Overview of hypertension in adults

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INTRODUCTION

The global prevalence of hypertension is high, and among nonpregnant adults in the United States, treatment of hypertension is the most common reason for office visits and for the use of chronic prescription medications [1-3]. In addition, roughly one-half of hypertensive individuals do not have adequate blood pressure control. The prevalence and control of hypertension are discussed in other topics. (See "The prevalence and control of hypertension in adults" and "Patient adherence and the treatment of hypertension".)

This topic provides a broad overview of the definitions, pathogenesis, complications, diagnosis, evaluation, and management of hypertension. Detailed discussions of all these issues are found separately. The reader is directed, when necessary, to more detailed discussions of these issues in other topics.

DEFINITIONS

Hypertension — The following definitions and staging system, which are based upon appropriately measured blood pressure (table 1), were suggested in 2017 by the American College of Cardiology/American Heart Association (ACC/AHA) [4]; proper measurement technique, which is detailed below, is of paramount importance when identifying patients as having hypertension (see 'Blood pressure measurement' below):

- Normal blood pressure – Systolic <120 mmHg and diastolic <80 mmHg
- Elevated blood pressure – Systolic 120 to 129 mmHg and diastolic <80 mmHg

- Hypertension:
  - Stage 1 – Systolic 130 to 139 mmHg or diastolic 80 to 89 mmHg
  - Stage 2 – Systolic at least 140 mmHg or diastolic at least 90 mmHg

  If there is a disparity in category between the systolic and diastolic pressures, the **higher value** determines the stage.

Isolated systolic hypertension is defined as a blood pressure ≥130 mmHg systolic and <80 mmHg diastolic, and isolated diastolic hypertension is defined as a blood pressure <130 mmHg systolic and ≥80 mmHg diastolic. Patients with a blood pressure ≥130 mmHg systolic and ≥80 mmHg diastolic are considered to have mixed systolic/diastolic hypertension.

In clinical practice, patients who are taking medications for hypertension are usually defined as having hypertension, specifically "treated hypertension," regardless of their observed blood pressure.

European guidance on the definition of hypertension contrasts with that of the ACC/AHA. The European Society of Cardiology and European Society of Hypertension (ESC/ESH), the International Society of Hypertension (ISH), as well as the National Institute for Health and Care Excellence (NICE) guidelines, define hypertension, using office-based blood pressure, as a systolic pressure ≥140 mmHg or diastolic pressure ≥90 mmHg (table 2) [5-7].

In general, definitions for hypertension are based upon the relationship between blood pressure and the incidence of cardiovascular events in large populations, derived from numerous observational studies and randomized trials, in which blood pressure was measured in various types of office settings with variable equipment and technique [8]. (See 'Complications of hypertension' below.)

When evaluating an individual patient, making the diagnosis of hypertension is complex and requires integration of repeated blood pressure measurements, using appropriate technique, both in and out of the office. The schema for establishing the diagnosis of hypertension is presented below (algorithm 1 and table 3). (See 'Making the diagnosis of hypertension' below.)

Definitions based upon ambulatory and home readings — The diagnosis of hypertension requires integration of home or ambulatory blood pressure monitoring (ABPM), whereas routine measurements made in the clinical setting should be used primarily for screening purposes. (See 'Making the diagnosis of hypertension' below.)

The use of ABPM and home blood pressure monitoring in adults is discussed in detail elsewhere. (See "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring" and "Blood pressure measurement in the diagnosis and management of hypertension in adults", section on 'Ambulatory blood pressure monitoring'.)

The following diagnostic criteria were suggested by the 2017 ACC/AHA guidelines; meeting one or more of these criteria using ABPM qualifies as confirmation of hypertension (table 3) [4].

- A 24-hour mean of ≥125 mmHg systolic or ≥75 mmHg diastolic
- Daytime (awake) mean of ≥130 mmHg systolic or ≥80 mmHg diastolic
- Nighttime (asleep) mean of ≥110 mmHg systolic or ≥65 mmHg diastolic

We find the daytime (awake) average of ≥130 mmHg systolic or ≥80 mmHg diastolic to be the most useful of these definitions.

Home readings correlate more closely with the results of daytime ambulatory measurements than with blood pressures that are typically obtained in the clinician's office (ie, using a manual cuff and stethoscope or using an oscillometric device with the care provider present in the room). We believe that hypertension can be confirmed by repeated home blood pressure readings that average ≥130/≥80 mmHg.

Guidelines from the ESC/ESH, ISH, and NICE differ somewhat from the ACC/AHA guidelines; using ambulatory or home blood pressures, the ESC/ESH, ISH, and NICE define hypertension as a 24-hour mean of ≥130 mmHg systolic or ≥80 mmHg diastolic or a daytime mean (or an average of home readings) that is ≥135 mmHg systolic or ≥85 mmHg diastolic (table 2) [5-7].

Both white coat hypertension and masked hypertension are conditions that can only be defined based upon the comparison of out-of-office blood pressure measurements (ABPM and home) with office-based blood pressure measurements.

White coat hypertension — White coat hypertension is defined as blood pressure that is consistently elevated by office readings but does not meet diagnostic criteria for hypertension based upon out-of-office readings. Identifying patients who should be evaluated for white coat hypertension, and the diagnosis of white coat hypertension, is presented elsewhere (table 4). (See "White coat and masked hypertension" and "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring".)

Masked hypertension — Masked hypertension is defined as blood pressure that is consistently elevated by out-of-office measurements but does not meet the criteria for hypertension based upon office readings. Identifying patients who should be evaluated for

masked hypertension, and the diagnosis of masked hypertension, is discussed separately (table 4). (See "White coat and masked hypertension" and "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring".)

BLOOD PRESSURE MEASUREMENT

Appropriate, standardized technique for blood pressure measurement, as described below, is critically important both in the office and at home [9]. Detailed discussions on ambulatory blood pressure monitoring (ABPM), home blood pressure monitoring, and office-based blood pressure measurement can be found in other topics. (See "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring" and "Blood pressure measurement in the diagnosis and management of hypertension in adults".)

Office-based blood pressure measurement — Proper technique and interpretation of the blood pressure is essential in the diagnosis and management of hypertension. A number of steps should ideally be followed to achieve maximum accuracy (table 1) [5,9,10]. An appropriately sized cuff must be used (table 5). (See "Blood pressure measurement in the diagnosis and management of hypertension in adults".)

Rather than an auscultatory device (one that requires a stethoscope), we recommend using an oscillometric blood pressure device designed specifically for the office setting. Automated devices can take multiple consecutive readings in the office with the patient sitting and resting alone (ie, unattended measurement) or with an observer present. Either unattended or attended automated oscillometric blood pressure (AOBP) measurement predict the results of awake ABPM better than traditional office blood pressure measurement and may reduce the white coat effect [11]. (See "Blood pressure measurement in the diagnosis and management of hypertension in adults", section on 'Automated oscillometric blood pressure measurement'.)

Given the importance of obtaining accurate and reproducible blood pressure readings, we suggest that all providers work towards having access to ABPM, automated office blood pressure monitoring (AOBPM), or both.

However, if AOBP measurement is not available, office measurements should be performed with the patient positioned properly and allowed to rest comfortably for at least five minutes, and measurements should be repeated at least twice (table 1). The average of these readings should also be provided to the patient.

In addition to obtaining multiple blood pressure measurements, blood pressure should be measured in both arms, at least at the initial visit. In older individuals or those with potential

orthostatic symptoms, postural measurements should also be taken:

- Systolic blood pressure readings in the left and right arms should be roughly equivalent. A discrepancy of more than 15 mmHg may indicate subclavian stenosis and, hence, peripheral arterial disease. If there is a significant difference in blood pressure between the two arms, the higher of the two should be used for measurement at subsequent visits. (See "Blood pressure measurement in the diagnosis and management of hypertension in adults".)

- Postural hypotension, defined as a 20 mmHg or greater fall in systolic pressure upon rising from supine to an unassisted upright position, should be pursued in patients over age 65 years, those experiencing dizziness or weakness upon standing, or those with diabetes or Parkinson disease. (See "Mechanisms, causes, and evaluation of orthostatic hypotension".)

Ambulatory blood pressure monitoring — Twenty-four-hour ABPM is the preferred method for confirming the diagnosis of hypertension and white coat hypertension but has limited availability in routine clinical practice. High-quality data suggest that ABPM predicts target-organ damage and cardiovascular events better than office blood pressure readings. ABPM records the blood pressure at preset intervals (usually every 15 to 20 minutes during the day and every 30 to 60 minutes during sleep). ABPM can identify or confirm white coat and masked hypertension and can also be used to confirm normal blood pressure readings obtained by self-monitoring at home (table 3) [12]. It is also the only method of blood pressure measurement that can reliably obtain nocturnal readings. (See "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring".)

In addition to patients with suspected white coat hypertension, ABPM should be considered in the following circumstances:

- Suspected episodic hypertension (eg, pheochromocytoma)
- Determining therapeutic response (ie, blood pressure control) in patients who are known to have a substantial white coat effect)
- Hypotensive symptoms while taking antihypertensive medications
- Resistant hypertension
- Autonomic dysfunction
- Suspected masked hypertension

Home blood pressure monitoring — Appropriate training and equipment are paramount to obtaining accurate home blood pressure readings. Patients should be instructed to use a validated, automated oscillometric device that measures blood pressure in the brachial artery (upper arm) and to perform measurements in a quiet room after five minutes of rest in the

seated position with the back and arm supported and legs uncrossed. At least 12 to 14 measurements should be obtained, with both morning and evening measurements taken, over a period of one week every month (table 6). Many patients require the use of a large cuff, usually sold separately. The mean of all available readings should be used for clinical decision-making.

Moderate-quality data suggest that blood pressure taken at home or work by the patient correlates more closely with the results of 24-hour or daytime ambulatory monitoring, with AOBPM, and with target-organ damage than usual blood pressure taken in the office [13]. (See "Blood pressure measurement in the diagnosis and management of hypertension in adults", section on 'Home blood pressure monitoring' and "Out-of-office blood pressure measurement: Ambulatory and self-measured blood pressure monitoring".)

Home readings should be used to complement office readings to determine whether a patient's blood pressure is under control. If there is a discrepancy between office and home blood pressures (ie, white coat or masked hypertension), ABPM should be obtained, if possible, to confirm the accuracy of home blood pressure measurements. If ABPM is not available, AOBPM can be used. (See 'Making the diagnosis of hypertension' below.)

PRIMARY HYPERTENSION

Pathogenesis — Maintenance of arterial blood pressure is necessary for organ perfusion. In general, the arterial blood pressure is determined by the following equation:

Blood pressure (BP) = Cardiac output (CO) x Systemic vascular resistance (SVR)

Blood pressure reacts to changes in the environment to maintain organ perfusion over a wide variety of conditions. The primary factors determining the blood pressure are the sympathetic nervous system, the renin-angiotensin-aldosterone system, and the plasma volume (largely mediated by the kidneys).

The pathogenesis of primary hypertension (formerly called "essential" hypertension) is poorly understood but is most likely the result of numerous genetic and environmental factors that have multiple compounding effects on cardiovascular and kidney structure and function. Some of these factors are discussed in the ensuing section.

Risk factors for primary (essential) hypertension — Although the exact etiology of primary hypertension remains unclear, a number of risk factors are strongly and independently associated with its development, including:

- Age – Advancing age is associated with increased blood pressure, particularly systolic blood pressure, and an increased incidence of hypertension.
- Obesity – Obesity and weight gain are major risk factors for hypertension and are also determinants of the rise in blood pressure that is commonly observed with aging [14,15]. (See "Overweight, obesity, and weight reduction in hypertension".)
- Family history – Hypertension is approximately twice as common in subjects who have one or two hypertensive parents, and multiple epidemiologic studies suggest that genetic factors account for approximately 30 percent of the variation in blood pressure in various populations [16,17]. (See "Genetic factors in the pathogenesis of hypertension".)
- Race – Hypertension tends to be more common, be more severe, occur earlier in life, and be associated with greater target-organ damage in Black patients. (See "Hypertensive complications in Black individuals".)
- Reduced nephron number – Reduced adult nephron mass may predispose to hypertension, which may be related to genetic factors, intrauterine developmental disturbance (eg, hypoxia, drugs, nutritional deficiency), premature birth, and postnatal environment (eg, malnutrition, infections). (See "Possible role of low birth weight in the pathogenesis of primary (essential) hypertension".)
- High-sodium diet – Excess sodium intake (eg, >3 g/day [sodium chloride]) increases the risk for hypertension, and sodium restriction lowers blood pressure in those with a high sodium intake. (See "Salt intake, salt restriction, and primary (essential) hypertension".)
- Excessive alcohol consumption – Excess alcohol intake is associated with the development of hypertension, and alcohol restriction lowers blood pressure in those with increased intake. (See "Cardiovascular benefits and risks of moderate alcohol consumption", section on 'Hypertension'.)
- Physical inactivity – Physical inactivity increases the risk for hypertension, and exercise (aerobic, dynamic resistance, and isometric resistance) is an effective means of lowering blood pressure [14,18]. (See "Exercise in the treatment and prevention of hypertension".)

SECONDARY OR CONTRIBUTING CAUSES OF HYPERTENSION

A number of common and uncommon medical conditions may increase blood pressure and lead to secondary hypertension. In many cases, these causes may coexist with risk factors for primary hypertension and are significant barriers to achieving adequate blood pressure control.

(See "Evaluation of secondary hypertension" and "Definition, risk factors, and evaluation of resistant hypertension", section on 'Secondary causes of hypertension'.)

Major causes of secondary hypertension include:

- Prescription or over-the-counter medications [4,5]:
  - Oral contraceptives, particularly those containing higher doses of estrogen (see "Effect of hormonal contraceptives and postmenopausal hormone therapy on blood pressure")
  - Nonsteroidal antiinflammatory agents (NSAIDs), particularly chronic use (see "NSAIDs and acetaminophen: Effects on blood pressure and hypertension")
  - Antidepressants, including tricyclic antidepressants, selective serotonin reuptake inhibitors, and monoamine oxidase inhibitors
  - Corticosteroids, including both glucocorticoids and mineralocorticoids
  - Decongestants, such as phenylephrine and pseudoephedrine
  - Some weight-loss medications
  - Sodium-containing antacids
  - Erythropoietin
  - Cyclosporine or tacrolimus
  - Stimulants, including methylphenidate and amphetamines
  - Atypical antipsychotics, including clozapine and olanzapine
  - Angiogenesis inhibitors, such as bevacizumab
  - Tyrosine kinase inhibitors, such as sunitinib and sorafenib
- Illicit drug use – Drugs such as methamphetamines and cocaine can raise blood pressure.
- Primary kidney disease – Both acute and chronic kidney disease can lead to hypertension. (See "Overview of hypertension in acute and chronic kidney disease".)
- Primary aldosteronism – The presence of primary mineralocorticoid excess, primarily aldosterone, should be suspected in any patient with the triad of hypertension, unexplained hypokalemia, and metabolic alkalosis. However, up to 50 to 70 percent of

patients will have a normal plasma potassium concentration. Other disorders or ingestions can mimic primary aldosteronism (apparent mineralocorticoid excess syndromes), including chronic licorice intake. (See "Pathophysiology and clinical features of primary aldosteronism" and "Diagnosis of primary aldosteronism" and "Apparent mineralocorticoid excess syndromes (including chronic licorice ingestion)".)

- Renovascular hypertension – Renovascular hypertension is often due to fibromuscular dysplasia in younger patients and to atherosclerosis in older patients. (See "Establishing the diagnosis of renovascular hypertension".)

- Obstructive sleep apnea – Disordered breathing during sleep appears to be an independent risk factor for systemic hypertension. (See "Obstructive sleep apnea and cardiovascular disease in adults".)

- Pheochromocytoma – Pheochromocytoma is a rare cause of secondary hypertension. Approximately one-half of patients with pheochromocytoma have paroxysmal hypertension; most of the rest have what appears to be primary hypertension. (See "Clinical presentation and diagnosis of pheochromocytoma" and "Treatment of pheochromocytoma in adults".)

- Cushing's syndrome – Cushing's syndrome is a rare cause of secondary hypertension, but hypertension is a major cause of morbidity and death in patients with Cushing's syndrome. (See "Epidemiology and clinical manifestations of Cushing's syndrome".)

- Other endocrine disorders – Hypothyroidism, hyperthyroidism, and hyperparathyroidism may also induce hypertension. (See "Cardiovascular effects of hypothyroidism" and "Cardiovascular effects of hyperthyroidism" and "Primary hyperparathyroidism: Clinical manifestations", section on 'Cardiovascular'.)

- Coarctation of the aorta – Coarctation of the aorta is one of the major causes of secondary hypertension in young children, but it may also be diagnosed in adulthood [19]. (See "Clinical manifestations and diagnosis of coarctation of the aorta".)

COMPLICATIONS OF HYPERTENSION

Hypertension is associated with a significant increase in risk of adverse cardiovascular and kidney outcomes. Each of the following complications is closely associated with the presence of hypertension (see "Cardiovascular risks of hypertension"):

- Left ventricular hypertrophy (LVH) (figure 1) [20,21] (see "Clinical implications and treatment of left ventricular hypertrophy in hypertension")
- Heart failure, both reduced ejection fraction (systolic) and preserved ejection fraction (diastolic) [22] (see "Epidemiology and causes of heart failure")
- Ischemic stroke [23,24] (see "Clinical diagnosis of stroke subtypes", section on 'Ecology and risk factors')
- Intracerebral hemorrhage [23,25] (see "Spontaneous intracerebral hemorrhage: Pathogenesis, clinical features, and diagnosis")
- Ischemic heart disease, including myocardial infarction and coronary interventions [23,26] (see "Overview of established risk factors for cardiovascular disease")
- Chronic kidney disease and end-stage kidney disease [27,28] (see "Clinical features, diagnosis, and treatment of hypertensive nephrosclerosis" and "Antihypertensive therapy and progression of nondiabetic chronic kidney disease in adults")

Quantitatively, hypertension is the most prevalent modifiable risk factor for premature cardiovascular disease, being more common than cigarette smoking, dyslipidemia, or diabetes, which are the other major risk factors [26]. Hypertension often coexists with these other risk factors as well as with overweight/obesity, an unhealthy diet, and physical inactivity. The presence of more than one risk factor increases the risk of adverse cardiovascular events [4].

The likelihood of having a cardiovascular event increases as blood pressure increases. In a meta-analysis of over one million adults, risk began to rise in all age groups with blood pressures >115 mmHg systolic or >75 mmHg diastolic (figure 2A-B) [8]. For every 20 mmHg higher systolic and 10 mmHg higher diastolic blood pressure, the risk of death from heart disease or strokes doubles.

The 2017 American College of Cardiology/American Heart Association (ACC/AHA) guidelines for the management of hypertension summarized the available meta-analyses of observational data by comparing the cardiovascular risk of different blood pressure strata with a reference group that had a blood pressure <120 mmHg systolic and <80 mmHg diastolic [4]. A blood pressure of 120 to 129 mmHg systolic and 80 to 84 mmHg diastolic was associated with a hazard ratio of 1.1 to 1.5 for cardiovascular events, and blood pressure of 130 to 139 mmHg systolic and 85 to 89 mmHg diastolic was associated with a hazard ratio of 1.5 to 2.0. This relationship was consistent across sex and race/ethnic subgroups but was somewhat attenuated among older adults.

The prognostic significance of systolic and diastolic blood pressure as a cardiovascular risk factor appears to be age dependent. The systolic pressure and the pulse pressure are greater predictors of risk in patients over the age of 50 to 60 years [29]. Under age 50 years, diastolic blood pressure is a better predictor of mortality than systolic readings [30]. When the systolic blood pressure is <130 mmHg, isolated diastolic hypertension does not predict an increased cardiovascular risk, regardless of age [31]. Systolic hypertension and pulse pressure in older individuals are discussed in detail separately. (See "Treatment of hypertension in older adults, particularly isolated systolic hypertension" and "Increased pulse pressure".)

While hypertension is associated with a relative increase in cardiovascular risk regardless of other cardiovascular risk factors, importantly, the **absolute** risk of cardiovascular risk is dependent on age and other cardiovascular risk factors in addition to the level of blood pressure (figure 3) [32]. (See "Cardiovascular risks of hypertension".)

MAKING THE DIAGNOSIS OF HYPERTENSION

Different clinical trials have used different definitions of hypertension and different methodology for measuring blood pressure. In addition, the relationship between blood pressure and cardiovascular risk is graded and continuous, without an obvious inflection point. Thus, we believe that the data supporting any particular threshold for the definition of hypertension is relatively **weak**.

In an individual patient, we feel that making the diagnosis of hypertension requires the integration of multiple blood pressure readings, the use of appropriate technique, and also the use of measurements made outside of the usual office setting.

Screening — For patients without a previous history of hypertension, we agree with the 2015 US Preventive Services Task Force (USPSTF) guidelines, the 2017 American College of Cardiology/American Heart Association (ACC/AHA) guidelines, and the 2018 European Society of Cardiology and European Society of Hypertension (ESC/ESH) guidelines that all individuals 18 years or older should be properly evaluated with appropriate technique for elevated blood pressure in the office or other clinical setting [4,5,33]. In practice, blood pressure measurement is simple and quick and should be performed at every clinical encounter.

At a minimum, the frequency of screening should be as follows:

- Adults with normal blood pressure should have reassessment of their blood pressure every year.

- Adults should be screened at least semiannually if they have risk factors for hypertension (eg, obesity) or if their previously measured systolic blood pressure was 120 to 129.

Diagnosis — Our approach is consistent with but not identical to recommendations from the USPSTF, the 2017 ACC/AHA guidelines, the 2018 ESC/ESH guidelines, the 2020 ISH guidelines, and the Canadian Hypertension Education Program (CHEP) (algorithm 1) [4-6,33,34]:

A diagnosis can be made, without further confirmatory readings, in the following **uncommon scenarios**:

- A patient who presents with hypertensive urgency or emergency (ie, patients with blood pressure ≥180 mmHg systolic or ≥120 mmHg diastolic) (see "Management of severe asymptomatic hypertension (hypertensive urgencies) in adults" and "Evaluation and treatment of hypertensive emergencies in adults")

- A patient who presents with an initial screening blood pressure ≥160 mmHg systolic or ≥100 mmHg diastolic and who also has known target end-organ damage (eg, left ventricular hypertrophy [LVH], hypertensive retinopathy, ischemic cardiovascular disease)

In **all other patients** who have an elevated office blood pressure, the diagnosis of hypertension should be confirmed using out-of-office blood pressure measurement whenever possible. Ambulatory blood pressure monitoring (ABPM) is considered the “gold standard” in determining out-of-office blood pressure. However, many payers require evidence of normal out-of-office readings (suspected white coat hypertension) for reimbursement of ABPM. As such, we suggest home blood pressure measurement as the initial strategy to confirm the diagnosis of hypertension in most patients [13,35]:

- Hypertension is diagnosed if the mean home blood pressure, when measured with appropriate technique and with a device that has been validated in the office, is ≥130 mmHg systolic or ≥80 mmHg diastolic.

- ABPM is an alternative to home blood pressure monitoring in settings where ABPM is readily available, particularly if adequate home blood pressures cannot be obtained, if there is doubt about the validity of home readings or if there is a large discrepancy between office and home readings. When using ABPM, hypertension is diagnosed if the mean daytime blood pressure is ≥130 mmHg systolic or ≥80 mmHg diastolic.

- Occasionally, out-of-office confirmation of hypertension is not possible because of issues with availability of equipment, insurance, and cost. In these situations, a diagnosis of hypertension can be confirmed by serial (at least three) office-based blood pressure measurements spaced over a period of weeks to months with a mean of ≥130 mmHg

systolic or ≥80 mmHg diastolic. While use of appropriate technique is important in all patients, it is particularly essential in those in whom the diagnosis of hypertension is based solely upon office readings (table 1). In settings where out-of-office blood pressure measurement is not readily available, we suggest using automated office blood pressure monitoring (AOBPM).

Patients found to have an office blood pressure of ≥130 mmHg systolic or ≥80 mmHg diastolic but an out-of-office blood pressure (either mean daytime or mean home) of <130 mmHg systolic and <80 mmHg diastolic have **white coat** hypertension rather than true hypertension [4]. In patients with home readings suggestive of white coat hypertension, we recommend confirmation with ABPM (algorithm 1). Patients with white coat hypertension should undergo reevaluation with out-of-office blood pressure monitoring at least yearly since these patients can develop hypertension over time.

Patients who have office readings of 120 to 129 mmHg systolic or 75 to 79 mmHg diastolic and established cardiovascular disease, known kidney disease, or elevated cardiovascular risk should also undergo out-of-office blood pressure measurement [4]. Patients with office blood pressure <130 mmHg systolic and <80 mmHg diastolic but an out-of-office blood pressure (either mean daytime or mean home) ≥130 mmHg systolic or ≥80 mmHg diastolic have **masked** hypertension. Although there are no randomized clinical trials, based upon risk, we believe that patients with masked hypertension should be treated the same as other patients with the diagnosis of hypertension.

EVALUATION

When hypertension is suspected based upon office readings or confirmed based upon out-of-office blood pressure readings, an evaluation should be performed to determine the following (see "Initial evaluation of the hypertensive adult"):

- The extent of target-organ damage, if any
- The presence of established cardiovascular or kidney disease
- The presence or absence of other cardiovascular risk factors (see "Overview of established risk factors for cardiovascular disease")
- Lifestyle factors that could potentially contribute to hypertension (see 'Risk factors for primary (essential) hypertension' above)

- Potential interfering substances (eg, chronic use of nonsteroidal antiinflammatory drugs [NSAIDs], estrogen-containing oral contraceptives) (see 'Secondary or contributing causes of hypertension' above)

History — The history should search for those facts that help to determine the presence of precipitating or aggravating factors (including prescription medications, nonprescription NSAIDs, and alcohol consumption), the duration of hypertension, previous attempts at treatment, the extent of target-organ damage, and the presence of other known risk factors for cardiovascular disease (table 7).

Physical examination — The main goals of the physical examination are to evaluate for signs of end-organ damage, for established cardiovascular disease, and for evidence of potential causes of secondary hypertension. The physical examination should include the underutilized but important funduscopic examination to evaluate for hypertensive retinopathy (table 8).

Laboratory testing — The following tests should be performed in all patients with newly diagnosed hypertension [4,36,37] (see "Initial evaluation of the hypertensive adult", section on 'Laboratory testing'):

- Electrolytes (including calcium) and serum creatinine (to calculate the estimated glomerular filtration rate)
- Fasting glucose
- Urinalysis
- Complete blood count
- Thyroid-stimulating hormone
- Lipid profile
- Electrocardiogram
- Calculate 10-year atherosclerotic cardiovascular disease risk (calculator 1)

Additional tests — Additional tests **may** be indicated in certain settings:

- Urinary albumin to creatinine ratio. Increased albuminuria is recognized as an independent risk factor for cardiovascular disease; it should be performed in all patients with diabetes or chronic kidney disease [38]. (See "Moderately increased albuminuria (microalbuminuria) and cardiovascular disease" and "Epidemiology of chronic kidney disease".)

- Echocardiography is a more sensitive means of identifying the presence of left ventricular hypertrophy (LVH) than an electrocardiogram, but its use is limited by expense and the lack of clinical trials that define outcome-based treatment differences when LVH is diagnosed

[39]. (See "Clinical implications and treatment of left ventricular hypertrophy in hypertension", section on 'Indications for echocardiography in hypertensive patients'.)

Testing for secondary hypertension — Secondary causes of hypertension are relatively uncommon, and testing for secondary hypertension may produce false-positive results. Thus, screening for secondary causes is **not** recommended for all patients with primary hypertension. Instead, a targeted approach is indicated whereby screening for secondary causes should be performed only in patients with one or more of the following features (see "Evaluation of secondary hypertension"):

- An unusual presentation of hypertension (eg, new onset at an especially young or especially old age, presentation with stage 2 hypertension, abrupt onset of hypertension in a patient with previously normal blood pressure, or significant recent elevation in blood pressure in a patient with previously well-controlled hypertension despite adherence to their antihypertensive regimen)
- Drug-resistant hypertension
- The presence of a clinical clue for a specific cause of hypertension, such as an abdominal bruit (suggestive of renovascular hypertension) or low serum potassium (suggestive of primary aldosteronism)

TREATMENT

Lifestyle modification should be prescribed to **all patients** with elevated blood pressure or hypertension; however, not all patients diagnosed with hypertension require pharmacologic therapy.

There are strong data supporting treatment decisions in some patient populations, such as those with severely elevated blood pressure, those at high cardiovascular risk, and older adults. However, data are weak and largely indirect for many other patient populations. As such, good clinical judgment and shared decision-making between patient and provider are paramount.

Nonpharmacologic therapy — Treatment of hypertension should involve nonpharmacologic therapy (also called lifestyle modification) alone or in concert with antihypertensive drug therapy (table 9) [4,5,40]. We suggest that at least one aspect of nonpharmacologic therapy should be addressed at every office visit.

- Dietary salt restriction – In well-controlled randomized trials, the overall impact of moderate sodium reduction is a fall in blood pressure in hypertensive and normotensive

individuals of 4.8/2.5 and 1.9/1.1 mmHg, respectively (figure 4) [41,42]. The effects of sodium restriction on blood pressure, cardiovascular disease, and mortality as well as specific recommendations for sodium intake, are discussed in detail elsewhere. (See "Salt intake, salt restriction, and primary (essential) hypertension".)

- Potassium supplementation, preferably by dietary modification, unless contraindicated by the presence of chronic kidney disease or use of drugs that reduce potassium excretion [4]. (See "Potassium and hypertension".)

- Weight loss – Weight loss in overweight or obese individuals can lead to a significant fall in blood pressure independent of exercise. The decline in blood pressure induced by weight loss can also occur in the absence of dietary sodium restriction [43], but even modest sodium restriction may produce an additive antihypertensive effect [44]. The weight loss-induced decline in blood pressure generally ranges from 0.5 to 2 mmHg for every 1 kg of weight lost (figure 5) [45]. (See "Diet in the treatment and prevention of hypertension" and "Overweight, obesity, and weight reduction in hypertension".)

- DASH diet – The Dietary Approaches to Stop Hypertension (DASH) dietary pattern is high in vegetables, fruits, low-fat dairy products, whole grains, poultry, fish, and nuts and low in sweets, sugar-sweetened beverages, and red meats. The DASH dietary pattern is consequently rich in potassium, magnesium, calcium, protein, and fiber but low in saturated fat, total fat, and cholesterol. A trial in which all food was supplied to normotensive or mildly hypertensive adults found that the DASH dietary pattern reduced blood pressure by 6/4 mmHg compared with a typical American-style diet that contained the same amount of sodium and the same number of calories. Combining the DASH dietary pattern with modest sodium restriction produced an additive antihypertensive effect. These trials and a review of diet in the treatment of hypertension are discussed in detail elsewhere. (See "Diet in the treatment and prevention of hypertension".)

- Exercise – Aerobic, dynamic resistance and isometric resistance exercise can decrease systolic and diastolic pressure by, on average, 4 to 6 mmHg and 3 mmHg, respectively, independent of weight loss. Most studies demonstrating a reduction in blood pressure have employed at least three to four sessions per week of moderate-intensity aerobic exercise lasting approximately 40 minutes for a period of 12 weeks. (See "Exercise in the treatment and prevention of hypertension".)

- Limited alcohol intake – Women who consume two or more alcoholic beverages per day and men who have three or more drinks per day have a significantly increased incidence of hypertension compared with nondrinkers [14,46]. Adult men and women with hypertension

should consume, respectively, no more than two and one alcoholic drinks daily [4]. (See "Cardiovascular benefits and risks of moderate alcohol consumption".)

The benefits of comprehensive lifestyle modification, including the DASH diet and increased exercise, were tested in the PREMIER trial [47]. At 18 months, there was a lower prevalence of hypertension (22 versus 32 percent) and less use of antihypertensive medications (10 to 14 versus 19 percent), although the difference was not statistically significant. (See "Diet in the treatment and prevention of hypertension", section on 'PREMIER trial'.)

Pharmacologic therapy — In large-scale randomized trials, pharmacologic antihypertensive therapy, as compared with placebo, produces a nearly 50 percent relative risk reduction in the incidence of heart failure, a 30 to 40 percent relative risk reduction in stroke, and a 20 to 25 percent relative risk reduction in myocardial infarction [48]. These relative risk reductions correspond to the following absolute benefits: antihypertensive therapy for four to five years in patients whose blood pressure is 140 to 159 mmHg systolic or 90 to 99 mmHg diastolic prevents a coronary event in 0.7 percent of patients and a cerebrovascular event in 1.3 percent of patients for a total absolute benefit of approximately 2 percent (figure 6) [49]. Thus, 100 patients must be treated for four to five years to prevent an adverse cardiovascular event in two patients. It is presumed that these statistics underestimate the true benefit of treating hypertension since these data were derived from trials of relatively short duration (five to seven years); this may be insufficient to determine the efficacy of antihypertensive therapy on longer-term diseases such as atherosclerosis and heart failure. (See "Goal blood pressure in adults with hypertension".)

Equal if not greater relative risk reductions have been demonstrated with antihypertensive treatment of older hypertensive patients (over age 65 years), most of whom have isolated systolic hypertension. Because advanced age is associated with higher overall cardiovascular risk, even modest and relatively short-term reductions in blood pressure may provide absolute benefits that are greater than that observed in younger patients. (See "Treatment of hypertension in older adults, particularly isolated systolic hypertension".)

The benefits of antihypertensive therapy are less clear and more controversial in patients who have stage 1 hypertension and no preexisting cardiovascular disease, in those with an estimated 10-year cardiovascular risk <10%, and in those >75 years of age who are non-ambulatory or living in nursing homes. (See "Goal blood pressure in adults with hypertension" and "Treatment of hypertension in older adults, particularly isolated systolic hypertension", section on 'Problem of frailty'.)

Who should be treated with pharmacologic therapy? — Randomized trials that demonstrated benefit from treating hypertension with antihypertensive drug therapy used a wide variety of inclusion criteria and variable techniques for measuring blood pressure. As a result, the decision to initiate antihypertensive therapy in individual patients, particularly those not well-represented in clinical trials, is sometimes uncertain.

The decision to initiate drug therapy should be individualized and involve shared decision-making between patient and provider. In general, we suggest that antihypertensive drug therapy be initiated in the following hypertensive patients (our suggestions broadly agree with those recommendations made by the 2017 American College of Cardiology/American Heart Association [ACC/AHA] guidelines) [4]:

- Patients with out-of-office daytime blood pressure ≥135 mmHg systolic or ≥85 mmHg diastolic (or an average office blood pressure ≥140 mmHg systolic or ≥90 mmHg diastolic if out-of-office readings are not available)
- Patients with an out-of-office blood pressure (mean home or daytime ambulatory) ≥130 mmHg systolic or ≥80 mmHg diastolic (or, if out-of-office readings are unavailable, the average of appropriately measured office readings ≥130 mmHg systolic or ≥80 mmHg diastolic) who have one or more of the following features:
    - Established clinical cardiovascular disease (eg, chronic coronary syndrome [stable ischemic heart disease], heart failure, carotid disease, previous stroke, or peripheral arterial disease)
    - Type 2 diabetes mellitus
    - Chronic kidney disease
    - Age 65 years or older
    - An estimated 10-year risk of atherosclerotic cardiovascular disease of at least 10 percent (calculator 1)

However, data are limited on the risks and benefits of initiating antihypertensive therapy in patients who have stage 1 hypertension (130 to 139 mmHg systolic and 80 to 89 mmHg diastolic) and who are either over the age of 75 or who have an estimated 10-year risk of atherosclerotic cardiovascular disease of at least 10 percent (but no clinical cardiovascular disease, diabetes, or chronic kidney disease). For these specific patient populations, we suggest an individualized approach with shared decision-making and would consider withholding

antihypertensive therapy among those with recurrent falls, dementia, multiple comorbidities, orthostatic hypotension, residence in a nursing home, or limited life expectancy.

Choice of initial antihypertensive agents — Multiple guidelines and meta-analyses conclude that the degree of blood pressure reduction, not the choice of antihypertensive medication, is the major determinant of reduction in cardiovascular risk in patients with hypertension [48,50-52]. Recommendations for the use of specific classes of antihypertensive medications are based upon clinical trial evidence of decreased cardiovascular risk, blood pressure-lowering efficacy, safety, and tolerability. Most patients with hypertension will require more than one blood pressure medication to reach goal blood pressure. Having multiple available classes of blood pressure medication permits clinicians to individualize therapy based upon individual patient characteristics and preferences.

Some patients have a “compelling” indication for a specific drug or drugs that is unrelated to primary hypertension (table 10). If there are no specific indications for a particular medication based upon comorbidities, most guidelines and recommendations, including the 2017 ACC/AHA guidelines, recommend that initial therapy be chosen from among the following four classes of medications [4]. (See "Choice of drug therapy in primary (essential) hypertension".)

- Thiazide-like or thiazide-type diuretics
- Long-acting calcium channel blockers (most often a dihydropyridine such as amlodipine)
- Angiotensin-converting enzyme (ACE) inhibitors
- Angiotensin II receptor blockers (ARBs)

A systematic review of the available data published in conjunction with the 2017 ACC/AHA guidelines demonstrated no significant difference in cardiovascular mortality between patients treated with these four drug classes [53].

Additional considerations in choice of initial therapy:

- A thiazide-like diuretic or long-acting dihydropyridine calcium channel blocker should be used as initial monotherapy in Black patients [4]. (See "Treatment of hypertension in black patients".)

- An ACE inhibitor **or** an ARB should be used for initial monotherapy in patients who have diabetic nephropathy or nondiabetic chronic kidney disease, especially when complicated by proteinuria. (See "Treatment of hypertension in patients with diabetes mellitus" and "Antihypertensive therapy and progression of nondiabetic chronic kidney disease in adults".)

- Beta blockers are no longer recommended as initial monotherapy in the absence of a specific (compelling) indication for their use, such as ischemic heart disease or heart failure with decreased ejection fraction [54,55]. (See "Choice of drug therapy in primary (essential) hypertension".)

Combination therapy — Single-agent therapy will not adequately control blood pressure in most patients whose baseline systolic blood pressure is 15 mmHg or more above their goal. Combination therapy with drugs from different classes has a substantially greater blood pressure-lowering effect than doubling the dose of a single agent, often with a reduction in side effects seen with a higher dose of monotherapy [56]. When more than one agent is needed to control the blood pressure, we recommend therapy with a long-acting ACE inhibitor or ARB in concert with a long-acting dihydropyridine calcium channel blocker. Combination of an ACE inhibitor or ARB with a thiazide diuretic can also be used but may be less beneficial when hydrochlorothiazide is used. ACE inhibitors and ARBs should **not** be used together. The supportive data for these recommendations are presented elsewhere. (See "Choice of drug therapy in primary (essential) hypertension", section on 'Combination therapy'.)

Initial combination antihypertensive therapy with two first-line agents of different classes is suggested in any patient whose blood pressure is more than 20 mmHg systolic or 10 mmHg diastolic above their goal blood pressure [4,5]. (See 'Blood pressure goals (targets)' below.)

If blood pressure remains uncontrolled (see 'Blood pressure goals (targets)' below) despite use of two antihypertensive medications, we recommend therapy with ACE inhibitor or ARB in conjunction with both a long-acting dihydropyridine calcium channel blocker and a thiazide-like diuretic (chlorthalidone preferred). If a long-acting dihydropyridine calcium channel blocker is not tolerated due to leg swelling, a non-dihydropyridine calcium channel blocker (ie, verapamil or diltiazem) may be used instead. If a thiazide-like diuretic is not tolerated or is contraindicated, a mineralocorticoid receptor antagonist (ie, spironolactone or eplerenone) may be used.

If the above drug classes cannot be used due to intolerance or contraindication, a beta blocker, alpha blocker, or direct arterial vasodilators present other options. Generally, concomitant use of beta blockers and non-dihydropyridine calcium channel blockers should be avoided. Patients not controlled on a combination of three antihypertensive medications that are taken at reasonable doses and that include a diuretic are considered to have drug-resistant hypertension (once nonadherence and white coat effect have been eliminated as possibilities). Diagnosis and management of drug-resistant hypertension is discussed in detail elsewhere. (See "Definition, risk factors, and evaluation of resistant hypertension" and "Treatment of resistant hypertension".)

Fixed-dose, single-pill combination medications should be used whenever feasible to reduce the pill burden on patients and improve medication adherence. (See "The prevalence and control of hypertension in adults", section on 'Methods to improve control rates'.)

Blood pressure goals (targets) — The ultimate goal of antihypertensive therapy is a reduction in cardiovascular events. The higher the absolute cardiovascular risk, the more likely it is that a patient will benefit from a more aggressive blood pressure goal. However, although cardiovascular events generally decrease with more intensive lowering of blood pressure, the risk of adverse effects, cost, and patient inconvenience increase as more medication is added. (See "Goal blood pressure in adults with hypertension" and "Antihypertensive therapy and progression of nondiabetic chronic kidney disease in adults" and "Treatment of hypertension in patients with diabetes mellitus" and "Antihypertensive therapy for secondary stroke prevention" and "Treatment of hypertension in older adults, particularly isolated systolic hypertension" and "Overview of secondary prevention of ischemic stroke".)

The authors suggestions for goal blood pressure are as follows, and depend upon the patient's baseline risk of having a cardiovascular event; these suggestions broadly agree with those recommendations made by the 2017 ACC/AHA guidelines but contrast with other guidelines (see "Goal blood pressure in adults with hypertension", section on 'Recommendations of others') [4]:

- The authors suggest a goal blood pressure of <130 mmHg systolic and <80 mmHg diastolic using out-of-office measurements (or, if out-of-office blood pressure is not available, then an average of appropriately measured office readings) in most patients who qualify for antihypertensive pharmacologic therapy. Identifying patients for initiation of antihypertensive drug therapy is presented above. (See 'Who should be treated with pharmacologic therapy?' above.)

  However, there is some disagreement among UpToDate authors and editors. Some believe that, among selected hypertensive patients who qualify for antihypertensive therapy but who are at low absolute cardiovascular risk, a less aggressive goal blood pressure of <135 mmHg systolic and <85 mmHg diastolic (using out-of-office measurement) or <140 mmHg systolic and <90 mmHg diastolic (using an average of appropriately measured office readings) is appropriate.

- We suggest a less aggressive goal blood pressure of <135 mmHg systolic and <85 mmHg diastolic (using out-of-office measurement) or <140 mmHg systolic and <90 mmHg diastolic (using an average of appropriately measured office readings) in the following groups of hypertensive patients:

- Patients with labile blood pressure or postural hypotension
- Patients with side effects to multiple antihypertensive medications
- Patients 75 years or older with a high burden of comorbidity or a diastolic blood pressure <55 mmHg

- In older adults with severe frailty, dementia, and/or a limited life expectancy, or in patients who are non-ambulatory or institutionalized (eg, reside in a skilled nursing facility), we individualize goals and share decision-making with the patient, relatives, and caretakers, rather than targeting one of the blood pressure goals mentioned above.

Once blood pressure goal is determined in an individual patient, it should be recorded in the patient's medical record, explicitly explained to the patient, and communicated to other members of the health care team. At every visit, a determination should be made as to whether or not blood pressure is at goal.

After antihypertensive therapy is initiated, patients should be re-evaluated and therapy should be increased monthly until adequate blood pressure control is achieved [4]. Once blood pressure control is achieved, patients should be reevaluated every three to six months to ensure maintenance of control [4].

Resistant hypertension — Resistant hypertension is defined as blood pressure that is not controlled to goal despite adherence to an appropriate regimen of three antihypertensive drugs of different classes (including a diuretic) in which all drugs are prescribed at suitable antihypertensive doses and after white coat effect has been excluded. Blood pressure that requires at least four medications to achieve control is considered controlled resistant hypertension [57]. The definition, evaluation, and treatment of resistant hypertension are discussed in detail elsewhere. (See "Definition, risk factors, and evaluation of resistant hypertension" and "Treatment of resistant hypertension".)

Many patients who appear to have resistant hypertension actually have pseudoresistance rather than true resistance. Pseudoresistance results from some or all of the following problems (see "Definition, risk factors, and evaluation of resistant hypertension", section on 'Apparent, true, and pseudoresistant hypertension'):

- Inaccurate blood pressure measurement (eg, use of an inappropriately small blood pressure cuff, not allowing a patient to rest quietly before taking readings)
- Poor adherence to blood pressure medications
- Poor adherence to lifestyle and dietary approaches to lower blood pressure

- Suboptimal antihypertensive therapy, due either to inadequate doses, an inappropriate drug combination, or exclusion of a diuretic from the antihypertensive regimen
- White coat hypertension

One or more of the following issues may contribute to true resistant hypertension (see "Definition, risk factors, and evaluation of resistant hypertension", section on 'Risk factors'):

- Extracellular volume expansion
- Increased sympathetic activation
- Ingestion of substances that can elevate the blood pressure, such as nonsteroidal antiinflammatory drugs (NSAIDs) or stimulants
- Secondary or contributing causes of hypertension

The evaluation and management of resistant hypertension is discussed in detail elsewhere. (See "Treatment of resistant hypertension".)

Hypertensive urgency and emergency — Severe hypertension (usually a diastolic blood pressure above 120 mmHg) with evidence of acute end-organ damage is defined as a hypertensive emergency [4]. Hypertensive emergencies can be life-threatening and require immediate treatment, usually with parenteral medications in a monitored setting (table 11). The causes and treatment of hypertensive emergency are presented elsewhere. (See "Evaluation and treatment of hypertensive emergencies in adults".)

Severe hypertension (usually a diastolic blood pressure above 120 mmHg) in asymptomatic patients who are not experiencing acute end-organ damage is referred to as hypertensive urgency [4]. There is no proven benefit from rapid reduction in blood pressure in such patients [4,58-60]. Hypertensive urgency is common in clinical practice, especially among patients with known hypertension who are not fully adherent to their medications. Most cases of asymptomatic blood pressure elevations can be addressed in the office setting without referral to a higher level of care. Management of severe asymptomatic hypertension is discussed separately. (See "Management of severe asymptomatic hypertension (hypertensive urgencies) in adults".)

Discontinuing therapy — Some patients with stage 1 hypertension are well controlled, often on a single medication. After a period of years, the question arises as to whether antihypertensive therapy can be gradually diminished or even discontinued.

After discontinuation of treatment, a substantial proportion of patients remain normotensive for at least one to two years [61]; a larger fraction of patients do well with a decrease in the number and/or dose of medications taken [62,63].

More gradual tapering of drug dose is indicated in well-controlled patients taking multiple drugs [64]. (See "Can drug therapy be discontinued in well-controlled hypertension?".)

Abrupt cessation of some antihypertensive drugs, especially higher doses of short-acting beta blockers (such as propranolol) or the short-acting alpha-2 agonist (clonidine) can lead to a potentially fatal withdrawal syndrome. Gradual discontinuation of these agents over a period of weeks should prevent this problem. (See "Withdrawal syndromes with antihypertensive drug therapy".)

Systems approach to blood pressure management — Multiple clinical trials have demonstrated that enhancements to usual care can improve blood pressure control. Many of these enhancements involve changes in the overall approach to the management of hypertension. To improve blood pressure control rates, we recommend adoption of one or more of the following team-based strategies [4]:

- Electronic or telephonic transfer of home blood pressure readings using validated devices
- Increased availability of ambulatory blood pressure monitoring (ABPM) and/or clinic automated office blood pressure monitoring (AOBPM)
- Increased communication (in person, by phone, or electronically) with medical assistants and/or nurses who can assess blood pressure control and work with providers to adjust medications if not controlled
- Integration of clinical pharmacists into the treatment team
- Use of fixed stepped care algorithms for titration of medications
- Increased availability of clinical hypertension specialists to evaluate patients with difficult-to-control blood pressure

Increasingly, incomplete adherence is being identified as a primary contributor to poorly controlled and resistant hypertension. (See "Patient adherence and the treatment of hypertension".)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Hypertension in adults".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: High blood pressure in adults (The Basics)" and "Patient education: Controlling your blood pressure through lifestyle (The Basics)" and "Patient education: Coping with high drug prices (The Basics)" and "Patient education: Medicines for high blood pressure (The Basics)" and "Patient education: High blood pressure emergencies (The Basics)")

- Beyond the Basics topics (see "Patient education: High blood pressure in adults (Beyond the Basics)" and "Patient education: High blood pressure treatment in adults (Beyond the Basics)" and "Patient education: High blood pressure, diet, and weight (Beyond the Basics)" and "Patient education: Coping with high drug prices (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

Definition of hypertension

- The following definitions and staging system, which are based upon appropriately measured blood pressure (table 1), were suggested in 2017 by the American College of Cardiology/American Heart Association (ACC/AHA) (see 'Definitions' above):

    - Normal blood pressure – Systolic <120 mmHg and diastolic <80 mmHg

    - Elevated blood pressure – Systolic 120 to 129 mmHg and diastolic <80 mmHg

    - Hypertension:

- Stage 1 – Systolic 130 to 139 mmHg or diastolic 80 to 89 mmHg
- Stage 2 – Systolic at least 140 mmHg or diastolic at least 90 mmHg

If there is a disparity in category between the systolic and diastolic pressures, the higher value determines the stage.

- The diagnosis of hypertension requires integration of home or ambulatory blood pressure monitoring (ABPM) in addition to measurements made in the clinical setting (table 3). Meeting one or more of these criteria using ABPM qualifies as hypertension (see 'Definitions based upon ambulatory and home readings' above):
  - A 24-hour mean of ≥125 mmHg systolic or ≥75 mmHg diastolic
  - Daytime (awake) mean of ≥130 mmHg systolic or ≥80 mmHg diastolic
  - Nighttime (asleep) mean of ≥110 mmHg systolic or ≥65 mmHg diastolic

  We find the daytime (awake) average of ≥130 mmHg systolic or ≥80 mmHg diastolic to be the most useful of these definitions.

Measurement of blood pressure

- Proper technique and interpretation of the blood pressure is essential in the diagnosis and management of hypertension (see 'Blood pressure measurement' above):
  - A number of steps should ideally be followed to achieve maximum accuracy of office measurement (table 1). Rather than an auscultatory device (one that requires a stethoscope), we recommend using an oscillometric blood pressure device designed specifically for the office setting. Automated oscillometric office blood pressure (AOBP) devices can take multiple consecutive readings in the office with the patient sitting and resting alone (ie, unattended measurement) or with an attendant present. Either unattended or attended AOBP better predicts the results of awake (daytime) ABPM than traditional office blood pressure measurement and may reduce the white coat effect. (See 'Office-based blood pressure measurement' above.)
  - ABPM is the preferred method for confirming the diagnosis of hypertension. High-quality data suggest that ABPM predicts target organ damage and cardiovascular events better than office blood pressure readings. (See 'Ambulatory blood pressure monitoring' above.)
  - To measure blood pressure at home, patients should be instructed to use a validated, automated oscillometric device that measures blood pressure in the brachial artery

(upper arm) and to perform measurements in a quiet room after five minutes of rest in the seated position with the back and arm supported and legs uncrossed. At least 12 to 14 measurements should be obtained, with both morning and evening measurements taken, over a period of one week each month. (See 'Home blood pressure monitoring' above.)

Diagnosis of hypertension

- In an individual patient, we feel that making the diagnosis of hypertension requires the integration of multiple blood pressure readings, the use of appropriate technique, and also the use of measurements made outside of the usual office setting (algorithm 1). (See 'Making the diagnosis of hypertension' above.)

- A diagnosis can be made, without further confirmatory readings, in the following **uncommon scenarios**:

  - A patient who presents with hypertensive urgency or emergency (ie, patients with blood pressure ≥180 mmHg systolic or ≥120 mmHg diastolic).

  - A patient who presents with an initial screening blood pressure ≥160 mmHg systolic or ≥100 mmHg diastolic and who also has known target end-organ damage (eg, left ventricular hypertension [LVH], hypertensive retinopathy, ischemic cardiovascular disease).

  In **all other patients** who have an elevated office blood pressure, the diagnosis of hypertension should be confirmed using out-of-office blood pressure measurement whenever possible. ABPM is considered the “gold standard” in determining out-of-office blood pressure. However, many payers require evidence of normal out-of-office readings (suspected white coat hypertension) for reimbursement of ABPM. As such, we suggest home blood pressure measurement as the initial strategy to confirm the diagnosis of hypertension in most patients:

  - Hypertension is diagnosed if the mean home blood pressure, when measured with appropriate technique and with a device that has been validated in the office, is ≥130 mmHg systolic or ≥80 mmHg diastolic.

  - ABPM is an alternative to home blood pressure monitoring in settings where ABPM is readily available, particularly if adequate home blood pressures cannot be obtained, if there is doubt about the validity of home readings, or if there is a large discrepancy between office and home readings. When using ABPM, hypertension is diagnosed if the mean daytime blood pressure is ≥130 mmHg systolic or ≥80 mmHg diastolic.

- Occasionally, out-of-office confirmation of hypertension is not possible because of issues with availability of equipment, insurance, and cost. In these situations, a diagnosis of hypertension can be confirmed by serial (at least three) office-based blood pressure measurements spaced over a period of weeks to months with a mean of ≥130 mmHg systolic ≥80 mmHg diastolic. While use of appropriate technique is important in all patients, it is particularly essential in those in whom the diagnosis of hypertension is based solely upon office readings (table 1). In settings where out-of-office blood pressure measurement is not readily available, we suggest using AOBPM.

Evaluation of hypertension

- When hypertension is suspected based upon office readings or confirmed based upon out-of-office blood pressure readings, an evaluation should be performed to determine the following (see 'Evaluation' above):
  - The extent of target-organ damage, if any
  - The presence of established cardiovascular or kidney disease
  - The presence or absence of other cardiovascular risk factors
  - Lifestyle factors that could potentially contribute to hypertension
  - Potential interfering substances (eg, chronic use of nonsteroidal antiinflammatory drugs [NSAIDs], oral contraceptives)

Treatment of hypertension

- Lifestyle modification should be prescribed to **all patients** with elevated blood pressure or hypertension (table 9); however, not all patients diagnosed with hypertension require pharmacologic therapy. (See 'Nonpharmacologic therapy' above.)
- The decision to initiate drug therapy should be individualized and involve shared decision-making between patient and provider. In general, we suggest that antihypertensive drug therapy be initiated in the following hypertensive patients (see 'Who should be treated with pharmacologic therapy?' above):
  - Patients with out-of-office daytime blood pressure ≥135 mmHg systolic or ≥85 mmHg diastolic (or an average office blood pressure ≥140 mmHg systolic or ≥90 mmHg diastolic if out-of-office readings not available)
  - Patients with an out-of-office blood pressure (mean home or daytime ambulatory) ≥130 mmHg systolic or ≥80 mmHg diastolic (or, if out-of-office readings are unavailable, the average of appropriately measured office readings ≥130 mmHg systolic or ≥80 mmHg diastolic) who have one or more of the following features:

- Established clinical cardiovascular disease (eg, chronic coronary syndrome [stable ischemic heart disease], heart failure, carotid disease, previous stroke, or peripheral arterial disease)
- Type 2 diabetes mellitus
- Chronic kidney disease
- Age 65 years or older
- An estimated 10-year risk of atherosclerotic cardiovascular disease of at least 10 percent (calculator 1)

- However, in patients who have stage 1 hypertension (130 to 139 mmHg systolic or 80 to 89 mmHg diastolic), we would consider withholding antihypertensive therapy among those 75 years or older or those who do not have established cardiovascular disease, diabetes, or chronic kidney disease if, in addition, they have recurrent falls, dementia, multiple comorbidities, orthostatic hypotension, residence in a nursing home, or limited life expectancy. (See 'Who should be treated with pharmacologic therapy?' above.)

- Some patients have a "compelling" indication for a specific drug or drugs that are unrelated to primary hypertension (table 10). If there are no specific indications for a particular medication based upon comorbidities, we recommend that initial therapy be chosen from among the following four classes of medications (see 'Choice of initial antihypertensive agents' above):

  - Thiazide-like or thiazide-type diuretics
  - Long-acting calcium channel blockers (most often a dihydropyridine such as amlodipine)
  - Angiotensin-converting enzyme (ACE) inhibitors
  - Angiotensin II receptor blockers (ARBs)

- Our suggestions for goal blood pressure are as follows and depend upon the patient's baseline risk of having a cardiovascular event (see 'Blood pressure goals (targets)' above):

  - We suggest a goal blood pressure of <130 mmHg systolic and <80 mmHg diastolic using out-of-office measurements (or, if out-of-office blood pressure is not available, then an average of appropriately measured office readings) in most patients who qualify for antihypertensive pharmacologic therapy.

    However, there is some disagreement among UpToDate authors and editors. Some believe that, among selected hypertensive patients who qualify for antihypertensive therapy but who are at low absolute cardiovascular risk, a less aggressive goal blood

pressure of <135 mmHg systolic and <85 mmHg diastolic (using out-of-office measurement) or <140 mmHg systolic and <90 mmHg diastolic (using an average of appropriately measured office readings) is appropriate.

- We suggest a less aggressive goal blood pressure of <135 mmHg systolic and <85 mmHg diastolic (using out-of-office measurement) or <140 mmHg systolic and <90 mmHg diastolic (using an average of appropriately measured office readings) in the following groups of hypertensive patients:
  - Patients with highly variable (labile) blood pressure or postural hypotension
  - Patients with side effects to multiple antihypertensive medications
  - Patients 75 years or older with a high burden of comorbidity or a diastolic blood pressure <55 mmHg
- In older adults with severe frailty, dementia, and/or a limited life expectancy, or in patients who are non-ambulatory or institutionalized (eg, reside in a skilled nursing facility), we individualize goals and share decision-making with the patient, relatives, and caretakers, rather than targeting one of the blood pressure goals mentioned above.

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Topic 3852 Version 65.0

GRAPHICS

Checklist for accurate measurement of blood pressure

Key steps for proper BP measurements	Specific instructions
Step 1: Properly prepare the patient	1. Have the patient relax, sitting in a chair (feet on floor, back supported) for >5 minutes. 2. The patient should avoid caffeine, exercise, and smoking for at least 30 minutes before measurement. 3. Ensure patient has emptied his/her bladder. 4. Neither the patient nor the observer should talk during the rest period or during the measurement. 5. Remove all clothing covering the location of cuff placement. 6. Measurements made while the patient is sitting or lying on an examining table do not fulfill these criteria.
Step 2: Use proper technique for BP measurements	1. Use a BP measurement device that has been validated, and ensure that the device is calibrated periodically.* 2. Support the patient's arm (eg, resting on a desk). 3. Position the middle of the cuff on the patient's upper arm at the level of the right atrium (the midpoint of the sternum). 4. Use the correct cuff size, such that the bladder encircles 80% of the arm, and note if a larger- or smaller-than-normal cuff size is used. 5. Either the stethoscope diaphragm or bell may be used for auscultatory readings.
Step 3: Take the proper measurements needed for diagnosis and treatment of elevated BP/hypertension	1. At the first visit, record BP in both arms. Use the arm that gives the higher reading for subsequent readings. 2. Separate repeated measurements by one to two minutes. 3. For auscultatory determinations, use a palpated estimate of radial pulse obliteration pressure to estimate SBP. Inflate the cuff 20 to 30 mmHg above this level for an auscultatory determination of the BP level. 4. For auscultatory readings, deflate the cuff pressure 2 mmHg per second, and listen for Korotkoff sounds.
Step 4: Properly document accurate BP readings	1. Record SBP and DBP. If using the auscultatory technique, record SBP and DBP as onset of the first Korotkoff sound and disappearance of all Korotkoff sounds, respectively, using the nearest even number. 2. Note the time of most recent BP medication taken before measurements.
Step 5: Average the readings	1. Use an average of ≥2 readings obtained on ≥2 occasions to estimate the individual's level of BP.
Step 6: Provide BP readings to patient	1. Provide patients the SBP/DBP readings both verbally and in writing.

BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure.

Graphic 115862 Version 2.0

Definition of hypertension according to office, ambulatory, and home BP levels per guideline statements

SBP/DBP	Clinic	HBPM	Daytime ABPM	Nighttime ABPM	24-hour ABPM
ACC/AHA Guidelines 2017[1]	≥130/80	≥130/80	≥130/80	≥110/65	≥125/75
ESC/ESH Guidelines 2018[2]	≥140/90	≥135/85	≥135/85	≥120/70	≥130/80

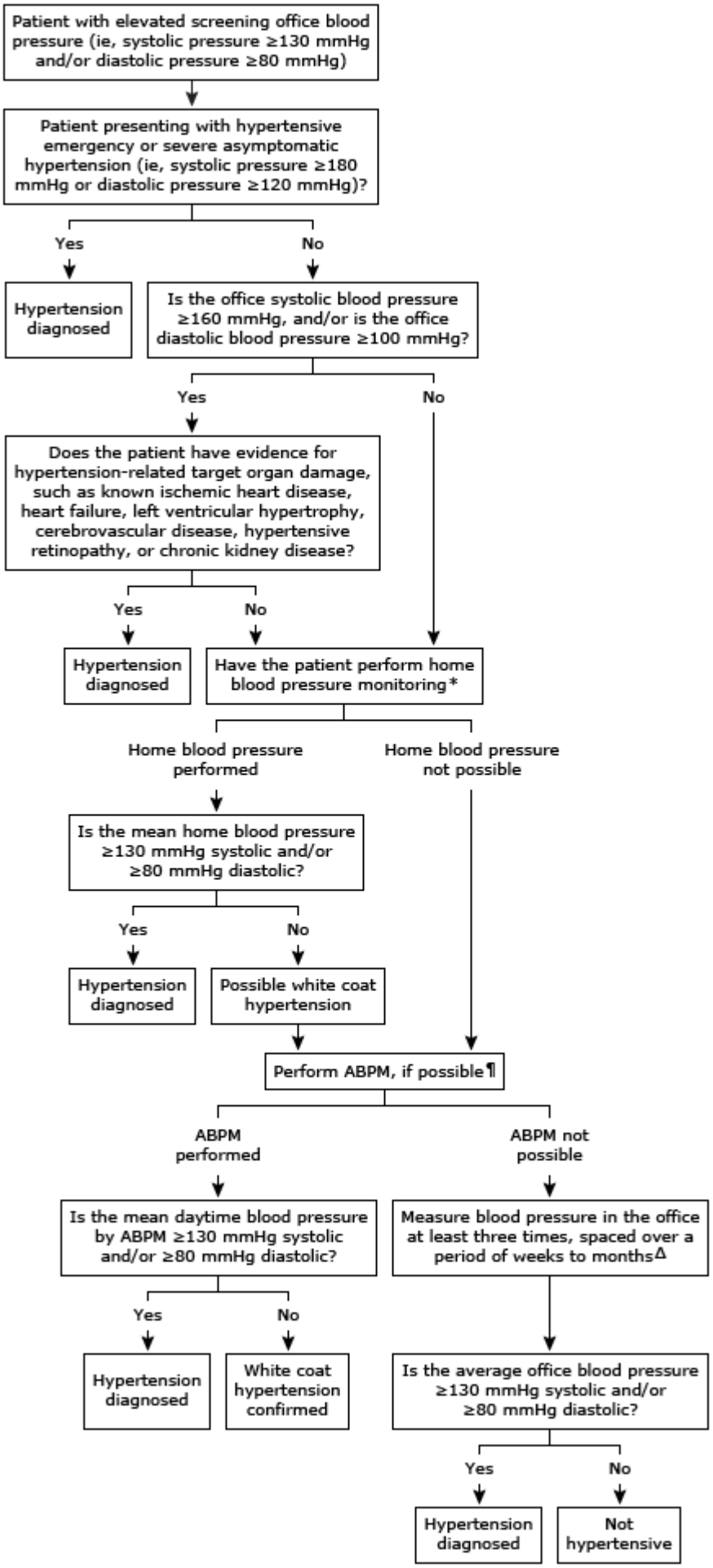
BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; HBPM: home blood pressure monitoring; ABPM: ambulatory blood pressure monitoring; ACC/AHA: American College of Cardiology/American Heart Association; ESC/ESH: European Society of Cardiology/European Society of Hypertension.

Data from:

1. *Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 2018; 71:e127.*
2. *Williams B, Giuseppe M, Spiering W, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J 2018; 39:3021.*

Graphic 119219 Version 1.0

Diagnosis of hypertension in adults


Patient with elevated screening office blood pressure (ie, systolic pressure ≥130 mmHg and/or diastolic pressure ≥80 mmHg)
Patient presenting with hypertensive emergency or severe asymptomatic hypertension (ie, systolic pressure ≥180 mmHg or diastolic pressure ≥120 mmHg)?
Yes
No
Hypertension diagnosed
Is the office systolic blood pressure ≥160 mmHg, and/or is the office diastolic blood pressure ≥100 mmHg?
Yes
No
Does the patient have evidence for hypertension-related target organ damage, such as known ischemic heart disease, heart failure, left ventricular hypertrophy, cerebrovascular disease, hypertensive retinopathy, or chronic kidney disease?
Yes
No
Hypertension diagnosed
Have the patient perform home blood pressure monitoring*
Home blood pressure performed
Home blood pressure not possible
Is the mean home blood pressure ≥130 mmHg systolic and/or ≥80 mmHg diastolic?
Yes
No
Hypertension diagnosed
Possible white coat hypertension
Perform ABPM, if possible¶
ABPM performed
ABPM not possible
Is the mean daytime blood pressure by ABPM ≥130 mmHg systolic and/or ≥80 mmHg diastolic?
Measure blood pressure in the office at least three times, spaced over a period of weeks to months△
Yes
No
Hypertension diagnosed
White coat hypertension confirmed
Is the average office blood pressure ≥130 mmHg systolic and/or ≥80 mmHg diastolic?
Yes
No
Hypertension diagnosed
Not hypertensive

ABPM: ambulatory blood pressure monitoring; AOBPM: automated oscillometric blood pressure monitoring.

* Home blood pressure must be performed adequately in order for the measurements to be used for diagnosis and management. To be adequate: The accuracy of the home device should be verified in the clinician's office; the patient should measure their blood pressure while seated (with feet flat on the floor), with arm supported (such as on a table), and after several minutes of rest; the blood pressure should be measured at different times per day and over a series of multiple days. A common strategy is to have the patient measure his or her blood pressure twice daily (once in the morning and once in the evening) for seven days. Readings from the first day are discarded, and the remaining 12 measurements are averaged. Home blood pressure should not be used for diagnosis and management if it cannot be performed adequately. Adequate home blood pressure should be possible in most cases. Inexpensive devices to measure blood pressure at home are available over the counter. Alternatively, such devices can be borrowed (eg, provided by the clinic). Only rarely are such devices unavailable or unaffordable.

¶ ABPM is performed by having the patient wear, typically for 24 hours, an electronic blood pressure device that automatically measures the blood pressure, usually every half-hour during the day and hourly at night. We use the mean daytime value to determine the presence of hypertension. ABPM is possible if it is available in the clinic or via an external vendor and if it can be paid for by the patient's insurance or by the patient.

Δ Blood pressure measured in the office may vary according to the manner in which it is obtained. If blood pressure in the office is to be used for the diagnosis of hypertension (rather than using out-of-office blood pressures),we suggest performing unattended AOBPM(using a device that can average multiple readings while the patient sits alone in a room). Unattended AOBPM may provide a measurement that is 5 to 10 mmHg less than a manual measurement (ie, with a stethoscope). Office blood pressure must be performed with proper technique (eg, patient given time to rest, seated with feet flat on the floor, use of multiple measurements, appropriate-sized cuff placed on bare arm, etc). Office blood pressure measured with improper technique **should not** be used for diagnosis and management of hypertension. Refer to UpToDate topics on measurement of blood pressure for details of proper technique.

Graphic 105050 Version 5.0

Corresponding values of SBP/DBP for clinic, HBPM, daytime, nighttime, and 24-hour ABPM measurements

Clinic	HBPM	Daytime ABPM	Nighttime ABPM	24-hour ABPM
120/80	120/80	120/80	100/65	115/75
130/80	130/80	130/80	110/65	125/75
140/90	135/85	135/85	120/70	130/80
160/100	145/90	145/90	140/85	145/90

SBP: systolic blood pressure; DBP: diastolic blood pressure; HBPM: home blood pressure monitoring; ABPM: ambulatory blood pressure monitoring.

References:

1. *Uhlig K, Balk EM, Patel K, et al. Self-Measured Blood Pressure Monitoring: Comparative Effectiveness. Agency for Healthcare Research and Quality, Rockville, MD 2012.*
2. *Margolis KL, Asche SE, Bergdall AR, et al. Effect of home blood pressure telemonitoring and pharmacist management on blood pressure control: a cluster randomized clinical trial. JAMA 2013; 310:46.*
3. *McManus RJ, Mant J, Haque MS, et al. Effect of self-monitoring and medication self-titration on systolic blood pressure in hypertensive patients at high risk of cardiovascular disease: the TASMIN-SR randomized clinical trial. JAMA 2014; 312:799.*
4. *Siu AL. Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2015; 163:778.*
5. *Yi SS, Tabaei BP, Angell SY, et al. Self-blood pressure monitoring in an urban, ethnically diverse population: a randomized clinical trial utilizing the electronic health record. Circ Cardiovasc Qual Outcomes 2015; 8:138.*
6. *Agarwal R, Bills JE, Hecht TJW, et al. Role of home blood pressure monitoring in overcoming therapeutic inertia and improving hypertension control: a systematic review and meta-analysis. Hypertension 2011; 57:29.*
7. *O'Brien E, Stergiou GS. The pursuit of accurate blood pressure measurement: a 35-year travail. J Clin Hypertens (Greenwich) 2017; 19:746.*
8. *Mancia G, Fagard R, Narkiewicz K, et al. 2013 ESH/ESC guidelines for the management of arterial hypertension: the Task Force for the Management of Arterial Hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Eur Heart J 2013; 34:2159.*
9. *Pickering TG, Miller NH, Ogedegbe G, et al. Call to action on use and reimbursement for home blood pressure monitoring: a joint scientific statement from the American Heart Association, American Society of Hypertension, and Preventive Cardiovascular Nurses Association. Hypertension 2008; 52:10.*
10. *National Clinical Guideline Centre. Hypertension: The Clinical Management of Primary Hypertension in Adults: Update of Clinical Guidelines 18 and 34. Roayl College of Physicians, London 2011.*

Graphic 116037 Version 1.0

Reasons to evaluate a patient for masked or white coat hypertension

Reason	Antihypertensive treatment status	Suspected classification
▪ Office-based blood pressures 10 mmHg or less below the patient's goal (eg, systolic pressure 120 to 129 mmHg)	Not on treatment	Masked hypertension
▪ Office-based blood pressures below the patient's goal plus any of the following: • Elevated atherosclerotic cardiovascular disease risk (eg, 10-year atherosclerotic cardiovascular disease risk >10%) • Chronic kidney disease • Diabetes mellitus • Evidence of new or worsening end-organ damage (eg, prior atherosclerotic cardiovascular event, heart failure, left ventricular hypertrophy, hypertensive retinopathy)	On treatment	Masked uncontrolled hypertension
▪ Office-based blood pressures above the patient's goal (but <180/120 mmHg) despite a 3-month trial of lifestyle modifications, and no evidence of hypertensive end-organ damage	Not on treatment	White coat hypertension
▪ Office-based blood pressures above the patient's goal	On a minimum of 3 medications	White coat effect
▪ Office-based blood pressures at or above the patient's goal with symptoms of hypotension (eg, lightheadedness, falls) at home or work	On treatment	White coat effect
▪ Labile office-based blood pressures	Not on treatment or on treatment	All of the above

Adapted from:

1. *Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. Hypertension 2018; 71:e13.*
2. *Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. Eur Heart J 2018; 39:3021.*
3. *Nerenberg KA, Zarnke KB, Leung AA, et al. Hypertension Canada's 2018 guidelines for diagnosis, risk assessment, prevention, and treatment of hypertension in adults and children. Can J Cardiol 2018; 34:506.*

Graphic 126949 Version 1.0

Selection criteria for blood pressure cuff size for measurement of blood pressure in adults[1,2]

Arm circumference	Usual cuff size
22 to 26 cm	Small adult
27 to 34 cm	Adult
35 to 44 cm	Large adult
45 to 52 cm	Adult thigh

References:

1. *Pickering TG, Hall JE, Appel LJ, et al. Recommendations for blood pressure measurement in humans and experimental animals: part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Circulation 2005; 111:697.*
2. *Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. Hypertension 2017. DOI: 10.1161/HYP.0000000000000065.*

Graphic 115863 Version 1.0

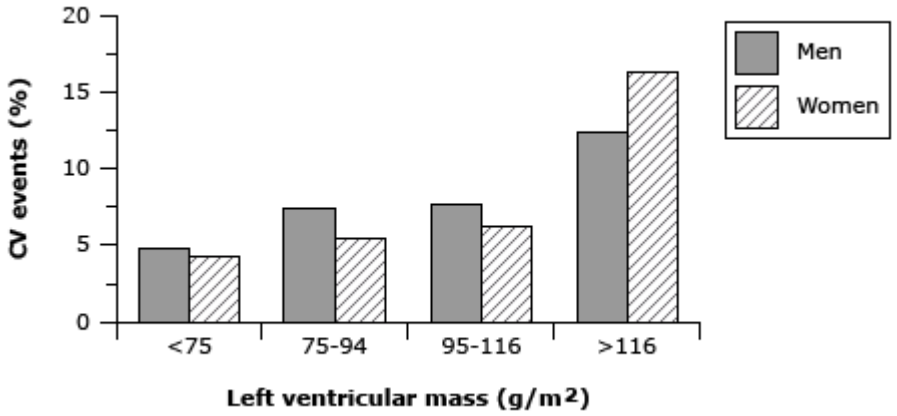
Procedures for use of home blood pressure monitoring

Patient training should occur under medical supervision, including:
▪ Information about hypertension.
▪ Selection of equipment.
▪ Acknowledgment that individual BP readings may vary substantially.
▪ Interpretation of results.
Devices:
▪ Verify use of automated validated devices. Use of auscultatory devices (mercury, aneroid, or other) is not generally useful for HBPM because patients rarely master the technique required for measurement of BP with auscultatory devices.
▪ Monitors with provision for storage of readings in memory are preferred.
▪ Verify use of appropriate cuff size to fit the arm.
▪ Verify that left/right inter-arm differences are insignificant. If differences are significant, instruct patient to measure BPs in the arm with higher readings.
Instructions on HBPM procedures:
▪ **Remain still:**
• Avoid smoking, caffeinated beverages, or exercise within 30 minutes before BP measurements.
• Ensure ≥5 minutes of quiet rest before BP measurements.
▪ **Sit correctly:**
• Sit with back straight and supported (on a straight-backed dining chair, for example, rather than a sofa).
• Sit with feet flat on the floor and legs uncrossed.
• Keep arm supported on a flat surface (such as a table), with the upper arm at heart level.
▪ **Bottom of the cuff should be placed directly above the antecubital fossa (bend of the elbow).**
▪ **Take multiple readings:**
• Take at least 2 readings 1 minute apart in morning before taking medications and in evening before supper. Optimally, measure and record BP daily. Ideally, obtain weekly BP readings beginning 2 weeks after a change in the treatment regimen and during the week before a clinic visit.
▪ **Record all readings accurately:**
• Monitors with built-in memory should be brought to all clinic appointments.
• BP should be based on an average of readings on ≥2 occasions for clinical decision making.
The information above may be reinforced with videos available online:
▪ http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/SymptomsDiagnosisMonitoringofHighBloodPressure/Home-Blood-Pressure-Monitoring_UCM_301874_Article.jsp#.WcQNfLKGMnM ▪ https://targetbp.org/tools_downloads/self-measured-blood-pressure-video/

BP: blood pressure; HBPM: home blood pressure monitoring.

Graphic 115864 Version 2.0

Cardiovascular risk with LVH by echocardiography



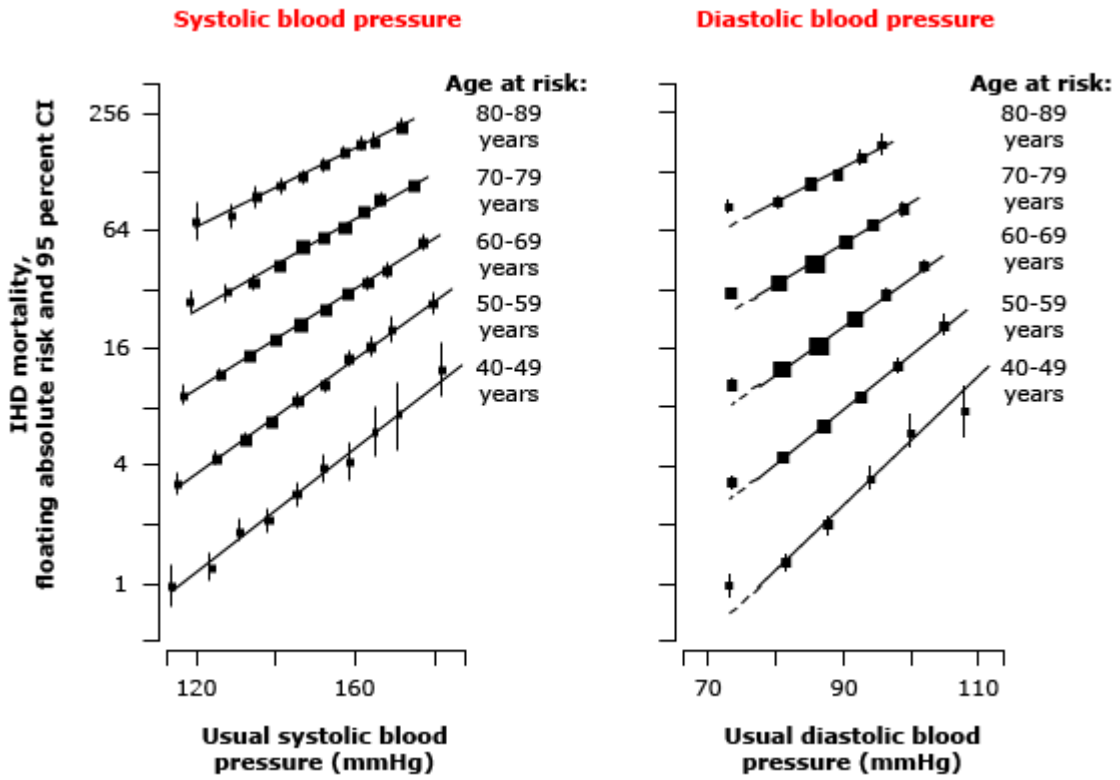
Four-year, age-adjusted incidence of cardiovascular events in men and women in the Framingham Study according to left ventricular mass determined by echocardiography. Subjects with increased left ventricular mass (far right panel) had a marked increase in cardiovascular risk.

LVH: left ventricular hypertrophy; CV: cardiovascular.

Adapted from: Levy D, Garrison RJ, Savage DD, et al. Prognostic implications of echocardiographically determined left ventricular mass in the Framingham Heart Study. N Engl J Med 1990; 322:1561.

Graphic 52329 Version 4.0

Coronary heart disease mortality related to blood pressure and age

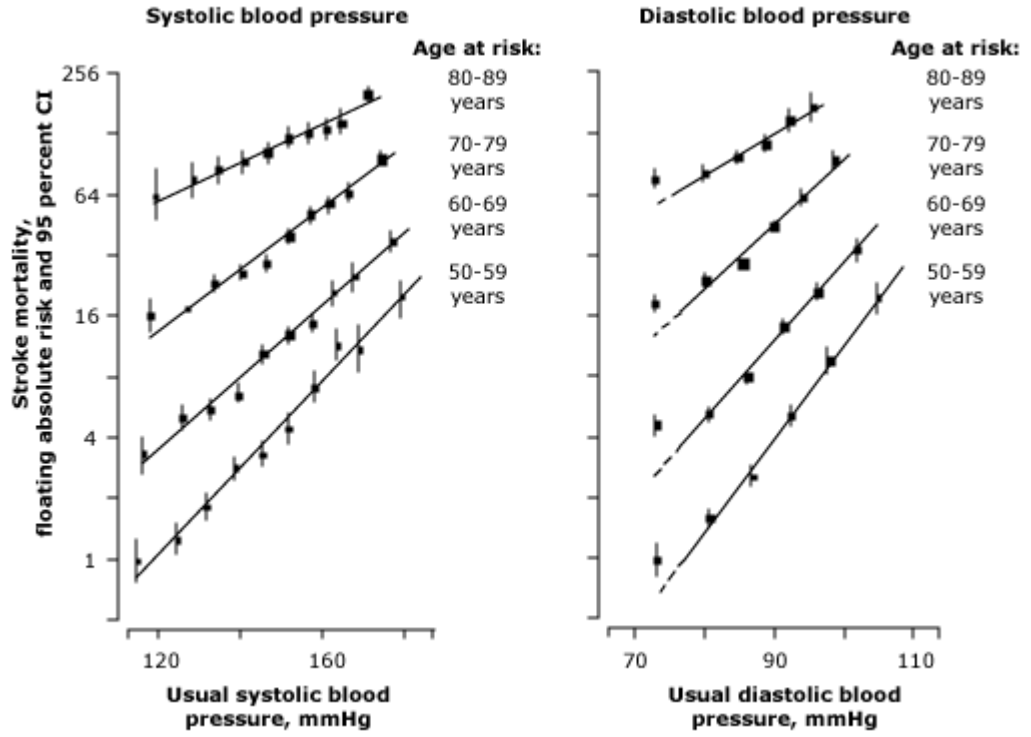


Coronary heart disease (CHD) mortality rate, pictured on a log scale with 95% confidence intervals (CI), in each decade of age in relation to the estimated usual systolic and diastolic blood pressure at the start of that decade. CHD mortality increases with both higher pressures and older ages. For diastolic pressure, each age-specific regression line ignores the left-hand point (ie, at slightly less than 75 mmHg) for which the risk lies significantly above the fitted regression line (as indicated by the broken line below 75 mmHg).

IHD: ischemic heart disease.

Graphic 75106 Version 9.0

Stroke mortality related to blood pressure and age



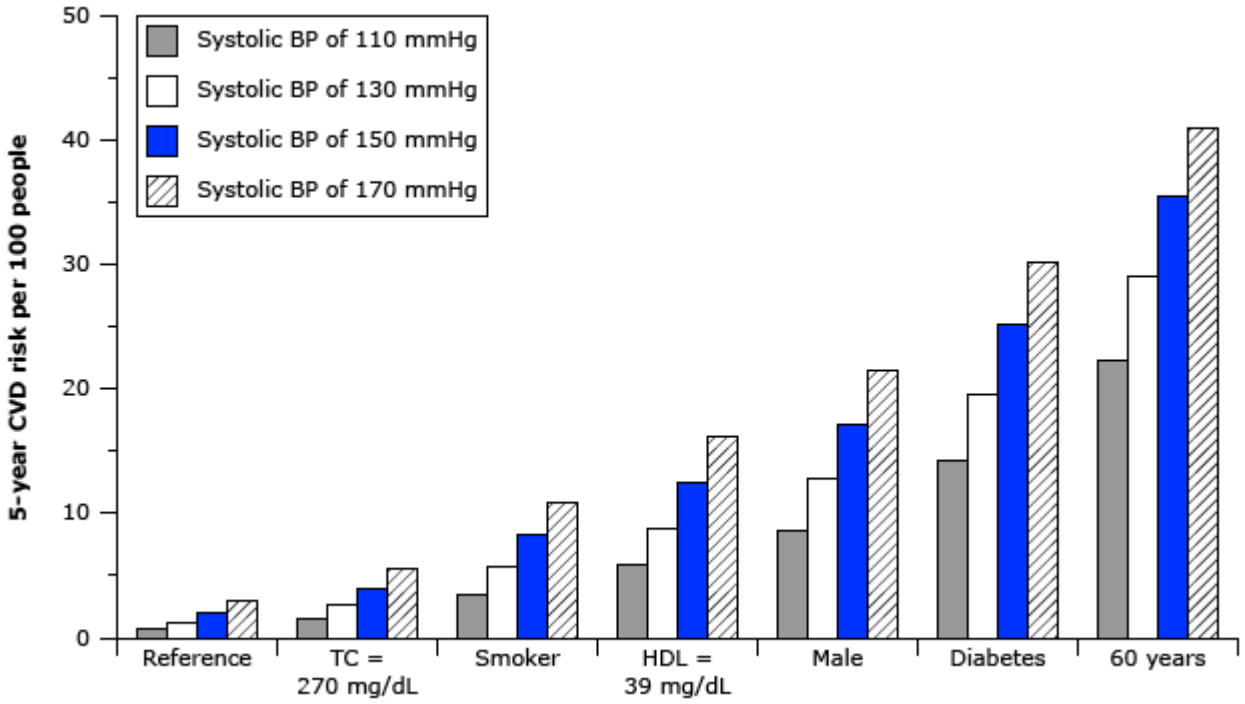
Stroke mortality rate, pictured on a log scale with 95% CI, in each decade of age in relation to the estimated usual systolic and diastolic blood pressure at the start of that decade. Stroke mortality increases with both higher pressures and older ages. For diastolic pressure, each age-specific regression line ignores the left-hand point (ie, at slightly less than 75 mmHg) for which the risk lies significantly above the fitted regression line (as indicated by the broken line below 75 mmHg).

CI: confidence interval.

Data from Prospective Studies Collaboration, Lancet 2002; 360:1903.

Graphic 66793 Version 5.0

Additive effects of risk factors on cardiovascular disease at 5 years



Cumulative absolute risk of CVD at 5 years according to systolic blood pressure and specified levels of other risk factors. The reference category is a non-diabetic, non-smoking 50-year-old woman with a serum TC of 154 mg/dL (4.0 mmol/L) and HDL cholesterol of 62 mg/dL (1.6 mmol/L). The CVD risks are given for systolic blood pressure levels of 110, 130, 150, and 170 mmHg. In the other categories, the additional risk factors are added consecutively. As an example, the diabetes category is a 50-year-old diabetic man who is a smoker and has a TC of 270 mg/dL (7 mmol/L) and HDL cholesterol of 39 mg/dL (1 mmol/L).

BP: blood pressure; CVD: cardiovascular disease; HDL: high-density lipoprotein; TC: total cholesterol.

Adapted from: Jackson R, Lawes CM, Bennett DA, et al. Lancet 2005; 365:434.

Graphic 55353 Version 12.0

Important aspects of the history in the patient with hypertension

Duration of hypertension
Last known normal blood pressure
Course of the blood pressure
Prior treatment of hypertension
Drugs: types, doses, side effects
Intake of agents that may cause hypertension
Nonsteroidal antiinflammatory drugs
Estrogens
Adrenal steroids
Cocaine
Sympathomimetics
Excessive sodium
Family history
Hypertension
Premature cardiovascular disease or death
Familial diseases: pheochromocytoma, renal disease, diabetes, gout
Symptoms of secondary causes
Muscle weakness
Spells of tachycardia, sweating, tremor
Thinning of the skin
Flank pain
Symptoms of target-organ damage
Headaches
Transient weakness or blindness
Loss of visual acuity
Chest pain
Dyspnea
Claudication

Presence of other risk factors
Smoking
Diabetes
Dyslipidemia
Physical inactivity
Dietary history
Sodium
Processed foods
Alcohol
Saturated fats
Psychosocial factors
Family structure
Work status
Educational level
Sexual function
Features of sleep apnea
Early morning headaches
Daytime somnolence
Loud snoring
Erratic sleep

Graphic 77599 Version 6.0

Important aspects of the physical examination in the hypertensive patient

Accurate measurement of blood pressure
General appearance
Distribution of body fat
Skin lesions
Muscle strength
Alertness
Fundoscopy
Hemorrhage
Papilledema
Cotton wool spots
Arteriolar narrowing and arteriovenous nicking
Neck
Palpation and auscultation of carotids
Thyroid
Heart
Size
Rhythm
Sounds
Lungs
Rhonchi
Rales
Abdomen
Renal masses
Bruits over aorta or renal arteries
Femoral pulses
Extremities
Peripheral pulses
Edema
Neurologic assessment
Visual disturbance
Focal weakness
Confusion

Graphic 69470 Version 4.0

Best proven nonpharmacologic interventions for prevention and treatment of hypertension*

	Nonpharmacologic intervention	Dose	Approximate impact on SBP		
			Hypertension	Normotension	Reference
Weight loss	Weight/body fat	▪ Best goal is ideal body weight, but aim for at least a 1 kg reduction in body weight for most adults who are overweight. Expect about 1 mmHg for every 1 kg reduction in body weight.	-5 mmHg	-3 mmHg	[1]
Healthy diet	DASH dietary pattern	▪ Consume a diet rich in fruits, vegetables, whole grains, and low-fat dairy products, with reduced content of saturated and total fat.	-11 mmHg	-3 mmHg	[2,3]
Reduced intake of dietary sodium	Dietary sodium	▪ Optimal goal is <1500 mg/day, but aim for at least a 1000 mg/day reduction in most adults.	-5 to -6 mmHg	-2 to -3 mmHg	[4,5]
Enhanced intake of dietary potassium	Dietary potassium	▪ Aim for 3500 to 5000 mg/day, preferably by consumption of a diet rich in potassium.	-4 mmHg	-2 mmHg	[6]
Physical activity	Aerobic	▪ 90 to 150 minutes/week. ▪ 65 to 75% heart rate reserve.	-5 to -8 mmHg	-2 to -4 mmHg	[7,8]
	Dynamic resistance	▪ 90 to 150 minutes/week. ▪ 50 to 80% of maximum 1 repetition weight. ▪ 6 exercises, 3 sets/exercise, 10 repetitions/set.	-4 mmHg	-2 mmHg	[7]
	Isometric resistance	▪ 4 × 2 minutes (hand grip), 1 minute rest between exercises, 30 to 40% maximum voluntary contraction, 3 sessions/week. ▪ 8 to 10 weeks.	-5 mmHg	-4 mmHg	[9,10]
Moderation in alcohol intake	Alcohol consumption	▪ In individuals who drink alcohol, reduce alcohol to:¶ • Men: ≤2 drinks daily. • Women: ≤1 drink daily.	-4 mmHg	-3 mmHg	[11-13]

SBP: systolic blood pressure; DASH: Dietary Approaches to Stop Hypertension.

* Type, dose, and expected impact on BP in adults with a normal BP and with hypertension.

¶ In the United States, one "standard" drink contains roughly 14 g of pure alcohol, which is typically found in 12 oz of regular beer (usually about 5% alcohol), 5 oz of wine (usually about 12% alcohol), and 1.5 oz of distilled spirits (usually about 40% alcohol).[14]

Resources:

- *National Heart, Lung, and Blood Institute. Your Guide to Lowering Your Blood Pressure With DASH. Available at: https://www.nhlbi.nih.gov/files/docs/public/heart/new_dash.pdf (Accessed on August 16, 2019).*
- *Top 10 DASH Diet Tips. Available at: http://dashdiet.org/dash_diet_tips.asp (Accessed on September 18, 2017).*

References:

1. *Neter JE, Stam BE, Kok FJ, et al. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension 2003; 42:878.*

2. *Appel LJ, Champagne CM, Harsha DW, et al. Effects of comprehensive lifestyle modification on blood pressure control: main results of the PREMIER clinical trial. JAMA 2003; 289:2083.*
3. *Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med 1997; 336:1117.*
4. *Aburto NJ, Ziolkovska A, Hooper L, et al. Effect of lower sodium intake on health: systematic review and metaanalyses. BMJ 2013; 346:f1326.*
5. *He FJ, Li J, MacGregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. BMJ 2013; 346:f1325.*
6. *Whelton PK, He J, Cutler JA, et al. Effects of oral potassium on blood pressure. Meta-analysis of randomized controlled clinical trials. JAMA 1997; 277:1624.*
7. *Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. J Am Heart Assoc 2013; 2:e004473.*
8. *Whelton SP, Chin A, Xin X, et al. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann Intern Med 2002; 136:493.*
9. *Carlson DJ, Dieberg G, Hess NC, et al. Isometric exercise training for blood pressure management: a systematic review and meta-analysis. Mayo Clin Proc 2014; 89:327.*
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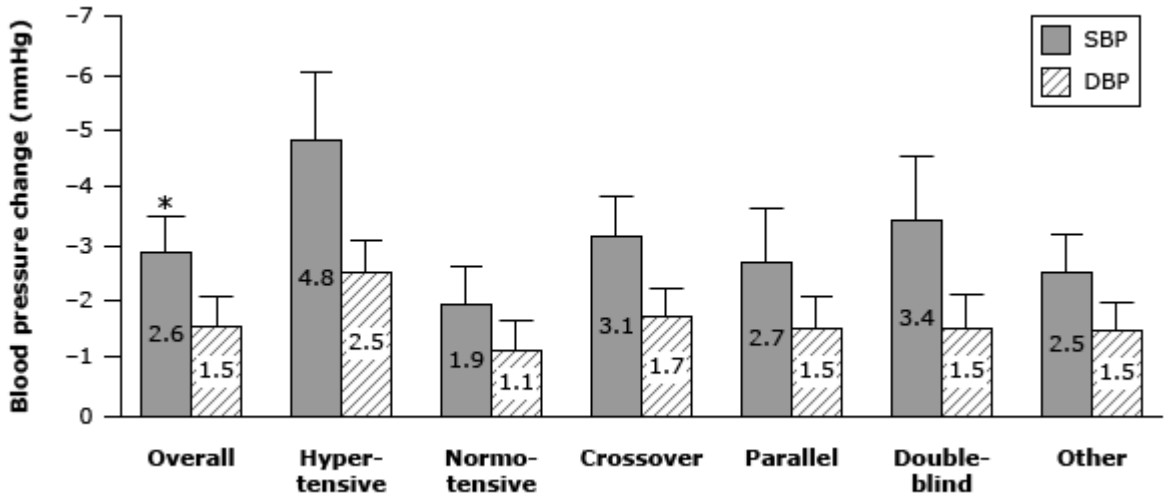
11. *Whelton SP, Chin A, Xin X, et al. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. Ann Intern Med 2002; 136:493.*
12. *Xin X, He J, Frontini MG, et al. Effects of alcohol reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension 2001; 38:1112.*
13. *Roerecke M, Kaczorowski J, Tobe SW, et al. The effect of a reduction in alcohol consumption on blood pressure: a systematic review and meta-analysis. Lancet Public Health 2017; 2:e108.*
14. *National Institute on Alcohol Abuse and Alcoholism (NIAAA). What Is A Standard Drink? Available at: https://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/what-standard-drink (Accessed on August 16, 2017).*

Graphic 116041 Version 3.0

Blood pressure change and sodium reduction



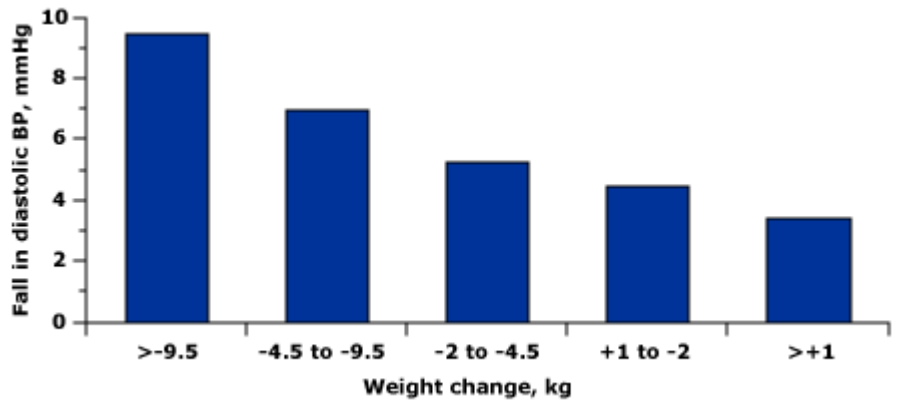
Pooled results from all sodium-reduction trials concerning the mean net change in blood pressure due to restrictions in sodium intake among various subsets of patients.

SBP: systolic blood pressure; DBP: diastolic blood pressure.
* The mean change is compared with control values.

Data from: Cutler JA, Follmann D, Allender PS. Am J Clin Nutr 1997; 65:643S.

Graphic 81634 Version 4.0

Weight loss-induced reduction in diastolic blood pressure



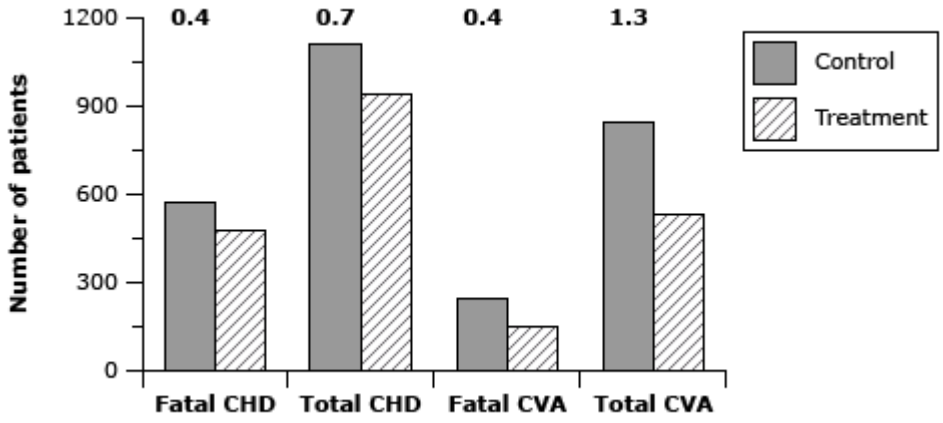
Relationship between the quantity of weight lost and the fall in diastolic blood pressure in 308 moderately obese patients given a weight reduction regimen for 18 months. The patients began with a diastolic pressure between 80 and 89 mmHg; those who lost the most weight had the largest reduction in diastolic pressure. The decreases in the systolic pressure were similar.

BP: blood pressure.

Data from: Stevens VJ, Corrigan SA, Obarzanek E, et al. Weight loss intervention in phase 1 of the Trials of Hypertension Prevention. The TOHP Collaborative Research Group. Arch Intern Med 1993; 153:849.

Graphic 60178 Version 6.0

Cardiovascular benefit of treating mild hypertension



Reduced incidence of fatal and total coronary heart disease (CHD) events and strokes following antihypertensive therapy in 17 controlled studies involving almost 48,000 patients with mild to moderate hypertension. The number of patients having each of these events is depicted, with active treatment lowering the incidence of coronary events by 16 percent and stroke by 40 percent. However, the absolute benefit (as shown, in percent, by the numbers at the top of the graph) was much less. Treatment for approximately four to five years prevented a coronary event or a stroke in 2 percent of patients (0.7 + 1.3), including prevention of death in 0.8 percent.

CVA: cerebrovascular accident (stroke).

Data from: Hebert PR, Moser M, Mayer J, et al. Recent evidence on drug therapy of mild to moderate hypertension and decreased risk of coronary heart disease. Arch Intern Med 1993; 153:578.

Graphic 52231 Version 8.0

Considerations for individualizing antihypertensive therapy

Indication or contraindication	Antihypertensive drugs
Compelling indications (major improvement in outcome independent of blood pressure)	
Heart failure with reduced ejection fraction	ACE inhibitor or ARB, beta blocker, diuretic, aldosterone antagonist*
Postmyocardial infarction	ACE inhibitor or ARB, beta blocker, aldosterone antagonist
Proteinuric chronic kidney disease	ACE inhibitor or ARB
Angina pectoris	Beta blocker, calcium channel blocker
Atrial fibrillation rate control	Beta blocker, nondihydropyridine calcium channel blocker
Atrial flutter rate control	Beta blocker, nondihydropyridine calcium channel blocker
Likely to have a favorable effect on symptoms in comorbid conditions	
Benign prostatic hyperplasia	Alpha blocker
Essential tremor	Beta blocker (noncardioselective)
Hyperthyroidism	Beta blocker
Migraine	Beta blocker, calcium channel blocker
Osteoporosis	Thiazide diuretic
Raynaud phenomenon	Dihydropyridine calcium channel blocker
Contraindications	
Angioedema	Do not use an ACE inhibitor
Bronchospastic disease	Do not use a non-selective beta blocker
Liver disease	Do not use methyldopa
Pregnancy (or at risk for)	Do not use an ACE inhibitor, ARB, or renin inhibitor (eg, aliskiren)
Second- or third-degree heart block	Do not use a beta blocker, nondihydropyridine calcium channel blocker unless a functioning ventricular pacemaker
Drug classes that may have adverse effects on comorbid conditions	
Depression	Generally avoid beta blocker, central alpha-2 agonist
Gout	Generally avoid loop or thiazide diuretic
Hyperkalemia	Generally avoid aldosterone antagonist, ACE inhibitor, ARB, renin inhibitor
Hyponatremia	Generally avoid thiazide diuretic
Renovascular disease	Generally avoid ACE inhibitor, ARB, or renin inhibitor

ACE: angiotensin-converting enzyme; ARB: angiotensin receptor blocker.
* A benefit from an aldosterone antagonist has been demonstrated in patients with NYHA class III-IV heart failure or decreased left ventricular ejection fraction after a myocardial infarction.

Adapted from: The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. JAMA 2003; 289:2560.

Graphic 63628 Version 15.0

Hypertensive emergencies

Grades III to IV hypertensive retinopathy with severely elevated blood pressures
Cerebrovascular
Hypertensive encephalopathy
Atherothrombotic brain infarction with severe hypertension
Intracerebral hemorrhage
Subarachnoid hemorrhage
Cardiac
Acute aortic dissection
Acute left ventricular failure
Acute or impending myocardial infarction
After coronary bypass surgery
Renal
Acute glomerulonephritis
Renal crises from collagen vascular diseases
Severe hypertension after kidney transplantation
Microangiopathic hemolytic anemia
Excessive circulating catecholamines
Pheochromocytoma crisis
Food or drug interactions with monoamine-oxidase inhibitors
Sympathomimetic drug use (cocaine)
Rebound hypertension after sudden cessation of antihypertensive drugs
Eclampsia
Surgical
Severe hypertension in patients requiring immediate surgery
Postoperative hypertension
Postoperative bleeding from vascular suture lines
Severe body burns
Severe epistaxis

Graphic 54145 Version 5.0