

Chapter 15

Hypertension

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Introduction

Hypertension is the most common chronic condition seen in primary care practice. Hypertension is not only a major preventable cause of cardio-cerebrovascular morbidity and mortality; it is also an independent risk factor for end-organ damage including myocardial infarction, stroke, heart failure, retinopathy, and end-stage renal disease. Social determinants coupled with behavioral and genetic factors play an important role in the development of hypertension and its related complications.

Scope of the Problem

Annually, over ten million deaths worldwide can be attributed to hypertension [1]. Approximately 80 million, or one in three American adults, have high blood pressure. About one in three

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American adults also have prehypertension, blood pressure values that are higher than normal but not yet in the high blood pressure range. Seventy-seven percent of individuals diagnosed with hypertension are using antihypertensive medications, but only 54% have their condition controlled. The prevalence of hypertension is projected to increase about 8% between 2013 and 2030. High blood pressure costs the nation \$48.6 billion each year. This total includes the cost of healthcare services, medications to treat high blood pressure, and missed days of work [2].

Based on the data provided by the American Heart Association in 2015 [3], there is widespread racial and gender disparity in the prevalence of high blood pressure in the US population. Rates in African-Americans are among the highest of any population in the world.

- 46% of African-American women have high blood pressure.
- 45% of African-American men have high blood pressure.
- 33% of white men have high blood pressure.
- 30% of white women have high blood pressure.
- 30% of Hispanic men have high blood pressure.
- 30% of Hispanic women have high blood pressure.

Key History and Physical Exam

Contributing factors to elevated blood pressure need to be assessed during an initial visit and all subsequent visits. Every clinical encounter requires a review of systems and family history of symptoms of cardio-cerebrovascular disease, renal disease, diabetes, dyslipidemia, and gout. History of symptoms suggestive of secondary hypertension should be explored, e.g., weight gain, sedentary lifestyle, physical activity, and tobacco use [4]. Psychosocial and environmental factors that may elevate blood pressure such as social determinants, family situation, employment status, working conditions, and education level need to be addressed. Sodium intake, alcohol use, and intake of saturated fat and cholesterol should be assessed. Medication history should include effectiveness of prior therapy and/or intolerance to previous

antihypertensive therapy and use of commonly prescribed over-the-counter medications, herbal and illicit medications, or recreational drugs that may raise blood pressure or interfere with the effectiveness of antihypertensive medications.

Decision-Making/Differential Diagnoses

The early stages of hypertension may have no clinical manifestations except elevated blood pressures. Primary or essential hypertension should be considered when there are consecutive elevated blood pressures, bilateral temporal throbbing headaches, and unexplained lower extremity edema.

Similar to primary hypertension, secondary hypertension usually does not have specific signs and symptoms even with elevated pressures. However, blood pressures not responding to usual medications, early onset (before age 30) or late onset, normal BMI, no family history, and presence of end-organ damage and/or dysfunction should be evaluated for secondary hypertension (Tables 15.1 and 15.2).

Physical Examination

Physical examination establishes the diagnosis and may reveal the severity of disease. The following examination should be performed:

TABLE 15.1 Classification of blood pressure in adults

Blood pressure	Systolic (mmHg)	Diastolic (mmHg)
Normal	<120	And <80
Prehypertension	120–139	Or 80–89
Stage 1 hypertension	140–159	Or 90–99
Stage 2 hypertension	≥160	≥100
Stage 3 hypertension	>180	>110
Isolated systolic hypertension	>140	<90

TABLE 15.2 Categories of secondary hypertension in adults

Secondary
Renal
Parenchymal diseases
Vascular (renal artery stenosis)
Tumors (renin producing)
Adrenal
Cushing's disease
Primary aldosteronism
Pheochromocytoma
Endocrine
Hypothyroidism
Hyperthyroidism
Acromegaly
Carcinoid tumors
Vascular
Coarctation of the aorta
Aortic regurgitation
Medications
Oral contraceptives
Erythropoietin
NSAIDS
Corticosteroids
Cyclosporine
Miscellaneous

(continued)

TABLE 15.2 (continued)

Secondary

Pregnancy

Perioperative period

Alcohol withdrawal

Obstructive sleep apnea

Caffeine

 Nicotine

- Blood pressure measurements bilaterally to detect and confirm the presence of high blood pressure
- Examination of the eyes including fundus:
 - Arteriolar narrowing
 - Arteriovenous nicking
 - Exudates, hemorrhages, and papilledema
- Examination of the neck:
 - Carotid bruits
 - Distended veins
 - Enlarged thyroid gland
- Examination of the heart:
 - Increased rate and size
 - Precordial heave
 - Clicks and murmurs
 - Arrhythmias
 - Third (S3) and fourth (S4) heart sounds
- Examination of the abdomen:
 - Bruits and abnormal aortic pulsation
 - Enlarged kidneys
 - Masses
- Examination of the extremities:
 - Diminished, delayed, or absent peripheral arterial pulsations
 - Bruits
 - Edema

- Body habitus, looking for changes associated with secondary hypertension
- Peripheral and central nervous system for ischemic changes

Measuring Blood Pressure

The accurate measurement of blood pressure remains the most important technique for evaluating hypertension [5]. The following steps are recommended when measuring blood pressure to avoid inaccuracies:

- No caffeine, exercise, or smoking for 30 min prior.
- Seated quietly for 5 min in a high-back chair.
- Upper arms free of constrictive clothing.
- Both feet on the floor, legs should not be crossed, and arm supported at the level of the heart.
- Cuff bladder should encircle at least 80% of the arm circumference.
- At least two blood pressure measurements per arm to obtain an average reading.
- Inflate the cuff to 20–30 mmHg above pulse extinction.
- Deflate at a rate of 2–3 mmHg/s.
- Systolic BP = onset of the first Korotkoff sound.
- Diastolic BP = disappearance of Korotkoff sounds.
- Neither the patient nor the observer should talk during the measurement.

Laboratory Tests

Baseline tests are recommended to identify those individuals at risk for hypertension or to obtain clues to diagnose secondary hypertension:

- Electrocardiogram
- Urinalysis
- Blood glucose measurement
- Complete blood count

- Measurement of serum potassium, calcium, creatinine levels or estimated glomerular filtration rate
- Fasting lipid profile
- Measurement of urinary albumin excretion or albumin/creatinine ratio

Treatment

The treatment of high blood pressure requires a multi-pronged approach, which includes lifestyle management and non-pharmacological and pharmacological interventions.

Lifestyle Management

A healthy lifestyle is essential in the management of high blood pressure [7]. Diet, nutrient intake, and physical activity can play an important role in the prevention and treatment of high blood pressure and its associated complications. Dietary modifications include weight loss, reduced salt intake, increased potassium intake, moderation of alcohol consumption, and adhering to a healthy diet.

Diet—Emphasis on intake of vegetables and fruits (8–10 servings/day), whole grains, low-fat dairy products (2–3 servings/day), poultry, fish, legumes, nontropical vegetable oils, and nuts and limited intake of sweets, sugar-sweetened beverages, and red meat are recommended. Recommendation of dietary patterns listed below should take into account personal and cultural food preferences, appropriate calorie intake, and other medical conditions.

- DASH or its variant diet
- US Department of Agriculture diet
- American Heart Association diet

Dietary supplements—Garlic has been shown to have blood pressure-lowering properties and has been used as a dietary supplement to lower blood pressure.

Cocoa has a small blood pressure-lowering effect (average of 2–3 mmHg) in adults with hypertension, but there is no evidence that it improves cardiovascular events.

Although vitamin C, coenzyme Q10, omega-3 fatty acids, and magnesium are used for lowering blood pressure, there is no clear evidence to support their use in the prevention or treatment of hypertension.

Sodium—2400 mg/day or less is recommended if the desired BP goal is not achieved.

Potassium—Increase potassium intake to >4.0 gm/day.

Physical activity—Engaging in aerobic physical activity for 3–4 sessions per week lasting on average 40 min per session (moderate to vigorous intensity) or at least 150 min per week of moderate intensity is beneficial in reducing blood pressure.

Weight loss—Losing weight to a body mass index of ≤ 25 is recommended.

Smoking cessation—Smoking cessation lowers blood pressure and heart rate reducing overall cardiovascular morbidity and mortality.

Alcohol use—Limit to ≤ 2 alcoholic drinks per day for men and ≤ 1 alcoholic drink per day for women. One alcoholic drink is defined as 12 ounces of regular beer, 5 ounces of wine, or 1.5 ounces of 80 proof distilled spirits.

Relaxation techniques—There is sporadic evidence for yoga, transcendental meditation, acupuncture, and biofeedback techniques in lowering blood pressure.

Pharmacological Interventions

In 2014, the Eighth Joint National Committee (JNC 8) released evidence-based recommendations on treatment thresholds, goals, and pharmacological interventions in the management of hypertension in adults [8]. Other medical organizations have published similar recommendations along with lifestyle management including diet.

Pharmacologic treatment should be initiated for adults between the ages of 18 and 60 years, when the systolic pressure

is 140 mmHg or higher or when the diastolic pressure is 90 mmHg or higher with a target systolic pressure less than 140 mmHg and a target diastolic pressure less than 90 mmHg.

Pharmacologic treatment should be initiated for adults 60 years of age and older, when the systolic pressure is 150 mmHg or higher, or when the diastolic pressure is 90 mmHg or higher with a target systolic pressure of less than 150 mmHg and a target diastolic pressure of less than 90 mmHg (Table 15.3).

Clinical Quality Measure

Controlling blood pressure is part of a condition-specific clinical quality measure. The Healthcare Effectiveness Data and Information Set (HEDIS) measures the percentage of adults aged 18–85 with a diagnosis of hypertension, whose most recent blood pressure reading was controlled based on the following criteria:

Age 18–59 whose BP was <140/90

Age 60–85 with a diagnosis of diabetes whose BP was <140/90

Age 60–85 without a diagnosis of diabetes whose BP was <150/90

Exclusions: Patients with end-stage renal disease (ESRD) or kidney transplant and pregnant status during the measurement year. Admission to a non-acute inpatient setting during the measurement year.

Home (Self) and Ambulatory Blood Pressure Monitoring (ABPM)

The office blood pressure measurement can vary by 20–25 mmHg between visits due to various factors and limitations such as poor technique, masked effect, white coat effect, and a small number of readings. Moreover, the traditional office blood pressure (BP) may not provide accurate estimates of blood pressure status. There are currently two methods of out-of-office blood pressure monitoring that have

TABLE 15.3 Choice and indications of antihypertensive medications (Modified with permission from a card developed by Cole Glenn, Pharm D, and James Taylor, Pharm D www.nmhs.net/documents/27JNC8HTNGuidelinesBooklet.pdf)

Initial drugs of choice for hypertension	Beta-1 selective beta-blockers (BB)
<ul style="list-style-type: none"> • ACE inhibitor (ACEI) • Angiotensin receptor blocker (ARB) • Thiazide diuretic • Calcium channel blocker (CCB) 	<p>Safer in patients with COPD, asthma, diabetes, and peripheral vascular disease</p> <ul style="list-style-type: none"> • Metoprolol • Bisoprolol • Betaxolol • Acebutolol
<i>Recommended indications</i>	
<i>Indication</i>	<i>Treatment choice</i>
Heart failure	ACEI/ARB + BB + diuretic + spironolactone
Post-MI/clinical CAD	ACEI/ARB and BB
CAD	ACEI, BB, diuretic, CCB
Diabetes	ACEI/ARB, CCB, diuretic
CKD	ACEI/ARB

Recurrent stroke prevention		ACEI, diuretic
Pregnancy		Labetolol (first line), nifedipine, methyldopa
<i>Class</i>	<i>Choice of medications</i>	<i>Comments</i>
Diuretics	HCTZ 12.5–50 mg, chlorthalidone 12.5–25 mg, indapamide 1.25–2.5 mg	Monitor for hypokalemia
	K ⁺ -sparing diuretics: spironolactone 25–50 mg, amiloride 5–10 mg, triamterene 100 mg	Most side effects are metabolic in nature
	Furosemide 20–80 mg twice daily, torsemide 10–40 mg	Most effective when combined with ACEI
		Stronger clinical evidence with chlorthalidone.
		Spironolactone-induced gynecomastia and hyperkalemia
		Loop diuretics may be needed when GFR <40 mL/min

(continued)

Calcium channel blockers	<p><i>Dihydropyridines:</i> amlodipine 5–10 mg, nifedipine ER 30–90 mg</p> <p><i>Non-dihydropyridine:</i> diltiazem ER 180–360 mg, verapamil 80–120 mg three times daily, or verapamil ER 240–480 mg</p>	Cause edema; dihydropyridines may be safely combined with a beta-blocker
Vasodilators	<p>Hydralazine 25–100 mg twice daily, minoxidil 5–10 mg once daily</p> <p>Terazosin 1–5 mg, doxazosin 1–4 mg given at bedtime</p>	Hydralazine and minoxidil may cause reflex tachycardia and fluid retention—usually require diuretic + BB
Centrally acting agents	Clonidine 0.1–0.2 mg twice daily, methyl dopa 250–500 mg twice daily	Alpha-blockers may cause orthostatic hypotension Clonidine available in weekly patch formulation for resistant hypertension

been recommended such as self- or home monitoring and ambulatory blood pressure monitoring. The blood pressure measured over 24 h by an ambulatory recording (ABPM) is the best method for estimating an individual's cardiovascular risk related to hypertension and response to antihypertensive therapies [9]. The ABPM is also the most effective means to determine white coat or masked hypertension and the BP values during sleep when nocturnal hypertension or non-dipping profiles are suspected. For both self- and ambulatory blood pressure monitoring, monitors that use the upper arm are better than the wrist, except in very obese individuals. Finger devices are not reliable. An up-to-date list of monitors can be retrieved from www.dableducational.org [10]. Currently, ABPM is not widely used in clinical practice, mainly because the expenses are often not reimbursed by payors, but this will change as healthcare moves toward a value-based reimbursement system (Figs. 15.1 and 15.2) (Table 15.4).

Refractory or Resistant Hypertension

Refractory or resistant hypertension is defined as a blood pressure of at least 140/90 mmHg despite adherence to treatment with full doses of at least three antihypertensive medications, including a diuretic [11].

In order to diagnose refractory hypertension, various factors that need to be considered are secondary causes of hypertension (Table 15.2), improper blood pressure measurement, volume overload, competing substances, obesity, nonadherence to treatment, inadequate doses or inappropriate combinations of medications, and alcohol consumption [12] (Fig. 15.3).

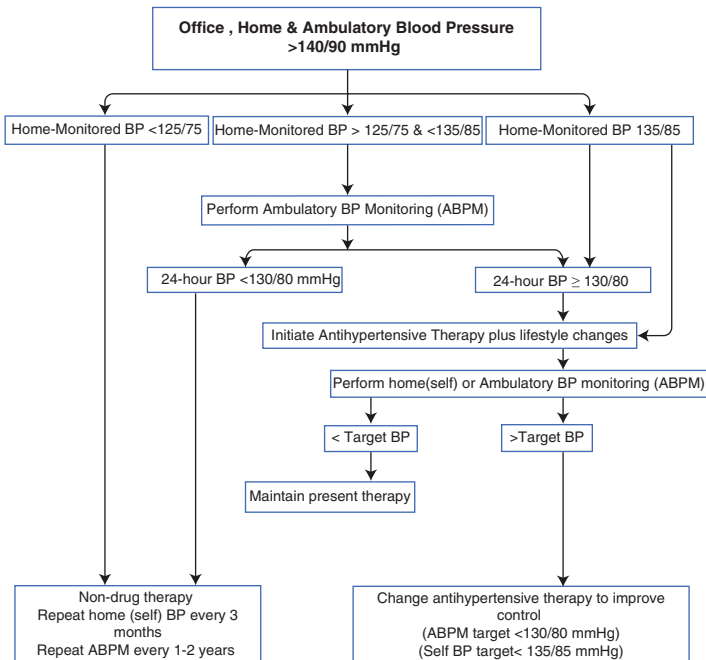


FIG. 15.1 Practical use of home (self) BP monitoring and ambulatory blood pressure monitoring (ABPM). Home (self) BP monitoring should be performed according to strict guidelines prior to clinical decision-making. Following initiation of antihypertensive therapy, the determination to use home (self) BP monitoring vs. ABPM is made according to availability, clinical judgment, and insurance coverage

Role of Digital Health in Hypertension

Digital health interventions for hypertension include blood pressure sensors, upper arm blood pressure monitors, mobile applications, and remote monitoring technologies. Wearable trackers have the potential to improve hypertension control and medication adherence through real-time capture of clinical data, better connectivity with healthcare providers, and medication reminder alerts. With increasing emphasis on home and ambulatory blood pressure monitoring to confirm

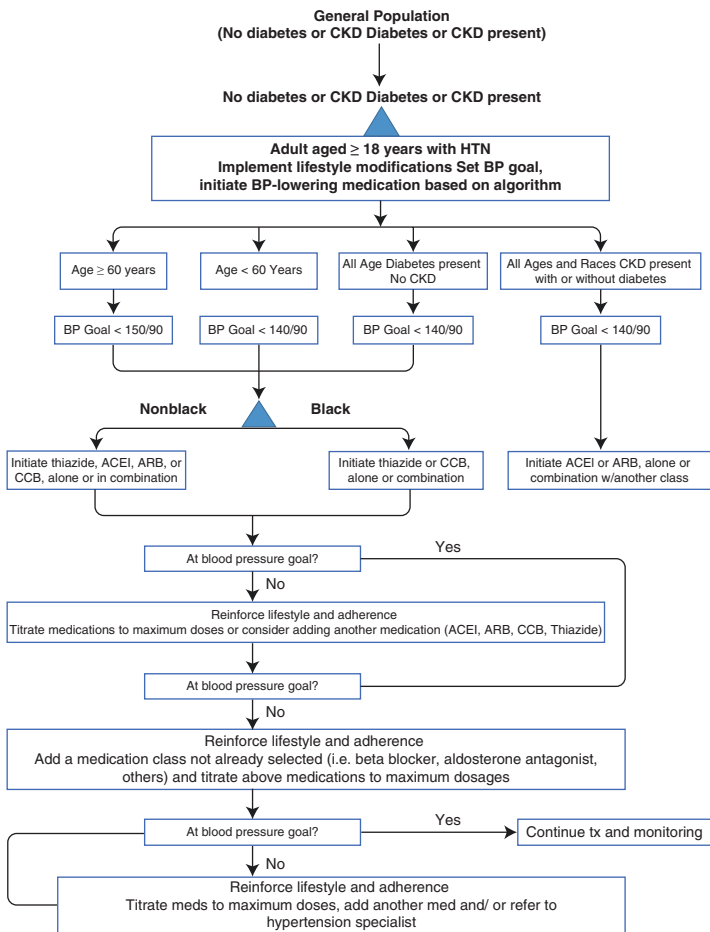


FIG. 15.2 JNC 8: evidence-based guideline for the management of high blood pressure in adults [6]

TABLE 15.4 Blood pressure patterns that can be determined by office BP, ambulatory blood-pressure monitoring (ABPM), and home (self) BP measurements

Blood pressure	Office BP	ABPM	Home (self)
Predict events	+	+	+
Diagnostic utility	+	+	+
White coat hypertension	-	+	+/-
Masked hypertension	-	+	-
Measures diurnal variation of BP	-	+	-
Cost	Low	High	Low
Duration of drug effects	-	+	+
Reimbursement	Yes	Partial	No

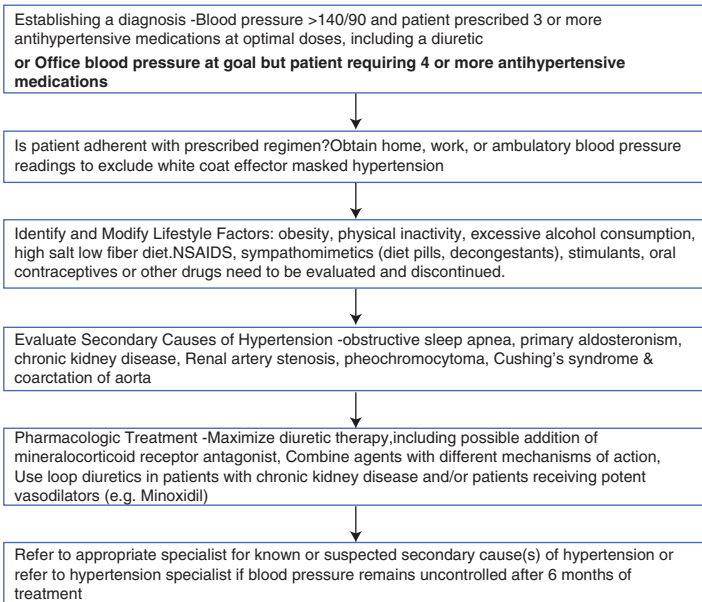


FIG. 15.3 Refractory or resistant hypertension: management algorithm

hypertension prior to treatment, such devices also can help improve the diagnostic and treatment paradigm.

For wider adoption, device manufacturers and clinical researchers should collaborate on the development of clinical trials and evidence-based guidelines for better clinical outcomes associated with emerging technologies.

Clinical Pearls

- Hypertension in its early stages is an asymptomatic process and has no clinical manifestations.
- Hypertension is preventable and an independent risk factor for end-organ damage—myocardial infarction, stroke, heart failure, retinopathy, and end-stage renal disease.
- Social determinants and behavioral factors play an important role in the development of hypertension and its related complications.
- Lifestyle management including diet and physical activity are an integral part of blood pressure control along with pharmacological interventions.

Adequate screening and control of blood pressure is an important clinical quality measure.

Don't Miss This!

- Hypertension can be either isolated systolic, isolated diastolic, or both systolic and diastolic.
- Secondary causes of hypertension should be assessed when resistant hypertension is present.
- Ambulatory blood pressure monitoring is a useful tool in the management of hypertension.
- The antihypertensive medications ACE inhibitors, angiotensin receptor blockers (ARBs), and renin inhibitors can cause fetal abnormalities and should be avoided in women of childbearing age.
- While prescribing pharmacological agents, one should consider associated medical illnesses and patient's preferences including cost of the medications.

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