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Comments

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Home Blood Pressure Monitoring to Improve Hypertension Control: A Narrative Review of International Guideline Recommendations

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Short Title: Review of home blood pressure monitoring

Abstract: Home blood pressure monitoring (HBPM) is a convenient way to assess out-of-office blood pressure control and is recommended by numerous international guidelines to aid clinicians in the diagnosis and management of essential hypertension. Although available guidelines recommend the use of HBPM in patients receiving antihypertensive medication, their specific recommendations regarding optimal monitoring schedule, duration, and clinician interpretation of home blood pressure readings may differ among guidelines. The purpose of this article is to review available international hypertension guideline recommendations related to the use of HBPM to improve hypertension control among patients receiving antihypertensive therapy. We also briefly highlight clinical trials that have shown improved blood pressure control using HBPM to intensify antihypertensive therapy and provide a practical guide for implementing HBPM to improve hypertension control. Eleven international guidelines were identified and reviewed. In total, recommendations relating to which HBPM to use, number of measurements per day, and how to interpret home blood pressure values were largely in agreement among available guidelines. Clinicians recommending HBPM to their patients with hypertension should utilize a standardized HBPM protocol, based on available guideline recommendations.

Key Words: home blood pressure, hypertension, monitoring

Word count: 2806 (excluding tables and figures)

Introduction

Hypertension, or elevated blood pressure (BP), is a leading modifiable risk factor for cardiovascular disease, stroke, and kidney disease.[1] In the United States (US), the prevalence of hypertension varies from approximately 32% to 45% of adults, depending on BP thresholds used to define elevated BP.[2] Despite effective and affordable antihypertensive medications, an estimated 28.7% of patients treated for hypertension have uncontrolled BP.[2] Unfortunately, recent data suggest that BP control rates are declining among US adults with hypertension, while cardiovascular deaths related to hypertension are increasing.[3,4]

Historically, decisions to initiate or intensify antihypertensive therapy have been based on office-measured BP values taken at clinician's office. Multiple factors can lead to inaccurate office-measured BP readings, including improper patient position, inappropriate BP measurement technique, and patient anxiety attributed to the healthcare setting.[5] Given the potential for inaccurate office-measured BP and increased availability of home BP monitors, recent guidelines have advocated for the use of out-of-office BP monitoring to confirm the diagnosis of hypertension and to monitor treatment response in those taking antihypertensive therapy.[5–7] Current options for out-of-office BP measurement include 24-hour ambulatory BP monitoring and home BP monitoring (HBPM). HBPM has several advantages over office-measured BP, including a more reliable assessment of patients' BP in their natural setting, multiple readings over several days, and has been shown to be more closely related to risks of developing hypertension end-organ damage and cardiovascular events compared to office-measured BP.[8] Current hypertension guidelines recommend HBPM to confirm the diagnosis of hypertension, assess for white-coat or masked hypertension in patients not currently taking antihypertensive therapy, and evaluate BP control and medication adherence in those receiving antihypertensive treatment.[9]

27   Use of HBPM in clinical practice appears to be increasing as clinicians are increasingly

28   recommending HBPM to their patients with elevated BP. In one survey, 96.8% of primary care

29   clinicians reported using patient self-monitored BP readings and 98.5% reported making

30   changes to medications based on patients' home BP readings.[9] Likewise, patients are open to

31   HBPM also. A recent survey of patients with hypertension reported that 30.1% stated their

32   physician had recommended HBPM.[10] Among those recommended to use HBPM, 82%

33   reportedly complied.[10] While multiple international hypertension guidelines recommend HBPM

34   for patients treated with antihypertensive medications,[5,7,11,12] standardized clinical HBPM

35   protocols for educating patients on appropriate use or recommended monitoring schedules are

36   lacking. In a survey of primary care providers, nearly 97% of clinicians reported using HBPM in

37   their patients; however, 99.5% of clinicians reported that HBPM patient education was done by

38   a team member and not the clinician.[9] Another survey examined the proportion of clinics with

39   appropriate procedures for recommending HBPM based on current guidelines for out-of-office

40   BP monitoring. Among the surveyed clinics, 48.8% utilized a non-clinician staff to provide HBPM

41   training to patients, while only 27.6% reported a standardized policy for training patients on

42   appropriate HBPM use.[9]

43

44   Given the increasing use of HBPM to manage hypertension, a consistent protocol for

45   assessing and interpreting home BP readings is needed to ensure clinicians are following best

46   practices. In this review, we compare recommendations from available international

47   hypertension guidelines on clinical use of HBPM and interpreting home BP values to adjust

48   antihypertensive medication. Additionally, we review monitoring schedules used in several

49   clinical trials supporting HBPM to improve hypertension control, as well as provide a practical

50   guide for implementing HBPM in clinical practice to improve BP control rates.

51

52

Recommendations for Home Blood Pressure Monitoring

A search for international hypertension guidelines providing specific recommendations for use of HBPM in patients treated for hypertension was conducted using PubMed. Guideline statements and consensus documents published from major hypertension management organizations within the last 10 years, and providing specific recommendations for HBPM and interpretation were included. Although the terms, "self-measured BP monitoring" and "HBPM" may seem interchangeable, HBPM specifically refers to BP measurement in ones' home, but may be performed by someone other than the patient.[5] Self-measured BP monitoring refers to BP measured by the individual, although it may occur outside of their home.[9] For the remainder of this article, the term HBPM will be used as it is the term commonly used in available guidelines. A total of eleven international guidelines were identified and are summarized in Table 1.

Recommendations for Home BP Monitoring Devices

Reviewed guidelines favor the use of automated, oscillometric HBPM devices over the use of manual devices. Automated monitors with upper-arm cuffs assessing pressure of the brachial artery are consistently preferred over wrist or finger devices (Figure 1) when appropriate cuff sizes are available.[5,6,8,11–17] Wrist monitors are less reliable in comparison to upper arm cuffs due to incorrect positioning in relation to the heart and measurement of BP in both the radial and ulnar arteries, but may be considered in patients who are unable to obtain an appropriately sized upper-arm cuff.[8] All eleven reviewed guidelines recommend using a validated HBPM for assessing BP control, yet only five cite resources for choosing a validated monitor[6,8,14–16] (Table 2). Home BP monitors should also be routinely calibrated, and guidelines recommend clinicians compare office-measured BP against patients' home device before initiation HBPM and periodically thereafter.[5,12–15,17] Patients should receive education regarding

78   appropriate HBPM use, and clinicians should assess patients' technique before initiation HBPM,

79   and periodically thereafter.[5,12,14,15]

80

81   **Recommendations for Optimal BP Monitoring Schedule**

82   Available guidelines provide specific instructions for the number of BP measurements

83   per day and frequency of monitoring for appropriate assessment. All guidelines agree upon

84   testing BP twice daily (in the morning and evening), with two consecutive measurements taken

85   1-2 minutes apart each time. Prior to each measurement, patients should be resting for at least

86   5-minutes and positioned correctly (Figure 2). Reviewed guidelines offer varying

87   recommendations regarding conditions prior to taking BP measurements, such as before or

88   after meals and time since waking in the morning, yet most agree that morning BP

89   measurements should be taken after emptying one's bladder and before typical morning

90   activities (caffeine, exercise, smoking). Four guidelines recommend assessing BP before the

91   morning meal,[11–13,16] and nine guidelines specify morning BP readings be taken before

92   administering antihypertensive medications.[5,6,8,11–13,15–17] Recommendations for evening BP

93   readings are less consistent regarding timing in relation to meals. Three guidelines recommend

94   measuring evening BP before the evening meal,[8,16,17] two guidelines recommend measuring

95   after the evening meal,[11,15] and three guidelines call for measuring BP before bed.[5,12,13]

96   Considering some patients may be taking antihypertensive medications more than once per

97   day, two guidelines specify that evening BP measurements be taken before administering

98   evening antihypertensive medications.[11,16]

99   The duration of HBPM assessment varies slightly between the reviewed guidelines;

100   however, it is acknowledged that longer periods of continuous assessment provide superior

101   data for managing hypertension. Consecutive measurements taken over a 3-day and ideally 7-

102   day period are recommended to assess BP control. Excluding BP measurements taken the first-

103   day is recommended by most guidelines, given expected higher values on the first day of

104   evaluation. Once BP control is achieved, recommendations for continued HBPM measurement

105   are mixed, ranging from weekly to biannually.[6,8,11,13–16] Time frames to reassess control of

106   hypertension with HBPM should be determined based on patient-specific factors such as

107   medication adherence, cardiovascular risk, comorbid conditions, age, and potential for labile

108   BP. Providers should be mindful of "*monitoring-fatigue*" when patients are asked to continuously

109   monitor home BP despite controlled BP.

110

111   **Evaluating Home BP to Guide Treatment Intensification**

112   In patients treated with antihypertensive medications, assessing BP control with HBPM

113   requires patients to measure BP over a minimum 3-day period, preferably a consecutive 7-day

114   period, beginning 1-week prior to their next clinic visit. To assess BP control, guidelines

115   recommend averaging all systolic and diastolic values taken during the 3 to 7-day measurement

116   period (excluding readings on day 1). Two guidelines recommend averaging morning and

117   evening values separately.[12,13] If the calculated average home BP is 135/85 mmHg or higher,

118   equivalent to an office-measured BP of 140/90 mmHg, guidelines unanimously recommend

119   intensifying antihypertensive therapy. Specific home BP goals are not recommended by most

120   guidelines, although two guidelines offer specific home BP goals. The HOPE Asia Network

121   recommends home BP goal of <135/85 mmHg for patients under 80 years, home BP of <145/85

122   mmHg for patients above age 80, and a systolic BP (SBP) goal of <125 mmHg for patients at

123   increased cardiovascular risk, such as those with diabetes, chronic kidney disease, or

124   cardiovascular disease.[12] The 2020 Taiwan Hypertension Society considers home BP to be

125   "well-controlled" if both the morning and evening average BP values are <135/85 mmHg.[13]

126 Further, patients with hypertension-related organ damage are recommended to achieve a home

127 BP of <130/80 mmHg.[13] Time frames for reassessing home BP following adjustment of

128 antihypertensive medications is provided in two guidelines. Recommendations from Australian

129 guidelines[16] call for reassessing home BP values approximately 4-weeks after medication

130 adjustment, while guidelines from Taiwan[13] recommend re-evaluating home BP control after 2

131 weeks.

132

133 **Home Blood Pressure Monitoring Schedules from Clinical Trials**

134 Multiple studies have evaluated changes in BP when HBPM is combined with additional

135 management compared to usual care. A brief review of several of those trials, including how

136 HBPM data was used to guide hypertension treatment, is described below.

137

138 A randomized trial compared HBPM with pharmacist management to usual care among

139 patients with uncontrolled BP.[13] Patients randomized to the HBPM group received a HBPM

140 home and advised to check home BP 3-times per week and upload their results weekly to a

141 web-based application which calculated weekly averages. These results were reviewed by

142 clinical pharmacists, who contacted patients to assess medication adherence and if needed,

143 intensify antihypertensive therapy. The proportion of patients with controlled BP at 6-months

144 was greater in the HBPM group compared to usual care (Table 3). Additionally, patient reported

145 satisfaction with hypertension care was also greater in the HBPM group versus usual care.

146

147 A randomized cluster trial evaluated hypertension control rates among patients receiving

148 HBPM with pharmacist-management compared to usual care over an 18-month period.[18]

149 Patients in the HBPM cohort were asked to submit at least six BP readings per week, preferably

150 3 readings taken in the morning and 3 readings in the evening. Pharmacist follow-up with HBPM

151   patients occurred every 2 weeks until their home BP was controlled. Instead of average BP

152   values to determine control, pharmacists evaluated the proportion of controlled home BP

153   readings, where treatment intensification would be recommended if less than 75% of BP

154   readings were controlled. HBPM and follow-up was continued for 12 months, then patients

155   returned to usual care for hypertension management. Hypertension control rates were

156   significantly higher among the HBPM cohort compared to usual care even at 18-months, 6-

157   months after the HBPM intervention had ended.[18] An extension of this trial found no significant

158   difference in systolic or diastolic BP (DBP) at 54 months between HBPM and usual care groups,

159   concluding that maintaining long-term BP control requires continued monitoring and resumption

160   of HBPM intervention if BP increases.[19]

161

162   Home BP monitoring with additional management appears to improve hypertension

163   control compared to usual care, but whether HBPM alone results in improved hypertension

164   control was assessed in a randomized trial by Green et al.[20] Patients with uncontrolled

165   hypertension despite antihypertensive therapy were eligible for one of three interventions: usual

166   care, HBPM with results reported to their primary care physician (HBPM-PCP), or HBPM with

167   pharmacist-management (HBPM-Pharmacist). Patients in both HBPM groups received training

168   on appropriate use of a validated BP meter, and instructions to measure their BP at least twice

169   per week, with two measurements each time. Home BP values were reported to PCPs or

170   clinical pharmacists via a secure web-based messaging system. Patients randomized to the

171   HBPM-Pharmacist group received follow-up management from clinical pharmacists every two

172   weeks until their BP was controlled. The HBPM-Pharmacist group resulted in the largest

173   proportion of patients with controlled in-clinic BP (defined as <140/90 mmHg) at 12-months.[20]

174

175

176

Discussion

177

178   Among the international guidelines for HBPM, there is overwhelmingly agreement

179   among recommendations for using HBPM to assess and manage hypertension. Available

180   guidelines provide similar recommendations for choosing a validated monitor and patient-

181   preparation prior to BP measurements (empty bladder, resting for at least 5 minutes, using a

182   monitor device with an arm cuff, and placing the BP cuff on bare skin).[5,8,11,12,16] Perhaps key to

183   using HBPM is ensuring patients use a validated BP monitor and education on appropriate use

184   and monitoring schedule. Specific resources where patients and clinicians can view validated

185   BP monitors are provided in five guidelines.[6,8,14–16] . Recommended schedules to evaluate BP

186   control in patients receiving antihypertensive medication were highly concordant in endorsing

187   two measurements per day, in the morning before antihypertensive medication and in the

188   evening, with 2 readings taken at least 1-minute apart each time. Additionally, at least 3-days of

189   HBPM data and optimally 7-days is sufficient to assess BP control, with average home BP

190   values 135/85 mmHg or higher indicating uncontrolled hypertension. Seven guidelines

191   recommend omitting first-day readings due to concerns that these readings will likely be higher

192   than subsequent day readings, and may increase the 7-day average.[6,8,11–14,16,17]

193

194   Recommendations with the greatest disagreement were related to guidance on timing of

195   evening BP measurements. Among the guidelines reviewed, three offered no recommendation

196   regarding evening BP measurements with regard to meals,[6,7,14] three recommend measuring

197   before the evening meal,[8,16,17] three recommend measuring before bedtime,[5,12,13] and one

198   guideline specifies measuring evening 2-hours after the evening meal.[11] Postprandial

199   hypotension, defined as a reduction in SBP of 20 mmHg or more within 2 hours of a meal, is

200   common in elderly patients and may or may not be symptomatic.[22] To minimize the postprandial

201   hypotension, which may produce artificially low evening BP values, evening BP should be

202   measured before meals, or at least 2-hours after. When interpreting home BP readings, the

203   average SBP and DBP should be used to assess BP control, rather than assessing the

204   proportion of days controlled. Consistent among all included guidelines was an average home

205   BP of 135/85 mmHg or higher corresponded to an office-measured BP of 140/90 mmHg or

206   more, and should prompt treatment intensification. While most guidelines (6 out of 11)

207   recommend routine calibration of home BP monitors against office-BP, specific details regarding

208   when and how often this should be done are lacking. At a minimum, annual evaluation of

209   patients' HBPM technique and the accuracy of their HBPM seems appropriate.

210

211   Evidence supporting use of HBPM with additional management utilized a variety of

212   HBPM schedules, none of which follow current recommendations. Although trials used different

213   HBPM schedules, each used the same home BP threshold of ≥135/85 mmHg to guide

214   antihypertensive intensification, thus the specific monitoring schedule may be less relevant than

215   treatment intensification when average home BP readings are elevated. A 2017 meta-analysis

216   evaluated changes in BP and control rates with HBPM compared to usual care, but categorized

217   HBPM use by levels of additional co-interventions.[23] Twenty trials with individual patient data

218   were included, and stratified by intensity of co-intervention. Studies which used HBPM alone

219   showed modest reductions in SBP and DBP at 12 months, and no significant improvement in

220   BP control rates. However, studies which combined HBPM with more intense interventions,

221   such as patient education and medication management, were associated with significant

222   decreases in SBP (-6.1 mmHg) and DBP (-2.3 mmHg).[23] Additionally, patients who received

223   HBPM with more intensive co-interventions were 40-50% more likely to achieve BP control

224   compared to usual care.[23] Thus, available data support greater reductions in SBP and DBP, as

225   well as improved BP control rates, when HBPM is used along with additional patient education

226   or medication management strategies.

227

228   Best practices related to HBPM for hypertension management should include

229   standardized patient-education material, including written instructions clearly explaining proper

230   measurement and monitoring schedule for obtaining home BP values. Additionally, a

231   standardized approach for assessing BP control using home-monitored BP values according to

232   current guidelines should be encouraged among all clinicians. Given that some clinicians may

233   not be aware of recommendations for HBPM or evaluating home BP values, a recent statement

234   on the use of self-measured BP monitoring from the American Heart Association and American

235   Medical Association (AHA/AMA) has called for additional education for health care professionals

236   to increase their knowledge and skills related to self-measured BP monitoring and ensure core

237   competencies of HBPM in clinical practice.[9] All clinicians involved in treating hypertension

238   should be aware of the recommended monitoring schedule, as well as correctly interpreting

239   home BP values to improve hypertension control rates.

240

241   **Conclusion**

242   Hypertension control rates remain unsatisfactorily low among patients treated with

243   effective antihypertensive therapy. HBPM is recommended by multiple international

244   hypertension guidelines as an effective way to assess BP control in patients treated with

245   antihypertensive medications. Clinicians who recommend HBPM should educate patients on

246   proper home BP measurement techniques, as well as recommend validated automatic monitors

247   which measure BP from the upper arm. Available guidelines largely recommend a standardized

248   HBPM schedule, including measuring BP twice per day for seven days, should be used to

249   assess BP control. Averaged home BP values should be used to evaluate BP control, with

250   prompt antihypertensive adjustment recommended if average home BP readings are above

251   135/85 mmHg, and close follow-up monitoring thereafter to ensure continued BP control.

252

253   **Declarations of Interest**: All authors report no conflicts of interest.

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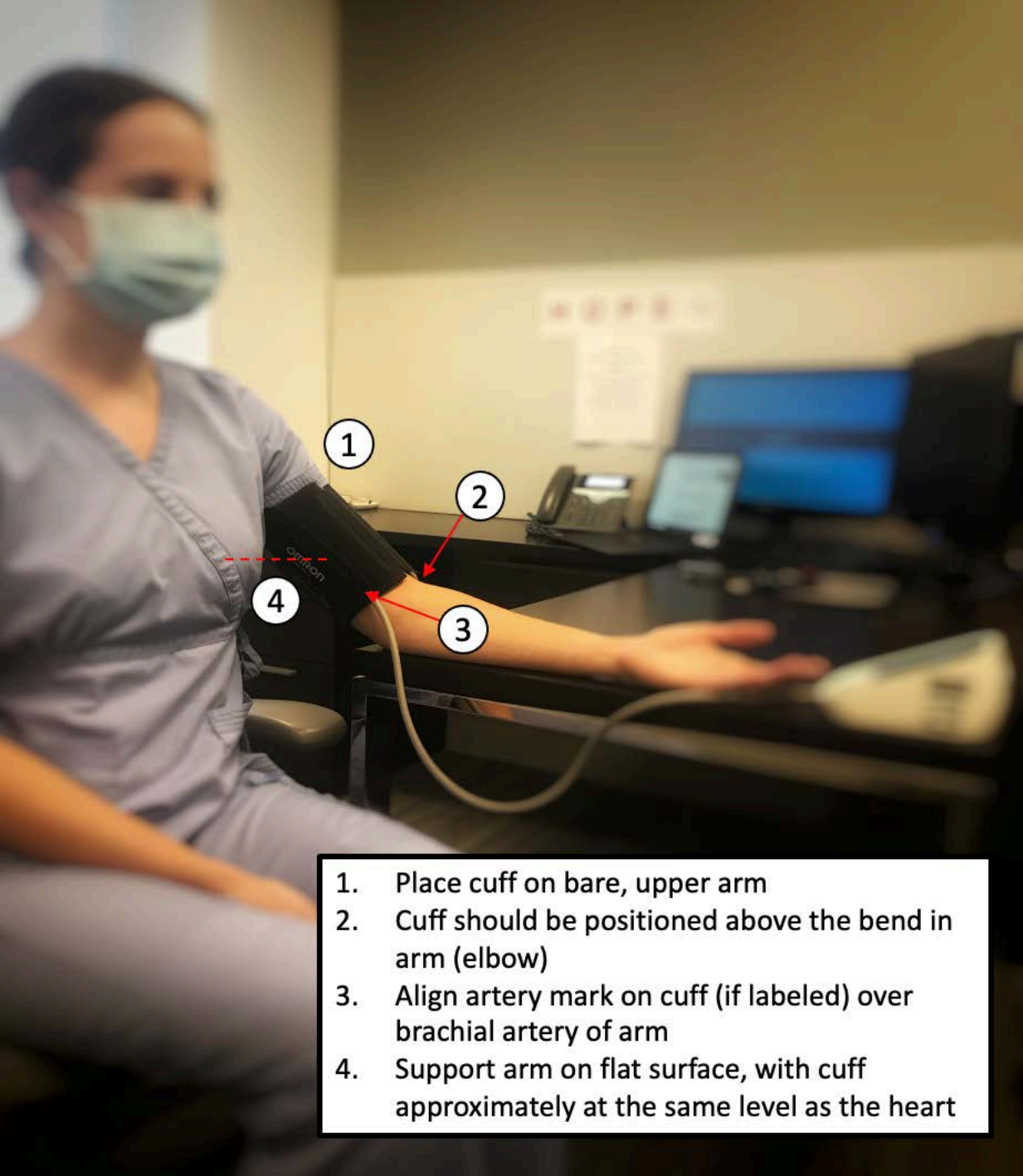
1. Place cuff on bare, upper arm
2. Cuff should be positioned above the bend in arm (elbow)
3. Align artery mark on cuff (if labeled) over brachial artery of arm
4. Support arm on flat surface, with cuff approximately at the same level as the heart

Pre-monitoring patient education

- Choose a validated, upper-arm home BP device, with appropriate size cuff

- Demonstrate appropriate measurement technique; ensure patient can replicate appropriate technique

- Prepare for BP measurement
  - Empty bladder
  - Rest for ≥5 minutes quietly
  - Sit up right, with legs uncrossed and flat on floor
  - Place cuff on bare arm and rest arm on flat surface (Figure 1)
  - Avoid exercise, caffeine, or tobacco at least 30 minutes
  - Do not talk during rest or BP measurements
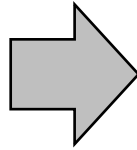
Home BP Measurement

- Beginning 1-week prior to the clinician visit, measure BP twice per day
  - In the morning and evening
  - Before taking BP medications
  - Before meals

- Take 2 readings each time, separated by 1-2 minutes
- Record the time, date, and BP results for at least 3 days in a row, but preferrable 7 days in a row

- Bring results and home BP monitor to clinician appointment
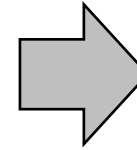
Clinician Evaluation

- Review patient's home BP readings
  - Minimum of 3-days (12 readings); preferably 7-days (28 BP readings)
  - Consider discarding readings from the first day of measurement
- Assess patient's adherence to lifestyle modifications and medication(s)
- Average systolic and diastolic readings (discard first-day values may be appropriate)
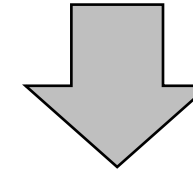
If average home BP ≥135/85 mm Hg:
- Re-enforce adherence to lifestyle modifications and medication(s)
- Intensify antihypertensive treatment to achieve average BP <135/85 mm Hg
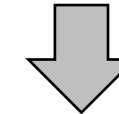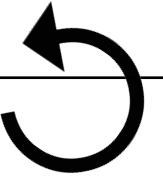
Follow-up in 2-4 weeks:
- Evaluate last 3-7 days worth of home BP readings and adherence as recommended above
- Once home BP controlled, advise patient to monitor 1-2 days per week every 3-6 months

Annually:
- Evaluate patient's BP measurement technique
- Validate patient's HBPM for accuracy

Figure 1: Correct position of arm with home blood pressure monitor

Figure 2: Recommended clinical approach to implementing home blood pressure monitoring to improve hypertension control.

Guideline or Consensus document	Frequency of readings	Time of day	Duration of assessment	Evaluation	Notes
2021 European Society of Hypertension[8]	2 measurements per occasion taken 1 minute apart	Morning: before medications and food Evening: before medications and food	**Uncontrolled**: 7 days recommended with minimum of 3 days (12 readings) before clinic visit **Controlled**: Two measurements 1-2 per week or per month	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm oscillometric device with automated measurement storage and averaging features preferred with semi-automated or automated devices -Validated wrist devices by be used in those with very large arms
2020 Taiwan Hypertension Society[13]	≥2 readings 1 minute apart	Morning: within 1 hour of awakening, before food and medications Evening: within 1 hour of bedtime	**Uncontrolled:** 4-7 consecutive days once a month or beginning 2-weeks after adjusting medication **Controlled:** Perform 722 principle at least every 3 months	Average AM and evening values separately, excluding first-day readings BP<135/85 mmHg for AM and evening considered controlled For patients with hypertension-mediated organ damage, BP<130/80 mmHg considered controlled	-Upper arm preferred location with validated, oscillometric device -defines a "722" principle, relating to every 7 days, measure BP twice a day, with 2 readings each time -in well-controlled patients, one duplicate measurement once per week may be an alternative to performing the 722 principle every 3 months.

2020 International Society of Hypertension[6]	2 successive measurements 1 min apart	Morning: before medications and evening	**Uncontrolled**: 3-7 days **Controlled**: 1-2 measurements per week or month	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm preferred location with validated, oscillometric device
2020 Hypertension Canada[11]	2 duplicate measurements conducted in series	Morning: before breakfast and before medication Evening: 2 hours after dinner and before medication	**Uncontrolled**: 7 days **Controlled**: 1-week HBPM every 3 months	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm preferred location with validated oscillometric device -Non-dominant arm should be used unless SBP between arms is >10 mm Hg in which arm with highest value is used -Wrist devices can be used for patients with large arm circumference

AHA 2019 Scientific Statement[5]	2 readings at least 1 minute apart	Morning: before medication Evening: before bed	**Uncontrolled**: ≥ 7 consecutive days with minimum of 3 days before next provider appointment	Average HBPM values, consecutive day monitoring ideal If 1st day readings discarded, evaluate days 4-8 BP ≥135/85 mmHg suggests uncontrolled BP	-If first day of readings is excluded, 4-8 days of average HBPM values are required -Upper arm preferred location with validated, oscillometric device. -Device should automatically store all readings, print log of stored readings, and electronically send data to provider
2019 Chinese Hypertension League[15]	2-3 consecutive measurements 1 minute apart after 5 minutes of rest	Morning: 1 hour after getting up, before breakfast and medication Evening: after meal	**Uncontrolled**: Successively for 5-7 days **Controlled**: Minimum of 1 day per week	Average HBPM values BP ≥135/85 mmHg suggests uncontrolled BP	- Upper-arm automated oscillometric electronic, validated devices per standardized protocol -Finger and wrist devices not recommended -Recommended that normotensive patients assess HBPM yearly
2019 Latin American Society of Hypertension[17]	2 successive measurements at each check taken 1-2 minutes apart	Morning: before medication Evening: before dinner	Minimum of 3 days and preferred 7 days before clinic visit	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm automated device that has been validated according to internationally accepted validated protocols -Wrist cuffs not recommended except in

					the case of severe obesity with very large arm size
2017 HOPE Asia network[12]	2 successive measurements	Morning: within 1-hour of waking, before medication and food Evening: before bedtime	**Uncontrolled**: Minimum of 3 days and preferred 7-days	Average HBPM values, excluding first-day readings Calculate average for morning and evening values separately BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm preferred location with validated, brachial oscillometric device -Alternative monitors acceptable when brachial device is not feasible. Requires device calibration every 6-12 months -Assess morning variability with standard deviation of morning values over minimum of 3 consecutive days -Assess morning surge by subtracting evening SBP from morning SBP -Assess morning/evening difference by subtracting sleep SBP from morning SBP
2018 ESC/ESH Hypertension Guideline[7]	2 successive measurements 1-2 minutes apart	Morning and evening	**Uncontrolled**: Minimum of 3 consecutive days with preferred 6- 7 consecutive days	Average HBPM values, excluding first-day readings	-Upper arm preferred location with validated oscillometric device

				BP ≥135/85 mmHg suggests uncontrolled BP	
2016 Royal Australian College[16]	2 successive measurements at least 1 minute apart	Morning and evening at same time each day and before medication, food, and vigorous exercise Acceptable to assess in late morning (especially if on antihypertensive medications) to catch lowest BP value	**Uncontrolled**: 7-day period before clinic visit; minimum 5 days **Medication adjustment**: 7-day HBPM 4 weeks after medication adjustment **Controlled**: Conduct HBPM at regular intervals (e.g., every 6 months)	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm preferred location with automated, validated device. -Device with memory storage preferred -Validated wrist device acceptable if large arm circumference
British Hypertension Society home blood pressure monitoring protocol[14]	2 consecutive measurements 1 minute apart	Morning: between 6 AM and 12 PM Evening: between 6 PM and 12 AM before medication	**Uncontrolled**: 4-7 days before clinic appointment **Controlled**: 1-2X per week Or 4-7 days consecutively every 4-6 months	Average HBPM values, excluding first-day readings BP ≥135/85 mmHg suggests uncontrolled BP	-Upper arm preferred location with automatic, validated, oscillometric device -Arm with higher systolic reading should be used for assessment

Abbreviations: AHA= American Heart Association; BP=blood pressure; ESC/ESH=European Society of Cardiology/European Society of Hypertension; HBPM=home blood pressure monitoring.

Table I: Recommendations for home blood pressure monitoring from International Hypertension Guidelines

Resource listing validated home blood pressure monitors	Recommended by International Guideline
www.stridebp.org	2019 Chinese Hypertension League 2020 International Society of Hypertension 2021 European Society of Hypertension
www.bihsoc.org	2016 Royal Australian College of General Practitioners British and Irish Hypertension Society
www.validatebp.org	Recommended for United States population

Table 2: Available resources for choosing validated home blood pressure monitors.

Study	Population	Intervention	Recommended home BP monitoring schedule	Results
Green et al.[20]	Patients with uncontrolled office-BP while receiving antihypertensive therapy	Usual care (n=258) HBPM values reported to PCP [HBPM-PCP] (n=259) HBPM with pharmacist management [HBPM-Pharm] (n=261)	At least 2 readings per week; 2 measurements each time Follow-up with pharmacist management occurred every 2 weeks	**Change in SBP (mmHg) at 12-months:** • Usual care: -5.3 • HBPM to PCP: -8.2 ($P<0.05$ for usual care versus HBPM to PCP groups) • HBPM-Pharm: -14.2 ($p<0.001$ for HBPM-PCP versus HBPM-Pharm) **Change in DBP (mmHg) at 12-months:** • Usual care: -3.5 • HBPM-PCP: -4.4 • HBPM-Pharm: -7.0 ($p<0.001$ for HBPM-PCP vs HBPM-Pharm with) **Proportion of patients with controlled BP at 12-months:** • Usual care: 31% • HBPM-PCP: 36% • HBPM-Pharm: 56% ($p<0.001$ for HBPM-PCP vs HBPM-Pharm)
Magid et al.[21]	Patients from 10 Kaiser Permanente clinics with uncontrolled BP while taking ≤ 3	Usual Care (n=173) HBPM with pharmacist	At least 3 BP measurements per week, uploaded weekly	**Proportion of patients who met BP goal at 6-months:** • Usual Care: 35.4% • HBPM: 54.1% ($p>0.001$)

	antihypertensive agents	management (n=175)	Weekly average BP reviewed by clinical pharmacists	**Reduction in BP (mmHg) in HBPM group vs usual care at 6-months:** • SBP: -12.4 • DBP: -5.7 **Percentage of patients reporting very or completely satisfied with hypertension care:** • Usual Care: 42% • HBPM: 58% (p<0.001)
Margolis et al.[18]	Patients with uncontrolled BP while receiving antihypertensive therapy	Usual Care for 12 months (n=222) HBPM with pharmacist intervention for 12 months (n=228)	At least 6 BP readings weekly (3 from morning; 3 from evening) Follow-up with pharmacist management occurred every 2 weeks	**6-month BP control (HBPM vs usual care):** • 71.8% vs 45.2% (p<0.0001) **12-month BP control (HBPM vs usual care):** • 71.2% vs 52.8% (p<0.005) **18-month BP control (HBPM vs usual care):** • 71.8% vs 57.1% (p<0.003) **Reduction in SBP at 12-months (HBPM vs usual care):** • -9.7 mmHg (p<0.001) **Reduction in DBP at 12-months (HBPM vs usual care):** • -5.1 mmHg (p<0.001)

Abbreviations: BP= blood pressure; DBP= diastolic blood pressure; HBPM=home blood pressure monitoring; PCP= primary care physician; SBP= systolic blood pressure

Table 3: Home blood pressure monitoring schedules and outcomes from select clinical trials