

Blood Pressure Monitoring

Worldwide, hypertension (high blood pressure) affects more than 40% of adults over 25 years of age.² Based on the lower thresholds for hypertension from the ACC/AHA (2017), nearly one-half of U.S. adults have high blood pressure.²³ Blood pressure is one of the most important clinical measurements. Hypertension is a major risk factor for coronary heart disease, kidney failure, heart failure, stroke, and other conditions.³ More than one-half of patients report monitoring their blood pressure at home.⁴ Provide our patient education handout, *How to Check Your Blood Pressure*, to help patients choose a monitor and take accurate blood pressures at home. The accuracy of blood pressure readings can be affected by the method of measurement, technique used, and a number of other factors. The chart below answers common questions about monitoring blood pressure.

Abbreviations: DBP = diastolic blood pressure; SBP = systolic blood pressure.

Question	Answer/Pertinent Information
<p>What are the various ways for patients to measure their blood pressure?</p> <p><i>Continued</i></p>	<ul style="list-style-type: none"> ● Out-of-office blood pressure measurements (generally lower than clinic readings) may be a better predictor of risk compared to clinic blood pressure measurement.^{4,5,28} <ul style="list-style-type: none"> ○ U.S. guidelines recommend out-of-office measurements to confirm diagnoses and assist with medication titrations.²³ ○ In addition, Canadian guidelines also provide specific criteria to use out-of-office measurements to diagnose hypertension:^{2,4} <ul style="list-style-type: none"> ▪ Home SBP ≥135 mmHg or DBP ≥85 mmHg ▪ Mean 24-hour ambulatory “awake” SBP ≥130 mmHg or DBP ≥80 mmHg ● Out-of-office blood pressure measurement options include home monitoring, blood pressure kiosks, and ambulatory monitoring. <ul style="list-style-type: none"> ○ Home blood pressure monitoring <ul style="list-style-type: none"> ▪ Patients should be trained under medical supervision on correct technique, device selection, and interpretation of readings (described in later sections).⁶ ▪ Advantages of home blood pressure monitoring include:^{6,28} <ul style="list-style-type: none"> ○ Improved treatment adherence and blood pressure control. ○ Ability to take multiple measurements over days, weeks, or months in a patient’s usual environment. ○ <u>White coat hypertension</u> (elevated office, normal out-of-office) is less likely to occur. ○ <u>Masked hypertension</u> (normal office, elevated out-of-office) is less likely to be missed. ○ Blood pressure kiosks <ul style="list-style-type: none"> ▪ In most retail pharmacies, but not as accurate as validated monitors. With only one cuff size usually available:¹¹ <ul style="list-style-type: none"> ● May underestimate blood pressure in very thin patients.^{1,11}

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Question	Answer/Pertinent Information
Ways for patients to measure their blood pressure, continued	<ul style="list-style-type: none">• May overestimate in overweight patients.^{1,11}▪ Kiosks cannot replace other forms of blood pressure monitoring, due to high chance of inaccuracy.^{12,13}▪ Advise patients to have a healthcare professional check their blood pressure if they have repeated high readings on a kiosk after resting and ensuring proper technique.○ Ambulatory blood pressure monitoring<ul style="list-style-type: none">▪ Blood pressure measured at a preset interval (e.g., every 15, 30, or 60 minutes, preferably on a work day).¹⁰▪ Readings are stored in monitor and converted to a report, providing mean values by hour and period (e.g., daytime, nighttime, 24-hour values).▪ Useful to identify patients with non-dipping blood pressure (blood pressure does not decrease during sleep), white coat hypertension, masked hypertension, or to evaluate resistant hypertension.^{1,3,9,10}▪ Infrequently used due to lack of availability and cost, although some payers will cover it for certain indications.^{7,8}▪ Evidence suggests nighttime blood pressure may be the best predictor of cardiovascular risk.^{1,4,10}▪ Ambulatory blood pressure monitoring (preferred out-of-office monitoring in Canada) may be considered if:^{3,28}<ul style="list-style-type: none">• Autonomic dysfunction is present• Drug resistance is apparent in clinic• Hypotensive symptoms are present with antihypertensive medications• Patient experiences episodic hypertension• White coat hypertension is suspected
Does insurance pay for out-of-office blood pressure monitoring?	<ul style="list-style-type: none">• Though data suggest they are cost effective, home blood pressure monitors may not be covered by all insurance companies.¹⁴<ul style="list-style-type: none">○ Work with patients to check their individual insurance plans to determine if home monitors are covered.○ Some state Medicaid plans cover home monitors (e.g., Alaska, Louisiana, Massachusetts, Michigan, New York).• Know which Healthcare Common Procedure Coding System (HCPCS) codes to use:²⁶<ul style="list-style-type: none">○ A4660 (mercury sphygmomanometer with cuff and stethoscope)○ A4663 (cuff only)○ A4670 (automatic monitor)• Tell patients that home monitors can be reimbursed by many healthcare flexible spending accounts (FSAs).• Insurance may provide reimbursement for ambulatory blood pressure monitoring if certain criteria are met.<ul style="list-style-type: none">○ For example, Medicare (U.S.) pays for ambulatory blood pressure monitoring for patients with suspected white coat hypertension and absence of target organ damage.²⁴<ul style="list-style-type: none">▪ HCPCS codes include 93784, 93786, 93788, and 93790 depending on how the data are used.²⁵• Insurance coverage for home/ambulatory blood pressure monitoring may vary by province and insurance plan in Canada.

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Question	Answer/Pertinent Information
<p>What blood pressure monitors can be recommended for home blood pressure monitoring?</p>	<p>Automatic blood pressure monitors are easy to use and correlate well with the auscultatory method, which is typically not recommended at home due to difficulty of use.^{3,6}</p> <ul style="list-style-type: none">• Available to measure blood pressure from the upper arm, wrist, or finger.<ul style="list-style-type: none">○ <u>Arm monitors</u> are recommended for most patients (monitors that take and average multiple readings preferred in Canada), as wrist and finger monitors are less accurate.^{6,22,28}○ <u>Wrist monitors</u> are smaller than arm monitors and should be reserved for extremely obese people if needed since wrist diameter is rarely affected by obesity.^{4,6}<ul style="list-style-type: none">▪ Not recommended for use by the American Heart Association.²²▪ If a wrist monitor is used, stress the importance of keeping the wrist supported at heart level.²⁷○ <u>Finger monitors</u> are inaccurate and should not be recommended.^{3,4,6,22}• May be more expensive than manual blood pressure monitors, at up to around \$100.• May not be appropriate for individuals with a pulse irregularity such as atrial fibrillation.²²• Optional features of automatic monitors include backlit displays, large digit display, built-in memory, connectivity with computers or mobile devices, solar charging, automatic triple readings, compact size, etc.• Remind patients who use monitors with built-in memory to make sure other people’s readings (if the monitor is shared) aren’t mistakenly saved as their own.• Recommend a monitor that has been validated according to an internationally recognized protocol, such as by the British Hypertension Society (BHS), the U.S. Association for the Advancement of Medical Instrumentation (AAMI), the American National Standards Institute (ANSI), the Canadian Hypertension Society (CHS), or the International Protocol (IP).^{15,28}• For an up-to-date list of validated blood pressure monitors, go to: www.dableducational.org/sphygmomanometers/recommended_cat.html• For the most up-to-date information about monitors endorsed by Hypertension Canada, go to: www.hypertension.ca/en/devices-endorsed-by-hypertension-canada• Store brands may be made by reputable companies (e.g., <i>Omron</i>, <i>A&D</i> [includes <i>LifeSource</i> products]), but cost less.• Home monitors should be checked for accuracy at least once a year.^{1,22}• Encourage patients to compare their home blood pressure readings with readings from their primary care provider’s office.²²

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Question	Answer/Pertinent Information
<p>How should a cuff size be chosen?</p>	<ul style="list-style-type: none"> • The correct cuff size (based on arm or thigh circumference) must be used to ensure accuracy of readings.^{1,2,4,6,23} <ul style="list-style-type: none"> ○ 22 to 26 cm (Small adult arm [cuff dimension: 12 by 22 cm]) ○ 27 to 34 cm (Adult arm [cuff dimension: 16 by 30 cm]) ○ 35 to 44 cm (Large adult arm [cuff dimension: 16 by 36 cm]) ○ 45 to 52 cm (Adult thigh [cuff dimension: 16 by 42 cm]) • The inflatable rubber bladder inside the cuff should encircle at least 80% of the arm circumference.^{1,2,6,23} • Cuff should cover two-thirds of the distance between the elbow and the shoulder. • If a cuff is too small, blood pressure may be overestimated, and vice versa.^{1,2} <ul style="list-style-type: none"> ○ The magnitude of error can be as great as 30 mmHg.⁸
<p>What factors can affect blood pressure readings?</p>	<ul style="list-style-type: none"> • Control factors that may affect blood pressure, or at a minimum take them into consideration when evaluating results (e.g., room temperature; exercise; alcohol, caffeine, or nicotine consumption; arm position; muscle tension; bladder distension; talking; and background noise).^{1,2,3,23} <ul style="list-style-type: none"> ○ Some of these can transiently raise systolic blood pressure up to 25 mmHg.³⁰ • Patients should empty their bladder prior to blood pressure measurements.²³ • Optimal rest time before blood pressure measurement is still undefined. <ul style="list-style-type: none"> ○ One study suggests a ten-minute resting time may improve the precision and accuracy of blood pressure measurement to match the patient’s true blood pressure.⁶ <ul style="list-style-type: none"> ▪ SBP may drop by almost 11 mmHg after a 16-minute resting time.¹⁶ ▪ Recommend consistent rest times before measuring blood pressure.¹⁶ <ul style="list-style-type: none"> • Consider recording the wait time to better interpret blood pressure readings.¹⁶ • Patients should avoid caffeine (however, regular use unlikely to affect blood pressure), exercise, and tobacco for at least 30 minutes prior to blood pressure measurement (per Canadian guidelines, avoid caffeine and tobacco for at least one hour, avoid meals for at least two hours).^{2,3,6,22,23} • Some experts question if 30 minutes is long enough after caffeine consumption or whether the effect of caffeine is significant in people who consume it regularly. <ul style="list-style-type: none"> ○ Data regarding the effects of caffeine on blood pressure are conflicting and effects may be different for each individual. ○ Acute caffeine consumption may increase blood pressure to some extent for a few hours.^{17,18} ○ There is no clear evidence that chronic caffeine consumption increases the risk of hypertension over time.¹⁸ ○ Some experts suggest measuring blood pressure before ingestion of caffeinated products, waiting a couple of hours after caffeine ingestion, or interpreting the result with prior coffee ingestion in consideration.¹⁷ • Cigarette smoking/tobacco can acutely raise blood pressure.³ <ul style="list-style-type: none"> ○ Level generally returns to baseline about 15 minutes after smoking.³

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Question	Answer/Pertinent Information
Factors affecting blood pressure readings, continued	<ul style="list-style-type: none">○ Chronic smokers are at a higher risk for developing masked hypertension where office blood pressure measurements (when not smoking) are generally lower than daytime home blood pressure measurements (when smoking).⁹○ There is evidence that patients with untreated masked hypertension are at higher risk for cardiac morbidity.⁹○ Home blood pressure monitoring or 24-hour ambulatory blood pressure measurement may be especially useful in chronic smokers.³● Posture affects blood pressure. Blood pressure tends to increase from the lying to the sitting or standing position.¹⁹<ul style="list-style-type: none">○ In most people, posture is unlikely to cause significant errors as long as the arm is supported at heart level.¹⁹○ Readings tend to be higher in an unsupported arm.<ul style="list-style-type: none">▪ An arm at a level lower than the heart may lead to overestimation of blood pressure.^{1,3,19}▪ An arm at a level higher than the heart may lead to underestimation.^{1,3,19}▪ The magnitude of error can be as high as 10 mmHg in SBP and DBP.^{1,19}○ Studies have shown significant differences in blood pressure readings between arms.^{1,19}<ul style="list-style-type: none">▪ There is no clear pattern and the difference does not seem to depend on whether the patient is right- or left-handed.¹○ Blood pressure should be checked in both arms at a first examination.¹○ If blood pressure is consistently higher in one arm (e.g., >10 mmHg), the higher reading should be used to determine the need for antihypertensive therapy.^{1,2,22}
What is the proper technique for measuring blood pressure?	<ul style="list-style-type: none">● The patient should quietly relax with both feet on the ground and not crossed, back supported, arms supported at heart level and free of constrictive clothing, and avoid talking for at least five minutes prior to measurement.^{1-3,23}<ul style="list-style-type: none">○ If blood pressure is measured in a supine position, support the arm with a pillow so it is not below heart level.¹● Place the midline of the cuff bladder (usually marked) over the arterial pulsation over the patient's bare upper arm.²³● The lower end of the cuff should be two to three centimeters (about one inch) above the bend in the elbow.¹● The cuff should be loose enough so that two fingertips can be slipped under the top edge.● For manual measurement, inflate the cuff rapidly to about 20 to 30 mmHg above the pulse-obliteration pressure.^{19,23}● The deflation rate should be 2 mmHg per second.²³<ul style="list-style-type: none">○ A deflation rate >2 mmHg per second can lead to significant underestimation of blood pressure.^{1,19}● Two to three consecutive readings should be taken at least one minute apart and the average should be recorded.^{1,22}● Both the time and date that measurements are taken should be recorded.²²● Encourage patients to also note any significant events such as missed doses of blood pressure meds.
How often should patients check their own blood pressure? <i>Continued...</i>	<ul style="list-style-type: none">● Perform home blood pressure monitoring for at least three and optimally seven days before a doctor's visit to:^{6,20}<ul style="list-style-type: none">○ Confirm a diagnosis of hypertension.○ Assess the effects of antihypertensive treatment, such as at the initiation of therapy or with dose changes.

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Question	Answer/Pertinent Information
Frequency of home blood pressure checks, continued	<ul style="list-style-type: none">• Measurements should be taken in the morning and in the evening, prior to eating and dosing of any antihypertensive medications (since effect may be wearing off).^{2,4,6,23}• Early morning readings are useful, as cardiovascular risk is highest during the early waking hours.²⁹• Readings from the first day should usually not be used (they may be unreliable as the patient gets used to the process).⁶<ul style="list-style-type: none">○ Average reading from several days should be considered.⁶• Patients being treated for high blood pressure should perform regular measurements (e.g., once or twice a week).⁶<ul style="list-style-type: none">○ Provide specific monitoring plans for patients to follow at home (e.g., morning readings, evening readings, frequency)○ Check for efficacy (e.g., two hours after medication doses) and duration of effectiveness (e.g., pre-dose readings).
What should patients be advised to do if they get high blood pressure readings at home?	<ul style="list-style-type: none">• Tell patients their target blood pressure.• Tell patients a single high reading is not immediate cause for alarm.^{22,23}<ul style="list-style-type: none">○ Recommend rechecking high readings a few times to confirm results.^{22,23}• Patients should contact his or her provider if readings continue to be high.<ul style="list-style-type: none">○ It is appropriate to make sure there isn't a problem with the monitor as well.^{22,23}○ Emergency medical treatment is required for an SBP >180 mmHg or DBP >120 mmHg.^{22,23}
What tools and technology can patients use for monitoring blood pressure?	<ul style="list-style-type: none">• Instructional videos and online resources:<ul style="list-style-type: none">○ http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/HighBloodPressureToolsResources/Blood-Pressure-Trackers_UCM_303465_Article.jsp○ https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/multimedia/how-to-measure-blood-pressure/vid-20084749○ http://www.hypertension.ca/en/hypertension/what-do-i-need-to-know/how-to-measure-my-blood-pressure• Several apps are available for recording, tracking, and analyzing blood pressure.<ul style="list-style-type: none">○ Many are capable of exporting data to a provider.○ Note that apps that actually measure blood pressure are not validated or approved as measuring devices by the FDA.²¹• Sources of information about apps with utility for patients with hypertension include the following:<ul style="list-style-type: none">○ Information about FDA regulation of mobile medical apps: https://www.fda.gov/MedicalDevices/DigitalHealth/MobileMedicalApplications/default.htm#c○ Apps that have been cleared or approved by the FDA: https://www.fda.gov/MedicalDevices/DigitalHealth/MobileMedicalApplications/ucm368784.htm○ A review of evidence-based features for patient-centric apps: http://www.imedicalapps.com/2014/03/evidence-based-list-hypertension-apps/○ A search for information and reviews on blood pressure monitoring apps: http://www.imedicalapps.com (type “blood pressure” under “search for apps.”)

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Project Leader in preparation of this clinical resource (340102): Beth Bryant, Pharm.D., BCPS, Assistant Editor





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