Original Article

Assessment of appropriate utilization of out-of-office diagnostic tools for the diagnosis of hypertension

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Abstract

Background: Out-of-office blood pressure (BP) measurement devices, such as ambulatory BP monitoring (ABPM) and home BP monitoring (HBPM), enhance the accuracy and reliability of BP readings, detecting white-coat and masked hypertension. The American Heart Association (AHA) advises confirming hypertension diagnoses with ABPM to prevent overdiagnosis, emphasizing the importance of precise out-of-office diagnostic tools. This study aimed to 1) explore the prevalence of ABPM and HBPM use prior to hypertension diagnosis; 2) assess the adherence to AHA recommendations regarding ABPM utilization; and 3) investigate the association between patient characteristics and out-of-office BP monitoring practices. **Methods:** A retrospective cross-sectional study analyzed a random sample of adult patients newly diagnosed with essential hypertension at a tertiary hospital primary care center in Riyadh, Saudi Arabia, between 2016 and 2022. **Results:** This study evaluated the use of ABPM and HBPM in a sample of 268 newly diagnosed hypertensive patients, with a mean age of 49.17 ± 12.69 years. Although ABPM orders were placed for 57.8% of patients, only 48.5% completed the procedure. Notably, 42.2% of hypertension diagnoses were solely based on ABPM, while 7.1% and 1.1% utilized HBPM alone or in combination with ABPM, respectively. This analysis revealed a lower utilization of ABPM among older adults, individuals with diabetes or chronic kidney disease, and married patients ($P < 0.05$). However, this association with marital status, diabetes, and chronic kidney disease was no longer statistically significant in a fully adjusted model ($P > 0.05$). **Conclusion:** Out-of-office BP monitoring, particularly ABPM, was underutilized in newly diagnosed hypertensive patients, especially in older age groups and patients with specific comorbidities, who may benefit the most from this method. These results underscore the need for increasing physician knowledge and compliance with the existing guidelines.

Keywords: ABPM, AHA guideline, diagnosis, HBPM, hypertension

Introduction

Blood pressure (BP) measurement is crucial in clinical medicine, and it plays an important role in the screening, diagnosis, and treatment of hypertensive patients. BP has traditionally been measured manually using a mercury sphygmomanometer; however, this approach is prone to human error.[1,2] The use of automatic devices has not only improved and simplified the technical aspects of obtaining a BP reading, but also opened up the possibility of less error prone, more reliable readings, including ABPM and automated office BP measurements.[1] A study comparing conventional and automated BP measurements highlighted the superiority of automated methods, confirming that they provide readings more closely aligned with true

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BP levels, thereby enhancing the accuracy and reliability of hypertension management.[3] Now that a better understanding of cardiovascular physiology and dynamic variations in BP has been established, current guidelines focus on proper BP techniques.[4] Furthermore, BP varies throughout the day, and it is influenced by both physiological and psychological variables.[4]

Out-of-office BP measurements allow for the detection of white coat hypertension (WCH) in patients. This refers to individuals with high BP in clinic but are normotensive when out-of-office BP is measured. Out-of-office readings also allow for the detection of masked hypertension, in which normal clinic BP readings are measured but out-of-office BP readings are in the hypertensive range.[5,6] Individuals with masked hypertension carry a higher risk of cardiovascular complications than those with persistent normotension.[4,5] WCH without organ damage has been associated with increased cardiovascular risk and mortality, risk of developing cardiac and renal organ damage, and risk of developing sustained hypertension.[7]

According to the current guidelines, after initial office screening, out-of-office BP monitoring (e.g. home BP monitoring [HBPM] or ambulatory BP monitoring [ABPM]) is recommended to confirm a diagnosis of hypertension before initiating treatment.[8,9] Relying solely on clinic or home BP readings could result in significant overdiagnosis; thus, current evidence suggests that 24-hour ABPM is critical in making treatment decisions.[10] Utilizing out-of-office diagnostic tools improves hypertension control by accurately identifying WCH and providing valuable insights into nocturnal BP trends, crucial for assessing cardiovascular risk. They also track BP variability throughout the day, aiding in crafting individualized treatment plans.[11,12]

Moreover, not only is ABPM a more cost-effective technique than repeated office BP measurement, but it also results in a significant reduction in spending on investigations related to hypertension complications.[13,14]

Despite the necessity of out-of-office BP measurements as suggested by international guidelines, Family Medicine Physicians continue to use suboptimal manual BP measurements to screen for hypertension and underutilize out-of-office BP measurements.[15,16]

According to a study conducted in Saudi Arabia, if only in-office BP measurements were used, one out of every three people would be treated inappropriately.[17] Shedding light on the importance of appropriately utilizing out-of-office diagnostic tools in measuring BP will improve the accuracy of screening and aid in the diagnosis of hypertension. Therefore, this study's objectives are 1) to explore the prevalence rates of ABPM and HBPM use prior to the diagnosis of hypertension; 2) to evaluate the appropriate use of ABPM in accordance with American Heart Association (AHA) recommendations; 3) to investigate the association between patient characteristics and the utilization of out-of-office BP monitoring techniques. By emphasizing the above objectives, this research attempts to improve our comprehension of diagnostic methods and their resulting implications for the detection and management of hypertension in Saudi Arabia.

Methodology

A retrospective cross-sectional study was conducted at the primary care center in a tertiary hospital in Riyadh, Saudi Arabia. The medical records of patients above the age of 18 years who met the eligibility criteria were collected from 1 January 2016 to 31 December 2022. Newly diagnosed patients with hypertension were identified by reviewing the data via disease-coding labels (International Classification of Disease, 10th version, Code I-10), and patients' medical records were reviewed. Patients who were on medication that lowered BP or were previously diagnosed with medical conditions known to be associated with increased BP or to cause secondary hypertension, such as sleep disorders and endocrine diseases, were excluded from the study.

Out-of-office BP measures are recommended by the AHA guidelines to confirm the diagnosis of hypertension. As per ACC/AHA Criteria 2017, Office BP > 130/80, 24H Average > 125/75, Daytime average BP > 130/80 and Night time Average BP > 110/65 and HBPM average > 130/80 is considered to meet the diagnostic criteria for hypertension.[4] In ABPM, the diagnostic thresholds consider both daytime and nighttime BP values. The appropriateness of the utilization of out-of-office diagnostic tools (ABPM or HBPM) for hypertension diagnosis was evaluated. The usage rate and compliance with these tools were assessed by reviewing the order status in the database.

The initial calculated sample size was 153 patients, which was based on the effect size of hypertension in Riyadh. The margin of error was 3% with a power of 80%, indicating the maximum acceptable deviation from the true population parameter, and signifying the desired ability to detect a true effect if it exists. A randomized sampling technique was employed for the participants' selection to ensure the representativeness of the sample, reduce potential bias, and increase the likelihood of generalizing findings to the broader population.

Ethical approval was obtained from the Research Ethics Committee at King Faisal Specialist Hospital and Research Center on 01 August 2022 (RAC 2221264), and a waiver of informed consent was granted.

Statistical analysis

Descriptive statistics for the categorical variables were reported as the number of cases (percentages), while the continuous variables were presented as mean ± standard deviation (SD). Inferential statistics analysis was conducted using an independent *t*-test to measure any statistical differences among the continuous variables. For categorical variables, the Chi-squared test and Fisher's exact test were used. Univariate and multivariate logistic regression using the backward stepwise method was conducted

to predict the associations between performing ABPM for the diagnosis and the relevant factors. The significance level was set at 0.05, with a 95% confidence interval (CI). All statistical analyses were performed using the Statistical Package for the Social Sciences, version 23.0 (IBM Corp., Armonk, NY, USA).

Results

After reviewing the medical records, 268 newly diagnosed patients with hypertension were included in the analysis. The mean age of the patients was 49.17 ± 12.69, and the predominant age group was the 40–49 years age group (49.8%). Among the study sample, there was a near-even split in terms of gender distribution. However, certain characteristics were more common, including being married (72.4%), Saudi citizens (64.2%), nonsmoking status (85.8%), and obese (46.7%). Regarding comorbidities, it was found that 25% of the patients included in the study had dyslipidemia while 21.3% had diabetes. ABPM utilization was ordered for 57.8% of the patients, but only 48.5% of these orders were completed.

In our research, ABPM was employed to diagnose 42.2% of new hypertension cases. Office BP readings were the diagnostic method in 49.6% of cases, while HBPM readings were utilized in 7.1%. In 1.1% of cases, both ABPM and HBPM were concurrently used to reach a hypertension diagnosis. Clearly, there is a large proportion of new Hypertension Diagnoses being reached without the benefit of ABPM. Hence, we further probed whether the apparent ABPM hesitancy could be attributed to physician or patient factors.

Further investigation of medical records revealed that while 48.5% of the time when ABPM was requested by the physician, it was indeed carried out and contributed to the diagnosis, whereas 42.2% of the time, it was never requested and hence never performed. Finally, in 9.3% of the diagnoses, the ABPM had been requested, but not been completed/carried out.

This important finding clearly outlines that there is still a large proportion of cases where ABPM may have been underutilized as a resource by the physicians, but in a small percentage of cases (9.3%), there may be patient resistance to the idea as well. Table 1 demonstrates the prevalence of demographic factors, comorbidities, and the utilization of ABPM and HBPM.

As shown in Table 2, age statistically differs among patients diagnosed with Hypertension using ABPM and those who were not, where the mean age (45.74 ± 12.36) was significantly lower among patients diagnosed based on ABPM ($P < 0.05$). It was observed that the utilization of ABPM was highest among the age group of patients younger than 40 years (35.7%), while the lowest utilization was observed in the age group of 60 years and above (13.9%). Furthermore, there was a statistical difference in the mean level of systolic BP, which was higher among patients who were not diagnosed based on ABPM (151.74 ± 16.05, $P < 0.05$). The diagnosis of hypertension based on ABPM was not statistically different among the evaluated comorbidities. Diagnosis based on ABPM was significantly lower among patients who had diabetes and chronic kidney disease (CKD) ($P < 0.05$). Moreover, none of the investigated factors differed between patients who were diagnosed based on HBPM, as reported in Table 3.

Table 1: Prevalence of demographic characteristics, blood pressure monitoring information, and other relevant factors

Variable	*n* (%)
Age (mean±SD)	49.17±12.69
<40	66 (24.9)
40–49	66 (24.9)
50–59	81 (30.6)
≥60	52 (19.6)
Gender	
Female	127 (47.4)
Male	141 (52.6)
Marital status	
Single	62 (23.1)
Married	194 (72.4)
Divorced	7 (2.6)
Widowed	5 (1.9)
Nationality	
Saudi	172 (64.2)
Non-Saudi	96 (35.8)
Smoking	
Current	25 (10.5)
Previous	9 (3.8)
Never	205 (85.8)
BMI	
Normal	47 (18)
Overweight	92 (35.2)
Obese	122 (46.7)
Hypertension diagnosis	
Office-based diagnosis	133 (49.6)
ABPM based diagnosis	113 (42.2)
HBPM based diagnosis	19 (7.1)
ABPM and HBPM based diagnosis	3 (1.1)
ABPM order	
Not ordered or completed	113 (42.2)
Ordered but not completed	25 (9.3)
Ordered and completed	130 (48.5)
Comorbidities	
Diabetes	57 (21.3)
Dyslipidemia	67 (25)
Chronic kidney disease	6 (2.2)
Ischemic heart disease	3 (1.1)

As demonstrated in Table 4, the odds of ABPM utilization were reduced by 0.478 times in the 40–49 years age group and by 0.271 times in the 60 years and above age group compared to the below 40 years age group. Additionally, the same pattern for age was observed after adjusting for systolic BP level. Systolic BP level had an equally important role, where each one-unit increase in systolic BP decreased the likelihood of ABPM utilization by

Table 2: Comparison of hypertension diagnoses based on ABPM with demographic characteristics and comorbidities

Diagnosis based on ABPM	No	Yes	*P*
Age (mean±SD)	51.80±12.34	45.74±12.36	0.001
<40	25 (16.7)	41 (35.7)	0.002
40–49	37 (24.7)	29 (25.2)	
50–59	52 (34.7)	29 (25.2)	
≥60	36 (24)	16 (13.9)	
Gender			
Female	69 (45.1)	58 (50.4)	0.386
Male	84 (54.9)	57 (49.6)	
Marital status			
Single	28 (18.3)	34 (29.6)	0.093
Married	118 (77.1)	76 (66.1)	
Divorced	3 (2)	4 (3.5)	
Widowed	4 (2.6)	1 (0.9)	
Nationality			
Saudi	100 (65.4)	72 (62.6)	0.642
Non-Saudi	53 (34.6)	43 (37.4)	
Smoking			
Current	14 (10.5)	11 (10.4)	0.837
Previous	4 (3)	5 (4.7)	
Never	115 (86.5)	90 (84.9)	
BMI			
Normal	27 (18.4)	20 (17.5)	0.979
Overweight	52 (35.4)	40 (35.1)	
Obese	68 (46.3)	54 (47.4)	
Systolic blood pressure (mean±SD)	151.74±16.05	143.14±9.58	0.001
Diastolic blood pressure (mean±SD)	90.09±11.79	88.84±7.83	0.318
Diabetes			
No	111 (72.5)	100 (87)	0.004
Yes	42 (27.5)	15 (13)	
Dyslipidemia			
No	110 (71.9)	91 (79.1)	0.176
Yes	43 (28.1)	24 (20.9)	
Chronic kidney disease			
No	147 (96.1)	115 (100)	0.039
Yes	6 (3.9)	0 (0)	
Ischemic heart disease			
No	151 (98.7)	114 (99.1)	0.999
Yes	2 (1.3)	1 (0.9)	

Table 3: Comparison of hypertension diagnoses based on HBPM with demographic characteristics and comorbidities

Diagnosis based on HBPM	No	Yes	*P*
Age (mean±SD)	48.95±12.72	51.64±12.33	0.342
<40	62 (93.9)	4 (6.1)	0.468
40–49	62 (93.9)	4 (6.1)	
50–59	74 (91.4)	7 (8.6)	
≥60	45 (86.5)	7 (13.5)	
Gender			
Female	113 (89)	14 (11)	0.176
Male	132 (93.6)	9 (6.4)	
Marital status			
Single	57 (91.9)	5 (8.1)	0.769
Married	177 (91.2)	17 (8.8)	
Divorced	6 (85.7)	1 (14.3)	
Widowed	5 (100)	0 (0)	
Nationality			
Saudi	156 (90.7)	16 (9.3)	0.573
Non-Saudi	89 (92.7)	7 (7.3)	
Smoking			
Current	22 (88)	3 (12)	0.761
Previous	9 (100)	0 (0)	
Never	187 (91.2)	18 (8.8)	
BMI			
Normal	41 (87.2)	6 (12.8)	0.461
Overweight	86 (93.5)	6 (6.5)	
Obese	111 (91)	11 (9)	
Systolic blood pressure (mean±SD)	147.57±14.15	153.18±15.13	0.079
Diastolic blood pressure (mean±SD)	89.66±10.45	88.5±8.58	0.615
Diabetes			
No	190 (90)	21 (10)	0.181
Yes	55 (96.5)	2 (3.5)	
Dyslipidemia			
No	186 (92.5)	15 (7.5)	0.257
Yes	59 (88.1)	8 (11.9)	
Chronic kidney disease			
No	239 (91.2)	23 (8.8)	0.666
Yes	6 (100)	0 (0)	
Ischemic heart disease			
No	242 (91.3)	23 (8.7)	0.999
Yes	3 (100)	0 (0)	

5% after adjusting for age. Patients diagnosed with diabetes were 60.4% less likely to be diagnosed with Hypertension based on ABPM than patients without diabetes in nonadjusted model. Regarding marital status, married patients were 47.0% less likely to be diagnosed with hypertension based on ABPM compared to single patients. However, the associations in diabetes and marital status ceased to exist in a fully adjusted model.

Discussion

Hypertension is a prevalent disease with serious consequences, firmly establishing itself as one of the leading preventable factors associated with mortality. Consequently, the reliable and accurate measurement of BP is extremely important in identifying at-risk individuals. Currently, ABPM is seen as the most reliable method for making clinical decisions. Numerous reviews and guidelines now strongly recommend ABPM as the gold standard for the diagnosis of hypertension.[4]

The findings of our study revealed significant variations in the utilization of ABPM for the diagnosis of hypertension across different age groups. Among the 268 newly diagnosed patients with hypertension included in our analysis, it became evident that ABPM utilization was more common among individuals under the age of 40, while its utilization decreased as patients' ages advanced, with the lowest usage observed in those aged 60 years and above. This disparity in ABPM utilization can be attributed to various factors. First, younger patients may have a higher likelihood of being exposed to out-of-office diagnostic tools due to greater familiarity with technology and a greater

Table 4: Predictive factors of ABPM utilization

Variable	COR	95% CI		*P*	AOR	95% CI		*P*
		Lower	Upper			Lower	Upper	
Age								
<40		Reference				Reference		
40–49	0.478	0.238	0.958	0.037	0.450	0.211	0.960	0.039
50–59	0.340	0.173	0.667	0.002	0.392	0.190	0.812	0.012
≥60	0.271	0.125	0.586	0.001	0.301	0.130	0.695	0.005
Marital status								
Single		Reference						
Married	0.530	0.298	0.945	0.031				
Divorced	1.098	0.227	5.322	0.908				
Widowed	0.206	0.022	1.949	0.168				
Systolic blood pressure	0.950	0.928	0.972	0.001	0.952	0.930	0.975	0.001
Diabetes								
No		Reference						
Yes	0.396	0.207	0.758	0.005				

tendency to seek medical advice and engage with healthcare innovations. Additionally, healthcare providers might be more inclined to recommend ABPM to younger patients to monitor their BP over a 24-hour period, as they are often perceived as more likely to have undiagnosed hypertension or white coat syndrome. Conversely, older individuals may have pre-existing notions about traditional office-based measurements and may be less willing to embrace newer diagnostic technologies. Furthermore, healthcare providers may be more conservative in recommending ABPM to older patients, assuming that WCH is less prevalent in this demographic and that these patients are more likely to have real Hypertension.

In comparison to another study in Hong Kong, which highlighted a marked underutilization of ABPM, unlike our study, their use of out-of-office BP assessment techniques (HBPM or ABPM) in Hypertension diagnosis was not associated with any demographic characteristics, including age, sex, or work-sector.[15]

Furthermore, we detected a statistically significant variance in the average systolic BP levels between those whose diagnosis relied on ABPM and those who did not undergo this procedure. Specifically, patients who did not undergo ABPM displayed higher systolic BP levels. This finding emphasizes the capability of ABPM to identify elevated BP that might escape detection through traditional office-based assessments. It underscores the crucial role of ABPM as a valuable diagnostic instrument for pinpointing cases of hypertension. Other studies showed overall dependence on office measurements and that physicians do not obtain ABPM-based diagnoses, which indicates the possibility of missing or delayed diagnoses when relying only on office-based measurements, thereby increasing the risk of cardiovascular complications.[15,16] These findings show the urgency of an early diagnosis in situations of elevated BP and highlight the overreliance on conventional clinic-based assessments to diagnose hypertension and initiate treatment to avoid cardiovascular events. Therefore, this study points to the significance of ABPM as an accurate tool in the identification of people with hypertension. This approach can assist in facilitating appropriate interventions to be implemented immediately for lowering the possible negative health outcomes.

This study also demonstrated that patients with comorbidities such as CKD or diabetes were less likely to be diagnosed with hypertension through ABPM. One meta-analysis showed that patients with comorbid conditions, such as diabetes mellitus or CKD, were at high risk for cardiovascular events or progression to end-stage renal disease. Furthermore, lowering BP had a significant effect on patients with diabetes mellitus, who experienced a reduction in their risk of stroke.[8,15] It could account for starting antihypertensive treatment early without the support of ABPM to avoid serious complications. However, there is an association between high normal BP and masked hypertension. Research suggests that 32% of people with BP values deemed normal during routine visits might actually have high BP outside of these situations.[17] Additionally, masked hypertension has been connected to additional factors, including CKD, advanced age, and obesity.[4,17] Moreover, another study has shown that BP readings taken in clinics or at home are not sensitive or specific enough to diagnose hypertension.[10] This supports the superiority of out-of-office BP monitoring in diagnosing and treating hypertension despite existing comorbidities, as it can categorize the patient accurately.

The initial association between marital status and ABPM utilization is thought-provoking. Although the association disappears after adjusting for other factors, the initial observation sparks discussions about the influence of social support, lifestyle factors, and psychological aspects on diagnosis method preferences. Patients with greater family support and potentially those with better chances of returning for further ABPM testing, along with the additional clinic follow-ups that it entails, were possibly the ones responsible for the initial association, although we cannot conclusively prove the latter suggestion within the bounds of a retrospective study.

The research findings have direct implications for clinical practice. In our study, ABPM was used in 42.2% of the patients for diagnosing hypertension. Office BP readings were used in 49.6%, HBPM readings were used in 7.1% and ABPM and HBPM were jointly used in 1.1% of the cases in reaching a diagnosis of hypertension. Many physicians rely on office-based BP measurements, such as mercury or automated office-based BP monitoring. In one study, it was shown that ABPM was only used in 1.6% of the participants in hypertension diagnosis, regardless of patients' characteristics or risk factors.[15] Likewise, in another study, ABPM was only used in 14.4% of the patients to screen for hypertension, although it was readily available.[16] However, these studies were conducted earlier than our study at a time when the new hypertension guidelines (including AHA ones) were not widely implemented and known to physicians. These findings underscore the importance of guiding physicians in making informed decisions about diagnostic methods and being aware of a patient's characteristics, medical history, and risk factors. Physicians should be more vigilant and proactive in utilizing and advocating the use of ABPM in these cohorts of patients.

Based on this study, dependence on office measurements was observed despite the patient's risk factors. However, other research proves that clinic and home measurements of BP have poor specificity and sensitivity in the diagnosis of hypertension.[10] In addition, ambulatory monitoring might lead to more appropriate targeted treatment before the start of lifelong drug treatment. One study showed that out-of-office methods are more cost-effective than office-based ones. This is explained by the decrease in clinic visits and the limiting of unnecessary antihypertensive treatment, as ABPM rules out WCH.[4,6] Additionally, a recent study illustrated that one in three Saudi patients are managed inappropriately with reliance on in-office BP readings only.[17] This demonstrates the superiority of ambulatory monitoring in the accurate identification of hypertension. Therefore, the use of ABPM should be emphasized and reinforced among health practitioners to improve patient care.

According to the reviewed literature, this study is the first to investigate the issue of the appropriateness of Hypertension diagnosis at a Primary care center in Riyadh City. The main strength of this study is that it focuses on newly diagnosed patients at a primary care center, which provides a representation of the local community. The study used multiple statistical techniques to measure the association between ABPM utilization and the investigated factors. Due to the nature of the study design, causality between ABPM utilization and the investigated factors cannot be established because the temporal relationship between the risk factors and ABPM was not assessed. One study demonstrated the association of HBPM and ABPM with cardiovascular disease incidence and concluded that the complementary use of both methods may be useful for a more detailed assessment of cardiovascular risk.[18]

As this study was based on a retrospective review of electronic medical records, some essential factors could not be feasibly measured, such as patients' compliance with the primary physician's orders and patients' lifestyle habits. Although the study's sample represents the population of Saudi Arabia, the findings might not be generalized to all primary care centers in the country since some of them lack the availability of basic equipment such as the ABPM device. However, those devices are available in most of the hospitals and secondary care units.

Conclusion

Out-of-office BP measurements (ABPM and HBPM) were underutilized by primary care physicians to confirm the diagnosis of hypertension in the outpatient setting. This was noted more in older patients, those with diabetes and CKD, and patients presenting with higher systolic BP readings. This highlights the need to provide further education to frontline physicians regarding clinical practice guidelines and to address any challenges in their implementation. More research is needed to study the role of out-of-office measurements of BP in cardiovascular risk assessment and reduction.

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Ethics of approval

Ethical approval was obtained from the Research Ethics Committee at King Faisal Specialist Hospital and Research Center on 01 August 2022 (RAC 2221264), and a waiver of informed consent was granted.

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Conflicts of interest

There are no conflicts of interest.

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