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## REVIEW ARTICLE

# What should Patients Know About Self Blood Pressure Measurement? A Review Article

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### Abstract

Many people measure their blood pressure (BP) outside doctors' offices with a common goal of concerning their health status. Self-BP monitoring devices are widely accessible as health care products or available in different community institutes. Patients often seek their doctors' advice on their BP readings in our daily practice. Current international guidelines recommend that correct self-BP measurement with validated devices can enhance patients' self-management and drug compliance, improving overall BP control. While most of the clinicians are supportive of their patients' efforts, they are also concerned about the validity and reliability of the out-of-office BP readings. How can we effectively educate patients to get meaningful BP readings, which may improve their overall BP control? This article will review the current best evidence on patient self-BP monitoring.

**Keywords:** Self blood pressure monitoring, Home blood pressure monitoring, Hypertension, Review article

### Introduction

Hypertension is the most prevalent chronic disease worldwide. The World Health Organization estimated that 1 in 4 men and 1 in 5 women – over a billion people have hypertension [1]. Uncontrolled blood pressure (BP) leads to significant mortality and morbidity from cardiovascular disease [2]. However, many patients did not achieve the recommended BP level despite various effective antihypertensive medications [3]. Most clinicians can only measure patients' BP in a clinical setting; therefore, patients' actual BP profile remains challenging to assess [4]. One of the effective strategies is empowering patients' self-management, which can engage patients in their own BP control [5]. Patients who participated in self BP monitoring (SBPM) have demonstrated a reduction in BP levels in many randomized controlled trials, given that antihypertensive titration, telemonitoring of BP and other clinical interventions were offered after SBPM

[6]. Systematic reviews also showed well-controlled out-of-office BP was protective against adverse cardiovascular outcomes [7]. Therefore, it is common to see the promotion of SBPM devices and regular self-measurement in commercial advertisements and different health care settings.

#### *Who should measure BP themselves?*

Current evidence supports the use of SBPM in the diagnosis and monitoring of hypertension, particularly for patients with white coat hypertension, masked hypertension and hypertension with white coat effect [8,9]. The definition of hypertension varies among different authorities under different clinical circumstances [10]. The most commonly accepted definition is systolic BP  $\geq 140$  mmHg, and/or diastolic BP  $\geq 90$  mmHg in  $\geq 2$  visits. Whitecoat hypertension is defined as persistent elevated BP in a clinical setting with normal out-of-office BP. On the contrary, masked hypertension is defined as

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normal BP in a clinical setting with high out-of-office BP. Hypertension with the white coat effect is when patients on hypertensive treatment have persistently elevated BP in a clinical setting. Still, their out-of-office BP is within normal ranges. The treatment target BP is variable according to the overall cardiovascular risk, existing cardiovascular events, presence of kidney disease, diabetes mellitus, patients' tolerance to treatment, and clinical condition.

Given the above definitions, all patients on anti-hypertensive treatment, presented with sometimes high BP or elevated clinic BPs, are potential candidates for SBPM, no matter if they are newly presented with high BP or already on antihypertensive treatment. Some patients may report elevated BP in out-of-office settings, such as incidental measurements at home, institutes, or community settings if they can access a valid BP monitor and they or their care-takers can perform BP measurement correctly.

Conventionally, ambulatory BP monitoring (ABPM) is a gold standard option for diagnosing and monitoring out-of-office BP [11]. Table 1 showed the different BP cut-off levels of hypertension diagnosis for clinic BP, 24-h ABPM and SBPM readings. Clinicians attach ambulatory BP monitors to patients' upper arms, and BP measurements are automatically performed once every 30–60 minutes. Patients can continue their normal daily activities except during BP measurement. Comparing SBPM with ABPM, ABPM can also assess the whole day's BP profile, including active status and sleep time. The information is essential for patients with highly fluctuating BP, which require fine medication adjustment. ABPM devices are professional products with generally higher quality and technical specifications. They do not require patients' operations and records. Studies showed both ABPM and SBPM measurements correlated well with patients' overall cardiovascular mortality and morbidity outcomes, independent of patients' office BP level [7,12]. However, repeated ABPM may be less acceptable to patients when compared with SBPM

because of the need for repeated clinic visits and disturbance to normal daily activities [13].

#### *Benefits and risk of SBPM*

SBPM is widely accessible, acceptable and affordable for people with or without hypertension. Systematic reviews found that healthcare interventions, including SBPM and patient education, reduced BP [6]. The process of SBPM education can engage patients to understand treatment targets and their overall control. Compared with patients with no SBPM, those performing SBPM regularly had better knowledge of hypertension and its complications [14]. Patients' health literacy should not limit high-quality SBPM, which may be achieved by structured patient education [15].

The accuracy of SBPM readings is always clinicians' and patients' concern. Ideally, patients should select the brachial SBPM devices which have undergone standardized validation [16]. The regularly updated list of devices is available online. However, only a minority of commercially available SBPM devices have been validated. The cost of SBPM devices varies significantly among different brands and models. Many patients encounter difficulty in selecting an appropriate monitor. Patients may wrongly measure and record BP [17]. Inaccurate SBPM may mislead doctors' diagnosis and subsequent management. Patients' responses to BP readings may also be highly variable. Some patients may overreact to the readings, while others may delay seeking medical advice despite persistently abnormal readings [18].

Clinicians generally support patient self-management—nevertheless, there is concern in successful transfer of knowledge and skills. There is also commonly a time constraint for SBPM education. Doctors are expected to review patients' SBPM readings and manage patients' BP accordingly. Patients also wish doctors to give feedback on their homework. Some doctors and nurses may find it difficult to implement in a busy daily practice,

Table 1. Blood Pressure (BP) cut-off for diagnosing hypertension for clinic, 24-hour ambulatory BP monitoring (ABPM) and Self BP monitoring (SBPM).

Hypertension diagnostic cut-off <sup>a</sup>	Systolic BP (mmHg)	Diastolic BP (mmHg)	Reference, Remark
Clinic BP	140	90	[9,22,33]
24-hour ABPM	135	85	[34]
Daytime (awake)	120	70	
Nighttime (asleep)	130	85	
Overall (24-hour)			
SBPM	135	85	[34]

<sup>a</sup> The cut-off level is lower for patients with high cardiovascular risk and other comorbidity.

particularly for those patients with multiple comorbidities [19].

#### *Common mistakes of SBPM*

The common mistakes during SBPM listed in the literature include inaccurate SBPM machine machine, wrong cuff size, measuring technical errors such as inadequate rest, the BP monitors not placing at heart level, cuff position, frequency of measurement, arms are not supported, leg crossing and reporting errors [20,21]. Many commercially available BP monitors did not pass proper validation protocols [16]. The general public usually buy monitors in pharmacies, sales points for health care equipment, or online shops. If they do not know how to select, they typically rely on promoters' recommendation of models, which may or may not be an appropriate choice. In addition, many commercially available BP monitors only provide standard brachial cuffs size.

#### *How should patients be advised on SBPM?*

The American College of Cardiology/American Heart Association, the European Society of Hypertension (ESH), Hypertension Canada, National Heart Foundation of Australia and the National Institute for Health and Care Excellence issued guidelines for the recommendations and procedures for the use of SBPM [8,9,22].

For patients motivated in self-care, clinicians can first advise patients on selecting validated brachial type SBPM monitors by international standardized protocols [23]. The British Hypertension Society (BHS) Protocol, the Association for the Advancement of Medical Instrumentation (AAMI) Standard, and the International Protocol of the European Society of Hypertension (IP) published a universal, widely accepted protocol for brachial cuff type BP monitor validation [24]. In the protocol, at least 85 subjects with different arm circumferences are recruited from the general population for sequential BP measurements in different BP ranges. If more than 85% of the readings have less than 10 mmHg error, the device is acceptable.

The list of validated BP devices is accessible in the Dabl Educational Trust and the US Blood Pressure Validated Device Listing (VDL) [25]. Patients may find it difficult to tell if their SBPM device has been validated. Therefore, the clinician's recommendations following the list of reliable devices in the market would be helpful. If cost is less concerned, monitors with sufficient readings memory or Bluetooth synchronization with mobile

device functions are preferred. If patients can share the details of BP records, including time, frequency, readings, with calculated mean daytime and night-time BP, clinicians can ensure optimal BP control. Patient information on the steps of SBPM measurement is shown in Table 2 and Table 3 (Chinese Version).

#### *Community resources for SBPM*

Some patients may prefer SBPM under professional supervision. Other patients may be unable to perform SBPM because of physical, mental or literacy limitations. Clinicians may consider introducing their patients in Hong Kong to visit the District Health Centres (DHC) [26]. Currently, the Kwai Tsing, Tuen Mun, Wong Tai Sin and Sham Shui Po DHC operate until late evening. Besides, when there is less concern in the COVID pandemic, self-BP monitors are available for public use in some health care institutes or sports venues. Non-government organizations have provided a Patient Empowerment Program for patients with diabetes since 2010. Structured disease knowledge and self-care education are developed to motivate patients [27]. Registered nurses train participants and their family members about self-BP monitoring.

#### *New advances in out-of-office BP monitoring*

Given limitation in ABPM and SBPM, new advances in wearable digital blood pressure monitors with minimal stress on the patient is a global trend in the digital era. They are not yet accepted in clinical use because of limited evidence and validation protocol [28].

Oscillometric measurement at the wrist is similar to the conventional SBPM and ABPM brachial devices. The regular stress to the wrist is less disturbing than the brachial devices. Several validation studies of the wrist device were published using international BP device validation protocols [29].

Applanation tonometry method uses radial arterial wall applanation to measure the waveform of arterial BP [30]. The sensor must be stabilized at the wrist, and no patient movement is allowed during measurement. The most common application is to measure night-time BP surges, especially in patients with sleep apnea [31].

Photoplethysmography sensors can be worn over fingers or wrists. There are ongoing studies on the multiple site cuffless photoplethysmography measurement [32]. The pulse transit time of the arterial pulse wave in different sites can be used to estimate the BP profile.

Table 2. Self BP Monitoring checklist.

No		✓	;×
1.	No exercise, smoke or consume foods or drinks containing caffeine (such as tea or coffee) at least 30 min. Rest at least 5 min. Wear loose-fitting and comfortable clothes, Roll up the sleeve to expose your upper arm		
2.	Choose a stable table and chair of appropriate height (at heart level) with arm rest. Sit comfortably and relaxed with your back supported, keep your feet on the floor and do not cross the legs		
3.	Check if the cuff size and cuff position is appropriate (fits the arm within the accepted range indicated on the cuff with appropriate tightness. The lower border of the cuff should be 2 cm above the pit of elbow, which is approximately two finger-breadths. Make sure the tubing is placed at the centre of your arm facing the front and that the sensor is correctly placed. Patient can just slip two fingertips beneath the cuff, near its edge at the top end		
4.	no talking/movement during measurement, after complete release of cuff, repeat measurement at least 1 min apart		
5.	Record all readings accurately		
6.	Record Schedule: <ul style="list-style-type: none"> <li>• Twice daily: before taking medicine and before dinner</li> <li>• Daily after change in treatment regimen for 2 weeks + Daily for one week before clinic visit</li> <li>• Measure at least 7 days [22,34]</li> </ul>		
7.	Web-base resources: BHS British Hypertension Society <a href="https://bihsoc.org/wp-content/uploads/2017/09/How_to_instructional_leaflet.pdf">https://bihsoc.org/wp-content/uploads/2017/09/How_to_instructional_leaflet.pdf</a> AHS American Heart Association <a href="https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings/monitoring-your-blood-pressure-at-home">https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings/monitoring-your-blood-pressure-at-home</a> RACGP Royal Australian College of General Practitioners: <a href="https://www.racgp.org.au/download/Documents/AFP/2016/January/February/Clinical-Sharman.pdf">https://www.racgp.org.au/download/Documents/AFP/2016/January/February/Clinical-Sharman.pdf</a>		
			

Table 3. Self BP Monitoring checklist (Chinese Version).

No		✓	;×
1.	量度血壓30分鐘前請勿吸煙或飲用含咖啡因食品(咖啡或茶), 最少休息5分鐘, 穿著鬆身衣物, 衫袖卷高。		
2.	舒適地安坐在有椅背及扶手的椅子上, 雙腳平放在地上 把血壓機平放在心臟水平的桌面上, 把血壓機袖帶包好		
3.	選擇適當大小的血壓機帶, 帶長度應能完全包裹手臂, 不宜太鬆或太緊。包好後剛好能在帶內放下兩隻手指 帶應包在手踭兩公分以上, 連接血壓機的膠管要放在手臂正中央前方		
4.	量度時不應移動或講話, 量度完後1分鐘後待帶完全放鬆後, 再按鈕量度一次		
5.	準確地記錄所有血壓		
6.	每日量度兩次:早上服藥前及晚飯前 建議在覆診前一星期量度7天(量度最少12次)		

## Conclusion

Current international guidelines recommend accurate SBPM as a diagnostic and monitoring investigation in patients with high-normal and elevated BP, whether they are on antihypertensive drugs or not. Patients should be trained with the proper SBPM technique and recommended a validated SBPM device. Physicians' response and action according to patients' SBPM records could engage patients for better drug compliance and more

healthy lifestyle activities. We may be able to apply the latest advances in non-invasive BP monitoring in daily practice very soon.

## Conflict of Interest

None declared.

## Ethics information

Not applicable.

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