Blood Pressure Measurement Modalities: A Primer for Busy Practitioners

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Having our blood pressure (BP) measured is a common experience when visiting the doctor's office. BP is an important characteristic of general health and often used as an initial diagnostic tool. In the context of patients at risk for developing hypertension, BP screening becomes of paramount importance. High BP is currently the greatest threat to the global burden of disease:[1–3] it continues to be the most common diagnosis in adult primary care practice and the most salient cardiovascular disease risk factor.[4]

Despite this general and specific importance of BP assessment, a methodological incongruity must be borne in mind: while it is remarkably (and arguably scarily) easy to obtain ***a*** BP reading, it can be disturbingly difficult to estimate the ***correct*** BP level in a given circumstance.[5] Pickering and colleagues[6] observed that "Any clinical measurement of BP may be regarded as a surrogate measure for the 'true' BP of the patient, which may be defined as the mean level over prolonged periods." In addition to the long-time standard approach of utilizing manual readings taken using a stethoscope and sphygmomanometer, referred to here as office BP measurement, a triumvirate of additional modalities is now available to physicians wishing to obtain the best representation of a patient's BP: automated office BP measurement, home BP monitoring, and ambulatory BP monitoring (ABPM). A burgeoning (and, for the busy practitioner, potentially daunting) literature describing clinical research employing these approaches is providing increasingly sophisticated evidence about their relative strengths in various circumstances. This editorial therefore samples the literature in a narrative fashion to give practitioners a flavor of current evidence concerning each assessment modality, particularly home BP monitoring and ABPM.

MANUAL MEASUREMENT IN THE PHYSICIAN'S OFFICE

Many of us are so familiar with the traditional method of measuring BP, which results from the work of pioneers such as Harvey, Hales, Poiseuille, von Basch, Riva-Rocci, and Korotkoff,[7,8] that some of its peculiarities may no longer routinely occur to us. There are two issues. The first is the technique and equipment itself. Mercury manometers have long been replaced with aneroid sphygmomanometers. Aneroid equipment does not contain toxic mercury but does require frequent calibration that is often not performed. (Automated devices also require periodic calibration that is also often overlooked.) The other limitations of this assessment methodology have been well documented[9] and include that it often involves taking just a single reading (a snapshot in time, typically during daytime hours and in the seated position only, although hypertension specialists may take standing and supine readings as well when assessing postural symptoms). These single readings allow for the possibility of the physician's (or that of other healthcare providers) aura temporarily and misleadingly raising the patient's BP—the occurrence known as white-coat hypertension.[10,11] In addition, while this method of BP measurement has been standardized for generations, standards are infrequently adhered to in practice by physicians or by ancillary staff. Nonetheless, since this measurement modality will not vanish altogether in the foreseeable future, optimizing office BP measurement despite these limitations should remain a focus of education in medical and allied healthcare schools.[12–16]

AUTOMATED MEASUREMENT IN THE PHYSICIAN'S OFFICE

The automated office BP measurement modality involves multiple BP readings being taken with a fully automated device while the patient rests quietly and alone in a room within the physician's office suite. Advantages include improved accuracy, reduced digit preferences, absence of observer bias and hence the influence behind white-coat hypertension, and a stronger relationship between BPs taken in this manner with readings obtained via ABPM and target organ damage compared with manual readings.[17,18] Andreadis and colleagues[18] noted that automated office BP measurements correlated more highly with mean awake ABPM readings than did manual BP readings, and that they compared favorably with 24-hour ABPM readings in the appraisal of cardiac remodeling. Myers and colleagues have advocated for automated office BP measurements to replace traditional office BP assessment.[17,19–21] Still, even when using automated BP equipment, most physician offices still measure a single reading, or at most two, if the patient, or the provider, is not happy with the first.

MEASUREMENT AT HOME

As Stergiou and colleagues[22] observed, "In the last two decades, considerable evidence on home BP monitoring has accumulated." They listed advantages of home BP monitoring that include the following: (1) home BP monitoring predicts subclinical target organ damage

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and cardiovascular events in a superior manner than does office BP measurement and in a manner similar to ABPM; (2) home BP monitoring shows considerable agreement with ABPM in detecting white-coat and masked hypertension in both untreated and treated patients; and (3) in treated hypertensive patients, home BP monitoring improves long-term adherence to antihypertensive drug treatment and hence improves hypertension control rates. The authors commented that as long as current recommendations are followed, home BP monitoring should have a "primary role in diagnosis, treatment adjustment, and long-term follow-up of most cases with hypertension."[22]

Additional references are provided.[23–25]

AMBULATORY MEASUREMENT

ABPM facilitates collection of BP readings several times an hour across a 24-hour period. These readings can be aggregated to yield 24-hour means and also grouped into time windows (eg, mean daytime and nighttime values).[4,6,9] These various BP categorizations are valuable for clinical management of hypertension because they increase the accuracy for diagnosis and the prediction of cardiovascular risk.[26] ABPM enables white-coat hypertension to be ruled out, thus precluding patients who do not need pharmacologic interventions at that time from being prescribed such intervention, while also identifying individuals who should commence antihypertensive therapy. It also facilitates the assessment of BP during sleep-time: a nondipping pattern and nocturnal hypertension are strongly associated with increased cardiovascular morbidity and mortality.[4]

Additional references are provided.[27–29]

COMPARISONS OF THE TWO OUT-OF-OFFICE MODALITIES

Given the generally accepted viewpoint that out-of-office measurements have a lot to offer to BP evaluation, various authors have presented comparisons of the different methodologies with which to measure them. For example, Paolasso and colleagues[30] examined whether BP measurement was concordant between home BP monitoring and ABPM and whether treatment modification decisions differed by modality. While the concordance was very good for systolic BP and good for diastolic BP, more treatment modification decisions were made based on ABPM. Kang and colleagues[31] evaluated the accuracy of home BP monitoring in the diagnosis of white-coat and masked hypertension in comparison with ABPM. They reported that home BP monitoring had high specificity but low sensitivity in the diagnoses, and that it may therefore be a useful complement to, but not a replacement for, ABPM.

The forcefulness of opinions expressed varies from passionate advocacy of one modality to equally passionate advocacy of the other. For example, Imai and colleagues[32] commented that the superiority of home BP monitoring over ABPM and office BP measurement "is apparent from almost all practical and clinical research perspectives." They argued that while ABPM provides BP information at many points on a particular (often single) day during unrestricted daily activities, home BP monitoring provides a large amount of BP information obtained at fixed times and conditions over a long period of time: this leads to greater reproducibility of values. They also suggested that patients' active, ongoing involvement in monitoring their own BP leads to greater adherence to antihypertensive medication regimens, a point also made by Stergiou and colleagues.[22] In contrast, O'Brien and colleagues[33] noted one salient advantage of ABPM, the widespread provision of this service that can be facilitated by pharmacists: pharmacists have been shown to provide ABPM services that are as good as those provided by physicians, "and often at a fraction of the cost." Pharmacists can then relay the data to physicians and liaise closely with them to successfully implement the treatment regimens they prescribe based on the ABPM data (for an extended discussion on this topic, see O'Brien[9]).

Given the relatively limited number of studies including both home and ABPM, Breaux-Shropshire and colleagues[34] suggested that both measurement modalities "should be incorporated into the design of randomized clinical trials within hypertensive populations."

Additional references are provided.[35,36]

REIMBURSEMENT POLICIES FOR HOME AND AMBULATORY BP MONITORING

There is no shortage of guidelines addressing out-of-office modalities, nor of discussions of them.[27,28,37–44] Whatever the content of relevant guidelines, however, the advantages of a given modality can only be realized if that modality is available and employed. Scarcity of reimbursement for ABPM contributes considerably to its limited availability in some regions, including the United States. The only currently reimbursable indication from Medicare is suspected white-coat hypertension; private insurers reimburse for more indications, but these vary from carrier to carrier. Many countries outside the United States do not provide any reimbursement.[27] However, this is arguably a "penny wise, dollar foolish" strategy. Although ABPM will be more expensive than a clinic BP measurement, cost-effectiveness in the long term results from avoidance of multiple clinic visits during which BP measurements would be obtained and the cost savings from not treating patients who do not actually need antihypertensive medication because white-coat hypertension was ruled out early on by ABPM.[4]

This rationale formed the basis of the United Kingdom's National Institute for Health and Care Excellence's (NICE's) 2011 guideline for the clinical management of primary hypertension in adults.[45,46] In the section entitled "Diagnosing Hypertension" the following recommendations are made:[45]

- If the clinic BP is 140/90 mm Hg or higher, offer ABPM to confirm the diagnosis of hypertension.
- If a person is unable to tolerate ABPM, home BP monitoring is a suitable alternative to confirm the diagnosis of hypertension.
- If the person has severe hypertension, consider starting antihypertensive drug treatment immediately, without waiting for the results of ambulatory or home BP monitoring.

Of considerable interest to many healthcare professionals in the United States is the fact that the US Preventive Services Task Force (USPSTF) has now released a Draft Recommendation Statement entitled "Hypertension in Adults: Screening and Monitoring," available on their Web site,[47] that also addresses ambulatory and home BP monitoring. The draft statement was made available for public comment for a period of time ending on January 26, 2015, and comments received will be considered by the USPSTF as they prepare the final version of the Recommendation Statement. The draft recommendation reads as follows:

- The USPSTF recommends screening for high BP in adults aged 18 years and older. ABPM is recommended to confirm high BP before the diagnosis of hypertension, except in cases for which immediate initiation of therapy is necessary.

This recommendation is based on the USPSTF's review of available evidence, and their finding that "elevated 24-hour systolic ambulatory BP was consistently and significantly associated with stroke and other cardiovascular outcomes, independent of office BP measurements, and with greater predictive value."[47] Because of its large evidence base, ABPM was considered to be the best confirmatory test for hypertension. The USPSTF also noted that "Home BP monitoring may also be a reasonable confirmatory method but has less evidence supporting its use."[47] If the final version remains true to the intent of the draft recommendation, it will be a strong endorsement of the NICE guideline and it will have profound ramifications for the use of ABPM in the United States.

Evidence of cost-effectiveness of both out-of-office modalities has been discussed in the literature for a decade,[48–50] so what has prevented progress to date? With regard to ABPM, Bloch and Basile[51] observed in 2011 that even if we believe that routine use of ABPM will better secure the diagnosis of hypertension and save money in the long run, "there is simply no group that is appropriately incentivized to make the needed short-term investment required to make it practical in our system." Perhaps the cost-benefit analysis of home BP monitoring vs office BP measurement reported in 2014 by Arrieta and colleagues[52] might exert some influence, since it conveys an insurer perspective. The authors reported as follows: "Our results suggest that reimbursement of home BP monitoring is cost beneficial from an insurer's perspective for diagnosing and treating hypertension. Depending on the insurance plan and age group categories considered, estimated net savings associated with the use of home BP monitoring range from $33 to $166 per member in the first year and from $415 to $1364 in the long run (10 years)."[52]

Additional references are provided.[53,54]

RELATIONSHIPS TO HARD CLINICAL ENDPOINTS

It should be recognized here that, until recently, virtually all established relationships between BP and clinical outcomes of interest have involved office BP measurement. Graves and Sheps[55] provided a useful summary of the findings from multiple large studies. However, this situation is starting to change and various studies are now making at least preliminary steps in examining the relationship between out-of-office measurements and preclinical and clinical target organ damage.[56,57]

CONCLUDING COMMENTS

Despite the conclusive evidence that aggressive BP lowering is beneficial to a broad population of patients with hypertension, it is interesting to note that the majority of clinical trials demonstrating this relied exclusively on office BP measurements by physicians. It should be noted that the recently completed SPRINT trial utilized automated office BP measurement and found similar results.[58] The perhaps inevitable consequence was to effectively "train" healthcare professionals to rely on office BP measurements with similar exclusivity. In the contemporary era, significant improvements in out-of-office BP assessment methods have enabled BP monitoring at any time of day or night by trained professionals or by the patients themselves. There are now ample clinical research data supporting the added value that home BP monitoring and ABPM provide to the busy practitioner, especially when there is concern that office BP measurements may be yielding spurious results, as in cases of white-coat hypertension. Undoubtedly, these additional BP monitoring modalities will someday routinely assist clinicians in more effectively diagnosing and managing BP, thereby improving outcomes. However, practical issues must be overcome before the full potential of these benefits are realized.

First, effective real-world implementation of home BP monitoring and ABPM requires that the US healthcare system expand its BP assessment training to patients in addition to clinicians. Participants in clinical research studies are extensively trained to take measurements only at assigned times and under proper conditions. Similar training must be offered to real-world patients participating in out-of-office BP monitoring to ensure delivery of appropriate, life-extending care.

Second, adequate reimbursement for home BP monitoring and ABPM is an absolute necessity to expand the use of these methods and ensure the quality of the data they provide. Physicians will likely need to spend incrementally more time training patients (or other in-home providers) to use these modalities, transferring the data to patients' health records, and interpreting these

additional data sets to formulate more effective treatment plans. The current dearth of reimbursement for such activities is short-sighted and a disservice to physicians and their patients.

Finally, leading clinicians and researchers must continue to study the potential benefits and pitfalls of these alternate BP assessment modalities in controlled and real-world studies to confirm their benefits, while also exploring methods for ensuring the quality and uniformity of the data. Only after these practical issues are resolved will the true benefit of these methods be realized by the largest numbers of patients in need.

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