EDITORIALS

Is It Time for a Blood Pressure Measurement "Bundle"?

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The poor reliability of clinic-based blood pressure (BP) measurements is not news to any practicing primary care provider (PCP). Many studies have documented significant differences between BP values measured in the context of a clinic visit, a research study, at home, and using ambulatory monitors.[1–3] For this very reason, some PCPs habitually repeat the BP measurements provided by their staff, something they wouldn't necessarily consider for more reliable primary care measures like a patient's body weight.

The study by Ray and colleagues in this issue of JGIM adds to the literature about the reliability of clinic-based BP measurements in a number of ways.[4] First, the authors explore the magnitude of the differences between two BP values independently measured on 40 of their hypertensive patients - one measured by clinical staff at triage, and the other by research assistants using BP measurement methods recommended by the American Heart Association (AHA).[5] Second, the authors use trained observers to identify the types and number of BP measurement errors made by the two groups, using the AHA BP measurement method as the gold standard. Lastly, they examine the impact of the identified differences in BP measurements on treatment decisions.

Their findings are concerning. Over 90% of their patients had a clinically significant difference in BP when measured by the triage staff versus the research assistant. In addition, over 10% of their patients who met their BP goal with the triage method were higher than their BP goal with the AHA method. These differences in BP measurements were likely the result of technical errors by triage staff, which were exceedingly common despite explicit observation by trained researchers. The mean number of errors in BP measurement technique was approximately four per patient, with the most common errors being lack of bilateral measurements (100%), lack of resting 5 minutes prior to measurement (93%), measuring BP over clothes as opposed to a bare arm (93%), not having the patients feet flat on the ground (48%), and incorrect cuff size (40%).

To explore the impact of the differences in BP values resulting from the two measurement methods, the study authors created two written profiles for each patient: one with their AHA BP measurement as their most recent BP and the other using their staff triage BP measurement, and asked three physicians to independently determine whether or not they would initiate or change the patients BP regimen based on the profile, and if so how. The profiles also included the patients' past medical histories, medication lists, allergies, pertinent physical exam findings, lab values, and vital signs from the visit prior to their study visit. In all, 45% of patients would have received different treatments by at least one provider depending on whether their staff triage measurements or their AHA measurements were used in their profiles. The differences in treatment included increasing therapies when the triage BP was falsely elevated, failing to change treatment when it was necessary, or reducing treatment when the triage BP was falsely low.

A strength of the study was that the study patients were randomized to receive either the triage or AHA measurement first. This blunted the potential effects of the ordering of the BP measurement methods on the differences seen between the two measurements. Weaknesses of the study included its small sample size and limited generalizability (only 40 patients were included from a single academic primary care clinic). As the authors note, the types and numbers of BP measurement errors identified may have been a function of the specific clinic, and may differ for clinics with different set-ups or patient characteristics. For example, clinics with arm rests on their triage chairs will have fewer errors related to the position of the arm relative to the heart, and clinics with more obese patients will have fewer errors related to undercuffing. Another limitation was the use of hypothetical clinical scenarios to gauge the impact of the BP differences on provider treatment decisions. In clinical practice, the provider would have had access to more information than that provided in the written scenarios, including the ability to recheck the BP measurements themselves. Thus, the written scenarios may overestimate the number of changes in treatment decisions

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that would have resulted from using the triage BP measurement versus the AHA measurement.

So what are the implications of these findings? First, they suggest that common errors in technique can lead to errors in BP measurement that can actually result in over or under treatment. As numerous studies have shown, chronic under-treatment of hypertension can result in stark increases in morbidity and mortality.[4] This can occur even when systolic BPs are elevated by as little as 5 mmHg over time, or when diastolic BPs are elevated by as little as 2 mmHg over time, which is how "clinical significance" was defined in this study.[4] The consequences of under- or over-treatment also include the use of too few or too many drugs, with their associated costs and complications.

All of this begs the question of how do we improve clinic-based BP measurements? In their conclusion, the authors of the study suggest that clinic staff be better educated on the AHA recommendations for BP measurement.[4] But as described in a previous editorial, standards for BP measurement have existed for over half a century, and staff education alone is unlikely to improve the reliability of BP measurements.[6] Instead, such improvements will likely only occur as a result of multimodal interventions or "bundles", similar to those used by infection preventionists to combat outbreaks or reduce healthcare-associated infections.[7–9]

There are a number of strategies that could be combined into a multifaceted approach to improve clinic BP measurements. Some authors have suggested using regulatory agencies to monitor compliance with BP measurement standards.[6] This could work, but would require the redeployment of regulatory staff or the addition of new regulatory staff to observe BP measurements. In addition, compliance with standards may falter outside the narrow context of surveys by regulators.

Alternatively, patients could be empowered to advocate for themselves. Infection preventionists have taught us the value of this strategy in the area of hand hygiene.[10] Along with asking their physicians if they've washed their hands, patients could ask their physicians to make sure their BP cuff fits, that their BP is measured on a bare arm, and that their feet are resting comfortably on the ground. Such patient empowerment initiatives are becoming increasingly common as patient-centeredness gets its due (most notably with the funding of the Patient Centered Outcomes Research Institute) [11,12] and national organizations like the Joint Commission provide resources like the "Speak Up Program" to help patients advocate for their own care [13]. Healthcare facilities could also use their own clinical staff to monitor and report adherence to BP measurement standards, much like is done for hand hygiene compliance.

Infection preventionists have also taught us the value of systems changes, ergonomics, and human factors engineering to improve compliance with standards in healthcare.[14,15] As described in the current study, measuring BP using the AHA method takes on average nine minutes, which is seven more minutes than the staff BP measurement. This time difference will likely be an impediment to improving staff BP measurements unless systems are changed to reduce this difference in time. Similar to providing new technologies like alcohol-based hand-rub dispensers in convenient locations for improving hand hygiene [16–18], automated BP monitors that measure BPs multiple times without requiring the presence of clinical staff could improve the time difference and performance gap between a staff BP measurement and an AHA measurement [19]. In addition, simple changes to clinic set-up like ensuring the triage areas have chairs with arm rests instead of exam tables would likely increase adherence to many of the AHA BP measurement standards, including the recommendations for patients to have their feet resting on the ground, back supported, arm supported, and arm at the level of the heart during BP measurement. These and other key recommendations could be combined to create a new BP measurement bundle called "5BACC"—a 5-minute wait before measurement, ***b****ilateral* measurements on bare ***a****rms*, the availability of appropriate ***c****uffs*, and BP measurement while patients are seated comfortably in a ***c****hair*. The bundle could even be marketed through a patient advocacy approach, where patients are empowered to ask for "Five Back" whenever they get their BP measured.

Beyond the question of how to improve clinic-based BP measurements, perhaps a more pressing question is whether we should even be using clinic-based BP measurements, knowing how unreliable they can be? Recent studies suggest that home BP measurements and ambulatory BP monitoring (similar to Holter monitoring for arrhythmias) are superior to clinic BP measurements in terms of reliability, accuracy, and ability to predict cardiovascular outcomes.[1,2,6,19,20] The superiority of these home and ambulatory measurements is driven not only by the avoidance of "white-coat" effects, but also by the multiple independent BP measures taken and averaged over time, producing values that are much more reliable than any one clinic-based estimate. Yet, before such measures can become the gold standard for use in the diagnosis and treatment of hypertension, clinical studies need to examine the impact of using home and ambulatory BP measures versus standard clinic based measures on target organ damage resulting from hypertension. Currently, all of the major trials examining the effect of hypertension management on morbidity or mortality have used clinic-based measures.[19] In the meantime, perhaps the best way that we can use clinic-based measurements is to average them over time. The evidence and guidelines support the use of an average of 4-5 independent measures over time to both diagnose and monitor hypertension.[6,19] Some authors have

suggested that the electronic health record (EHR) and computerized clinical decision support can help providers leverage the clinic-based BP data collected electronically over time to calculate a more reliable average measure, and offer decision support based on these averaged BP values for the diagnosis and treatment of hypertension.[6] Home BP measurements entered into the EHR through patient portals could also enable the integration of home measurements with clinic-based measurements to improve the reliability and accuracy of BP monitoring.[6,21] Another approach to improve the use of clinic-based BP measurements might be to eliminate BP performance measures that compel providers to treat single isolated BP measurements that are high.[20]

To address the questions outlined above, future research examining the effect of interventions to improve adherence to BP measurement standards as well as the reliability and accuracy of clinic-based BP measurements is vital. Multimodal strategies and bundles that leverage patients, clinical staff, systems changes, and technology may be the most promising. Future trials should also compare the effect of hypertension management using home versus ambulatory versus clinic BP monitoring on hypertension complications. In sum, this research could be used by clinicians and institutions, as well as future guideline panels to inform recommendations regarding how, where, and when to measure BPs for the diagnosis and treatment of hypertension.[22,23] Given the ubiquity of BP measurements and hypertension, the devastating consequences of poor treatment, and the known implications of unreliable BP measurements on treatment decisions, the health of our population, as well as the quality, safety and value of their care, depends on it.[24]

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