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Research Article

Integration of Home Blood Pressure Monitoring in Hypertension Management

Abstract

Background: White coat syndrome, masked hypertension, and poor technique may produce inaccurate office-based blood pressure (BP) readings and lead to over diagnosis and over treatment with antihypertensive agents. National and international hypertension guidelines recommend using home BP monitoring in conjunction with office readings for hypertension diagnostic and/or treatment evaluation.

Purpose of study: Evaluate the impact of hypertension diagnosis and medication management for patients referred to a home BP monitoring program integrated with clinic based hypertension management.

Results / Main findings: Over the first year of the program, 75 patients were referred for either medication management evaluation (n=41) or hypertension diagnosis confirmation (n=34). For medication management referred patients, roughly half (n=20) had some clinical action taken and roughly half (n=21) had no action taken. Of the 34 patients referred for hypertension diagnosis confirmation, 23 (68%) had home BP readings averaging less than 135/85 mmHg resulting in no formal diagnosis of hypertension and no medication prescribed. This was particularly pronounced in those patients with an office BP goal of <150/90 mmHg, a relatively older group.

Conclusion: This data suggests that integrating home BP monitoring with office-based hypertension management is clinically important and may have substantial impact in the accuracy of diagnosis and the appropriateness of medication use.

Brief summary: Patients with uncontrolled hypertension despite medication therapy or having elevated blood pressure readings in clinic without a diagnosis of hypertension were referred to the clinic's home BP monitor loaner program facilitated by a clinical pharmacist. For a period of at least 5 days, patients recorded 3 consecutive BP readings in the morning and in the evening. At a scheduled follow-up office visit with the clinical pharmacist, the patient returned the monitor with the completed log sheet. The clinical pharmacist facilitated standardized documentation for efficient evaluation.

Potential implications: Facilitating a structured home BP monitoring program for patients with uncontrolled hypertension despite medication therapy or for establishing the diagnosis of hypertension can provide a clinician an accurate and comprehensive view of overall BP control to avoid over-treatment, under-treatment, and misdiagnosis while individualizing patients' therapy

Abbreviations

BP: Blood Pressure; HTN: Hypertension; HBPM: Home Blood Pressure Monitoring; BMI: Body Mass Index TIA: Transient Ischemic Attack; CI: 95% Confidence Interval; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

Background

Office-based blood pressure (BP) measurements have been the conventional method for hypertension (HTN) diagnosis and management. This method is consistent with outcomes data from clinical trials [1,2], but has limitations in achieving accurate readings in all patients. Poor technique, masked hypertension, and the white-coat syndrome may lead to inaccurate BP readings and impact diagnosis and treatment decisions.

Twenty-four hour ambulatory BP monitoring has been recommended to give a more accurate view of true BP readings when confirmation of clinic blood pressure is warranted. However, in practice this is cumbersome for patients as they must take a day off work to get set up with the machine, and

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is also costly. Home blood pressure monitoring (HBPM) has become an accessible method for a patient to monitor their BP out of the office setting. Devices can be purchased without a prescription at local pharmacies or on the internet. HBPM has been shown to be reliable [3], reflective of cardiovascular risk [4,5] and target organ damage [6,7], is relatively inexpensive, and encourages the patient to become engaged in their health care.

The technology has advanced so that nearly all home monitors now use the oscillometric method which has replaced ausculatory technique. This fully automated method greatly improves the monitors' ease of use. The patient only needs to follow simple instructions for cuff placement, and the monitor automatically inflates and produces digital readings of systolic pressure, diastolic pressure, and pulse with a press of a button. Several BP readings can be taken in a short amount of time and recorded for multiple days in a row to present BP data as a trend. This information, used as an adjunct with office-based BP readings has the potential to improve judgment in diagnosis and treatment decisions. Literature that describes clinic-based HBPM programs and their impact in primary care is limited.

National and international guidelines recommend using HBPM in conjunction with office BP readings for HTN management and recommend a BP reading of 135/85 mmHg as a normal cut off when evaluating home readings [8-11]. The US Preventive Services Task Force recommends obtaining BP readings outside of the clinical setting for diagnostic confirmation before starting treatment [12] and the American Heart Association, the American Society of Hypertension, and the Preventive Cardiovascular Nurses Association have published a call to action for integrating HBPM as a routine component of BP management and for reimbursement of its practice [13].

This paper describes the first year impact of a program that integrates HBPM in office-based HTN management in a federally qualified community health center.

Materials and Methods

Beginning in the spring of 2014, providers at the adult medicine department in a community health center in urban Boston, MA began a BP monitor loaner program so that HBPM would assist in confirming a diagnosis of hypertension or obtaining additional information that would aid in BP medication management decisions. Patients were lent a BP monitor to use at home, and then returned it to the clinic.

Fully automatic, upper arm oscillometric BP monitors were used. They were purchased from local pharmacies and each cost between $70 and $85. Each monitor was listed as having accuracy testing through the British Hypertension Society, the Association for the Advancement of Medical Instrumentation, or the International Protocol of the European Society of Hypertension. Additional accuracy of each monitor was measured by multiple comparisons between the device and the health center's fully automatic BP monitor with a normotensive volunteer. Monitors were used clinically if accuracy was within 5 mmHg. Guidelines for office-based BP goal and treatment was followed by the Eighth Joint National Committee (JNC 8) as well as a clinic-based HTN protocol designed by the providers in the department of Adult Medicine at the health center.

Patients were referred by their primary care provider to an office visit with a clinical pharmacist for HTN education, medication review (if applicable), and BP monitor instruction. Patients received a bag to take home which included the BP monitor, written instructions, a BP log sheet to record readings, and a general information pamphlet about high BP. For a period of at least 5 days, patients were instructed to record 3 consecutive BP readings in the morning and in the evening. At a scheduled follow-up office visit with the clinical pharmacist, the patient returned the monitor with the completed log sheet.

Home BP readings were prepared for clinical consideration in the following manner: the first of the 3 BP readings was discarded, and the remaining 2 were averaged together producing an average morning and evening BP reading for each day. The overall average morning and evening BP readings were calculated using daily averages. The average heart rate was calculated in the same manner. Chart note documentation in the electronic medical record was standardized for each initial and follow up visit by the clinical pharmacist in order to facilitate efficient decision making. This included a trend of the daily averaged morning and evening BP readings and an averaged overall BP reading for the morning and evening. This information was discussed with the patient and medication changes were made if warranted in collaboration with the primary care provider. Date and results of the home monitoring were recorded within the patient's problem list.

A written log was used to keep track of each BP monitor lent out from the clinical pharmacist that included the patient name, date of birth, date lent out, type of monitor, and scheduled day of return. If a scheduled return office visit was not feasible for the patient, the patient could drop off the bag with the BP monitor and recorded log sheet at the health center's laboratory. After each BP monitor was returned, a thorough cleaning of the monitor and replacement of instructions, BP log sheet, and HTN literature was done in order to be ready for the next patient.

The Institutional Review Boards from Dotwell Health and Northeastern University approved the retrospective analysis of data to be completed. Data collection included age, gender, race, BMI, smoking status, the presence or absence of hypertension, diabetes, hyperlipidemia, coronary artery disease, heart failure, or having a history of stroke or transient ischemic attack. Also collected was the average of the last 2 office BP readings prior to HBPM referral, reason for HBPM referral, the overall averaged home systolic and diastolic readings, and action that resulted from HBPM. A patient with an arm circumference that exceeded what is recommended for the cuff size was unable to participate in HBPM. All patients who took home a home BP monitor for use where included in this analysis. A patient was excluded if they were unable to achieve taking 3 consecutive home BP readings at a time or if HBPM was less than 80% of the requested 5-day minimum duration.

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Differences between the averaged office BP readings and the overall averaged home BP readings were examined by pre-selected multivariate analysis and stratified by baseline BP goal and reason for HBPM referral. Statistical analysis was performed by paired t test with a two-sided p-value of <0.05 considered to be statistically significant. All statistical calculations were performed using Microsoft Excel and demonstrated normal distribution.

Results

Ninety-nine patients were referred for HBPM to either confirm a HTN diagnosis or for BP medication management evaluation during the program's first year. Twenty-four patients were excluded from this analysis for not completing 3 consecutive morning or evening BP readings or for not recording home readings for at least 80% of the 5-day duration. Of the 75 remaining patients, 34 (45%) were referred for HTN diagnosis confirmation and 41 (55%) were referred for BP medication management evaluation. Table 1 includes patient baseline characteristics that illustrates an overall younger, minority dominate, moderate cardiovascular risk population.

BP goal < 140/90 mmHg:

Fifty-three patients had a goal BP of <140/90 mmHg. Twenty-four (45%) were referred for HTN diagnosis confirmation and 29 (55%) were referred for BP medication management evaluation. The average clinic systolic and diastolic BP readings prior to HBPM for this group were 147.7 mmHg and 87.3 mmHg, respectively. The average HBPM systolic and diastolic readings were 139.3 mmHg and 88.5 mmHg, respectively. The average systolic home BP reading was significantly lower than the average clinic systolic BP readings (p<0.001) but the average diastolic BP readings were similar (p= 0.45).

Following HBPM, 23 patients (43.4%) added medication or increased current medication dosages, 1 patient (1.9%) added an additional agent and increased the dose of another, 1 patient (1.9%) discontinued their current medication, and 28 patients (52.8%) had no changes.

BP goal < 150/90 mmHg:

Twenty-two patients had a goal BP of <150/90 mmHg. Ten patients (45%) were referred for HTN diagnosis confirmation and 12 (55%) were referred for BP medication management evaluation. The average clinic systolic and diastolic BP readings prior to HBPM for this group were 154.6 mmHg and 82.0 mmHg, respectively. The average HBPM systolic and diastolic readings were 132.5 mmHg and 76.7 mmHg, respectively. The average systolic and diastolic home BP readings were significantly lower than the average clinic systolic and diastolic BP readings (p<0.001 and p=0.01).

Following HBPM, 3 patients (13.6%) added medication or increased current medication dosages, 1 patient (4.5%) discontinued one medication while increasing the dose of another, 2 patients (9.0%) discontinued medication, and 16 patients (72.7%) had no changes.

Table 2 compares the blood pressure average readings between the clinic and home monitoring for patients separated by their BP goal and reason for referral. The reason for referral was balanced between those referred for BP medication management evaluation and for HTN diagnosis confirmation. For those patients referred for medication management evaluation, roughly half of the patients (n=20) had some clinical action taken and roughly half (n=21) had no

Table 1: Baseline Characteristics

Patient characteristics	No. (%)
Age – years (range 22-81)	56.27±12.5
Gender	
Female	41 (54.7)
Race	
Asian	27 (36.0)
African American	16 (21.3)
Hispanic	14 (18.7)
Caucasian	11 (14.7)
Other	7 (9.3)
BMI (kg/m^2)	28.70±6.27
Hypertension diagnosis prior to HBPM	41 (54.7)
Diabetes mellitus	15 (20.0)
Dyslipidemia	38 (50.7)
Smoking (current)	12 (16.0)
Coronary artery disease	1 (1.3)
Heart failure	0
Stroke or TIA	2 (2.7)
Blood pressure goal	
<140/90 mmHg	53 (70.7)
<150/90 mmHg	22 (29.3)
Reason for referral	
HTN diagnosis confirmation	34 (45.3)
HTN medication management	41 (54.7)

*BMI: Body Mass Index; HBPM: Home Blood Pressure Monitoring; TIA: Transient Ischemic Attack; HTN: Hypertension©

Table 2: Clinic versus Home Blood Pressure Readings.

	Referral reason	Clinical result		Clinic BP average (mmHg)	Home BP average (mmHg)
Goal BP < 140/90 mmHg N=53	Hypertension diagnosis confirmation	Start drug therapy N=11	SBP	145	149
			DBP	92	98
		No action N=13	SBP	148	132
			DBP	87	83
	BP medication management	Adjust drug therapy N=14	SBP	150	148
			DBP	89	96
		No action N=15	SBP	147	130
			DBP	83	80
Goal BP < 150/90 mmHg N=22	Hypertension diagnosis confirmation	Start drug therapy N=0	SBP	NA	NA
			DBP		
		No action N=10	SBP	154	131
			DBP	85	77
	BP medication management	Adjust drug therapy N=6	SBP	158	133
			DBP	78	77
		No action N= 6	SBP	153	134
			DBP	82	75

*BP: Blood Pressure, CI: 95% Confidence Interval, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure.

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action taken, suggesting that HBPM had value in assisting the provider to make the best judgment and to not over treat. Table 3 details medication changes that occurred as a result of HBPM. Of the 34 patients referred for HTN diagnosis confirmation, 23 (68%) had home BP readings averaging less than 135/85 (the recommended target BP goal for home monitoring) resulting in no formal diagnosis of hypertension and no medication prescribed. This was particularly pronounced in those patients with a BP goal of <150/90 mmHg, a relatively older group.

Although the total number of patients in this analysis is small, racial groups were evenly represented among results indicating that there was no one racial group that was more referred for home monitoring over another.

Limitations

This data represents a one year time period and is insufficient in determining the long-term value of integrating HBPM into office-based HTN management. On-going monitoring of these patients, particularly those with elevated BP solely in the office, is essential to ensure appropriate and timely diagnosis and management of HTN. Also, due to the small sample size, it was difficult to explore with confidence which baseline characteristics, if any, could be associated with those patients that experience elevated BP solely in the office.

The home BP cuffs used within our clinic are not able to accommodate obese patients with arm circumferences greater that what is recommended for the cuff's use. This means that some obese patients are not able to participate in this type of blood pressure monitoring. And although all of the home BP monitors contain a memory function, we did not utilize this function as a quality assurance check.

Table 3: Medication Changes Resulting from HBPM

	Referral reason	Clinical result	
Goal BP < 140/90 mmHg N=24	Hypertension diagnosis confirmation	Initiate drug therapy N=11	No action N=13
Goal BP < 150/90 mmHg N=10	Hypertension diagnosis confirmation	Initiate drug therapy N=0	No action N=10
Goal BP < 140/90 mmHg N=29	BP medication management	Adjust current drug therapy N=14 Increased drug dose (5) Add additional drug (7) Discontinue drug (1) Add additional drug and increase dose of another (1)	No action N=15
Goal BP < 150/90 mmHg N=12	BP medication management	Adjust current drug therapy N=6 Increased drug dose (2) Add additional drug (1) Discontinue drug (2) Discontinue drug and increase dose of another drug (1)	No action N=6

*BP: Blood Pressure.

Discussion

The white coat effect is described as a rise in BP when measured by medical staff but returns to normal levels in the person's everyday life. Situational anxiety, hyperactive alerting responses, or a conditioned response is credited for this phenomenon and may be experienced at some level in most hypertensive patients [14].

White coat hypertension is defined as a persistent elevation in BP when taken by medical staff or in the presence of a physician (systolic/diastolic BP measuring 140/90 mmHg or higher), but is normal when measured out of the office by 24-hour ambulatory blood pressure monitoring (systolic/diastolic BP measuring 125-130/80 mmHg or less) or home monitoring (systolic/diastolic BP measuring 135/85 mmHg or less) [15]. These phenomena have been appreciated for decades. The overall prevalence of white coat hypertension is estimated to be 13-15% [15-18] and up to 37% among untreated hypertensive patients [16].

Consequences of relying solely on office-based BP readings for HTN diagnosis or anti-hypertensive medication evaluation includes overtreatment and subsequent increased costs for the patient and the health care system. Clinical trials have shown HBPM to be effective while reducing medication use [19] and published HBPM programs involving telemonitoring or web communication improve BP control [20-22]. To our knowledge, this is the first published recount from a home BP monitor loaner program integrated with office-based HTN management. During the first year that we implemented our program, over half of the patients (59%) did not receive initial or additional medications based on HBPM. Additionally, 23 out of 34 patients (68%) did not receive a diagnosis of hypertension, as their home BP readings averaged less than 135/85 mmHg (this includes all patients referred for HTN diagnosis confirmation with an office BP goal of less than 150/90 mmHg). Within our methods, we did not confirm the patient's home readings with the BP monitor's memory function. Mengden et al demonstrated that patients may underreport higher readings when they return written home reading logs for review [23]. If this took place, under treatment may have resulted.

Twenty-four hour ambulatory BP monitoring has been considered the standard by which white coat hypertension is diagnosed and monitored, but the expense and lack of convenience produces barriers to implement in primary care. Home BP monitoring has lower barriers for use and is considered comparable to 24-hour ambulatory BP monitoring for the management of HTN3. Utilizing HBPM to confirm a diagnosis of white coat HTN is supported by HTN guidelines8-11 and may facilitate diagnosing and treating HTN more timely compared to multiple office visits for BP checks, and HBPM can also facilitate on-going BP monitoring that can be accomplished prior to a provider's office visit and create efficiencies within patient encounters.

Our community health center created a loaner HBPM program where patients were referred by their primary care

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provider to the program facilitator (a clinical pharmacist) if they felt HBPM would benefit in determining a HTN diagnosis or medication management evaluation. Important features to any HBPM program includes using validated meters, direct patient instruction on how to use and document multiple readings over several days, ensuring patient engagement through disease and results education, and defining a pre-determined method how the results are relayed to the provider for evaluation. We have found that having separate office visits from the primary care provider and defined clinical staff to facilitate the program has resulted in a sustainable means for the program to be successful.

Optimal methods described in the literature for HBPM includes taking multiple readings twice daily (morning and evening) in either duplicate [15,24] or triplicate [25] over several days (e.g., a week) [13]. It is also recommended that the first day of readings and the first of the 3 triplicate readings be discarded because those are consistently found to be elevated compared to subsequent readings [13, 25]. In the data presented, patients recorded triplicate morning and evening BP readings at home. Each first morning and evening triplicate reading was discarded prior to averaging the next two together and resulted in a minimum of 16 BP readings presented as an averaged daily BP trend of morning and evening readings. We chose to not discard the first day of readings. Although there is data to suggest including the first day of readings may not make a difference [24], this could have resulted in a higher overall average and over treatment. However, clinical decisions were made looking at the trend of readings and not one averaged number. Additionally, our data supports that all patients whose home readings resulted in no treatment action, had overall BP readings averaging less than 135/85 mmHg, so discarding the first day of readings may not have been clinically meaningful to this population. Regardless of that, our sample size is relatively small and it has been demonstrated that there is a better correlation between HBPM and 24-hour ambulatory monitoring when the first day of readings are discarded [26].

All monitors used for clinical decision making (whether they are purchased by a clinic for a loaner program or patient owned) need to have undergone accuracy testing according to an international standard protocol. The three most widely accepted protocols for testing home BP monitor accuracy have been developed by the British Hypertension Society, the Association for the Advancement of Medical Instrumentation, and the International Protocol of the European Society of Hypertension. If the monitor has undergone protocol testing, this information can be found within the product's labeling or on the internet (www.dableducational.org). Further, it is recommended to additionally test each home monitor before clinical use with multiple comparisons to a BP device used in the health center to ensure results are within 5 mmHg13.

Conclusion

This data suggests that integrating HBPM in office-based HTN management is clinically important and may have substantial impact in ensuring the accuracy of diagnosis and appropriateness of medication use. It also allows patients to be active participants in their care. Further research is encouraged to establish the best HBPM methods for patients and providers in different medical practices.

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