Optimizing Office Blood Pressure Measurement at a VAMC

John Nord, MD; Barry Stults, MD; Richard Rose, MD; Amelia E. Underwood, MD; Tyler Williams, MD; Gavin West, MD; Timothy Huhtala, MD; and Caroline K. Milne, MD

Errors in patient preparation and measurement technique lead to lack of blood pressure control in the veteran population.

Hypertension (HTN), the dominant contributor to global mortality, affects 29% of U.S. adults, 60% of Americans aged > 60 years, and more than 60% of patients in the VHA system.[1-3] Among treated patients with HTN, only 69% nationally and 75% in the VHA have their blood pressure (BP) controlled below 140/90 mm Hg.[2,3] Multiple factors contribute to this inadequate BP control, including patients' low adherence to treatment, failure of clinicians to properly intensify therapy ("therapeutic inertia"), suboptimal treatment regimens, and truly resistant HTN.[4,5] However, inaccurate BP measurement and failure to detect "white-coat" HTN (elevated office BP but normal out-of-office BP) also contribute to low HTN control rates in the clinic.[6-8] Most errors in patient preparation for the BP measurement and errors in measurement technique falsely elevate BP.[6-8]

A recent analysis of 5 studies with more than 1,600 patients found that routine BP measurement by clinic staff averaged 10/5 mm Hg higher than BP measured by trained personnel using guideline-recommended patient preparation and BP measurement technique.[8] As recently noted by 2 HTN experts: Despite its presumed simplicity, correct BP measurement technique is infrequently accomplished in most clinic settings.[9] Table 1 summarizes key techniques necessary for accurate BP measurement along with the BP errors that may occur if these techniques are not performed correctly.[6,7,10]

Accurate BP measurement by clinic staff requires not only intensive training in correct measurement techniques, but also necessitates a com-

Table 1. Accurate measurement of office BP

	Change in BP (mm Hg) if technique not performed
Equipment	
Mercury manometer	N/A
Aneroid manometer, calibrated ≤ every 6 months	Aneroid devices may read low by ≥ 5 mm Hg if not calibrated every 6 months
Electronic devices, validated	N/A
Preparation	
≥ 5-minute rest	↑ 12/6
No talking	↑ 17/13
Seated, back supported	↑ 6/8
Technique	
Sufficiently large cuff	↑ 6-18/4-13
Cuff at midsternal level	↑ (↓) 8/8 with cuff at 10 cm below (above) midsternal point
Bladder center over brachial artery	↑ 3-5/2-3
Determine systolic BP by palpation	Underestimate systolic BP if systolic auscultatory gap
Deflate cuff 2 mm Hg/sec	↓ systolic BP/ ↑ diastolic BP
Number of readings	
3 readings 1 minute apart; discard 1st, average last 2	Initial BP often falsely high due to alerting response

Dr. Nord is a staff physician, **Dr. Stults** is the chief of general medicine, **Dr. Rose** is a staff physician, **Dr. Underwood** is a staff physician, **Dr. West** is the associate chief of medicine, **Dr. Huhtala** is chief of ambulatory care, and **Dr. Milne** is a staff physician, all at the VA Salt Lake City Health Care System, Salt Lake City, Utah. **Dr. Williams** is an internal medicine provider at the Bountiful Intermountain Healthcare Center, Bountiful, Utah. Dr. Milne is also the program director for the Internal Medicine Residency at the University of Utah School of Medicine, Salt Lake City, Utah.

Table 2. Checklist to assess BP measurement skills[10]

Yes	No	
		Validated equipment used
☐	☐	Aneroid manometer calibrated every 6 months
☐	☐	Electronic device validated by American Association of Medical Instrumentation, British Hypertension Society, or European Society of Hypertension International Protocol
		Proper preparation and technique
☐	☐	Patient rests ≥ 5 minutes before BP check
☐	☐	Seated and back supported
☐	☐	Both feet flat on floor
☐	☐	Arm bare (no overlying clothing)
☐	☐	Cuff sufficiently large for arm
☐	☐	Cuff 3-4 cm above elbow crease
☐	☐	Cuff at midsternal level, arm supported
☐	☐	Center of cuff bladder over brachial artery
☐	☐	No talking by patient or health care provider
		For auscultation measurement
☐	☐	Increase pressure rapidly to 30 mm Hg above disappearance of radial pulse (systolic BP by palpation) to exclude systolic auscultatory gap
☐	☐	Deflate cuff at rate of 2 mm Hg/sec or 2 mm Hg/beat
☐	☐	Record BP to nearest 2 mm Hg on manometer
☐	☐	Take 3 measurements, 1 minute apart
☐	☐	Drop first measurement, average last 2
		For electronic devices that take 3 to 6 sequential measurements automatically
☐	☐	Observe first measurement to confirm cuff position and that device working
☐	☐	Patient left alone after first measurement

% Correct = ____% Passing score = ≥ ____%
☐ Other: _____

mitment to routinely integrate this relatively time-consuming task into the workflow of a busy clinic where staff have multiple additional duties. We investigated the baseline proficiency of BP measurement by our clinic staff and then initiated a formal training program to improve BP measurement technique. We describe our findings and consider the use of additional interventions to improve the quality of BP measurement in primary care clinic settings.

METHODS

We instituted a multifaceted intervention at the level of the clinic, the provider, and the patient to improve HTN control rates in the primary care teaching clinic of our medical center. The study was approved by the Institutional Review Board at the University of Utah and the Research Oversight Committee at the George E. Wahlen VAMC in Salt Lake City, Utah. The initial intervention was an attempt to improve BP measurement technique by our medical assistants and licensed practical nurses. To better understand the baseline proficiency in BP measurement of the medical assistants and nursing staff, a physician observer assessed their BP measurement technique during 72 randomly selected patient encounters in 2 half-day clinic sessions. Staff members were not aware they were being observed.

Staff members measured the BP with the Colin Check-Mate electronic oscillometric device, which was used at that time in our primary care clinic; no BP measurements were performed manually or with other electronic devices. BP measurement technique was assessed using an 11-item checklist similar to Table 2, based on the American Heart Association and the Canadian Hypertension Education Program recommendations.[6,10] A formal teaching session on BP measurement technique was then held for all clinic staff.[6,10] One week later, a physician observer using the same checklist again monitored 53 BP measurements by clinic staff in 2 half-day clinic sessions. Based on these results (*see* Results), a repeat teaching session for clinic staff was held 4 weeks later and attended by all but 1 of the clinic staff. Three weeks following the second teaching session, a physician observer again monitored 54 BP measurements by clinic staff, using the 11-item checklist. The percentages of selected techniques that were performed correctly during each of the 3 observation ses-

sions were compared using a 2-tailed Fisher's exact test.

RESULTS

The left-hand column in Table 3 lists the percentages of selected techniques performed correctly during the initially observed 72 BP measurements. Only 1 patient rested for 5 minutes before the BP measurement. Talking by patient, provider, or both occurred during most measurements, and only about one-half of initially elevated BP measurements were confirmed by a repeat BP measurement. The center column lists the percentages of correctly performed techniques 1 week following the formal teaching session. The only technique to significantly improve was rechecking an initially elevated BP. Use of the correct cuff size significantly declined. Compared with the baseline observation period, 3 weeks following the second teaching session (right-hand column), significant improvements were noted only in avoidance of conversation during the BP measurement, use of correct cuff size, and having feet flat on the floor during the measurement. Only 9% of patients rested for 5 minutes before the measurement, and only 67% of patients with an elevated BP had a repeat confirmatory measurement.

Table 3. Impact of teaching proper BP measurement technique

	Correctly performed (%)		
Technique	**Pre-instruction: (n = 72)**	**Post-1st instruction: (n = 53)**	**Post-2nd instruction: (n = 54)**
Rest 5 minutes	1	6 *P* = .31	9 *P* = .08
Feet flat on floor	61	59 *P* = .08	79 *P* = .03
Correct cuff size	79	62 *P* = .004	94 *P* = .019
No talking during measurement	39	28 *P* = .25	67 *P* = .002
Recheck initially elevated BP	57	82 *P* = .006	67 *P* = .35

Test applied: Fisher's exact test (2 tailed).

Table 4. Important concepts for home BP measurement[14,15]

Use American Association of Medical Instrumentation, British Hypertension Society, or European Society of Hypertension International Protocol validated upper arm cuffs • Determine if patient requires large adult (or larger) cuff
Confirm accuracy of home BP device against accurate mercury or aneroid device
Educate patient about proper preparation for home BP monitoring • Rest 5 minutes, seated, back supported, feet flat on floor, arm supported on flat surface at midsternal level • No smoking, caffeine, food, or exercise for previous 30 minutes • Do not take BP if under stress or believe BP is high
Educate patient about proper measurement techniques • Wrap BP cuff snugly around bare upper arm • Trigger BP monitor according to manufacturer instructions • Take BP twice at 1-minute intervals; average and record • Repeat this cycle twice daily for 7 days in the morning before medication and meal and in the evening before medication. Average last 6 days of BP measurements. Obtain 7 days of readings prior to office visits, and if controlled, every 3 to 4 months
Goal home BP • Uncomplicated hypertension: < 135/85 mm Hg • Diabetes, chronic kidney disease: < 130/80 mm Hg
Regular communication of results and any therapeutic adjustments, patient ↔ clinician • Telecommunication systems if available • Telephone, fax, regular mail, and e-mail

DISCUSSION

Confirming the results of previous investigations,[6-8] our study suggests that there are important deficiencies in the quality of BP measurement as routinely practiced in busy ambulatory clinic settings. Since most errors in BP measurement technique falsely elevate BP, inaccurate BP measurement may result in underestimation of HTN control rates and unnecessary, excessive antihypertensive therapy.[7,8] Our experience further indicates that improvement in BP measurement

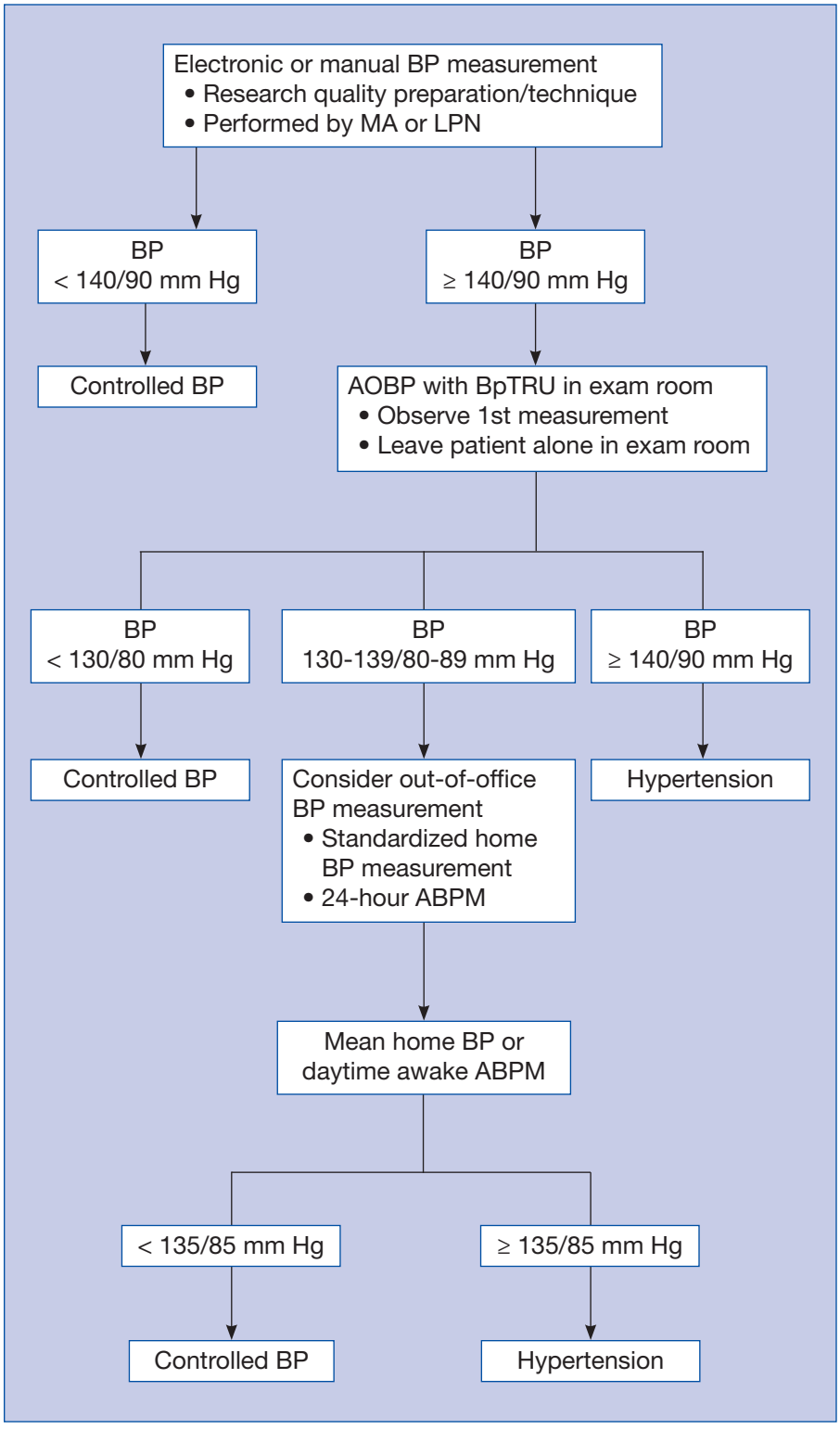

Figure 1. Approach to BP measurement at the George E. Wahlen VAMC.[13]
MA = medical assistant; LPN = licensed practical nurse.

technique by clinic staff is likely to require intensive training followed by periodic monitoring and retraining. BP measurement training and monitoring may be facilitated by the use of current clinical practice guidelines,[6,10] a recently published video demonstrating correct manual BP measurement technique,[11] and by our technique monitoring checklist in Table 2. However, our study also provides evidence that training and monitoring alone may be insufficient to improve important components of accurate BP measurement technique. Despite 2 intensive training sessions held within a 5-week time interval, a 5-minute rest period was still accomplished for only 9% of observed BP measurements. This persistent deficit may reflect important time barriers that confront clinic staff who struggle to maintain efficient clinic flow in the face of mounting health maintenance and other screening questionnaires that must be completed during a routine clinic visit. Our data highlight some of the difficulties inherent to accurate clinic BP measurement in a busy ambulatory clinic setting.

Recently, an alternative approach to routine clinic BP measurement has been proposed that may help circumvent some of the difficulties described above and may help to minimize the problem of white-coat HTN.[8,12,13] Automated office BP measurement (AOBP) by instruments that perform 3 to 6 sequential BP measurements at 1-minute intervals is now available. To our knowledge, 3 instruments have been validated for accuracy by national or international protocols. The BpTRU instrument takes 6 BP measurements at 1-minute intervals and automatically averages the last 5. The Omron HEM 907 and Microlife WATCH BP devices perform 3 measurements and automatically average all 3. AOBP instrumentation eliminates many of the technical errors of manual BP mea-

surement and by automatically averaging multiple measurements helps to efficiently control for some of the inherent variability of BP.[8] Equally important, if sequential AOBP measurements are performed while the patient is isolated in the examination room, studies that compare AOBP with 24-hour ambulatory BP monitoring suggest that the white-coat effect is at least reduced if not eliminated.[8,12,13] Sequential AOBP measurements performed on patients isolated in the examination room average about 5/5 mm Hg *lower* than accurately measured manual BP. An accurately measured manual BP of 140/90 mm Hg is, therefore, equivalent to a sequential AOBP measurement on an isolated patient of 135/85 mm Hg, and so AOBP BP goals must be adjusted downward by 5/5 mm Hg.[8]

We have incorporated sequential AOBP measurement with the BpTRU device into our HTN diagnosis and management protocols in the Primary Care Resident Teaching clinics at the George E. Wahlen VAMC. Figure 1 schematically displays our current approach to BP measurement as modified from a published algorithm.[13] If a research-quality manual BP measurement is ≥ 140/90 mm Hg, the patient is moved to the examination room for AOBP by the BpTRU; the first measurement is observed to confirm the device is working, and the patient remains alone in the room for the subsequent 5 measurements. If the mean BpTRU reading is ≥ 140/90 mm Hg, the patient is considered to be hypertensive, whereas a reading < 130/80 mm Hg is considered to be a controlled BP. For intermediate level BP readings of 130-139/80-89 mm Hg, it is important to consider the results of out-of-office BP measurements, especially in patients at particular risk for masked HTN (high-normal office BP but persistently high out-of-office BP) who have cardiovascular disease or diabetes. Table 4 lists important aspects of home BP measurement.[14,15] A mean home BP or daytime awake BP from an ambulatory BP monitoring (ABPM) study < 135/85 mm Hg would confirm controlled BP; some guidelines suggest a mean office and home BP goal < 130/80 mm Hg for patients with diabetes or chronic kidney disease.[6]

CONCLUSION

Appropriate diagnosis and monitoring of HTN begins with accurate BP measurement in the clinic supplemented in some patients by out-of-office BP measurement with home or 24-hour ambulatory BP measurement. In turn, accurate BP measurement in the clinic requires intensive training, regular audit, and retraining as well as a mechanism to maintain clinic efficiency and flow. Automated office BP measurement, particularly with devices that can perform sequential BP measurement on patients isolated in the examination room, may provide an opportunity to improve both the accuracy and efficiency of clinic BP measurement.

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Author disclosures

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