings.

Evidence on whether ABPM improves health outcomes for patients with elevated office BP will be summarized in 3 general areas of research:

1. Reference values for ABPM,
2. Accuracy of ABPM as a diagnostic test for hypertension, and
   a. Prospective cohort studies
   b. Cross-sectional studies.
3. Impact of ABPM on outcomes
   c. Clinical trials
   d. Prospective cohort studies.

**Reference Values for ABPM Monitoring**

Establishing reference values for ABPM is integral to providing guidelines for “normal” and “abnormal” ABPM readings. Studies that have compared ABPM measurements with office measurement have consistently revealed lower ABPM values. Therefore, it is not possible to use reference values for office BP to evaluate the results of ABPM.
Reference values for ABPM have been derived by several methods: (1) estimates of population-based ABPM results to define the range and distribution of ABPM values; (2) direct comparisons of average ABPM values and office BP to determine the level of ABPM that corresponds to an office BP of 140/90 mm Hg; and (3) correlations of ABPM results with cardiovascular outcomes to determine ABPM levels at which the risk for cardiovascular events increases, or is similar to the risk associated with an office BP of 140/90 mm Hg.\(^6,7\)

Although specific recommendations vary slightly, current thresholds for defining a normal ABPM are 24-hour average BP of 130/80 mm Hg and daytime average BP of 135/85 mm Hg. A 1999 ABPM consensus conference task force on ABPM considered data on the statistical distribution of ABPM, correlation with office BP, and correlation with cardiovascular outcomes in deriving recommendations for reference values for ABPM.\(^8\) Their recommendations are summarized in Table 1. Subsequent studies have identified racial and ethnic variations in ABPM results,\(^9\) but the impact of these differences on clinical management may be minimal.\(^10\)

### Table 1. ABPM Consensus Conference Task Force IV: Adult ABPM Thresholds\(^8\)

<table>
<thead>
<tr>
<th>ABPM Measure</th>
<th>95th Percentile</th>
<th>Normotension, mm Hg</th>
<th>Hypertension, mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-hour average, mm Hg</td>
<td>132/82</td>
<td>≤130/80</td>
<td>&gt;135/85</td>
</tr>
<tr>
<td>Daytime average, mm Hg</td>
<td>138/87</td>
<td>≤135/85</td>
<td>&gt;140/90</td>
</tr>
<tr>
<td>Nighttime average, mm Hg</td>
<td>123/74</td>
<td>≤120/70</td>
<td>&gt;125/75</td>
</tr>
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</table>

ABPM: ambulatory blood pressure monitoring.

**Section Summary: Reference Values for ABPM Monitoring**

Reference values for normal and abnormal ABPM results have been derived from epidemiologic research. These reference values vary slightly across sources, but are available for clinical use.

**Accuracy of ABPM as a Diagnostic Test for Hypertension**

Studies of the accuracy of ABPM as a diagnostic test for hypertension are of 2 types. First, prospective cohort studies that correlate results of ABPM with future cardiovascular events and compare this correlation with that of office BP measurements and provide indirect evidence on ABPM accuracy by assuming that the more accurate test will have a higher correlation with hypertension-related outcomes. Second, cross-sectional, diagnostic accuracy studies can directly compare the accuracy of ABPM with office BP, using a criterion standard for diagnosis. For these types of studies, ABPM is often considered the criterion standard, and accuracy of other methods of BP measurement is compared with ABPM.

**Prospective Cohort Studies**

Many prospective cohort studies have compared ABPM with office BP in predicting cardiovascular events. Although results of these studies are not entirely consistent, most have reported that ABPM has greater predictive ability for cardiovascular events than office BP measurement.\(^11,12\) A summary of relevant systematic reviews and meta-analyses of these studies follows.

Hansen et al (2007) conducted a patient-level meta-analysis using data from 4 populations in Belgium, Denmark, Japan, and Sweden (total N=7030 patients).\(^13\) The predictive values of ABPM and in-clinic BP for fatal and nonfatal cardiovascular events were reported. Both ABPM and office BP were predictors of outcomes in univariate and partially adjusted multivariate models. In the fully adjusted model, ABPM remained a significant predictor of outcomes while office BP did not.
Conen and Bamberg (2008) conducted a meta-analysis of 20 cohort studies that evaluated the correlation between ABPM and outcomes, controlling for office BP in the analysis. Reviewers reported that ABPM was a strong predictor of cardiovascular outcomes and that controlling for office BP had little effect on risk estimates. These results support the hypothesis that risk information obtained from ABPM is independent of that obtained from office BP.

Cross-Sectional Diagnostic Accuracy Studies
A systematic review by Piper, conducted for the U.S. Preventive Services Task Force (USPSTF), identified 7 studies of diagnostic accuracy were identified. Four were rated high quality and 3 moderate quality. Four studies directly compared ABPM with automated office BP readings. Using ABPM as the reference standard, the sensitivity of office BP measurement for the diagnosis of hypertension ranged from 51% to 91%, specificity ranged from 97% to 98%, and the positive predictive value ranged from 76% to 84%.

Numerous other studies have directly compared ABPM with office BP and/or home self-measured BP. Hodgkinson et al (2011) performed a systematic review of studies that compared ABPM with home or office BP and used defined thresholds to determine the accuracy of diagnosis of hypertension. Of 10 studies identified, 7 compared ABPM with office BP measurements and 3 compared ABPM with home self-measurement. Using a 24-hour ABPM threshold of 135/85 mm Hg, clinic BP measurements had a sensitivity of 75% (95% confidence interval [CI], 61% to 85%) and a specificity of 75% (95% CI, 48% to 90%). Home BP self-measurement had a sensitivity of 86% (95% CI, 78% to 91%) and a specificity of 62% (95% CI, 48% to 75%). The accuracy of office and home BP was considered inadequate for use as a single diagnostic test for hypertension, and it was hypothesized that the use of office and/or home measurements might lead to substantial overdiagnosis and overtreatment.

In a similar systematic review, Stergiou and Bliziotis (2011) compared the accuracy of ABPM with home BP measurement for the diagnosis of hypertension. Sixteen studies were selected for analysis. The sensitivity of home BP measurement, compared with ABPM, ranged from 36% to 100% (median, 74%). The specificity ranged from 44% to 96% (median, 84%). Reviewers also reported the diagnostic agreement between the 2 methods of BP measurement, as measured using the κ statistic. Kappa could be calculated in 11 studies; the range of scores was 0.37 to 0.73 (median, 0.46). This κ level indicates moderate agreement between ABPM and home monitoring in the diagnosis of hypertension.

Lovibond et al (2011) performed a cost-effectiveness study comparing ABPM with office BP measurement and home measurements. For most patient indications, ABPM resulted in the greatest amount of quality-adjusted life years gained, and, in individuals older than age 50 years, ABPM was consistently associated with the largest incremental gain in quality-adjusted life years. The se of ABPM produced cost-saving in all patient groups compared with alternatives and remained the most cost-effective alternative under the majority of sensitivity analyses. As a result of these findings, the authors recommended that ABPM be performed for most patients before the decision to start antihypertensive medications is made.

Other Studies
A number of trials have evaluated ABPM for the management of established hypertension, comparing the effect of ABPM use on BP control and medication use with usual care based on office
measurements. Some studies have compared home self-monitoring with ABPM and office measurement for management of medication treatment. Others have attempted to determine predictors of WCH based on clinical factors and office BP readings. However, these areas of research do not provide specific evidence on the use of ABPM for diagnosing and treating patients with elevated office BP and, thus, are not included in the final evidence base for this review.

**Section Summary: Accuracy of ABPM as a Diagnostic Test for Hypertension**

Studies comparing home BP monitoring to office monitoring with ABPM as the criterion standard have reported that the sensitivity and specificity of alternative methods of diagnosing hypertension are suboptimal.

**Impact of ABPM on Outcomes**

**Randomized Controlled Trials**

Direct evidence of the efficacy of ABPM for improving outcomes in this the outpatient setting would be obtained from randomized controlled trials comparing outcomes for (1) patients diagnosed and treated based on conventional BP measurements alone with (2) patients additionally undergoing ABPM used to guide therapy (eg, withholding or randomizing treatment among those with WCH). This notion parallels the statement from the U.S. National High Blood Pressure Education Program working group on ABPM in 1992: “Ideally, de novo longitudinal studies should be undertaken to determine which ambulatory profiles are associated with increased cardiovascular risk and what transformations of ambulatory profiles induced by antihypertensive therapy are associated with reductions in risk.” Randomized controlled trials using ABPM to monitor treatment response but not to diagnose hypertension have been conducted. However, a substudy of the Systolic Hypertension in Europe (Syst-Eur) trial (2000) addressed this question indirectly.

The Syst-Eur trial, a large, multicenter randomized controlled trials (2000), enrolled patients 60 years of age or older with isolated systolic hypertension and randomized them to antihypertensive treatment or placebo. A substudy evaluated 695 patients (from the total Syst-Eur sample of 4695 patients) who underwent 24-hour ABPM in addition to the usual study protocol. Conventional BP was defined from the mean of 6 baseline clinic BP readings (2 readings obtained with the patient seated at each of 3 baseline visits at least 1 month apart). Participants were classified into 3 groups based on ABPM readings: nonsustained hypertension (ie, WCH), mild-sustained hypertension, and moderate-sustained hypertension. Reduction in cardiovascular events was compared between active and placebo groups among patients in each category. For patients with nonsustained hypertension, there was a numerically lower rate of adverse outcomes in the treated group for stroke (0 vs 2, p=0.16) and cardiovascular events (2 vs 6, p=0.17), ie, differences were not statistically significant. There was a significant reduction in events with treatment only among patients with moderate-sustained hypertension.

Staessen et al (1999) analyzed follow-up data (median follow-up, 4.4 years) from an apparently overlapping subset of 808 older individuals from the Syst-Eur trial who had isolated systolic hypertension measured conventionally (ie, systolic BP, 160-219 mm Hg; diastolic BP, <95 mm Hg) and BP by ABPM. Average systolic BP and diastolic BP were higher with conventional measurements (by 21.9 and 1.9 mm Hg, respectively). ABPM was significantly associated with cardiovascular end points, even when conventional BP was taken into account.
Prospective Cohort Studies

Well-designed, prospective cohort studies could provide indirect evidence on the potential benefit of treating patients with WCH. Ideally, prospective studies would compare outcomes of untreated patients with WCH to normotensive and sustained hypertensive patients (the latter being treated). Studies would have to control for important potential confounders such as adequacy of BP control, age, sex, smoking status, lipid levels, and diabetes. Well-designed and conducted prospective cohort studies finding that untreated WCH patients have a cardiovascular event risk similar to that of normotensive patients would imply these patients accrue little treatment benefit. In contrast, if the cardiovascular risk for patients with WCH is increased, then there is a potential benefit to treatment.

A systematic review by Piper et al was performed for the USPSTF and identified 11 cohort studies that compared ABPM with alternate methods for predicting cardiovascular events. Six studies were rated good quality and 5 were rated fair quality. There was a significant correlation between ABPM measures and outcomes in most studies. For each 10-mm increase in the average 24-hour systolic BP, the hazard ratio (HR) for fatal and nonfatal cardiovascular events ranged from 1.11 to 1.42, and the hazard ratio for stroke ranged from 1.28 to 1.40.

Numerous large cohort studies have used ABPM to identify patients with WCH and compared subsequent cardiovascular outcomes in WCH patients, normotensive patients, and sustained hypertensive patients. These studies have generally been consistent in reporting that cardiovascular risk for patients with WCH is intermediate, between that of hypertensive patients and normotensive patients. For example, a 2015 meta-analysis found that mean left ventricular mass index and mean left atrial diameter in patients with WCH was intermediate, between that of hypertensive patients and normotensive individuals. A 2014 review found that, in patients with WCH, prevalence of cardiovascular risk factors (eg, glucose dysregulation, diabetes, increased left ventricular mass index, sustained hypertension) was increased compared with normotensive individuals, but the risk of cardiovascular events was not. Reviewers attributed the latter finding to the frequent use of antihypertensive treatment in WCH.

At least 3 other meta-analyses have summarized results of cohort studies. Fagard and Cornelissen (2007) assessed data from 7 cohort studies that compared outcomes in 4 groups of patients: normotensive patients, WCH patients, “masked” hypertensive patients, and sustained hypertensive patients (total N=11,502 patients). Average follow-up in these studies was 8.0 years. Using normotensive patients as the reference standard, the risk for patients with WCH was not significantly higher (HR=1.12; 95% CI, 0.84 to 1.50). There was an increased risk for patients with “masked” hypertension (HR=2.00; 95% CI, 1.58 to 2.52) and patients with sustained hypertension (HR=2.28; 95% CI, 1.87 to 2.78).

Hansen et al (2007) used patient-level data from 4 previous cohorts to construct an international database of ABPM. This database included 7069 patients from 4 cohorts in Europe and Japan that represented population-level patient samples. In this analysis, although the point estimate for the hazard ratio between cardiovascular event risk and WCH was greater than 1 (1.22), there was no significant association between cardiovascular event risk and the presence of WCH (HR=1.22; 95% CI, 0.96 to 1.53; p=0.09). Statistically increased risks were found in patients with “masked” hypertension (HR=1.62; 95% CI, 1.35 to 1.96; p<0.001) and sustained hypertension (HR=1.80; 95% CI, 1.59 to 2.03; p<0.001).
A third pooled analysis by Verdecchia et al (2005) included studies conducted in the United States, Italy, and Japan. This analysis compared short- and long-term stroke risks among 4406 individuals with essential hypertension and 1549 normotensive controls; none was treated at baseline. WCH was present in 9% of the hypertensive group. During the first 6 years, follow-up stroke incidence appeared similar among WCH and normotensive groups. However, by 9 years, stroke incidence among WCH patients reached that of the hypertensive group (measured by ABPM). At the last telephone contact or clinic visit, similar proportions of those initially classified as WCH and normotensive were receiving antihypertensive medications from 5 different drug classes. This result suggests WCH may not be entirely benign.

Section Summary: Impact of ABPM on Outcomes
Data from large prospective cohort studies have established that ABPM correlates more strongly with cardiovascular outcomes than other methods of BP measurement, and that WCH, as defined by ABPM, is associated with an intermediate risk of cardiovascular outcomes compared with normotensive and hypertensive patients.

ABPM in Children and Adolescents
ABPM has been used in children and adolescents for similar purposes as in adults, including use in children and adolescents with elevated office BP to distinguish true hypertension from WCH. The evidence base for children and adolescents is smaller but generally consistent with evidence in adults. A representative sample of studies identified follows.

Normative values for pediatric patients have been established by large population-based studies of children and adolescents. Elevated readings are defined as values greater than the 95th percentile for sex, age, and height. These studies have also established that patterns of ambulatory BP in children differ from those in adults. In children, ambulatory BP is generally higher than the corresponding office BP, in contrast to adult ambulatory BP readings that are on average lower than office BP. This pattern is more pronounced in younger children, and the difference progressively declines with age. Guidelines for classification of hypertension in children and adolescents were published by the American Heart Association in 2008.

In a European study, 139 children and adolescents between the ages of 4 and 19 years with elevated office BP were evaluated by ABPM. Thirty-two (23.0%) of 139 participants had WCH, as evidenced by a normal 24-hour ABPM result. Of patients with true hypertension, 21 (19.6%) of 107 had evidence of target organ damage, compared with none of the patients with WCH. In a similar study (2000) from the United States, 67 otherwise healthy children underwent ABPM, 51 of whom had an elevated office BP. Using 3 definitions of WCH of varying BP cutoffs, WCH was identified in 22% to 53% of children with elevated office BP. In a 2002 study from Japan, 206 children and adolescents between the ages of 6 and 25 years underwent ABPM, 70 of whom had elevated office BP. Among the 70 patients with elevated office BP, 33 (47%) had WCH, as defined by a normal ABPM result. A “white coat” effect of 10 mm Hg or more was reported in 50% of patients with office hypertension and 25% of patients with normal office BP.

Section Summary: ABPM in Children and Adolescents
Reference values for normal and abnormal ABPM results in children and adolescents, derived from epidemiologic research, have been used to differentiate WCH from true hypertension in pediatric patients.
SUMMARY OF EVIDENCE

For individuals with elevated office blood pressure (BP) who receive 24-hour automated ambulatory blood pressure monitoring (ABPM), the evidence includes randomized controlled trials, cohort studies, and studies of diagnostic accuracy. Relevant outcomes are test accuracy, other test performance measures, morbid events, and medication use. Data from large prospective cohort studies have established that ABPM correlates more strongly with cardiovascular outcomes than with other methods of BP measurement. When compared directly to other methods, ABPM performed over a 24-hour period has higher sensitivity, specificity, and predictive value for the diagnosis of hypertension than office or home BP measurements. Substantial percentages of patients with elevated office BP have normal BP on ABPM (white coat hypertension). Prospective cohort studies have reported that patients with white coat hypertension have an intermediate risk of cardiovascular outcomes compared with normotensive and hypertensive patients. The benefit of medication treatment in these patients is uncertain, and they are at risk for overdiagnosis and overtreatment based on office BP measurements alone. Use of ABPM in these patients will improve outcomes by eliminating unnecessary pharmacologic treatment and avoiding adverse events in patients not expected to benefit. The evidence is sufficient to determine qualitatively that the technology results in a meaningful improvement in the net health outcome.

PRACTICE GUIDELINES AND CONSENSUS STATEMENTS

National Institute for Health and Care Excellence

The U.K.’s National Institute for Health and Care Excellence (NICE) issued updated its 2011 guidance on hypertension in 2016.46 For diagnosing hypertension, NICE made the following recommendations concerning ABPM:

- “If the clinic blood pressure is 140/90 mmHg or higher, offer ambulatory blood pressure monitoring (ABPM) to confirm the diagnosis of hypertension.
- When using ABPM to confirm a diagnosis of hypertension, ensure that at least two measurements per hour are taken during the person’s usual waking hours.
  - Use the average of at least 14 measurements taken during usual waking hours to confirm a diagnosis of hypertension.”

Canadian Hypertension Education Program

Guidelines for blood pressure measurement, diagnosis, and risk assessment have been published annually by the Canadian Hypertension Education Program. Strength of evidence underlying recommendations is graded ranging from “A” (studies with high internal validity, statistical precision, and generalizability) to “D” (expert opinion).

The 2015 recommendations47 include the following statements:

- “Ambulatory BP readings can be used in the diagnosis of hypertension (grade C).
- ABPM should be considered when an office-induced increase in BP is suspected in treated patients with:
  - BP that is not below target despite receiving appropriate chronic antihypertensive therapy (grade C);
  - symptoms suggestive of hypotension (grade C); or
  - fluctuating office BP readings (grade D).
- Ambulatory monitoring upper arm devices that have been validated independently using established protocols must be used (grade D).
• Therapy adjustment should be considered in patients with a mean 24-hour ambulatory BP monitoring SBP of \( \geq 130 \) mm Hg or DBP of \( \geq 80 \) mm Hg or an awake SBP of \( \geq 135 \) mm Hg or DBP of \( \geq 85 \) mm Hg (grade D).
• The magnitude of changes in nocturnal BP should be taken into account in any decision to prescribe or withhold drug therapy based upon ambulatory BP (grade C) because a decrease in nocturnal BP of less than 10% is associated with increased risk of CV events.”

The 2016 annual update to the Canadian Hypertension Education Program was accompanied by an additional publication issuing a new algorithm that strongly recommends the performance of out-of-office measurement (ABPM or home blood pressure monitoring) after the first visit, specifically to identify patients with white coat hypertension (WCH) early in the process. It was emphasized that out-of-office measurement is preferred to serial standardized office measurement and the latter should be used only when the resources (human, technical, or financial) to perform out-of-office measurement are not available.\(^{48,49}\)

**American Heart Association**

The American Heart Association published consensus recommendations in 2008.\(^{42}\) These recommendations were updated in 2014.\(^{50}\) Consensus recommendations for routine ABPM included the following:

- To confirm the diagnosis of hypertension in a patient with hypertension according to casual BP measurements
  - Determine whether sustained hypertension or WCH exists.
- To evaluate for the presence of masked hypertension when there is a clinical suspicion of hypertension but normal or prehypertensive casual measurements
- To assess BP patterns in high-risk patients
  - Assess for abnormal circadian variation in BP, such as blunted dipping or isolated sleep hypertension in patients with diabetes mellitus, chronic kidney disease, solid organ transplants, and severe obesity with or without sleep-disordered breathing.
  - Assess the severity and persistence of BP elevation in patients at high risk for hypertensive target-organ damage.
- To evaluate effectiveness of drug therapy for hypertension
  - Confirm BP control in treated patients, especially those with secondary forms of hypertension.
  - Evaluate for apparent drug-resistant hypertension.
  - Determine whether symptoms can be attributed to drug-related hypotension.

**European Society of Cardiology/European Society of Hypertension**

In 2013, the European Society of Hypertension and European Society of Cardiology published joint evidence-based guidelines on the management of arterial hypertension.\(^{51}\) These guidelines recommended ABPM or home blood pressure monitoring for out-of-office BP measurements depending on indication, availability, ease, cost of use, and patient preference (class 2b recommendation [usefulness/efficacy is less well established; use may be considered] based on level C evidence [consensus expert opinion and/or small studies, retrospective studies, or registries]).
European Society of Hypertension
Since 2003, the European Society of Hypertension has published consensus-based guidelines on ABPM. Updates in 2013 and 2014 identified the white coat phenomenon, masked hypertension, and nocturnal hypertension as indications for ABPM.

In 2016, the Society made specific recommendations for children and adolescents; measurements made with the purpose of diagnosis, evaluation during treatment, as well as in clinical trials and other conditions, in which the presence of orthostatism or rapid and episodic elevation of BP are difficult to detect in the office. The authors stated: “Especially in children, 24-hour ABPM should be recommended before starting antihypertensive treatment, to avoid treating with drugs children with ‘white-coat hypertension’.”

National High Blood Pressure Education Program
The fourth report on the diagnosis, evaluation, and treatment of high BP in children and adolescents was published in 2004. This report made the following statements concerning the use of ABPM in children and adolescents:

- ABPM is especially helpful in the evaluation of WCH, as well as the risk for hypertensive organ injury, apparent drug resistance, and hypotensive symptoms with antihypertensive drugs.
- ABPM is also useful for evaluating patients for whom more information on BP patterns is needed, such as those with episodic hypertension, chronic kidney disease, diabetes, and autonomic dysfunction.
- Conducting ABPM requires specific equipment and trained staff. Therefore, ABPM in children and adolescents should be used by experts in the field of pediatric hypertension who are experienced in its use and interpretation.

Joint National Committee VII
The seventh report of the Joint National Committee on the prevention, detection, evaluation, and treatment of high BP, released in 2003, includes a brief section on the use of ABPM. The report states that “[a]mbulatory blood pressure monitoring is warranted for the evaluation of (white-coat) hypertension in the absence of target organ damage. It is also helpful to assess patients with apparent drug resistance, hypotensive symptoms with antihypertensive medications, episodic hypertension, and autonomic dysfunction.”

U.S. PREVENTIVE SERVICES TASK FORCE
The U.S. Preventive Services Task Force (USPSTF) published a recommendation in 2015 that individuals 18 years and older be screened for hypertension. The following recommendation was given a grade A rating:

“The USPSTF recommends screening for high blood pressure in adults aged 18 years or older. The USPSTF recommends obtaining measurements outside of the clinical setting for diagnostic confirmation before starting treatment.”

The document further elaborated on the choice of office measurements, with the following statement about ABPM:

“The USPSTF found convincing evidence that ABPM is the best method for diagnosing hypertension. Although the criteria for establishing hypertension varied across studies, there was significant discordance between the office diagnosis of hypertension and 12- and 24-
hour average blood pressures using ABPM, with significantly fewer patients requiring
treatment based on ABPM. Elevated ambulatory systolic blood pressure was consistently and
significantly associated with increased risk for fatal and nonfatal stroke and cardiovascular
events, independent of office blood pressure. For these reasons, the USPSTF recommends
ABPM as the reference standard for confirming the diagnosis of hypertension.”

ONGOING AND UNPUBLISHED CLINICAL TRIALS
Some currently unpublished trials that might influence this review are listed in Table 2.

Table 2. Summary of Key Trials

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ongoing</td>
<td>Comparative Effectiveness of Ambulatory Blood Pressure Monitoring vs Usual Care for Diagnosing and Managing Hypertension: A Pilot Study</td>
<td>30</td>
<td>Jun 2016 (ongoing)</td>
</tr>
</tbody>
</table>

NCT: national clinical trial.

CODING
The following codes for treatment and procedures applicable to this policy are included
below for informational purposes. Inclusion or exclusion of a procedure, diagnosis or device
code(s) does not constitute or imply member coverage or provider reimbursement. Please
refer to the member’s contract benefits in effect at the time of service to determine coverage
or non-coverage of these services as it applies to an individual member.

CPT/HCPCS
93784 Ambulatory blood pressure monitoring, utilizing a system such as magnetic tape
and/or computer disk, for 24 hours or longer; including recording, scanning
analysis, interpretation and report
93786 Ambulatory blood pressure monitoring, utilizing a system such as magnetic tape
and/or computer disk, for 24 hours or longer; recording only
93788 Ambulatory blood pressure monitoring, utilizing a system such as magnetic tape
and/or computer disk, for 24 hours or longer; scanning analysis with report
93790 Ambulatory blood pressure monitoring, utilizing a system such as magnetic tape
and/or computer disk, for 24 hours or longer; review with interpretation and
report
A4670 Automatic blood pressure monitor

ICD-9 Diagnoses
401.0 Essential hypertension, malignant
401.1 Essential hypertension, benign
401.9 Unspecified essential hypertension
796.2 Elevated blood pressure reading without diagnosis of hypertension

ICD-10 Diagnoses (Effective October 1, 2015)
I10 Essential (primary) hypertension
I11.0 Hypertensive heart disease with heart failure
I11.9  Hypertensive heart disease without heart failure
R03.0  Elevated blood-pressure reading, without diagnosis of hypertension
Z01.30 Encounter for examination of blood pressure without abnormal findings
Z01.31 Encounter for examination of blood pressure with abnormal findings

REVISIONS

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
</table>
| 11-06-2003 | Added #4 a and b - “One follow up test will be allowed at least three weeks after initial test for:  
|            | a. patients diagnosed with white-coat hypertension or  
|            | b. assessment of hypertension apparently resistant to appropriate therapy. |
| 09-18-2009 | In Description section:  
|            | • Updated wording                                                                 |
|            | In Policy section:  
|            | • Updated indications From:  
|            | "Ambulatory blood pressure monitoring: will be allowed for patients with symptoms meeting the following criteria:  
|            | 1. Failed home blood pressure monitoring  
|            | 2. Office pressure greater than 180/95 but less than 105 diastolic.  
|            | 3. Treatment resistant and taking multiple medications.  
|            | 4. One follow up test will be allowed at least three weeks after initial test for:  
|            | a. Patients diagnosed with white-coat hypertension or  
|            | b. Assessment of hypertension apparently resistant to appropriate therapy." |
|            | To:  
|            | "Automated ambulatory blood pressure monitoring (ABPM) includes multiple blood pressure (BP) measurements over a 24-hour period and is considered medically necessary, for up to 72 hours with FDA-approved devices, for the evaluation of individuals with any of the following:  
|            | 1. Suspected "White Coat Hypertension" (WCH) which is defined as:  
|            | • In-office BP >140/90 mmHg on at least three separate clinic/office visits with two separate measurements taken at each visit; and  
|            | • At least two documented separate BP measurements taken outside the office setting which are <140/90 mmHg; and  
|            | • No evidence of end-organ damage  
|            | 2. Individuals with resistant hypertension who are being treated with three or more medications  
|            | 3. Hypertensive individuals with hypotensive symptoms and/or syncopal events thought to be related to antihypertensive medications or neurological syndromes, including autonomic dysfunction.  
|            | 4. Episodic hypertension suspected when office BP measurements are normal and associated symptoms (e.g., excessive sweating, palpitations, pallor) suggest episodic hypertension secondary to an existing condition.  
|            | 5. Suspected autonomic dysfunction." |
| 12-07-2012 | Updated Coding section:  
|            | • Added HCPCS code: A4670. |
|            | In the Policy section:  
|            | • In the policy statement, removed "includes multiple blood pressure (BP) measurements over a 24 hour period and is" and inserted "performed one time over a 24 hour period"
Automated ambulatory blood pressure monitoring (ABPM) performed one time over a 24 hour period with FDA approved devices may be considered medically necessary..."

- In the policy statement, removed "for up to 72 hours with FDA approved devices" to read "may be considered medically necessary, for the evaluation of individuals with any of the following:"
- In Item #1, removed "which is" to read "Suspected White Coat Hypertension defined as:"
- In Item #2, revised "Individuals with resistant hypertension who are being treated with three or more medications" to read "Resistant hypertension being treated with three or more antihypertensive medications at therapeutic doses."

**Updated Rationale section.**

**Updated Reference section.**

**02-26-2013**

- Updated Rationale section.
- Updated Reference section.

**12-31-2013**

- In Coding section:
  - Added ICD-10 Diagnosis *(Effective October 1, 2013)*

**03-18-2015**

- Title of policy changed from "Ambulatory Blood Pressure Monitoring."
- Updated Description section.
- In Policy section:
  - Added Policy Guidelines:
    - "1. For pediatric patients, the principles of ABPM use to confirm a diagnosis of hypertension are the same as in adults, but there are special considerations as follows(1):
      - a. A device should be selected that is appropriate for use in pediatric patients, including use of a cuff size appropriate to the child’s size.
      - b. Threshold levels for the diagnosis of hypertension should be based on pediatric normative data, which use gender- and height-specific values derived from large pediatric populations.
      - c. Recommendations from the American Heart Association concerning classification of hypertension in pediatric patients using clinic and ambulatory BP are given in Table 1:
    - Added Table 1.

- Updated Rationale section.

- In Coding section:
  - Added ICD-10 codes I11.0, I11.9, Z01.30, and Z01.31.
  - Removed ICD-9 code 796.4.
  - Removed ICD-10 code R68.89.

- Updated References section.

**09-15-2016**

- Updated Description section.
- Updated Rationale section.
- Updated References section.

**07-11-2017**

- Updated Description section.
- Updated Rationale section.
- Updated References section.
REFERENCES
2. Blue Cross and Blue Shield Association Technology Evaluation Center (TEC). 24-hour ambulatory blood pressure monitoring for the evaluation of patients with elevated office blood pressure. TEC Assessments. 1999;Volume 14:Tab 8.


Other References
1. Blue Cross and Blue Shield of Kansas Family Practice Liaison Committee, July 2009; July 2012.
2. Blue Cross and Blue Shield of Kansas Internal Medicine Liaison Committee, August 2009.
3. Blue Cross and Blue Shield of Kansas Internal Medicine Liaison Committee, CB, September 2012.