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: Executive Summary

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines

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Preamble

Since 1980, the American College of Cardiology (ACC) and American Heart Association (AHA) have translated scientific evidence into clinical practice guidelines (guidelines) with recommendations to improve cardiovascular health. In 2013, the

National Heart, Lung, and Blood Institute (NHLBI) Advisory Council recommended that the NHLBI focus specifically on reviewing the highest-quality evidence and partner with other organizations to develop recommendations.[P-1,P-2] Accordingly, the ACC and AHA collaborated with the NHLBI and stakeholder and professional organizations to complete and publish 4 guidelines (on assessment of cardiovascular risk, lifestyle modifications to reduce cardiovascular risk, management of blood cholesterol in adults, and management of overweight and obesity in adults) to make them available to the widest possible constituency. In 2014, the ACC and AHA, in partnership with several other professional societies, initiated a guideline on the prevention, detection, evaluation, and management of high blood pressure (BP) in adults. Under the management of the ACC/AHA Task Force, a Prevention Subcommittee was appointed to help guide development of the suite of guidelines on prevention of cardiovascular disease (CVD). These guidelines, which are based on systematic methods to evaluate and classify evidence, provide a cornerstone for quality cardiovascular care. The ACC and AHA sponsor the development and publication of guidelines without commercial support, and members of each organization volunteer their time to the writing and review efforts. Guidelines are official policy of the ACC and AHA.

Intended Use

Practice guidelines provide recommendations applicable to patients with or at risk of developing CVD. The focus is on medical practice in the United States, but guidelines developed in collaboration with other organizations can have a global impact. Although guidelines may be used to inform regulatory or payer decisions, they are intended to improve patients' quality of care and align with patients' interests. Guidelines are intended to define practices meeting the needs of patients in most, but not all, circumstances and should not replace clinical judgment.

Clinical Implementation

Management in accordance with guideline recommendations is effective only when followed by both practitioners and patients. Adherence to recommendations can be enhanced by shared decision making between clinicians and patients, with patient engagement in selecting interventions on the basis of individual values, preferences, and associated conditions and comorbidities.

Methodology and Modernization

The ACC/AHA Task Force on Clinical Practice Guidelines (Task Force) continuously reviews, updates, and modifies guideline methodology on the basis of published standards from organizations, including the Institute of Medicine,[P-3,P-4] and on the basis of internal reevaluation. Similarly, the presentation and delivery of guidelines are reevaluated and modified on the basis of evolving technologies and other factors to facilitate optimal dissemination of information to healthcare professionals at the point of care.

Toward this goal, this guideline continues the introduction of an evolved format of presenting guideline recommendations and associated text called the "modular knowledge chunk format." Each modular "chunk" includes a table of related recommendations, a brief synopsis, recommendation-specific supportive text, and when appropriate, flow diagrams or additional tables. References are provided within the modular chunk itself to facilitate quick review. Additionally, this format will facilitate seamless updating of guidelines with focused updates as new evidence is published, as well as content tagging for rapid electronic retrieval of related recommendations on a topic of interest. This evolved approach format was instituted when this guideline was near completion; therefore, the present document represents a transitional format that best suits the text as written. Future guidelines will fully implement this format, including provisions for limiting the amount of text in a guideline.

Recognizing the importance of cost–value considerations in certain guidelines, when appropriate and feasible, an analysis of the value of a drug, device, or intervention may be performed in accordance with the ACC/AHA methodology.[P-5]

To ensure that guideline recommendations remain current, new data are reviewed on an ongoing basis, with full guideline revisions commissioned in approximately 6-year cycles. Publication of new, potentially practice-changing study results that are relevant to an existing or new drug, device, or management strategy will prompt evaluation by the Task Force, in consultation with the relevant guideline writing committee, to determine whether a focused update should be commissioned. For additional information and policies regarding guideline development, we encourage readers to consult the ACC/AHA guideline methodology manual[P-6] and other methodology articles.[P-7–P-10]

Selection of Writing Committee Members

The Task Force strives to avoid bias by selecting experts from a broad array of backgrounds. Writing committee members represent different geographic regions, sexes, ethnicities, races, intellectual perspectives/biases, and scopes of clinical practice. The Task Force may also invite organizations and professional societies with related interests and expertise to participate as partners, collaborators, or endorsers.

Relationships With Industry and Other Entities

The ACC and AHA have rigorous policies and methods to ensure that guidelines are developed without bias or improper influence. The complete relationships with industry and other entities (RWI) policy can be found online. Appendix 1 of the present document lists writing committee members' relevant RWI. For the purposes of full transparency, writing committee members' comprehensive disclosure information is available online. Comprehensive disclosure information for the Task Force is available online.

Evidence Review and Evidence Review Committees

In developing recommendations, the writing committee uses evidence-based methodologies that are based on all available data.[P-6–P-9] Literature searches focus on randomized controlled trials (RCTs) but also include registries, nonrandomized comparative and descriptive studies, case series, cohort studies, systematic reviews, and expert opinion. Only key references are cited.

An independent evidence review committee (ERC) is commissioned when there are 1 or more questions deemed

of utmost clinical importance that merit formal systematic review. The systematic review will determine which patients are most likely to benefit from a drug, device, or treatment strategy and to what degree. Criteria for commissioning an ERC and formal systematic review include: a) the absence of a current authoritative systematic review, b) the feasibility of defining the benefit and risk in a time frame consistent with the writing of a guideline, c) the relevance to a substantial number of patients, and d) the likelihood that the findings can be translated into actionable recommendations. ERC members may include methodologists, epidemiologists, healthcare providers, and biostatisticians. The recommendations developed by the writing committee on the basis of the systematic review are marked with "SR."

Guideline-Directed Management and Therapy

The term guideline-directed management and therapy (GDMT) encompasses clinical evaluation, diagnostic testing, and pharmacological and procedural treatments. For these and all recommended drug treatment regimens, the reader should confirm the dosage by reviewing product insert material and evaluate the treatment regimen for contraindications and interactions. The recommendations are limited to drugs, devices, and treatments approved for clinical use in the United States.

Class of Recommendation and Level of Evidence

The Class of Recommendation (COR) indicates the strength of the recommendation, encompassing the estimated magnitude and certainty of benefit in proportion to risk. The Level of Evidence (LOE) rates the quality of scientific evidence that supports the intervention on the basis of the type, quantity, and consistency of data from clinical trials and other sources (Table 1).[P-6–P-8]

The reader is encouraged to consult the full-text guideline[P-11] for additional guidance and details about hypertension, since the executive summary contains mainly the recommendations.

Glenn N. Levine, MD, FACC, FAHA
Chair, ACC/AHA Task Force on Clinical Practice Guidelines

1. Introduction

In 2013, the National Heart, Lung, and Blood Institute (NHLBI) Advisory Council recommended that the NHLBI focus specifically on reviewing the highest-quality evidence and partner with other organizations to develop recommendations.[S1-1,S1-2] Accordingly, the ACC and AHA collaborated with the NHLBI and stakeholder and professional organizations to complete and publish 4 guidelines (on assessment of cardiovascular risk, lifestyle modifications to reduce cardiovascular risk, management of blood cholesterol in adults, and management of overweight and obesity in adults) to make them available to the widest possible constituency. In 2014, the ACC and AHA in partnership with several other professional societies initiated a guideline on the prevention, detection, evaluation and management of high blood pressure in adults. Under the management of the ACC/AHA Task Force, a Prevention Subcommittee was appointed to help guide development of the suite of guidelines on prevention of cardiovascular disease.

As early as the 1920s, and subsequently in the 1959 Build and Blood Pressure Study[S1-3] of almost 5 million adults insured between 1934 and 1954, a strong direct relationship was noted between level of BP and risk of clinical complications and death. In the 1960s, these findings were confirmed in a series of reports from the Framingham Heart Study.[S1-4] The 1967 and 1970 Veterans Administration Cooperative Study Group reports ushered in the era of effective treatment for high BP.[S1-5,S1-6] The first comprehensive guideline for detection, evaluation, and management of high BP was published in 1977, under the sponsorship of the NHLBI.[S1-7] In subsequent years, a series of Joint National Committee (JNC) BP guidelines were published to assist the practice community and improve prevention, awareness, treatment, and control of high BP.[S1-7–S1-9] The present guideline updates prior JNC reports.

1.1. Methodology and Evidence Review

An extensive evidence review, which included literature derived from research involving human subjects, published in English, and indexed in MEDLINE (through PubMed), EMBASE, the Cochrane Library, the Agency for Healthcare Research and Quality, and other selected databases relevant to this guideline, was conducted between February and August 2015. Key search words included but were not limited to the following: *adherence; aerobic; alcohol intake; ambulatory care; antihypertensive: agents, drug, medication, therapy; beta adrenergic blockers; blood pressure: arterial, control, determination, devices, goal, high, improve, measurement, monitoring, ambulatory; calcium channel blockers; diet; diuretic agent; drug therapy; heart failure: diastolic, systolic; hypertension: white coat, masked, ambulatory, isolated ambulatory, isolated clinic, diagnosis, reverse white coat, prevention, therapy, treatment, control; intervention; lifestyle: measures, modification; office visits; patient outcome; performance measures; physical activity; potassium intake; protein intake; renin inhibitor; risk reduction: behavior, counseling; screening; sphygmomanometers; spironolactone; therapy; treatment: adherence, compliance, efficacy, outcome, protocol, regimen; weight.* Additional relevant studies published through June 2016, during the guideline writing process, were also considered by the writing committee and added to the evidence tables when appropriate. The final evidence tables included in the Online Data Supplement summarize the evidence used by the writing committee to formulate recommendations.

As noted in the preamble, an independent ERC was commissioned to perform a formal systematic review of 4 critical clinical questions related to hypertension (Table 2), the results of which were considered by the writing committee for incorporation into this guideline. Concurrent with this process, writing committee members evaluated other published data relevant to the guideline. The findings of the ERC and the writing committee members were formally presented and discussed, and then guideline recommendations were developed. The systematic review report, "Systematic Review for the 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," is published in conjunction with this guideline,[S1-10] and its respective data supplements are available online. No writing

Table 1. Applying Class of Recommendation and Level of Evidence to Clinical Strategies, Interventions, Treatments, or Diagnostic Testing in Patient Care* (Updated August 2015)

CLASS (STRENGTH) OF RECOMMENDATION	
CLASS I (STRONG)	**Benefit >>> Risk**
Suggested phrases for writing recommendations: ■ Is recommended ■ Is indicated/useful/effective/beneficial ■ Should be performed/administered/other ■ Comparative-Effectiveness Phrases†: ○ Treatment/strategy A is recommended/indicated in preference to treatment B ○ Treatment A should be chosen over treatment B	
CLASS IIa (MODERATE)	**Benefit >> Risk**
Suggested phrases for writing recommendations: ■ Is reasonable ■ Can be useful/effective/beneficial ■ Comparative-Effectiveness Phrases†: ○ Treatment/strategy A is probably recommended/indicated in preference to treatment B ○ It is reasonable to choose treatment A over treatment B	
CLASS IIb (WEAK)	**Benefit ≥ Risk**
Suggested phrases for writing recommendations: ■ May/might be reasonable ■ May/might be considered ■ Usefulness/effectiveness is unknown/unclear/uncertain or not well established	
CLASS III: No Benefit (MODERATE) *(Generally, LOE A or B use only)*	**Benefit = Risk**
Suggested phrases for writing recommendations: ■ Is not recommended ■ Is not indicated/useful/effective/beneficial ■ Should not be performed/administered/other	
CLASS III: Harm (STRONG)	**Risk > Benefit**
Suggested phrases for writing recommendations: ■ Potentially harmful ■ Causes harm ■ Associated with excess morbidity/mortality ■ Should not be performed/administered/other	

LEVEL (QUALITY) OF EVIDENCE‡	
LEVEL A	
■ High-quality evidence‡ from more than 1 RCT ■ Meta-analyses of high-quality RCTs ■ One or more RCTs corroborated by high-quality registry studies	
LEVEL B-R	**(Randomized)**
■ Moderate-quality evidence‡ from 1 or more RCTs ■ Meta-analyses of moderate-quality RCTs	
LEVEL B-NR	**(Nonrandomized)**
■ Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies ■ Meta-analyses of such studies	
LEVEL C-LD	**(Limited Data)**
■ Randomized or nonrandomized observational or registry studies with limitations of design or execution ■ Meta-analyses of such studies ■ Physiological or mechanistic studies in human subjects	
LEVEL C-EO	**(Expert Opinion)**
Consensus of expert opinion based on clinical experience	

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR I and IIa; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

committee member reported a RWI. Drs. Whelton, Wright and Williamson had leadership roles in SPRINT (Systolic Blood Pressure Intervention Trial). Dr. Carey chaired committee discussions in which the SPRINT results were considered.

1.2. Organization of the Writing Committee

The writing committee consisted of clinicians, cardiologists, epidemiologists, internists, an endocrinologist, a geriatrician, a nephrologist, a neurologist, a nurse, a pharmacist, a physician assistant, and 2 lay/patient representatives. It included representatives from the ACC, AHA, American Academy of Physician Assistants (AAPA), Association of Black Cardiologists (ABC), American College of Preventive Medicine (ACPM), American Geriatrics Society (AGS), American Pharmacists Association (APhA), American Society of Hypertension (ASH), American Society for Preventive Cardiology (ASPC), National Medical Association (NMA), and Preventive Cardiovascular Nurses Association (PCNA).

Table 2. Systematic Review Questions on High BP in Adults

Question Number	Question	Section Number
1	Is there evidence that self-directed monitoring of BP and/or ambulatory BP monitoring are superior to office-based measurement of BP by a healthcare worker for 1) preventing adverse outcomes for which high BP is a risk factor and 2) achieving better BP control?	4.2
2	What is the optimal target for BP lowering during antihypertensive therapy in adults?	8.1.5 9.3 9.6
3	In adults with hypertension, do various antihypertensive drug classes differ in their comparative benefits and harms?	8.1.6 8.2
4	In adults with hypertension, does initiating treatment with antihypertensive pharmacological monotherapy versus initiating treatment with 2 drugs (including fixed-dose combination therapy), either of which may be followed by the addition of sequential drugs, differ in comparative benefits and/or harms on specific health outcomes?	8.1.6.1

BP indicates blood pressure.

1.3. Document Review and Approval

This document was reviewed by 2 official reviewers nominated by the ACC and AHA; 1 reviewer each from the AAPA, ABC, ACPM, AGS, APhA, ASH, ASPC NMA, and PCNA; and 38 individual content reviewers. Reviewers' RWI information was distributed to the writing committee and is published in this document (Appendix 2).

This document was approved for publication by the governing bodies of the ACC, AHA, AAPA, ABC, ACPM, AGS, APhA, ASH, ASPC, NMA, and PCNA.

1.4. Scope of the Guideline

The present guideline is intended to be a resource for the clinical and public health practice communities. It is designed to be comprehensive but succinct and practical in providing guidance for prevention, detection, evaluation, and management of high BP. It is an update of the NHLBI publication, "The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure" (JNC 7).[S1-9] It incorporates new information from studies of office-based BP-related risk of CVD, ambulatory blood pressure monitoring (ABPM), home blood pressure monitoring (HBPM), telemedicine, and various other areas. This guideline does not address the use of BP-lowering medications for the purposes of prevention of recurrent CVD events in patients with stable ischemic heart disease (SIHD) or chronic heart failure (HF) in the absence of hypertension; these topics are the focus of other ACC/AHA guidelines.[S1-11,S1-12] In developing the present guideline, the writing committee reviewed prior published guidelines, evidence reviews, and related statements. Table 3 contains a list of publications and statements deemed pertinent to this writing effort and is intended for use as a resource, thus obviating the need to repeat existing guideline recommendations.

1.5. Abbreviations and Acronyms

Abbreviation/ Acronym	Meaning/Phrase
ABPM	ambulatory blood pressure monitoring
ACE	angiotensin-converting enzyme
AF	atrial fibrillation
ARB	angiotensin receptor blocker
BP	blood pressure
CCB	calcium channel blocker
CHD	coronary heart disease
CKD	chronic kidney disease
CPAP	continuous positive airway pressure
CVD	cardiovascular disease
DBP	diastolic blood pressure
DM	diabetes mellitus
ECG	electrocardiogram
ESRD	end-stage renal disease
GDMT	guideline-directed management and therapy
GFR	glomerular filtration rate
HBPM	home blood pressure monitoring
EHR	electronic health record
HF	heart failure
HF*p*EF	heart failure with preserved ejection fraction
HF*r*EF	heart failure with reduced ejection fraction
ICH	intracerebral hemorrhage
JNC	Joint National Commission
LV	left ventricular
LVH	left ventricular hypertrophy
MI	myocardial infarction
MRI	magnetic resonance imaging
PAD	peripheral artery disease
RAS	renin-angiotensin system
RCT	randomized controlled trial
SBP	systolic blood pressure
SIHD	stable ischemic heart disease
TIA	transient ischemic attack

2. BP and CVD Risk

2.1. Observational Relationship

Observational studies have demonstrated graded associations between higher systolic blood pressure (SBP) and diastolic blood pressure (DBP) and increased CVD risk.[S2.1-1,S2.1-2] In a meta-analysis of 61 prospective studies, the risk of CVD increased in a log-linear fashion from SBP levels <115 mm Hg to >180 mm Hg and from DBP levels <75 mm Hg to >105 mm Hg.[S2.1-1] In that analysis, 20 mm Hg higher SBP and 10 mm Hg higher DBP were each associated with a doubling in the risk of death from stroke, heart disease, or other vascular disease. In a separate observational study including >1 million adult patients ≥30 years of age,

Table 3. Associated Guidelines and Statements

Title	Organization	Publication Year
Guidelines		
Lower-extremity peripheral artery disease	AHA/ACC	2016[S1-13]
Management of primary aldosteronism: case detection, diagnosis, and treatment	Endocrine Society	2016[S1-14]
Stable ischemic heart disease	ACC/AHA/AATS/PCNA/SCAI/STS	2014[S1-15]* 2012[S1-11]
Pheochromocytoma and paraganglioma	Endocrine Society	2014[S1-16]
Atrial fibrillation	AHA/ACC/HRS	2014[S1-17]
Valvular heart disease	ACC/AHA	2017[S1-18]
Assessment of cardiovascular risk	ACC/AHA	2013[S1-19]
Hypertension in pregnancy	ACOG	2013[S1-20]
Heart failure	ACC/AHA	2017[S1-21] 2013[S1-12]
Lifestyle management to reduce cardiovascular risk	AHA/ACC	2013[S1-22]
Management of arterial hypertension	ESH/ESC	2013[S1-23]
Management of overweight and obesity in adults	AHA/ACC/TOS	2013[S1-24]
ST-elevation myocardial infarction	ACC/AHA	2013[S1-25]
Treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults	ACC/AHA	2013[S1-26]
Cardiovascular diseases during pregnancy	ESC	2011[S1-27]
Effectiveness-based guidelines for the prevention of cardiovascular disease in women	AHA/ACC	2011[S1-28]
Secondary prevention and risk-reduction therapy for patients with coronary and other atherosclerotic vascular disease	AHA/ACC	2011[S1-29]
Assessment of cardiovascular risk in asymptomatic adults	ACC/AHA	2010[S1-30]
Thoracic aortic disease	ACC/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM	2010[S1-31]
Diagnosis, evaluation, and treatment of high blood pressure in children and adolescents	NHLBI	2004[S1-32]
Statements		
Salt sensitivity of blood pressure	AHA	2016[S1-33]
Cardiovascular team-based care and the role of advanced practice providers	ACC	2015[S1-34]
Treatment of hypertension in patients with coronary artery disease	AHA/ACC/ASH	2015[S1-35]
Ambulatory blood pressure monitoring in children and adolescents	AHA	2014[S1-36]
An effective approach to high blood pressure control	AHA/ACC/CDC	2014[S1-37]
Ambulatory blood pressure monitoring	ESH	2013 [S1-38]
Performance measures for adults with coronary artery disease and hypertension	ACC/AHA/AMA-PCPI	2011[S1-39]
Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults	AHA	2010[S1-40]
Resistant hypertension: diagnosis, evaluation, and treatment	AHA	2008[S1-41]

*The full-text SIHD guideline is from 2012.[S1-11] A focused update was published in 2014.[S1-15]

AATS indicates American Association for Thoracic Surgery; ACC, American College of Cardiology; ACOG, American College of Obstetricians and Gynecologists; ACR, American College of Radiology; AHA, American Heart Association; AMA, American Medical Association; ASA, American Stroke Association; ASH, American Society of Hypertension; CDC, Centers for Disease Control and Prevention; ESC, European Society of Cardiology; ESH, European Society of Hypertension; HRS, Heart Rhythm Society; NHLBI, National Heart, Lung, and Blood Institute; PCNA, Preventive Cardiovascular Nurses Association; PCPI, Physician Consortium for Performance Improvement; SCA, Society of Cardiovascular Anesthesiologists; SCAI, Society for Cardiovascular Angiography and Interventions; SIHD, stable ischemic heart disease; SIR, Society of Interventional Radiology; STS, Society of Thoracic Surgeons; SVM, Society for Vascular Medicine; and TOS, The Obesity Society.

higher SBP and DBP were associated with increased risk of CVD incidence and angina, myocardial infarction (MI), HF, stroke, peripheral artery disease (PAD), and abdominal aortic aneurysm, each evaluated separately.[S2.1-2] An increased risk of CVD associated with higher SBP and DBP has been reported across a broad age spectrum, from 30 years to >80 years of age. Although the relative risk of incident CVD associated with higher SBP and DBP is smaller at older ages,

the corresponding high BP–related increase in absolute risk is larger in older persons (≥65 years) given the higher absolute risk of CVD at an older age.[S2.1-1]

2.2. BP Components

Epidemiological studies have evaluated associations of SBP and DBP, as well as derived components of BP measurements (including pulse pressure, mean BP, and mid-BP), with CVD outcomes (Table 4). When considered separately, higher levels of both SBP and DBP have been associated with increased CVD risk.[S2.2-1,S2.2-2] Higher SBP has consistently been associated with increased CVD risk after adjustment for, or within strata of, DBP.[S2.2-3–S2.2-5] In contrast, after consideration of SBP through adjustment or stratification, DBP has not been consistently associated with CVD risk.[S2.2-6,S2.2-7] Although pulse pressure and mid-BP have been associated with increased CVD risk independent of SBP and DBP in some studies, SBP (especially) and DBP are prioritized in the present document because of the robust evidence base for these measures in both observational studies and clinical trials and because of their ease of measurement in practice settings.[S2.2-8–S2.2-11]

2.3. Population Risk

In 2010, high BP was the leading cause of death and disability-adjusted life years worldwide.[S2.3-1,S2.3-2] In the United States, hypertension (see Section 3.1 for definition) accounted for more CVD deaths than any other modifiable CVD risk factor and was second only to cigarette smoking as a preventable cause of death for any reason.[S2.3-3] In a follow-up study of 23 272 US NHANES (National Health and Nutrition Examination Survey) participants, >50% of deaths from coronary heart disease (CHD) and stroke occurred among individuals with hypertension.[S2.3-4] Because of the high prevalence of hypertension and its associated increased risk of CHD, stroke, and end-stage renal disease (ESRD), the population-attributable risk of these outcomes associated with hypertension is high.[S2.3-4,S2.3-5] In the population-based ARIC (Atherosclerosis Risk in Communities) study, 25% of the cardiovascular events (CHD, coronary revascularization, stroke, or HF) were attributable to hypertension. In the Northern Manhattan study, the percentage of events attributable to hypertension was higher in women (32%) than in men (19%) and higher in blacks (36%) than in whites (21%).[S2.3-6] In 2012, hypertension was the second leading assigned cause of ESRD, behind diabetes mellitus (DM), and accounted for 34% of incident ESRD cases in the US population.[S2.3-7]

Table 4. BP Measurement Definitions

BP Measurement	Definition
SBP	First Korotkoff sound*
DBP	Fifth Korotkoff sound*
Pulse pressure	SBP minus DBP
Mean arterial pressure	DBP plus one third pulse pressure†
Mid-BP	Sum of SBP and DBP, divided by 2

*See Section 4 for a description of Korotkoff sounds.

†Calculation assumes normal heart rate.

BP indicates blood pressure; DBP, diastolic blood pressure; and SBP, systolic blood pressure.

2.4. Coexistence of Hypertension and Related Chronic Conditions

Recommendation for Coexistence of Hypertension and Related Chronic Conditions

References that support the recommendation are summarized in Online Data Supplement 1.

COR	LOE	Recommendation
I	B-NR	1. Screening for and management of other modifiable CVD risk factors are recommended in adults with hypertension.[S2.4-1,S2.4-2]

Table 5. CVD Risk Factors Common in Patients With Hypertension

Modifiable Risk Factors*	Relatively Fixed Risk Factors†
Current cigarette smoking, secondhand smoking	CKD
	Family history
Diabetes mellitus	Increased age
Dyslipidemia/hypercholesterolemia	Low socioeconomic/educational status
Overweight/obesity	Male sex
Physical inactivity/low fitness	Obstructive sleep apnea
Unhealthy diet	Psychosocial stress

*Factors that can be changed and, if changed, may reduce CVD risk.

†Factors that are difficult to change (CKD, low socioeconomic/educational status, obstructive sleep apnea[S2.4-3]), cannot be changed (family history, increased age, male sex), or, if changed through the use of current intervention techniques, may not reduce CVD risk (psychosocial stress).

CKD indicates chronic kidney disease; and CVD, cardiovascular disease.

3. Classification of BP

3.1. Definition of High BP

Recommendation for Definition of High BP

References that support the recommendation are summarized in Online Data Supplement 2.

COR	LOE	Recommendation
I	B-NR	1. BP should be categorized as normal, elevated, or stage 1 or 2 hypertension to prevent and treat high BP (Table 6).[S3.1-1–S3.1-20]

Table 6. Categories of BP in Adults*

BP Category	SBP		DBP
Normal	<120 mm Hg	and	<80 mm Hg
Elevated	120–129 mm Hg	and	<80 mm Hg
Hypertension			
Stage 1	130–139 mm Hg	or	80–89 mm Hg
Stage 2	≥140 mm Hg	or	≥90 mm Hg

*Individuals with SBP and DBP in 2 categories should be designated to the higher BP category.

BP indicates blood pressure (based on an average of ≥2 careful readings obtained on ≥2 occasions, as detailed in Section 4); DBP, diastolic blood pressure; and SBP systolic blood pressure.

3.2. Lifetime Risk of Hypertension

Observational studies have documented a relatively high incidence of hypertension over periods of 5 to 10 years of follow-up.[S3.2-1,S3.2-2] Thus, there is a much higher long-term population burden of hypertension as BP progressively increases with age. Several studies have estimated the long-term cumulative incidence of developing hypertension.[S3.2-3,S3.2-4] In an analysis of 1132 white male medical students (mean age: approximately 23 years at baseline) in the Johns Hopkins Precursors study, 0.3%, 6.5%, and 37% developed hypertension at age 25, 45, and 65 years, respectively.[S3.2-5] In MESA (Multi-Ethnic Study of Atherosclerosis), the percentage of the population developing hypertension over their lifetimes was higher for African Americans and Hispanics than for whites and Asians.[S3.2-3] For adults 45 years of age without hypertension, the 40-year risk of developing hypertension was 93% for African-American, 92% for Hispanic, 86% for white, and 84% for Chinese adults.[S3.2-3] In the Framingham Heart Study, approximately 90% of adults free of hypertension at age 55 or 65 years developed hypertension during their lifetimes.[S3.2-4] All of these estimates were based on use of the 140/90–mm Hg cutpoint for recognition of hypertension and would have been higher had the 130/80–mm Hg cutpoint been used.

3.3. Prevalence of High BP

Table 7. Prevalence of Hypertension Based on 2 SBP/DBP Thresholds*†

	SBP/DBP ≥130/80 mm Hg or Self-Reported Antihypertensive Medication†		SBP/DBP ≥140/90 mm Hg or Self-Reported Antihypertensive Medication‡	
Overall, crude	46%		32%	
	Men (n=4717)	Women (n=4906)	Men (n=4717)	Women (n=4906)
Overall, age-sex adjusted	48%	43%	31%	32%
Age group, y				
20–44	30%	19%	11%	10%
45–54	50%	44%	33%	27%
55–64	70%	63%	53%	52%
65–74	77%	75%	64%	63%
75+	79%	85%	71%	78%
Race-ethnicity§				
Non-Hispanic white	47%	41%	31%	30%
Non-Hispanic black	59%	56%	42%	46%
Non-Hispanic Asian	45%	36%	29%	27%
Hispanic	44%	42%	27%	32%

The prevalence estimates have been rounded to the nearest full percentage.

*130/80 and 140/90 mm Hg in 9623 participants (≥20 years of age) in NHANES 2011–2014.

†BP cutpoints for definition of hypertension in the present guideline.

‡BP cutpoints for definition of hypertension in JNC 7.

§Adjusted to the 2010 age-sex distribution of the US adult population.

BP indicates blood pressure; DBP, diastolic blood pressure; NHANES, National Health and Nutrition Examination Survey; and SBP, systolic blood pressure.

4. Measurement of BP

4.1. Accurate Measurement of BP in the Office

Recommendation for Accurate Measurement of BP in the Office		
COR	**LOE**	**Recommendation**
I	C-EO	1. For diagnosis and management of high BP, proper methods are recommended for accurate measurement and documentation of BP (Table 8).

Table 8. Checklist for Accurate Measurement of BP[S4.1-1,S4.1-2]

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 min. 2. The patient should avoid caffeine, exercise, and smoking for at least 30 min 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 (Table 9). 5. Either the stethoscope diaphragm or bell may be used for auscultatory readings.[S4.1-3,S4.1-4]
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 1–2 min. 3. For auscultatory determinations, use a palpated estimate of radial pulse obliteration pressure to estimate SBP. Inflate the cuff 20–30 mm Hg above this level for an auscultatory determination of the BP level. 4. For auscultatory readings, deflate the cuff pressure 2 mm Hg per second, and listen for Korotkoff sounds.

(*Continued*)

Table 8. Continued

Key Steps for Proper BP Measurements	Specific Instructions
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	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	Provide patients the SBP/DBP readings both verbally and in writing.

*See Section 4.2 for additional guidance.

Adapted with permission from Mancia et al[S4.1-1] (Oxford University Press), Pickering et al[S4.1-5] (American Heart Association, Inc.), and Weir et al[S4.1-2] (American College of Physicians, Inc.).

BP indicates blood pressure; DBP, diastolic blood pressure; and SBP, systolic blood pressure.

4.2. Out-of-Office and Self-Monitoring of BP

Recommendation for Out-of-Office and Self-Monitoring of BP

References that support the recommendation are summarized in Online Data Supplement 3 and Systematic Review Report.

COR	LOE	Recommendation
I	A[SR]	1. Out-of-office BP measurements are recommended to confirm the diagnosis of hypertension (Table 11) and for titration of BP-lowering medication, in conjunction with telehealth counseling or clinical interventions.[S4.2-1–S4.2-4]

SR indicates systematic review.

Table 9. Selection Criteria for BP Cuff Size for Measurement of BP in Adults

Arm Circumference	Usual Cuff Size
22–26 cm	Small adult
27–34 cm	Adult
35–44 cm	Large adult
45–52 cm	Adult thigh

Adapted with permission from Pickering et al[S4.1-5] (American Heart Association, Inc.).

BP indicates blood pressure.

Table 10. Procedures for Use of HBPM[S4.2-5–S4.2-7]

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

(*Continued*)

Table 10. Continued

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 (Table 9).
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 min before BP measurements.
Ensure ≥5 min 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 min 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.

See Table 11 for HBPM targets.

BP indicates blood pressure; and HBPM, home blood pressure monitoring.

4.3. Masked and White Coat Hypertension

Recommendations for Masked and White Coat Hypertension

References that support recommendations are summarized in Online Data Supplements 4, 5, and 6.

COR	LOE	Recommendations
IIa	B-NR	1. In adults with an untreated SBP greater than 130 mm Hg but less than 160 mm Hg or DBP greater than 80 mm Hg but less than 100 mm Hg, it is reasonable to screen for the presence of white coat hypertension by using either daytime ABPM or HBPM before diagnosis of hypertension.[S4.3-1–S4.3-8]
IIa	C-LD	2. In adults with white coat hypertension, periodic monitoring with either ABPM or HBPM is reasonable to detect transition to sustained hypertension.[S4.3-2,S4.3-5,S4.3-7]

Recommendations for Masked and White Coat Hypertension (Continued)		
COR	**LOE**	**Recommendations**
IIa	C- LD	3. In adults being treated for hypertension with office BP readings not at goal and HBPM readings suggestive of a significant white coat effect, confirmation by ABPM can be useful.[S4.3-9,S4.3-10]
IIa	B-NR	4. In adults with untreated office BPs that are consistently between 120 mm Hg and 129 mm Hg for SBP or between 75 mm Hg and 79 mm Hg for DBP, screening for masked hypertension with HBPM (or ABPM) is reasonable.[S4.3-3,S4.3-4,S4.3-6,S4.3-8,S4.3-11]
IIb	C-LD	5. In adults on multiple-drug therapies for hypertension and office BPs within 10 mm Hg above goal, it may be reasonable to screen for white coat effect with HBPM (or ABPM).[S4.3-3,S4.3-7,S4.3-12]
IIb	C-EO	6. It may be reasonable to screen for masked uncontrolled hypertension with HBPM in adults being treated for hypertension and office readings at goal, in the presence of target organ damage or increased overall CVD risk.
IIb	C-EO	7. In adults being treated for hypertension with elevated HBPM readings suggestive of masked uncontrolled hypertension, confirmation of the diagnosis by ABPM might be reasonable before intensification of antihypertensive drug treatment.

Table 11. 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

ABPM indicates ambulatory blood pressure monitoring; BP, blood pressure; DBP, diastolic blood pressure; HBPM, home blood pressure monitoring; and SBP, systolic blood pressure.

Table 12. BP Patterns Based on Office and Out-of-Office Measurements

	Office/Clinic/ Healthcare Setting	Home/Nonhealthcare/ ABPM Setting
Normotensive	No hypertension	No hypertension
Sustained hypertension	Hypertension	Hypertension
Masked hypertension	No hypertension	Hypertension
White coat hypertension	Hypertension	No hypertension

ABPM indicates ambulatory blood pressure monitoring; and BP, blood pressure.

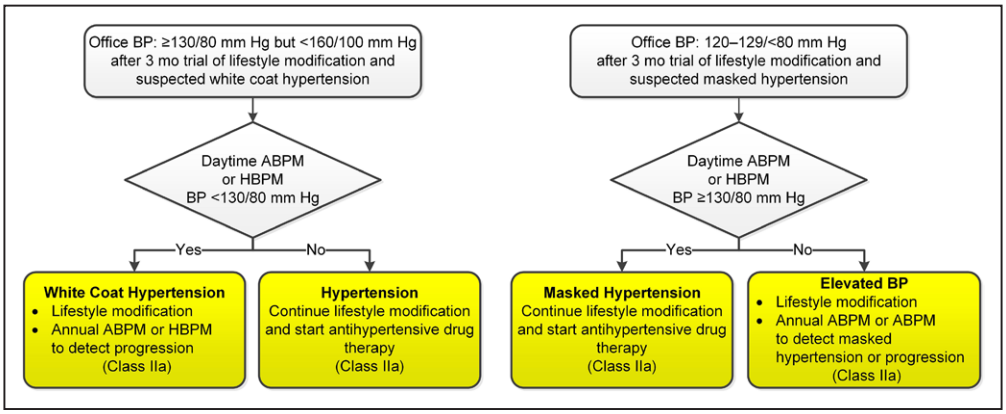

Figure 1. Detection of white coat hypertension or masked hypertension in patients not on drug therapy. Colors correspond to Class of Recommendation in Table 1. ABPM indicates ambulatory blood pressure monitoring; BP, blood pressure; and HBPM, home blood pressure monitoring.

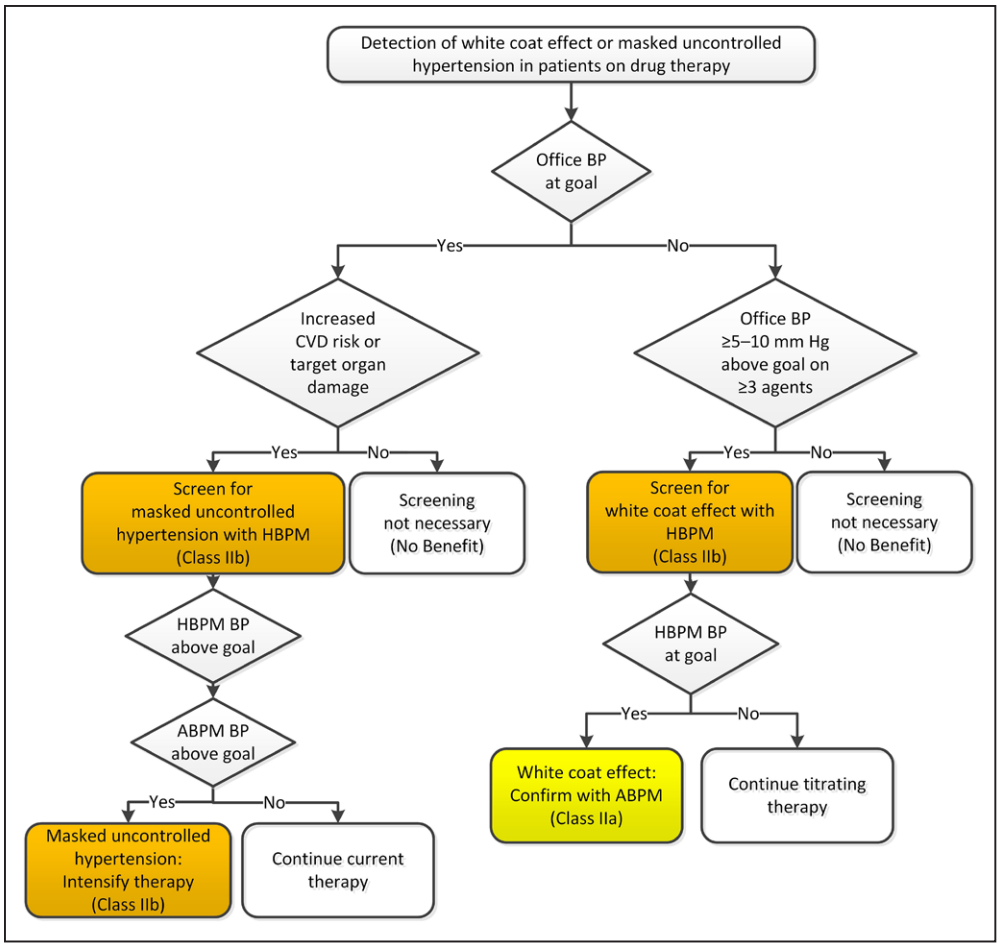

Figure 2. Detection of white coat effect or masked uncontrolled hypertension in patients on drug therapy. Colors correspond to Class of Recommendation in Table 1. See Section 8 for treatment options. ABPM indicates ambulatory blood pressure monitoring; BP, blood pressure; CVD, cardiovascular disease; and HBPM, home blood pressure monitoring.

5. Causes of Hypertension

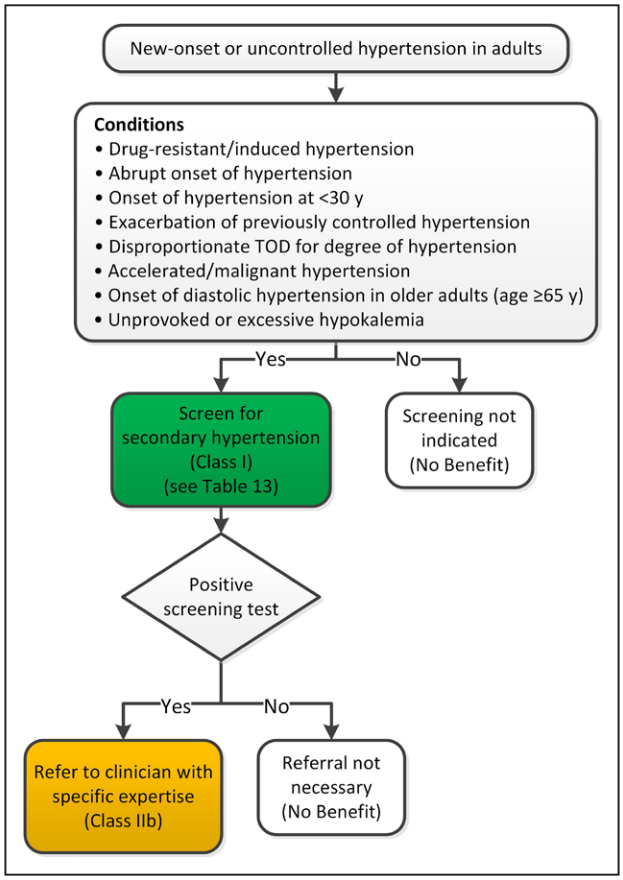

Figure 3. Screening for secondary hypertension. Colors correspond to Class of Recommendation in Table 1. TOD indicates target organ damage (eg, cerebrovascular disease, hypertensive retinopathy, left ventricular hypertrophy, left ventricular dysfunction, heart failure, coronary artery disease, chronic kidney disease, albuminuria, peripheral artery disease).

5.1. Secondary Forms of Hypertension

Recommendations for Secondary Forms of Hypertension		
COR	**LOE**	**Recommendations**
I	C-EO	1. Screening for specific form(s) of secondary hypertension is recommended when the clinical indications and physical examination findings listed in Table 13 are present or in adults with resistant hypertension.
IIb	C-EO	2. If an adult with sustained hypertension screens positive for a form of secondary hypertension, referral to a physician with expertise in that form of hypertension may be reasonable for diagnostic confirmation and treatment.

Table 13. Causes of Secondary Hypertension With Clinical Indications and Diagnostic Screening Tests

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/Confirmatory Tests
Common causes					
Renal parenchymal disease[S5.1-1,S5.1-2]	1%–2%	Urinary tract infections; obstruction, hematuria; urinary frequency and nocturia; analgesic abuse; family history of polycystic kidney disease; elevated serum creatinine; abnormal urinalysis	Abdominal mass (polycystic kidney disease); skin pallor	Renal ultrasound	Tests to evaluate cause of renal disease
Renovascular disease[S5.1-3]	5%–34%*	Resistant hypertension; hypertension of abrupt onset or worsening or increasingly difficult to control; flash pulmonary edema (atherosclerotic); early-onset hypertension, especially in women (fibromuscular hyperplasia)	Abdominal systolic-diastolic bruit; bruits over other arteries (carotid – atherosclerotic or fibromuscular dysplasia), femoral	Renal Duplex Doppler ultrasound; MRA; abdominal CT	Bilateral selective renal intra-arterial angiography

(*Continued*)

Table 13. Continued

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/Confirmatory Tests
Common causes (Continued)					
Primary aldosteronism[S5.1-4,S5.1-5]	8%–20%†	Resistant hypertension; hypertension with hypokalemia (spontaneous or diuretic induced); hypertension and muscle cramps or weakness; hypertension and incidentally discovered adrenal mass; hypertension and obstructive sleep apnea; hypertension and family history of early-onset hypertension or stroke	Arrhythmias (with hypokalemia); especially atrial fibrillation	Plasma aldosterone/renin ratio under standardized conditions (correction of hypokalemia and withdrawal of aldosterone antagonists for 4–6 wk)	Oral sodium loading test (with 24-h urine aldosterone) or IV saline infusion test with plasma aldosterone at 4 h of infusion Adrenal CT scan, adrenal vein sampling.
Obstructive sleep apnea[S5.1-6]‡	25%–50%	Resistant hypertension; snoring; fitful sleep; breathing pauses during sleep; daytime sleepiness	Obesity, Mallampati class III–IV; loss of normal nocturnal BP fall	Berlin Questionnaire;[S5.1-7] Epworth Sleepiness Score;[S5.1-8] overnight oximetry	Polysomnography
Drug or alcohol induced[S5.1-9]§	2%–4%	Sodium-containing antacids; caffeine; nicotine (smoking); alcohol; NSAIDs; oral contraceptives; cyclosporine or tacrolimus; sympathomimetics (decongestants, anorectics); cocaine, amphetamines and other illicit drugs; neuropsychiatric agents; erythropoiesis-stimulating agents; clonidine withdrawal; herbal agents (Ma Huang, ephedra)	Fine tremor, tachycardia, sweating (cocaine, ephedrine, MAO inhibitors); acute abdominal pain (cocaine)	Urinary drug screen (illicit drugs)	Response to withdrawal of suspected agent
Uncommon causes					
Pheochromocytoma/paraganglioma[S5.1-10]	0.1%–0.6%	Resistant hypertension; paroxysmal hypertension or crisis superimposed on sustained hypertension; "spells," BP lability, headache, sweating, palpitations, pallor; positive family history of pheochromocytoma/paraganglioma; adrenal incidentaloma	Skin stigmata of neurofibromatosis (café-au-lait spots; neurofibromas); Orthostatic hypotension	24-h urinary fractionated metanephrines or plasma metanephrines under standard conditions (supine position with indwelling IV cannula)	CT or MRI scan of abdomen/pelvis
Cushing's syndrome[S5.1-11]	<0.1%	Rapid weight gain, especially with central distribution; proximal muscle weakness; depression; hyperglycemia	Central obesity, "moon" face, dorsal and supraclavicular fat pads, wide (1-cm) violaceous striae, hirsutism	Overnight 1-mg dexamethasone suppression test	24-h urinary free cortisol excretion (preferably multiple); midnight salivary cortisol
Hypothyroidism[S5.1-9]	<1%	Dry skin; cold intolerance; constipation; hoarseness; weight gain	Delayed ankle reflex; periorbital puffiness; coarse skin; cold skin; slow movement; goiter	Thyroid-stimulating hormone; free thyroxine	None
Hyperthyroidism[S5.1-9]	<1%	Warm, moist skin; heat intolerance; nervousness; tremulousness; insomnia; weight loss; diarrhea; proximal muscle weakness	Lid lag; fine tremor of the outstretched hands; warm, moist skin	Thyroid-stimulating hormone; free thyroxine	Radioactive iodine uptake and scan
Aortic coarctation (undiagnosed or repaired)[S5.1-12]	0.1%	Young patient with hypertension (<30 y of age)	BP higher in upper extremities than in lower extremities; absent femoral pulses; continuous murmur over patient's back, chest, or abdominal bruit; left thoracotomy scar (postoperative)	Echocardiogram	Thoracic and abdominal CT angiogram or MRA

(*Continued*)

Table 13. Continued

	Prevalence	Clinical Indications	Physical Examination	Screening Tests	Additional/Confirmatory Tests
Uncommon Causes (Continued)					
Primary hyperparathyroidism[S5.1-13]	Rare	Hypercalcemia	Usually none	Serum calcium	Serum parathyroid hormone
Congenital adrenal hyperplasia[S5.1-14]	Rare	Hypertension and hypokalemia; virilization (11-beta-hydroxylase deficiency [11-beta-OH]); incomplete masculinization in males and primary amenorrhea in females (17-alpha-hydroxylase deficiency [17-alpha-OH])	Signs of virilization (11-beta-OH) or incomplete masculinization (17-alpha-OH)	Hypertension and hypokalemia with low or normal aldosterone and renin	11-beta-OH: elevated deoxycorticosterone (DOC), 11-deoxycortisol, and androgens17-alpha-OH; decreased androgens and estrogen; elevated deoxycorticosterone and corticosterone
Mineralocorticoid excess syndromes other than primary aldosteronism[S5.1-14]	Rare	Early-onset hypertension; resistant hypertension; hypokalemia or hyperkalemia	Arrhythmias (with hypokalemia)	Low aldosterone and renin	Urinary cortisol metabolites; genetic testing
Acromegaly[S5.1-15]	Rare	Acral features, enlarging shoe, glove, or hat size; headache, visual disturbances; diabetes mellitus	Acral features; large hands and feet; frontal bossing	Serum growth hormone ≥1 ng/mL during oral glucose load	Elevated age- and sex-matched IGF-1 level; MRI scan of the pituitary

*Depending on the clinical situation (hypertension alone, 5%; hypertension starting dialysis, 22%; hypertension and peripheral vascular disease, 28%; hypertension in the elderly with congestive heart failure, 34%).

†8% in general population with hypertension; up to 20% in patients with resistant hypertension.

‡Although obstructive sleep apnea is listed as a cause of secondary hypertension, RCTs on the effects of continuous positive airway pressure on lowering BP in patients with hypertension have produced mixed results (see Section 5.4.4 for details).

§For a list of frequently used drugs causing hypertension and accompanying evidence, see Table 14.

BP indicates blood pressure; CT, computed tomography; DOC, 11-deoxycorticosterone; IGF-1, insulin-like growth factor-1; IV, intravenous; MAO, monamine oxidase; MRI, magnetic resonance imaging; MRA, magnetic resonance arteriography; NSAIDs, nonsteroidal anti-inflammatory drugs; OH, hydroxylase; and RCT, randomized clinical trial.

5.1.1. Drugs and Other Substances With Potential to Impair BP Control

5.1.2. Primary Aldosteronism

Recommendations for Primary Aldosteronism

COR	LOE	Recommendations
I	C-EO	1. In adults with hypertension, screening for primary aldosteronism is recommended in the presence of any of the following concurrent conditions: resistant hypertension, hypokalemia (spontaneous or substantial, if diuretic induced), incidentally discovered adrenal mass, family history of early-onset hypertension, or stroke at a young age (<40 years).
I	C-LD	2. Use of the plasma aldosterone: renin activity ratio is recommended when adults are screened for primary aldosteronism.[S5.1.2-1]
I	C-EO	3. In adults with hypertension and a positive screening test for primary aldosteronism, referral to a hypertension specialist or endocrinologist is recommended for further evaluation and treatment.

5.1.3. Renal Artery Stenosis

Recommendations for Renal Artery Stenosis

References that support recommendations are summarized in Online Data Supplements 7 and 24.

COR	LOE	Recommendations
I	A	1. Medical therapy is recommended for adults with atherosclerotic renal artery stenosis.[S5.1.3-1,S5.1.3-2]
IIb	C-EO	2. In adults with renal artery stenosis for whom medical management has failed (refractory hypertension, worsening renal function, and/or intractable HF) and those with nonatherosclerotic disease, including fibromuscular dysplasia, it may be reasonable to refer the patient for consideration of revascularization (percutaneous renal artery angioplasty and/or stent placement).

Table 14. Frequently Used Medications and Other Substances That May Cause Elevated BP*

Agent	Possible Management Strategy
Alcohol	Limit alcohol to ≤1 drink daily for women and ≤2 drinks for men[S5.1.1-1]
Amphetamines (eg, amphetamine, methylphenidate dexmethylphenidate, dextroamphetamine)	Discontinue or decrease dose[S5.1.1-2] Consider behavioral therapies for ADHD[S5.1.1-3]
Antidepressants (eg, MAOIs, SNRIs, TCAs)	Consider alternative agents (eg, SSRIs) depending on indication Avoid tyramine-containing foods with MAOIs
Atypical antipsychotics (eg, clozapine, olanzapine)	Discontinue or limit use when possible Consider behavior therapy where appropriate Recommend lifestyle modification (see Section 6.2) Consider alternative agents associated with lower risk of weight gain, diabetes mellitus, and dyslipidemia (eg, aripiprazole, ziprasidone)[S5.1.1-4,S5.1.1-5]
Caffeine	Generally limit caffeine intake to <300 mg/d Avoid use in patients with uncontrolled hypertension Coffee use in patients with hypertension is associated with acute increases in BP; long-term use is not associated with increased BP or CVD[S5.1.1-6]
Decongestants (eg, phenylephrine, pseudoephedrine)	Use for shortest duration possible, and avoid in severe or uncontrolled hypertension Consider alternative therapies (eg, nasal saline, intranasal corticosteroids, antihistamines) as appropriate
Herbal supplements (eg, Ma Huang [ephedra], St. John's wort [with MAO inhibitors, yohimbine])	Avoid use
Immunosuppressants (eg, cyclosporine)	Consider converting to tacrolimus, which may be associated with fewer effects on BP[S5.1.1-7–S5.1.1-9]
Oral contraceptives	Use low-dose (eg, 20–30 mcg ethinyl estradiol) agents[S5.1.1-10] or a progestin-only form of contraception, or consider alternative forms of birth control where appropriate (eg, barrier, abstinence, IUD) Avoid use in women with uncontrolled hypertension[S5.1.1-10]
NSAIDs	Avoid systemic NSAIDs when possible Consider alternative analgesics (eg, acetaminophen, tramadol, topical NSAIDs), depending on indication and risk
Recreational drugs (eg, "bath salts" [MDPV], cocaine, methamphetamine, etc.)	Discontinue or avoid use
Systemic corticosteroids (eg, dexamethasone, fludrocortisone, methylprednisolone, prednisone, prednisolone)	Avoid or limit use when possible Consider alternative modes of administration (eg, inhaled, topical) when feasible
Angiogenesis inhibitor (eg, bevacizumab) and tyrosine kinase inhibitors (eg, sunitinib, sorafenib)	Initiate or intensify antihypertensive therapy

*List is not all inclusive.

ADHD indicates attention-deficit/hyperactivity disorder; BP, blood pressure; CVD, cardiovascular disease; IUD, intra-uterine device; MAOI, monoamine-oxidase inhibitors; MDPV, methylenedioxypyrovalerone; NSAIDs, nonsteroidal anti-inflammatory drugs; SNRI, serotonin norepinephrine reuptake inhibitor; SSRI, selective serotonin reuptake inhibitor; and TCA, tricyclic antidepressant.

5.1.4. Obstructive Sleep Apnea

Recommendation for Obstructive Sleep Apnea

References that support the recommendation are summarized in Online Data Supplement 8.

COR	LOE	Recommendation
IIb	B-R	1. In adults with hypertension and obstructive sleep apnea, the effectiveness of continuous positive airway pressure (CPAP) to reduce BP is not well established.[S5.1.4-1–S5.1.4-5]

6. Nonpharmacological Interventions

Recommendations for Nonpharmacological Interventions

References that support recommendations are summarized in Online Data Supplements 9-21.

COR	LOE	Recommendations
I	A	1. Weight loss is recommended to reduce BP in adults with elevated BP or hypertension who are overweight or obese.[S6-1–S6-4]
I	A	2. A heart-healthy diet, such as the DASH (Dietary Approaches to Stop Hypertension) diet, that facilitates achieving a desirable weight is recommended for adults with elevated BP or hypertension.[S6-5–S6-7]
I	A	3. Sodium reduction is recommended for adults with elevated BP or hypertension.[S6-8–S6-12]

Recommendations for Nonpharmacological Interventions (Continued)		
COR	**LOE**	**Recommendations**
I	A	4. Potassium supplementation, preferably in dietary modification, is recommended for adults with elevated BP or hypertension, unless contraindicated by the presence of CKD or use of drugs that reduce potassium excretion.[S6-13–S6-17]
I	A	5. Increased physical activity with a structured exercise program is recommended for adults with elevated BP or hypertension.[S6-3,S6-4,S6-12,S6-18–S6-22]
I	A	6. Adult men and women with elevated BP or hypertension who currently consume alcohol should be advised to drink no more than 2 and 1 standard drinks* per day, respectively.[S6-23–S6-28]

*In the United States, 1 "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).[S6-29]

Table 15. Best Proven Nonpharmacological Interventions for Prevention and Treatment of Hypertension*

	Nonpharmacological 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 mm Hg for every 1-kg reduction in body weight.	–5 mm Hg	–2/3 mm Hg	S6-1
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 mm Hg	–3 mm Hg	S6-6,S6-7
Reduced intake of dietary sodium	Dietary sodium	Optimal goal is <1500 mg/d, but aim for at least a 1000-mg/d reduction in most adults.	–5/6 mm Hg	–2/3 mm Hg	S6-9,S6-10
Enhanced intake of dietary potassium	Dietary potassium	Aim for 3500–5000 mg/d, preferably by consumption of a diet rich in potassium.	–4/5 mm Hg	–2 mm Hg	S6-13
Physical activity	Aerobic	90–150 min/wk 65%–75% heart rate reserve	–5/8 mm Hg	–2/4 mm Hg	S6-18,S6-22
	Dynamic resistance	90–150 min/wk 50%–80% 1 rep maximum 6 exercises, 3 sets/exercise, 10 repetitions/set	–4 mm Hg	–2 mm Hg	S6-18
	Isometric resistance	4 × 2 min (hand grip), 1 min rest between exercises, 30%–40% maximum voluntary contraction, 3 sessions/wk 8–10 wk	–5 mm Hg	–4 mm Hg	S6-19,S6-30
Moderation in alcohol intake	Alcohol consumption	In individuals who drink alcohol, reduce alcohol† to: Men: ≤2 drinks daily Women: ≤1 drink daily	–4 mm Hg	–3 mm Hg	S6-22–S6-24

Resources: Your Guide to Lowering Your Blood Pressure With DASH—How Do I Make the DASH? Available at: https://www.nhlbi.nih.gov/health/resources/heart/hbp-dash-how-to. Accessed September 15, 2017.[S6-31]

Top 10 Dash Diet Tips. Available at: http://dashdiet.org/dash_diet_tips.asp. Accessed September 15, 2017.[S6-32]

*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).[S6-29]

DASH indicates Dietary Approaches to Stop Hypertension; and SBP, systolic blood pressure.

7. Patient Evaluation

Table 16. Historical Features Favoring Hypertension Cause

Primary Hypertension	Secondary Hypertension
Gradual increase in BP, with slow rate of rise in BP	BP lability, episodic pallor and dizziness (pheochromocytoma)
Lifestyle factors that favor higher BP (eg, weight gain, high-sodium diet, decreased physical activity, job change entailing increased travel, excessive consumption of alcohol)	Snoring, hypersomnolence (obstructive sleep apnea)
	Prostatism (chronic kidney disease due to post-renal urinary tract obstruction)
Family history of hypertension	Muscle cramps, weakness (hypokalemia from primary aldosteronism or secondary aldosteronism due to renovascular disease)
	Weight loss, palpitations, heat intolerance (hyperthyroidism)
	Edema, fatigue, frequent urination (kidney disease or failure)
	History of coarctation repair (residual hypertension associated with coarctation)
	Central obesity, facial rounding, easy bruisability (Cushing's syndrome)
	Medication or substance use (eg, alcohol, NSAIDS, cocaine, amphetamines)
	Absence of family history of hypertension

BP indicates blood pressure; and NSAIDs, nonsteroidal anti-inflammatory drugs.

7.1. Laboratory Tests and Other Diagnostic Procedures

Table 17. Basic and Optional Laboratory Tests for Primary Hypertension

Basic testing	Fasting blood glucose*
	Complete blood count
	Lipid profile
	Serum creatinine with eGFR*
	Serum sodium, potassium, calcium*
	Thyroid-stimulating hormone
	Urinalysis
	Electrocardiogram
Optional testing	Echocardiogram
	Uric acid
	Urinary albumin to creatinine ratio

*May be included in a comprehensive metabolic panel.
eGFR indicates estimated glomerular filtration rate.

8. Treatment of High BP

8.1. Pharmacological Treatment

8.1.1. Initiation of Pharmacological BP Treatment in the Context of Overall CVD Risk

For any specific difference in BP, the relative risk of CVD is constant across groups that differ in absolute risk of atherosclerotic CVD,[S8.1.1-1–S8.1.1-4] albeit with some evidence of lesser relative risk but greater excess risk in older than in younger adults.[S8.1.1-5–S8.1.1-8] Thus, there are more potentially preventable CVD events attributable to elevated BP in individuals with higher than with lower risk of CVD and in older than in younger adults. The relative risk reduction for CVD prevention with use of BP-lowering medications is fairly constant for groups that differ in CVD risk across a wide range of estimated absolute risk [S8.1.1-9,S8.1.1-10] and across groups defined by sex, age, body mass index, and the presence or absence of DM, AF, and CKD.[S8.1.1-5,S8.1.1-11–S8.1.1-21] As a consequence, the absolute CVD risk reduction attributable to BP lowering is greater at greater absolute levels of CVD risk.[S8.1.1-9,S8.1.1-10,S8.1.1-12,S8.1.1-15–S8.1.1-19,S8.1.1-22,S8.1.1-23] Put another way, for a given magnitude of BP reduction due to antihypertensive medications, fewer individuals at high CVD risk would need to be treated to prevent a CVD event (ie, lower number needed to treat) than those at low CVD risk.

8.1.2. BP Treatment Threshold and the Use of CVD Risk Estimation to Guide Drug Treatment of Hypertension

Recommendations for BP Treatment Threshold and Use of Risk Estimation* to Guide Drug Treatment of Hypertension

References that support recommendations are summarized in Online Data Supplement 23.

COR	LOE	Recommendations
I	SBP: A	1. Use of BP-lowering medications is recommended for secondary prevention of recurrent CVD events in patients with clinical CVD and an average SBP of 130 mm Hg or higher or an average DBP of 80 mm Hg or higher, and for primary prevention in adults with an estimated 10-year atherosclerotic cardiovascular disease (ASCVD) risk of 10% or higher and an average SBP 130 mm Hg or higher or an average DBP 80 mm Hg or higher.[S8.1.2-1–S8.1.2-9]
	DBP: C-EO	
I	C-LD	2. Use of BP-lowering medication is recommended for primary prevention of CVD in adults with no history of CVD and with an estimated 10-year ASCVD risk <10% and an SBP of 140 mm Hg or higher or a DBP of 90 mm Hg or higher.[S8.1.2-3,S8.1.2-10–S8.1.2-13]

*ACC/AHA Pooled Cohort Equations (http://tools.acc.org/ASCVD-Risk-Estimator/)[S8.1.2-13a] to estimate 10-year risk of atherosclerotic CVD. ASCVD was defined as a first CHD death, non-fatal MI or fatal or non-fatal stroke.

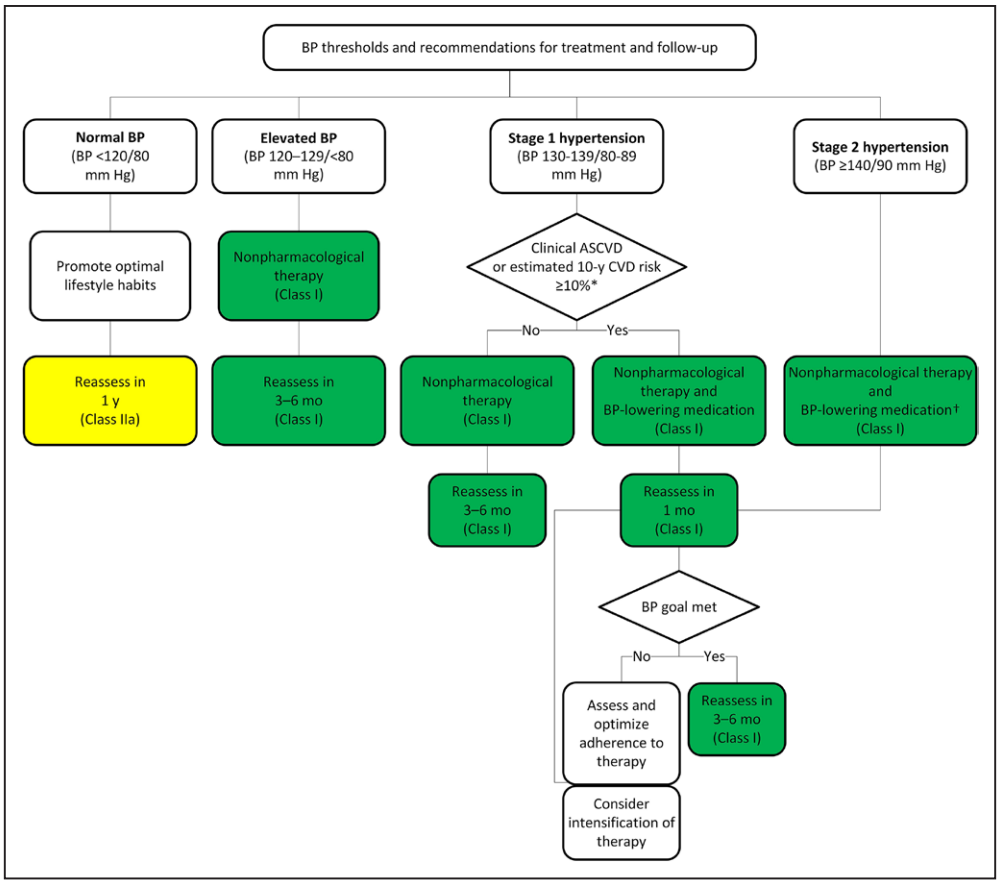

Figure 4. Blood Pressure (BP) thresholds and recommendations for treatment and follow-up. Colors correspond to Class of Recommendation in Table 1. *Using the ACC/AHA Pooled Cohort Equations.[S8.1.2-14,S8.1.2-15] Note that patients with DM or CKD are automatically placed in the high-risk category. For initiation of RAS inhibitor or diuretic therapy, assess blood tests for electrolytes and renal function 2 to 4 weeks after initiating therapy. †Consider initiation of pharmacological therapy for stage 2 hypertension with 2 antihypertensive agents of different classes. Patients with stage 2 hypertension and BP ≥160/100 mm Hg should be promptly treated, carefully monitored, and subject to upward medication dose adjustment as necessary to control BP. Reassessment includes BP measurement, detection of orthostatic hypotension in selected patients (eg, older or with postural symptoms), identification of white coat hypertension or a white coat effect, documentation of adherence, monitoring of the response to therapy, reinforcement of the importance of adherence, reinforcement of the importance of treatment, and assistance with treatment to achieve BP target. ACC indicates American College of Cardiology; AHA, American Heart Association; ASCVD, atherosclerotic cardiovascular disease; BP, blood pressure; CKD, chronic kidney disease; DM, diabetes mellitus; and RAS, renin-angiotensin system.

8.1.3. Follow-Up After Initial BP Evaluation

Recommendations for Follow-Up After Initial BP Evaluation

References that support recommendations are summarized in Online Data Supplement 24.

COR	LOE	Recommendations
I	B-R	1. Adults with an elevated BP or stage 1 hypertension who have an estimated 10-year ASCVD risk less than 10% should be managed with nonpharmacological therapy and have a repeat BP evaluation within 3 to 6 months.[S8.1.3-1,S8.1.3-2]
I	B-R	2. Adults with stage 1 hypertension who have an estimated 10-year ASCVD risk of 10% or higher should be managed initially with a combination of nonpharmacological and antihypertensive drug therapy and have a repeat BP evaluation in 1 month.[S8.1.3-1,S8.1.3-2]

Recommendations for Follow-Up After Initial BP Evaluation (Continued)

COR	LOE	Recommendations
I	B-R	3. Adults with stage 2 hypertension should be evaluated by or referred to a primary care provider within 1 month of the initial diagnosis, have a combination of nonpharmacological and antihypertensive drug therapy (with 2 agents of different classes) initiated, and have a repeat BP evaluation in 1 month.[S8.1.3-1,S8.1.3-2]
I	B-R	4. For adults with a very high average BP (eg, SBP ≥180 mm Hg or DBP ≥110 mm Hg), evaluation followed by prompt antihypertensive drug treatment is recommended.[S8.1.3-1,S8.1.3-2]
IIa	C-EO	5. For adults with a normal BP, repeat evaluation every year is reasonable.

8.1.4. General Principles of Drug Therapy

Recommendation for General Principle of Drug Therapy References that support recommendations are summarized in Online Data Supplement 25.		
COR	**LOE**	**Recommendation**
III: Harm	A	1. Simultaneous use of an ACE inhibitor, ARB, and/or renin inhibitor is potentially harmful and is not recommended to treat adults with hypertension.[S8.1.4-1–S8.1.4-3]

Table 18. Oral Antihypertensive Drugs

Class	Drug	Usual Dose, Range (mg/d)*	Daily Frequency	Comments
Primary agents				
Thiazide or thiazide-type diuretics	Chlorthalidone	12.5–25	1	Chlorthalidone is preferred on the basis of prolonged half-life and proven trial reduction of CVD. Monitor for hyponatremia and hypokalemia, uric acid and calcium levels. Use with caution in patients with history of acute gout unless patient is on uric acid–lowering therapy.
	Hydrochlorothiazide	25–50	1	
	Indapamide	1.25–2.5	1	
	Metolazone	2.5–5	1	
ACE inhibitors	Benazepril	10–40	1 or 2	Do not use in combination with ARBs or direct renin inhibitor. There is an increased risk of hyperkalemia, especially in patients with CKD or in those on K^+ supplements or K^+-sparing drugs. There is a risk of acute renal failure in patients with severe bilateral renal artery stenosis. Do not use if patient has history of angioedema with ACE inhibitors. Avoid in pregnancy.
	Captopril	12.5–150	2 or 3	
	Enalapril	5–40	1 or 2	
	Fosinopril	10–40	1	
	Lisinopril	10–40	1	
	Moexipril	7.5–30	1 or 2	
	Perindopril	4–16	1	
	Quinapril	10–80	1 or 2	
	Ramipril	2.5–20	1 or 2	
	Trandolapril	1–4	1	
ARBs	Azilsartan	40–80	1	Do not use in combination with ACE inhibitors or direct renin inhibitor. There is an increased risk of hyperkalemia in CKD or in those on K^+ supplements or K^+-sparing drugs. There is a risk of acute renal failure in patients with severe bilateral renal artery stenosis. Do not use if patient has history of angioedema with ARBs. Patients with a history of angioedema with an ACE inhibitor can receive an ARB beginning 6 weeks after ACE inhibitor is discontinued. Avoid in pregnancy.
	Candesartan	8–32	1	
	Eprosartan	600–800	1 or 2	
	Irbesartan	150–300	1	
	Losartan	50–100	1 or 2	
	Olmesartan	20–40	1	
	Telmisartan	20–80	1	
	Valsartan	80–320	1	
CCB—dihydropyridines	Amlodipine	2.5–10	1	Avoid use in patients with HF*r*EF; amlodipine or felodipine may be used if required. They are associated with dose-related pedal edema, which is more common in women than men.
	Felodipine	2.5–10	1	
	Isradipine	5–10	2	
	Nicardipine SR	60–120	2	
	Nifedipine LA	30–90	1	
	Nisoldipine	17–34	1	
CCB—nondihydropyridines	Diltiazem ER	120–360	1	Avoid routine use with beta blockers because of increased risk of bradycardia and heart block. Do not use in patients with HF*r*EF. There are drug interactions with diltiazem and verapamil (*CYP3A4* major substrate and moderate inhibitor).
	Verapamil IR	120-360	3	
	Verapamil SR	120–360	1 or 2	
	Verapamil-delayed onset ER	100–300	1 (in the evening)	

(*Continued*)

Table 18. Continued

Class	Drug	Usual Dose, Range (mg/d)*	Daily Frequency	Comments
Secondary agents				
Diuretics—loop	Bumetanide	0.5–2	2	These are preferred diuretics in patients with symptomatic HF. They are preferred over thiazides in patients with moderate-to-severe CKD (eg, GFR <30 mL/min).
	Furosemide	20–80	2	
	Torsemide	5–10	1	
Diuretics—potassium sparing	Amiloride	5–10	1 or 2	These are monotherapy agents and minimally effective antihypertensive agents. Combination therapy of potassium-sparing diuretic with a thiazide can be considered in patients with hypokalemia on thiazide monotherapy. Avoid in patients with significant CKD (eg, GFR <45 mL/min).
	Triamterene	50–100	1 or 2	
Diuretics—aldosterone antagonists	Eplerenone	50–100	1 or 2	These are preferred agents in primary aldosteronism and resistant hypertension. Spironolactone is associated with greater risk of gynecomastia and impotence as compared with eplerenone. This is common add-on therapy in resistant hypertension. Avoid use with K^+ supplements, other K^+-sparing diuretics, or significant renal dysfunction. Eplerenone often requires twice-daily dosing for adequate BP lowering.
	Spironolactone	25–100	1	
Beta blockers—cardioselective	Atenolol	25–100	2	Beta blockers are not recommended as first-line agents unless the patient has IHD or HF. These are preferred in patients with bronchospastic airway disease requiring a beta blocker. Bisoprolol and metoprolol succinate are preferred in patients with HFrEF. Avoid abrupt cessation.
	Betaxolol	5–20	1	
	Bisoprolol	2.5–10	1	
	Metoprolol tartrate	100–200	2	
	Metoprolol succinate	50–200	1	
Beta blockers—cardioselective and vasodilatory	Nebivolol	5–40	1	Nebivolol induces nitric oxide–induced vasodilation. Avoid abrupt cessation.
Beta blockers—noncardioselective	Nadolol	40–120	1	Avoid in patients with reactive airways disease. Avoid abrupt cessation.
	Propranolol IR	80–160	2	
	Propranolol LA	80–160	1	
Beta blockers—intrinsic sympathomimetic activity	Acebutolol	200–800	2	Generally avoid, especially in patients with IHD or HF. Avoid abrupt cessation.
	Penbutolol	10–40	1	
	Pindolol	10–60	2	
Beta blockers—combined alpha- and beta-receptor	Carvedilol	12.5–50	2	Carvedilol is preferred in patients with HFrEF. Avoid abrupt cessation.
	Carvedilol phosphate	20–80	1	
	Labetalol	200–800	2	
Direct renin inhibitor	Aliskiren	150–300	1	Do not use in combination with ACE inhibitors or ARBs. Aliskiren is very long acting. There is an increased risk of hyperkalemia in CKD or in those on K^+ supplements or K^+-sparing drugs. Aliskiren may cause acute renal failure in patients with severe bilateral renal artery stenosis. Avoid in pregnancy.
Alpha-1 blockers	Doxazosin	1–16	1	These are associated with orthostatic hypotension, especially in older adults. They may be considered as second-line agent in patients with concomitant BPH.
	Prazosin	2–20	2 or 3	
	Terazosin	1–20	1 or 2	
Central $alpha_2$-agonist and other centrally acting drugs	Clonidine oral	0.1–0.8	2	These are generally reserved as last-line because of significant CNS adverse effects, especially in older adults. Avoid abrupt discontinuation of clonidine, which may induce hypertensive crisis; clonidine must be tapered to avoid rebound hypertension.
	Clonidine patch	0.1–0.3	1 weekly	
	Methyldopa	250–1000	2	
	Guanfacine	0.5–2	1	

(*Continued*)

Table 18. Continued

Class	Drug	Usual Dose, Range (mg/d)*	Daily Frequency	Comments
Secondary agents (Continued)				
Direct vasodilators	Hydralazine	100-200	2 or 3	These are associated with sodium and water retention and reflex tachycardia; use with a diuretic and beta blocker. Hydralazine is associated with drug-induced lupus-like syndrome at higher doses. Minoxidil is associated with hirsutism and requires a loop diuretic. Minoxidil can induce pericardial effusion.
	Minoxidil	5–100	1-3	

*Dosages may vary from those listed in the FDA-approved labeling (available at https://dailymed.nlm.nih.gov/dailymed/). From Chobanian et al JNC 7.[S8.1.4-4]

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure; BPH, benign prostatic hyperplasia; CCB, calcium channel blocker; CKD, chronic kidney disease; CNS, central nervous system; CVD, cardiovascular disease; ER, extended release; GFR, glomerular filtration rate; HF, heart failure; HFrEF, heart failure with reduced ejection fraction; IHD, ischemic heart disease; IR, immediate release; LA, long-acting; and SR, sustained release.

8.1.5. BP Goal for Patients With Hypertension

Recommendations for BP Goal for Patients With Hypertension

References that support recommendations are summarized in Online Data Supplement 26 and Systematic Review Report

COR	LOE	Recommendations
I	SBP: B-R[SR] DBP: C-EO	1. For adults with confirmed hypertension and known CVD or 10-year ASCVD event risk of 10% or higher (see Section 8.1.2), a BP target of less than 130/80 mm Hg is recommended.[S8.1.5-1–S8.1.5-5]
IIb	SBP: B-NR DBP: C-EO	2. For adults with confirmed hypertension, without additional markers of increased CVD risk, a BP target of less than 130/80 mm Hg may be reasonable.[S8.1.5-6–S8.1.5-9]

SR indicates systematic review.

8.1.6. Choice of Initial Medication

Recommendation for Choice of Initial Medication

References that support the recommendation are summarized in Online Data Supplement 27 and Systematic Review Report

COR	LOE	Recommendation
I	A[SR]	1. For initiation of antihypertensive drug therapy, first-line agents include thiazide diuretics, CCBs, and ACE inhibitors or ARBs.[S8.1.6-1,S8.1.6-2]

SR indicates systematic review.

8.1.6.1. Choice of Initial Monotherapy Versus Initial Combination Drug Therapy

Recommendations for Choice of Initial Monotherapy Versus Initial Combination Drug Therapy*

COR	LOE	Recommendations
I	C-EO	1. Initiation of antihypertensive drug therapy with 2 first-line agents of different classes, either as separate agents or in a fixed-dose combination, is recommended in adults with stage 2 hypertension and an average BP more than 20/10 mm Hg above their BP target.

Recommendations for Choice of Initial Monotherapy Versus Initial Combination Drug Therapy*

COR	LOE	Recommendations
IIa	C-EO	2. Initiation of antihypertensive drug therapy with a single antihypertensive drug is reasonable in adults with stage 1 hypertension and BP goal <130/80 mm Hg with dosage titration and sequential addition of other agents to achieve the BP target.

*Fixed-dose combination antihypertensive medications are listed in Online Data Supplement D.

8.2. Follow-Up of BP During Antihypertensive Drug Therapy

Appropriate follow-up and monitoring enable assessment of adherence (see Section 12.1) and response to therapy, help identify adverse responses to therapy and target organ damage, and allow assessment of progress toward treatment goals. High-quality RCTs have successfully and safely developed strategies for follow-up, monitoring, and reassessment from which recommendations can be made (Figure 4).[S8.2-1,S8.2-2] A systematic approach to out-of-office BP assessment is an essential part of follow-up and monitoring of BP, to assess response to therapy; check for evidence of white coat hypertension, white coat effect, masked hypertension, or masked uncontrolled hypertension; and help achieve BP targets (see Sections 4 and 12).

8.2.1. Follow-Up After Initiating Antihypertensive Drug Therapy

Recommendation for Follow-Up After Initiating Antihypertensive Drug Therapy

References that support the recommendation are summarized in Online Data Supplement 28.

COR	LOE	Recommendation
I	B-R	1. Adults initiating a new or adjusted drug regimen for hypertension should have a follow-up evaluation of adherence and response to treatment at monthly intervals until control is achieved.[S8.2.1-1–S8.2.1-3]

8.2.2. Monitoring Strategies to Improve Control of BP in Patients on Drug Therapy for High BP

Recommendation for Monitoring Strategies to Improve Control of BP in Patients on Drug Therapy for High BP References that support the recommendation are summarized in Online Data Supplement 29.		
COR	**LOE**	**Recommendation**
I	A	1. Follow-up and monitoring after initiation of drug therapy for hypertension control should include systematic strategies to help improve BP, including use of HBPM, team-based care, and telehealth strategies.[S8.3.2-1–S8.3.2-6]

9. Hypertension in Patients With Comorbidities

Certain comorbidities may affect clinical decision-making in hypertension. These include ischemic heart disease, HF with reduced ejection fraction (HF*r*EF), HF*p*EF, CKD (including renal transplantation), cerebrovascular disease, AF, PAD, DM, and metabolic syndrome.[S9-1] As noted in Section 8.1.2, this guideline generally recommends use of BP-lowering medications for secondary prevention of CVD in patients with clinical CVD (CHD, HF, and stroke) and an average BP ≥130/80 mm Hg and for primary prevention of CVD in adults with an estimated 10-year ASCVD risk of ≥10% and an average SBP ≥130 mm Hg or an average DBP ≥80 mm Hg. Although we recommend use of the ACC/AHA Pooled Cohort Equations (http://tools.acc.org/ASCVD-Risk-Estimator/) to estimate 10-year risk of ASCVD to establish the BP threshold for treatment, the vast majority of adults with a co-morbidity are likely to have a 10-year risk of ASCVD that exceeds 10%. In some instances, clinical trial confirmation of treatment in patients with comorbidities is limited to a target BP of 140/90 mm Hg. In addition, the selection of medications for use in treating high BP in patients with CVD is guided by their use for other compelling indications (eg, beta blockers after MI, ACE inhibitors for HF*r*EF), as discussed in specific guidelines for the clinical condition.[S9-2–S9-4] The present guideline does not address the recommendations for treatment of hypertension occurring with acute coronary syndromes.

9.1. Stable Ischemic Heart Disease

Recommendations for Treatment of Hypertension in Patients With Stable Ischemic Heart Disease (SIHD) References that support recommendations are summarized in Online Data Supplements 30-32.		
COR	**LOE**	**Recommendations**
I	SBP: B-R DBP: C-EO	1. In adults with SIHD and hypertension, a BP target of less than 130/80 mm Hg is recommended.[S9.1-1–S9.1-5]
I	SBP: B-R DBP: C-EO	2. Adults with SIHD and hypertension (BP ≥130/80 mm Hg) should be treated with medications (eg, GDMT[S9.1-6] beta blockers, ACE inhibitors, or ARBs) for compelling indications (eg, previous MI, stable angina) as first-line therapy, with the addition of other drugs (eg, dihydropyridine CCBs, thiazide diuretics, and/or mineralocorticoid receptor antagonists) as needed to further control hypertension.[S9.1-7–S9.1-10]
I	B-NR	3. In adults with SIHD with angina and persistent uncontrolled hypertension, the addition of dihydropyridine CCBs to GDMT[S9.1-6] beta blockers is recommended.[S9.1-8,S9.1-11,S9.1-12]
IIa	B-NR	4. In adults who have had a MI or acute coronary syndrome, it is reasonable to continue GDMT[S9.1-6] beta blockers beyond 3 years as long-term therapy for hypertension.[S9.1-13,S9.1-14]
IIb	C-EO	5. Beta blockers and/or CCBs might be considered to control hypertension in patients with CAD (without HF*r*EF) who had an MI more than 3 years ago and have angina.

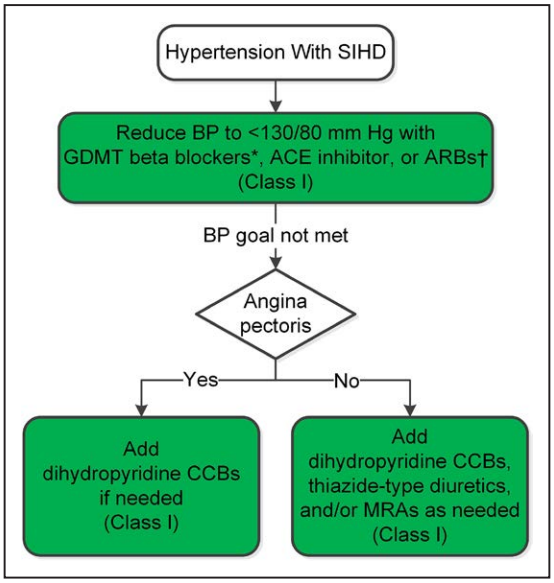

Figure 5. Management of hypertension in patients with SIHD. Colors correspond to Class of Recommendation in Table 1. *GDMT beta blockers for BP control or relief of angina include carvedilol, metoprolol tartrate, metoprolol succinate, nadolol, bisoprolol, propranolol, and timolol. Avoid beta blockers with intrinsic sympathomimetic activity. The beta blocker atenolol should not be used because it is less effective than placebo in reducing cardiovascular events. †If needed for BP control. ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure; CCB, calcium channel blocker; GDMT, guideline-directed management and therapy; and SIHD, stable ischemic heart disease.

9.2. Heart Failure

Recommendation for Prevention of HF in Adults With Hypertension References that support the recommendation are summarized in Online Data Supplement 33.		
COR	**LOE**	**Recommendation**
I	SBP: B-R DBP: C-EO	1. In adults at increased risk of HF, the optimal BP in those with hypertension should be less than 130/80 mm Hg.[S9.2-1–S9.2-3]

9.2.1. Heart Failure With Reduced Ejection Fraction

Recommendations for Treatment of Hypertension in Patients With HF*r*EF References that support recommendations are summarized in Online Data Supplement 34.		
COR	**LOE**	**Recommendations**
I	C-EO	1. Adults with HF*r*EF and hypertension should be prescribed GDMT (2) titrated to attain a BP of less than 130/80 mm Hg.
III: No Benefit	B-R	2. Nondihydropyridine CCBs are not recommended in the treatment of hypertension in adults with HF*r*EF.[S9.2.1-1]

9.2.2. Heart Failure With Preserved Ejection Fraction

Recommendations for Treatment of Hypertension in Patients With HF*p*EF References that support recommendations are summarized in Online Data Supplements 35 and 36.		
COR	**LOE**	**Recommendations**
I	C-EO	1. In adults with HF*p*EF who present with symptoms of volume overload, diuretics should be prescribed to control hypertension.
I	C-LD	2. Adults with HF*p*EF and persistent hypertension after management of volume overload should be prescribed ACE inhibitors or ARBs and beta blockers titrated to attain SBP of less than 130 mm Hg.[S9.2.2-1–S9.2.2-6]

9.3. Chronic Kidney Disease

Recommendations for Treatment of Hypertension in Patients With CKD References that support recommendations are summarized in Online Data Supplements 37 and 38 and Systematic Review Report		
COR	**LOE**	**Recommendations**
I	SBP: B-R[SR] DBP: C-EO	1. Adults with hypertension and CKD should be treated to a BP goal of less than 130/80 mm Hg.[S9.3-1–S9.3-6]
IIa	B-R	2. In adults with hypertension and CKD (stage 3 or higher or stage 1 or 2 with albuminuria [≥300 mg/d, or ≥300 mg/g albumin-to-creatinine ratio or the equivalent in the first morning void]), treatment with an ACE inhibitor is reasonable to slow kidney disease progression.[S9.3-3,S9.3-7–S9.3-12]
IIb	C-EO	3. In adults with hypertension and CKD (stage 3 or higher or stage 1 or 2 with albuminuria [≥300 mg/d, or ≥300 mg/g albumin-to-creatinine ratio in the first morning void]),[S9.3-7,S9.3-8] treatment with an ARB may be reasonable if an ACE inhibitor is not tolerated.

SR indicates systematic review.

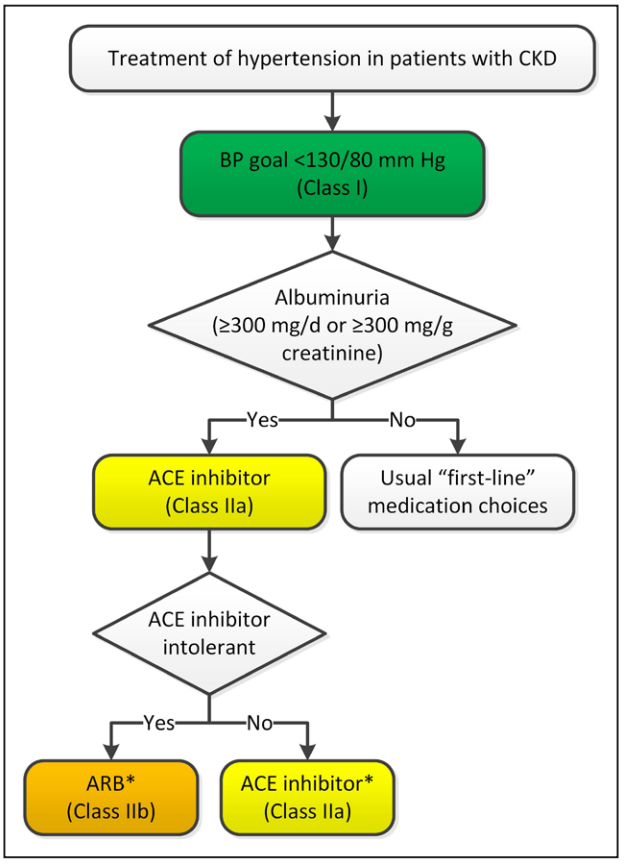

Figure 6. Management of hypertension in patients with CKD. Colors correspond to Class of Recommendation in Table 1. *CKD stage 3 or higher or stage 1 or 2 with albuminuria ≥300 mg/d or ≥300 mg/g creatinine. ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure; and CKD, chronic kidney disease.

9.3.1. Hypertension After Renal Transplantation

Recommendations for Treatment of Hypertension After Renal Transplantation References that support recommendations are summarized in Online Data Supplements 39 and 40.		
COR	**LOE**	**Recommendations**
IIa	SBP: B-NR DBP: C-EO	1. After kidney transplantation, it is reasonable to treat patients with hypertension to a BP goal of less than 130/80 mm Hg.[S9.3.1-1]

Recommendations for Treatment of Hypertension After Renal Transplantation (Continued)		
COR	LOE	Recommendations
IIa	B-R	2. After kidney transplantation, it is reasonable to treat patients with hypertension with a calcium antagonist on the basis of improved GFR and kidney survival.[S9.3.1-2]

9.4. Cerebrovascular Disease

9.4.1. Acute Intracerebral Hemorrhage

Recommendations for Management of Hypertension in Patients With Acute Intracerebral Hemorrhage (ICH) References that support recommendations are summarized in Online Data Supplement 41.		
COR	LOE	Recommendations
IIa	C-EO	1. In adults with ICH who present with SBP greater than 220 mm Hg, it is reasonable to use continuous intravenous drug infusion (Table 19) and close BP monitoring to lower SBP.
III: Harm	A	2. Immediate lowering of SBP (Table 19) to less than 140 mm Hg in adults with spontaneous ICH who present within 6 hours of the acute event and have an SBP between 150 mm Hg and 220 mm Hg is not of benefit to reduce death or severe disability and can be potentially harmful.[S9.4.1-1,S9.4.1-2]

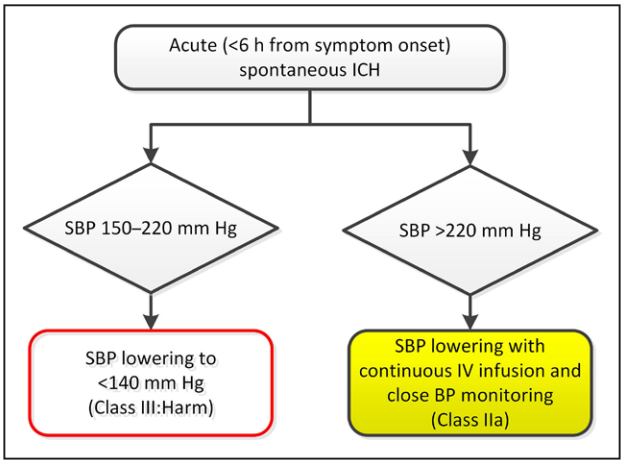

Figure 7. Management of hypertension in patients with acute ICH. Colors correspond to Class of Recommendation in Table 1. BP indicates blood pressure; ICH, intracerebral hemorrhage; IV, intravenous; and SBP, systolic blood pressure.

9.4.2. Acute Ischemic Stroke

Recommendations for Management of Hypertension in Patients With Acute Ischemic Stroke References that support recommendations are summarized in Online Data Supplement 42.		
COR	LOE	Recommendations
I	B-NR	1. Adults with acute ischemic stroke and elevated BP who are eligible for treatment with intravenous tissue plasminogen activator should have their BP slowly lowered to less than 185/110 mm Hg before thrombolytic therapy is initiated.[S9.4.2-1,S9.4.2-2]
I	B-NR	2. In adults with an acute ischemic stroke, BP should be less than 185/110 mm Hg before administration of intravenous tissue plasminogen activator and should be maintained below 180/105 mm Hg for at least the first 24 hours after initiating drug therapy.[S9.4.2-3]
IIa	B-NR	3. Starting or restarting antihypertensive therapy during hospitalization in patients with BP greater than 140/90 mm Hg who are neurologically stable is safe and reasonable to improve long-term BP control, unless contraindicated.[S9.4.2-4,S9.4.2-5]
IIb	C-EO	4. In patients with BP of 220/120 mm Hg or higher who did not receive intravenous alteplase or endovascular treatment and have no comorbid conditions requiring acute antihypertensive treatment, the benefit of initiating or reinitiating treatment of hypertension within the first 48 to 72 hours is uncertain. It might be reasonable to lower BP by 15% during the first 24 hours after onset of stroke.
III: No Benefit	A	5. In patients with BP less than 220/120 mm Hg who did not receive intravenous thrombolysis or endovascular treatment and do not have a comorbid condition requiring acute antihypertensive treatment, initiating or reinitiating treatment of hypertension within the first 48 to 72 hours after an acute ischemic stroke is not effective to prevent death or dependency.[S9.4.2-4–S9.4.2-9]

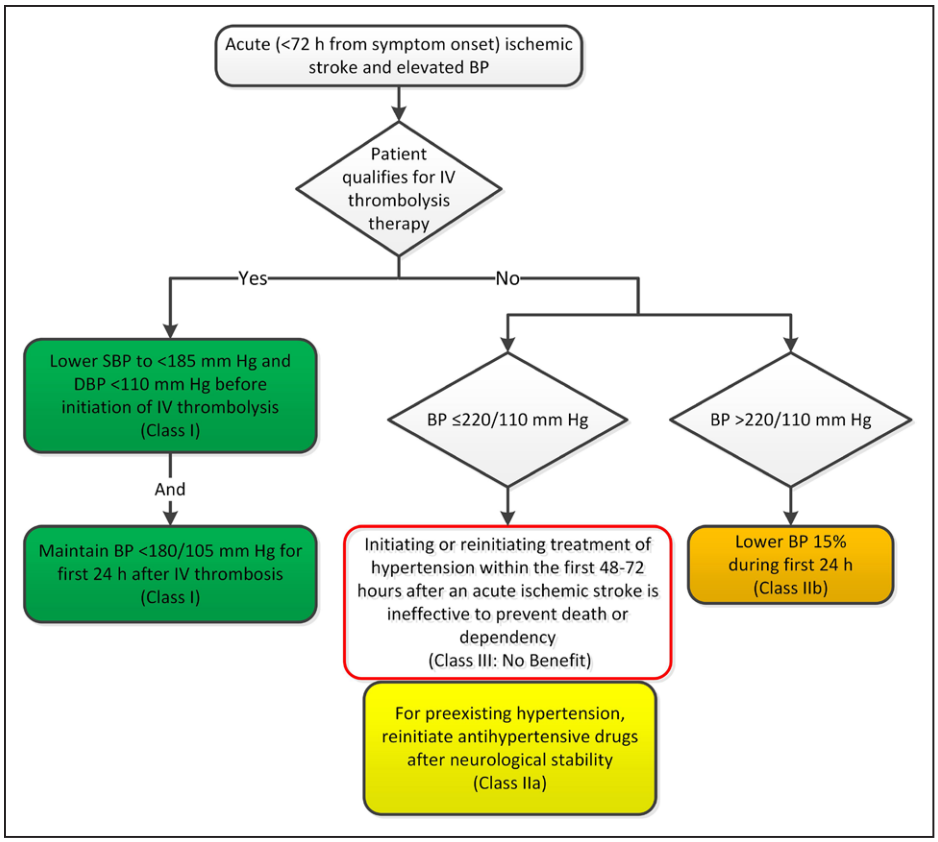

Figure 8. Management of hypertension in patients with acute ischemic stroke. Colors correspond to Class of Recommendation in Table 1. BP indicates blood pressure; DBP, diastolic blood pressure; IV, intravenous; and SBP, systolic blood pressure.

9.4.3. Secondary Stroke Prevention

Recommendations for Treatment of Hypertension for Secondary Stroke Prevention References that support recommendations are summarized in Online Data Supplements 43 and 44.		
COR	**LOE**	**Recommendations**
I	A	1. Adults with previously treated hypertension who experience a stroke or transient ischemic attack (TIA) should be restarted on antihypertensive treatment after the first few days of the index event to reduce the risk of recurrent stroke and other vascular events.[S9.4.3-1–S9.4.3-3]
I	A	2. For adults who experience a stroke or TIA, treatment with a thiazide diuretic, ACE inhibitor, or ARB, or combination treatment consisting of a thiazide diuretic plus ACE inhibitor, is useful.[S9.4.3-1,S9.4.3-3–S9.4.3-5]

Recommendations for Treatment of Hypertension for Secondary Stroke Prevention (Continued)		
COR	**LOE**	**Recommendations**
I	B-R	3. Adults not previously treated for hypertension who experience a stroke or TIA and have an established BP of 140/90 mm Hg or higher should be prescribed antihypertensive treatment a few days after the index event to reduce the risk of recurrent stroke and other vascular events.[S9.4.3-1–S9.4.3-3]
I	B-NR	4. For adults who experience a stroke or TIA, selection of specific drugs should be individualized on the basis of patient comorbidities and agent pharmacological class.[S9.4.3-6]
IIb	B-R	5. For adults who experience a stroke or TIA, a BP goal of less than 130/80 mm Hg may be reasonable.[S9.4.3-6,S9.4.3-7]
IIb	B-R	6. For adults with a lacunar stroke, a target SBP goal of less than 130 mm Hg may be reasonable.[S9.4.3-8]

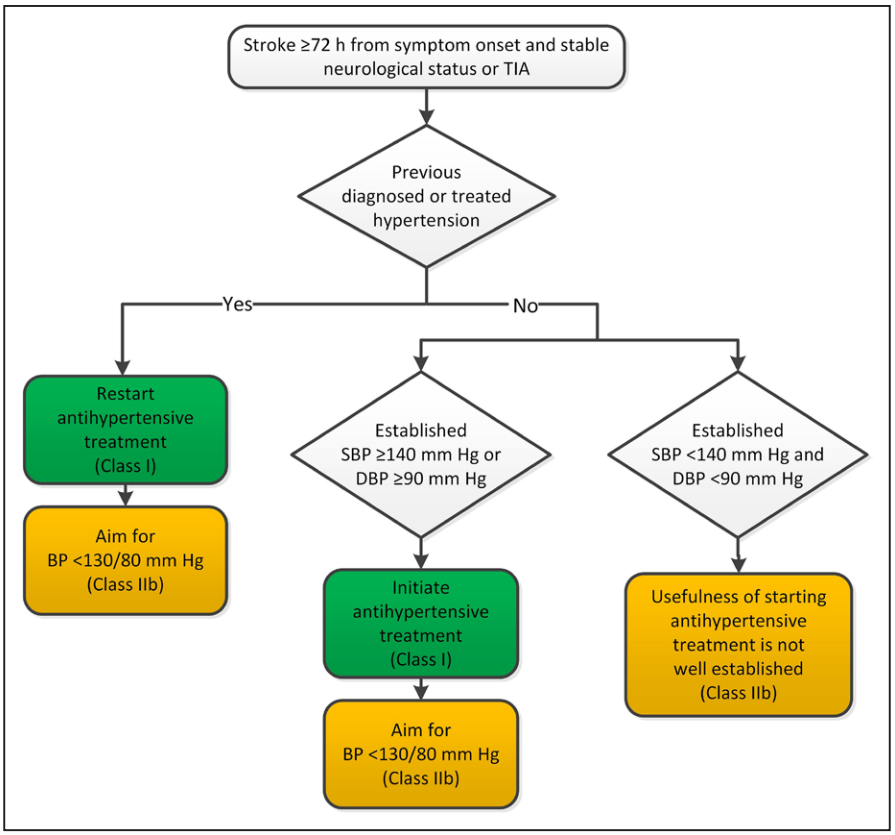

Figure 9. Management of hypertension in patients with a previous history of stroke (secondary stroke prevention). Colors correspond to Class of Recommendation in Table 1. DBP indicates diastolic blood pressure; SBP, systolic blood pressure; and TIA, transient ischemic attack.

Recommendations for Treatment of Hypertension for Secondary Stroke Prevention (Continued)

COR	LOE	Recommendations
IIb	C-LD	7. In adults previously untreated for hypertension who experience an ischemic stroke or TIA and have a SBP less than 140 mm Hg and a DBP less than 90 mm Hg, the usefulness of initiating antihypertensive treatment is not well established.[S9.4.3-9]

9.5. Peripheral Artery Disease

Recommendation for Treatment of Hypertension in Patients With PAD

References that support the recommendation are summarized in Online Data Supplement 45.

COR	LOE	Recommendation
I	B-NR	1. Adults with hypertension and PAD should be treated similarly to patients with hypertension without PAD.[S9.5-1–S9.5-4]

9.6. Diabetes Mellitus

Recommendations for Treatment of Hypertension in Patients With DM

References that support recommendations are summarized in Online Data Supplements 46 and 47 and Systematic Review Report.

COR	LOE	Recommendations
I	SBP: B-R[SR] DBP: C-EO	1. In adults with DM and hypertension, antihypertensive drug treatment should be initiated at a BP of 130/80 mm Hg or higher with a treatment goal of less than 130/80 mm Hg.[S9.6-1–S9.6-8]
I	A[SR]	2. In adults with DM and hypertension, all first-line classes of antihypertensive agents (ie, diuretics, ACE inhibitors, ARBs, and CCBs) are useful and effective.[S9.6-1,S9.6-9,S9.6-10]
IIb	B-NR	3. In adults with DM and hypertension, ACE inhibitors or ARBs may be considered in the presence of albuminuria.[S9.6-11,S9.6-12]

SR indicates systematic review.

9.7. Metabolic Syndrome

Metabolic syndrome is a state of metabolic dysregulation characterized by visceral fat accumulation, insulin resistance, hyperinsulinemia, and hyperlipidemia, as well as predisposition to type 2 DM, hypertension, and atherosclerotic CVD.[S9.7-1–S9.7-3] According to data from the NHANES III and NHANES 1999–2006,[S9.7-1,S9.7-4] the prevalence of metabolic syndrome in the United States was 34.2% in 2006 and has likely increased substantially since that time. The metabolic syndrome is linked to several other disorders, including nonalcoholic steatohepatitis, polycystic ovary syndrome, certain cancers, CKD, Alzheimer's disease, Cushing's syndrome, lipodystrophy, and hyperalimentation.[S9.7-5,S9.7-6]

Lifestyle modification, with an emphasis on improving insulin sensitivity by means of dietary modification, weight reduction, and exercise, is the foundation of treatment of the metabolic syndrome. The optimal antihypertensive drug therapy for patients with hypertension in the setting of the metabolic syndrome has not been clearly defined.[S9.7-1] Although caution exists with regard to the use of thiazide diuretics in this population because of their ability to increase insulin resistance, dyslipidemia, and hyperuricemia and to accelerate conversion to overt DM, no data are currently available demonstrating deterioration in cardiovascular or renal outcomes in patients treated with these agents.[S9.7-1] Indeed, as shown in follow-up of ALLHAT, chlorthalidone use was associated with only a small increase in fasting glucose levels (1.5–4.0 mg/dL), and this increase did not translate into increased CVD risk at a later date.[S9.7-7–S9.7-10] In addition, in post hoc analysis of the nearly two thirds of participants in ALLHAT that met criteria for the metabolic syndrome, chlorthalidone was unsurpassed in reducing CVD and renal outcomes compared with lisinopril, amlodipine, or doxazosin.[S9.7-9,S9.7-11] Similarly, high-dose ARB therapy reduces arterial stiffness in patients with hypertension with the metabolic syndrome, but no outcomes data are available from patients in which this form of treatment was used.[S9.7-12] Use of traditional beta blockers may lead to dyslipidemia or deterioration of glucose tolerance, and ability to lose weight.[S9.7-2] In several large clinical trials, the risk of developing DM as a result of traditional beta-blocker therapy was 15% to 29%.[S9.7-2] However, the newer vasodilating beta blockers (eg, labetalol, carvedilol, nebivolol) have shown neutral or favorable effects on metabolic profiles compared with the traditional beta blockers.[S9.7-13] Trials using vasodilator beta blockers have not been performed to demonstrate effects on CVD outcomes.

9.8. Atrial Fibrillation

Recommendation for Treatment of Hypertension in Patients With AF

References that support the recommendation are summarized in Online Data Supplement 48.

COR	LOE	Recommendation
IIa	B-R	1. Treatment of hypertension with an ARB can be useful for prevention of recurrence of AF.[S9.8-1,S9.8-2]

9.9. Valvular Heart Disease

Recommendations for Treatment of Hypertension in Patients With Valvular Heart Disease

References that support recommendations are summarized in Online Data Supplements 49 and 50.

COR	LOE	Recommendations
I	B-NR	1. In adults with asymptomatic aortic stenosis, hypertension should be treated with pharmacotherapy, starting at a low dose and gradually titrating upward as needed.[S9.9-1–S9.9-4]
IIa	C-LD	2. In patients with chronic aortic insufficiency, treatment of systolic hypertension with agents that do not slow the heart rate (ie, avoid beta blockers) is reasonable.[S9.9-5,S9.9-6]

9.10. Aortic Disease

Recommendation for Management of Hypertension in Patients With Aortic Disease

COR	LOE	Recommendation
I	C-EO	1. Beta blockers are recommended as the preferred antihypertensive agents in patients with hypertension and thoracic aortic disease.[S9.10-1,S9.10-2]

10. Special Patient Groups

Special attention is needed for specific patient subgroups.

10.1.1. Racial and Ethnic Differences in Treatment

Recommendations for Race and Ethnicity

References that support recommendations are summarized in Online Data Supplement 51.

COR	LOE	Recommendations
I	B-R	1. In black adults with hypertension but without HF or CKD, including those with DM, initial antihypertensive treatment should include a thiazide-type diuretic or CCB.[S10.1.1-1–S10.1.1-4]
I	C-LD	2. Two or more antihypertensive medications are recommended to achieve a BP target of less than 130/80 mm Hg in most adults with hypertension, especially in black adults with hypertension.[S10.1.1-5–S10.1.1-7]

10.2. Sex-Related Issues

The prevalence of hypertension is lower in women than in men until about the fifth decade but is higher later in life .[S10.2-1] Other than special recommendations for management of hypertension during pregnancy, there is no evidence that the BP threshold for initiating drug treatment, the treatment target, the choice of initial antihypertensive medication, or the combination of medications for lowering BP differs for women versus men.[S10.2-2,S10.2-3]

10.2.1. Women

A potential limitation of RCTs, including SPRINT, is that they are not specifically powered to determine the value of intensive SBP reduction in subgroups, including women in the case of SPRINT. However, in prespecified analyses, there was no evidence of an interaction between sex and treatment effect. Furthermore, no significant differences in CVD outcomes were observed between men and women in a large meta-analysis that included 31 RCTs with about 100 000 men and 90 000 women with hypertension (1 Some have called for conduct of a SPRINT-like trial with sufficient power to assess the effects of intensive SBP reduction in women {Wenger, 2016 #9131). Some have called for a SPRINT-like trial with sufficient power to assess the effects of intensive SBP reduction in women.[S10.2.1-2] In meta-analyses, there was no convincing evidence that different antihypertensive drug classes exerted sex-related differences in BP lowering or provided distinct CVD protection.[S10.2.1-1] Calcium antagonists offered slightly greater benefits for stroke prevention than did ACE inhibitors for women than for men, whereas calcium antagonists reduced all-cause deaths compared with placebo in men but not in women. However, these sex-related differences might have been due to chance because of the large number of statistical comparisons that were performed. The Heart Attack Trial and Hypertension Care Computing Project reported that beta blockers were associated with reduced mortality in men but not in women, but this finding was likely due to the low event rates in women.[S10.2.1-3] Similarly, in the open-label Second Australian National BP study, a significant reduction in CVD events was demonstrated in men but not in women with ACE inhibitors versus diuretics.[S10.2.1-4]

Adverse effects of antihypertensive therapy were noted twice as often in women as in men in the TOMHS study.[S10.2.1-5] A higher incidence of ACE inhibitor–induced cough and of edema with calcium antagonists was observed in women than in men.[S10.2.1-6] Women were more likely to experience hypokalemia and hyponatremia and less likely to experience gout with diuretics.[S10.2.1-7] Hypertension in pregnancy has special requirements (see Section 10.2.2).

10.2.2. Pregnancy

Recommendations for Treatment of Hypertension in Pregnancy

References that support recommendations are summarized in Online Data Supplement 53.

COR	LOE	Recommendations
I	C-LD	1. Women with hypertension who become pregnant, or are planning to become pregnant, should be transitioned to methyldopa, nifedipine, and/or labetalol[S10.2.2-1] during pregnancy.[S10.2.2-2–S10.2.2-6]
III: Harm	C-LD	2. Women with hypertension who become pregnant should not be treated with ACE inhibitors, ARBs, or direct renin inhibitors.[S10.2.2-4–S10.2.2-6]

10.3. Age-Related Issues

10.3.1. Older Persons

Recommendations for Treatment of Hypertension in Older Persons

References that support recommendations are summarized in Online Data Supplement 54.

COR	LOE	Recommendations
I	A	1. Treatment of hypertension with a SBP treatment goal of less than 130 mm Hg is recommended for noninstitutionalized ambulatory community-dwelling adults (≥65 years of age) with an average SBP of 130 mm Hg or higher.[S10.3.1-1]
IIa	C-EO	2. For older adults (≥65 years of age) with hypertension and a high burden of comorbidity and limited life expectancy, clinical judgment, patient preference, and a team-based approach to assess risk/benefit is reasonable for decisions regarding intensity of BP lowering and choice of antihypertensive drugs.

11. Other Considerations

11.1. Resistant Hypertension

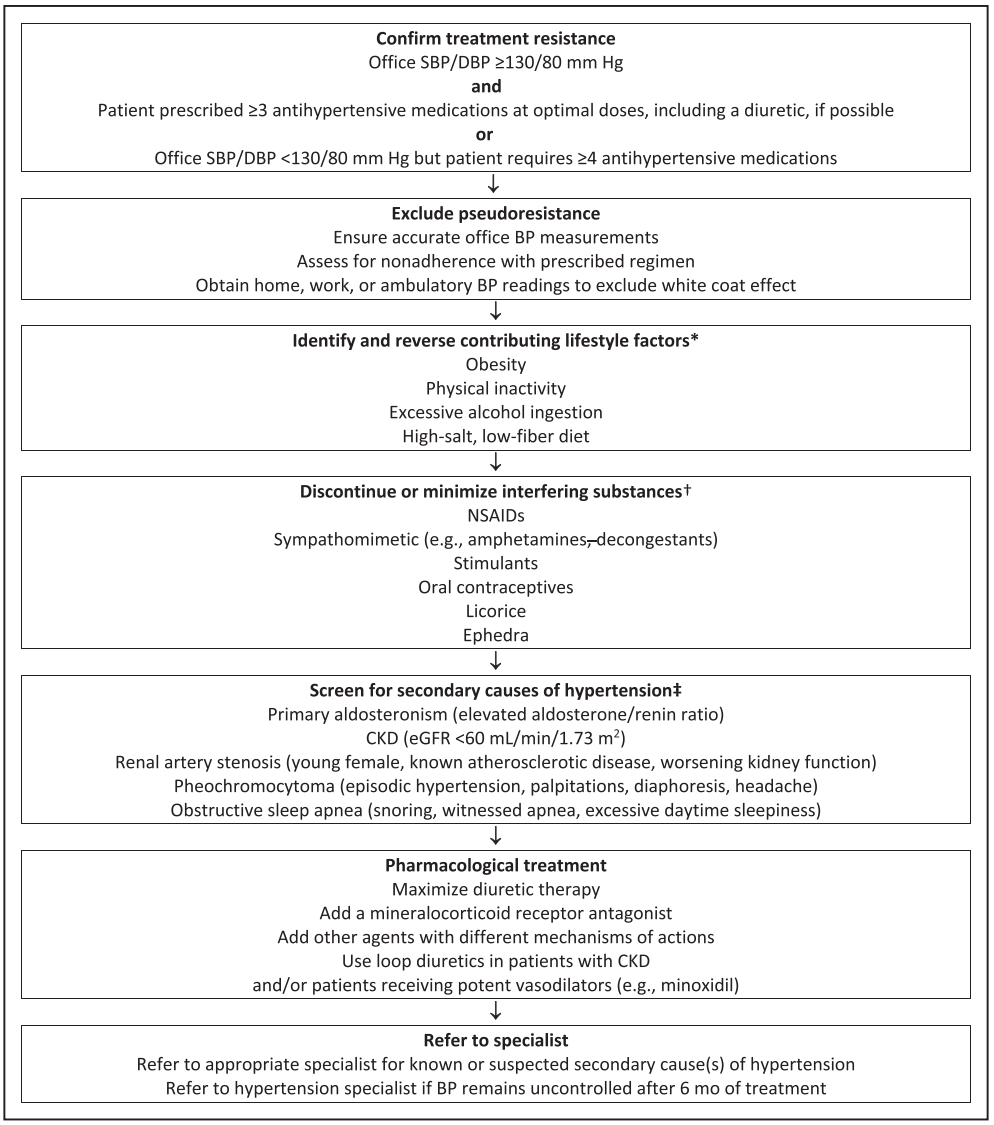

Figure 10. Resistant hypertension: diagnosis, evaluation, and treatment. *See additional details in Section 6, Nonpharmacological Intervention. †See Section 5.4.1 and Table 14 for complete list of drugs that elevate BP. ‡See Section 5.4 and Table 13 for secondary hypertension. BP indicates blood pressure; CKD, chronic kidney disease; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; NSAIDs, nonsteroidal anti-inflammatory drugs; and SBP, systolic blood pressure. Adapted with permission from Calhoun et al[S11.1-1] (American Heart Association, Inc.).

11.2. Hypertensive Crises—Emergencies and Urgencies

Recommendations for Hypertensive Crises and Emergencies

References that support recommendations are summarized in Online Data Supplement 55.

COR	LOE	Recommendations
I	B-NR	1. In adults with a hypertensive emergency, admission to an intensive care unit is recommended for continuous monitoring of BP and target organ damage and for parenteral administration of an appropriate agent (Tables 19 and 20).[S11.2-1,S11.2-2]

Recommendations for Hypertensive Crises and Emergencies (Continued)

COR	LOE	Recommendations
I	C-EO	2. For adults with a compelling condition (ie, aortic dissection, severe preeclampsia or eclampsia, or pheochromocytoma crisis), SBP should be reduced to less than 140 mm Hg during the first hour and to less than 120 mm Hg in aortic dissection.
I	C-EO	3. For adults without a compelling condition, SBP should be reduced by no more than 25% within the first hour; then, if stable, to 160/100 mm Hg within the next 2 to 6 hours; and then cautiously to normal during the following 24 to 48 hours.

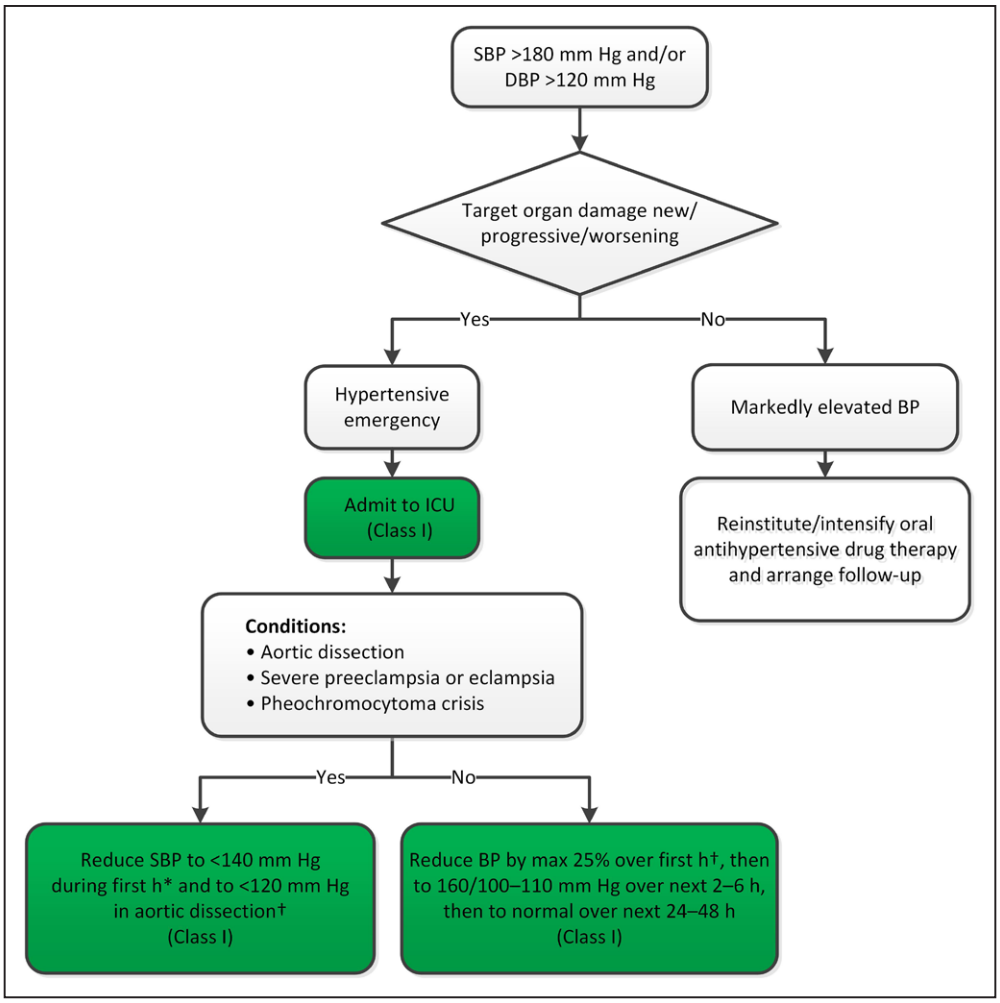

Figure 11. Diagnosis and management of a hypertensive crisis. Colors correspond to Class of Recommendation in Table 1. *Use drug(s) specified in Table 19. †If other comorbidities are present, select a drug specified in Table 20. BP indicates blood pressure; DBP, diastolic blood pressure; ICU, intensive care unit; and SBP, systolic blood pressure.

Table 19. Intravenous Antihypertensive Drugs for Treatment of Hypertensive Emergencies

Class	Drug(s)	Usual Dose Range	Comments
CCB—dihydropyridines	Nicardipine	Initial 5 mg/h, increasing every 5 min by 2.5 mg/h to maximum 15 mg/h.	Contraindicated in advanced aortic stenosis; no dose adjustment needed for elderly.
	Clevidipine	Initial 1–2 mg/h, doubling every 90 s until BP approaches target, then increasing by less than double every 5–10 min; maximum dose 32 mg/h; maximum duration 72 h.	Contraindicated in patients with soybean, soy product, egg, and egg product allergy and in patients with defective lipid metabolism (eg, pathological hyperlipidemia, lipoid nephrosis or acute pancreatitis). Use low-end dose range for elderly patients.
Vasodilators—Nitric-oxide dependent	Sodium nitroprusside	Initial 0.3–0.5 mcg/kg/min; increase in increments of 0.5 mcg/kg/min to achieve BP target; maximum dose 10 mcg/kg/min; duration of treatment as short as possible. For infusion rates ≥4–10 mcg/kg/min or duration >30 min, thiosulfate can be coadministered to prevent cyanide toxicity.	Intra-arterial BP monitoring recommended to prevent "overshoot." Lower dosing adjustment required for elderly. Tachyphylaxis common with extended use. Cyanide toxicity with prolonged use can result in irreversible neurological changes and cardiac arrest.
	Nitroglycerin	Initial 5 mcg/min; increase in increments of 5 mcg/min every 3–5 min to a maximum of 20 mcg/min.	Use only in patients with acute coronary syndrome and/or acute pulmonary edema. Do not use in volume-depleted patients.
Vasodilators—direct	Hydralazine	Initial 10 mg via slow IV infusion (maximum initial dose 20 mg); repeat every 4–6 h as needed.	BP begins to decrease within 10–30 min, and the fall lasts 2–4 h. Unpredictability of response and prolonged duration of action do not make hydralazine a desirable first-line agent for acute treatment in most patients.

(*Continued*)

Table 19. Continued

Class	Drug(s)	Usual Dose Range	Comments
Adrenergic blockers—beta$_1$ receptor selective antagonist	Esmolol	Loading dose 500–1000 mcg/kg/min over 1 min followed by a 50-mcg/kg/min infusion. For additional dosing, the bolus dose is repeated and the infusion increased in 50-mcg/kg/min increments as needed to a maximum of 200 mcg/kg/min.	Contraindicated in patients with concurrent beta-blocker therapy, bradycardia, or decompensated HF. Monitor for bradycardia. May worsen HF. Higher doses may block beta$_2$ receptors and impact lung function in reactive airway disease.
Adrenergic blockers—combined alpha$_1$ and nonselective beta receptor antagonist	Labetalol	Initial 0.3–1.0-mg/kg dose (maximum 20 mg) slow IV injection every 10 min or 0.4–1.0-mg/kg/h IV infusion up to 3 mg/kg/h. Adjust rate up to total cumulative dose of 300 mg. This dose can be repeated every 4–6 h.	Contraindicated in reactive airways disease or chronic obstructive pulmonary disease. Especially useful in hyperadrenergic syndromes. May worsen HF and should not be given in patients with second- or third-degree heart block or bradycardia.
Adrenergic blockers—nonselective alpha receptor antagonist	Phentolamine	IV bolus dose 5 mg. Additional bolus doses every 10 min as needed to lower BP to target.	Used in hypertensive emergencies induced by catecholamine excess (pheochromocytoma, interactions between monamine oxidase inhibitors and other drugs or food, cocaine toxicity, amphetamine overdose, or clonidine withdrawal).
Dopamine$_1$-receptor selective agonist	Fenoldopam	Initial 0.1–0.3 mcg/kg/min; may be increased in increments of 0.05–0.1 mcg/kg/min every 15 min until target BP is reached. Maximum infusion rate 1.6 mcg/kg/min.	Contraindicated in patients at risk of increased intraocular pressure (glaucoma) or intracranial pressure and those with sulfite allergy.
ACE inhibitor	Enalaprilat	Initial 1.25 mg over a 5-min period. Doses can be increased up to 5 mg every 6 h as needed to achieve BP target.	Contraindicated in pregnancy and should not be used in acute MI or bilateral renal artery stenosis. Mainly useful in hypertensive emergencies associated with high plasma renin activity. Dose not easily adjusted. Relatively slow onset of action (15 min) and unpredictability of BP response.

BP indicates blood pressure; CCB, calcium channel blocker; HF, heart failure; IV, intravenous; and MI, myocardial infarction.

Table 20. Intravenous Antihypertensive Drugs for Treatment of Hypertensive Emergencies in Patients With Selected Comorbidities

Comorbidity	Preferred Drug(s)*	Comments
Acute aortic dissection	Esmolol, labetalol	Requires rapid lowering of SBP to ≤120 mm Hg. Beta blockade should precede vasodilator (eg, nicardipine or nitroprusside) administration, if needed for BP control or to prevent reflex tachycardia or inotropic effect; SBP ≤120 mm Hg should be achieved within 20 min.
Acute pulmonary edema	Clevidipine, nitroglycerin, nitroprusside	Beta blockers contraindicated.
Acute coronary syndromes	Esmolol,† labetalol, nicardipine, nitroglycerin†	Nitrates given in the presence of PDE-5 inhibitors may induce profound hypotension. Contraindications to beta blockers include moderate-to-severe LV failure with pulmonary edema, bradycardia (<60 bpm), hypotension (SBP <100 mm Hg), poor peripheral perfusion, second- or third-degree heart block, and reactive airways disease.
Acute renal failure	Clevidipine, fenoldopam, nicardipine	N/A
Eclampsia or preeclampsia	Hydralazine, labetalol, nicardipine	Requires rapid BP lowering. ACE inhibitors, ARBs, renin inhibitors, and nitroprusside contraindicated.
Perioperative hypertension (BP ≥160/90 mm Hg or SBP elevation ≥20% of the preoperative value that persists for >15 min)	Clevidipine, esmolol, nicardipine, nitroglycerin	Intraoperative hypertension is most frequently seen during anesthesia induction and airway manipulation.
Acute sympathetic discharge or catecholamine excess states (eg, pheochromocytoma, post-carotid endarterectomy status)	Clevidipine, nicardipine, phentolamine	Requires rapid lowering of BP.
Acute ICH	Section 9.4.1	Section 9.4.1
Acute ischemic stroke	Section 9.4.2	Section 9.4.2

*Agents are listed in alphabetical order, not in order of preference.

†Agent of choice for acute coronary syndromes.

ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; BP, blood pressure; bpm, beats per minute; ICH, intracerebral hemorrhage; LV, left ventricular; PDE-5, phosphodiesterase type-5; and SBP, systolic blood pressure.

11.3. Cognitive Decline and Dementia

Recommendation for Prevention of Cognitive Decline and Dementia

References that support the recommendation are summarized in Online Data Supplement 56.

COR	LOE	Recommendation
IIa	B-R	1. In adults with hypertension, BP lowering is reasonable to prevent cognitive decline and dementia.[S11.3-1–S11.3-6]

11.4. Patients Undergoing Surgical Procedures

Recommendations for Treatment of Hypertension in Patients Undergoing Surgical Procedures

References that support recommendations are summarized in Online Data Supplements 57 and 58.

COR	LOE	Recommendations
Preoperative		
I	B-NR	1. In patients with hypertension undergoing major surgery who have been on beta blockers chronically, beta blockers should be continued.[S11.4-1–S11.4-7]
IIa	C-EO	2. In patients with hypertension undergoing planned elective major surgery, it is reasonable to continue medical therapy for hypertension until surgery.
IIb	B-NR	3. In patients with hypertension undergoing major surgery, discontinuation of ACE inhibitors or ARBs perioperatively may be considered.[S11.4-8–S11.4-10]
IIb	C-LD	4. In patients with planned elective major surgery and SBP of 180 mm Hg or higher or DBP of 110 mm Hg or higher, deferring surgery may be considered.[S11.4-11,S11.4-12]
III: Harm	B-NR	5. For patients undergoing surgery, abrupt preoperative discontinuation of beta blockers or clonidine is potentially harmful.[S11.4-2,S11.4-13]
III: Harm	B-NR	6. Beta blockers should not be started on the day of surgery in beta blocker–naïve patients.[S11.4-14]
Intraoperative		
I	C-EO	7. Patients with intraoperative hypertension should be managed with intravenous medications (Table 19) until such time as oral medications can be resumed.

12. Strategies to Improve Hypertension Treatment and Control

12.1. Adherence Strategies for Treatment of Hypertension

12.1.1. Antihypertensive Medication Adherence Strategies

Recommendations for Antihypertensive Medication Adherence Strategies

References that support recommendations are summarized in Online Data Supplements 59 and 60.

COR	LOE	Recommendations
I	B-R	1. In adults with hypertension, dosing of antihypertensive medication once daily rather than multiple times daily is beneficial to improve adherence.[S12.1.1-1–S12.1.1-3]
IIa	B-NR	2. Use of combination pills rather than free individual components can be useful to improve adherence to antihypertensive therapy.[S12.1.1-4–S12.1.1-7]

Available fixed-dose combination drug therapy is listed in Online Data Supplement D.

12.1.2. Strategies to Promote Lifestyle Modification

Recommendation for Strategies to Promote Lifestyle Modification

References that support the recommendation are summarized in Online Data Supplement 61.

COR	LOE	Recommendation
I	C-EO	1. Effective behavioral and motivational strategies to achieve a healthy lifestyle (ie, tobacco cessation, weight loss, moderation in alcohol intake, increased physical activity, reduced sodium intake, and consumption of a healthy diet) are recommended for adults with hypertension.[S12.1.2-1,S12.1.2-2]

12.2. Structured, Team-Based Care Interventions for Hypertension Control

Recommendation for Structured, Team-Based Care Interventions for Hypertension Control

References that support the recommendation are summarized in Online Data Supplement 62.

COR	LOE	Recommendation
I	A	1. A team-based care approach is recommended for adults with hypertension.[S12.2-1–S12.2-7]

12.3. Health Information Technology–Based Strategies to Promote Hypertension Control

12.3.1. EHR and Patient Registries

Recommendations for EHR and Patient Registries

References that support recommendations are summarized in Online Data Supplement 63.

COR	LOE	Recommendations
I	B-NR	1. Use of the EHR and patient registries is beneficial for identification of patients with undiagnosed or undertreated hypertension.[S12.3.1-1–S12.3.1-3]
I	B-NR	2. Use of the EHR and patient registries is beneficial for guiding quality improvement efforts designed to improve hypertension control.[S12.3.1-1–S12.3.1-3]

12.3.2. Telehealth Interventions to Improve Hypertension Control

Recommendation for Telehealth Interventions to Improve Hypertension Control

References that support the recommendation are summarized in Online Data Supplement 64.

COR	LOE	Recommendation
IIa	A	1. Telehealth strategies can be useful adjuncts to interventions shown to reduce BP for adults with hypertension.[S12.3.2-1–S12.3.2-5]

12.4. Improving Quality of Care for Patients With Hypertension

12.4.1. Performance Measures

Recommendation for Performance Measures

References that support the recommendation are summarized in Online Data Supplement 65.

COR	LOE	Recommendation
IIa	B-NR	1. Use of performance measures in combination with other quality improvement strategies at patient-, provider-, and system-based levels is reasonable to facilitate optimal hypertension control.[S12.4.1-1–S12.4.1-3]

12.4.2. Quality Improvement Strategies

Recommendation for Quality Improvement Strategies

References that support the recommendation are summarized in Online Data Supplements 66 and 67.

COR	LOE	Recommendation
IIa	B-R	1. Use of quality improvement strategies at the health system, provider, and patient levels to improve identification and control of hypertension can be effective.[S12.4.2-1–S12.4.2-8]

12.5. Financial Incentives

Recommendations for Financial Incentives

References that support recommendations are summarized in Online Data Supplement 68.

COR	LOE	Recommendations
IIa	B-R	1. Financial incentives paid to providers can be useful in achieving improvements in treatment and management of patient populations with hypertension.[S12.5-1–S12.5-3]
IIa	B-NR	2. Health system financing strategies (eg, insurance coverage and copayment benefit design) can be useful in facilitating improved medication adherence and BP control in patients with hypertension.[S12.5-4]

13. The Plan of Care for Hypertension

Recommendation for the Plan of Care for Hypertension

COR	LOE	Recommendation
I	C-EO	1. Every adult with hypertension should have a clear, detailed, and current evidence-based plan of care that ensures the achievement of treatment and self-management goals, encourages effective management of comorbid conditions, prompts timely follow-up with the healthcare team, and adheres to CVD GDMT (Table 22).

Table 21. Clinician's Sequential Flow Chart for the Management of Hypertension

Clinician's Sequential Flow Chart for the Management of Hypertension	
Measure office BP accurately	Section 4
Detect white coat hypertension or masked hypertension by using ABPM and HBPM	Section 4
Evaluate for secondary hypertension	Section 5
Identify target organ damage	Sections 5 and 7
Introduce lifestyle interventions	Section 6
Identify and discuss treatment goals	Sections 7 and 8
Use ASCVD risk estimation to guide BP threshold for drug therapy	Section 8.1.2
Align treatment options with comorbidities	Section 9
Account for age, race, ethnicity, sex, and special circumstances in antihypertensive treatment	Sections 10 and 11
Initiate antihypertensive pharmacological therapy	Section 8
Insure appropriate follow-up	Section 8
Use team-based care	Section 12
Connect patient to clinician via telehealth	Section 12
Detect and reverse nonadherence	Section 12
Detect white coat effect or masked uncontrolled hypertension	Section 4
Use health information technology for remote monitoring and self-monitoring of BP	Section 12

ABPM indicates ambulatory blood pressure monitoring; ASCVD, atherosclerotic cardiovascular disease; BP, blood pressure; and HBPM, home blood pressure monitoring.

Table 22. Evidence-Based Elements of the Plan of Care for Patients With Hypertension

Plan of Care	Associated Section(s) of Guideline and Other Reference(s)
Pharmacological and nonpharmacological treatments	
Medication selection (initial and ongoing)	Section 8.1
Monitoring for adverse effects and adherence	Sections 8.3.1, 8.3.2, 12.1.1
Nonpharmacological interventions Diet Exercise Weight loss if overweight Moderate alcohol consumption	Sections 6, 12.1.2[S13-1]
Management of common comorbidities and conditions	
Ischemic heart disease	Section 9.1[S13-2,S13-3]
Heart failure Reduced ejection fraction Preserved ejection fraction	Section 9.2[S13-4]
Diabetes mellitus	Section 9.6[S13-5]
Chronic kidney disease	Section 9.3
Cerebrovascular disease	Section 9.4
Peripheral artery disease	Section 9.5
Atrial fibrillation	Section 9.8
Valvular heart disease	Section 9.9
Left ventricular hypertrophy	Section 7.3
Thoracic aortic disease	Section 9.10
Patient and family education	
Achieving BP control and self-monitoring	Sections 4.2, 8.2
Risk assessment and prognosis	Section 8.1.2
Sexual activity and dysfunction	Section 11.4
Special patient groups	
Pregnancy	Section 10.2.2
Older persons	Section 10.3.1
Children and adolescents	Section 10.3.2
Metabolic syndrome	Section 9.7
Possible secondary causes of hypertension	Section 5.4
Resistant hypertension	Section 11.1
Patients with hypertension undergoing surgery	Section 11.5
Renal transplantation	Section 9.3.1
Psychosocial factors	
Sex-specific issues	Section 10.2
Culturally sensitive issues (race and ethnicity)	Section 10.1
Resource constraints	Section 12.5
Clinician follow-up, monitoring, and care coordination	
Follow-up visits	Sections 8.1.3, 8.3.1, 8.3.2
Team-based care	Section 12.2
Electronic health record	Section 12.3.1
Health information technology tools for remote and self-monitoring	Section 12.3.2
Socioeconomic and cultural factors	
Health literacy	Section 13.1.3
Access to health insurance and medication assistance plans	Section 13.1.3
Social services	Section 13.1.3
Community services	Section 13.1.3

(*Continued*)

Table 22. Continued

BP indicates blood pressure.

13.1. Health Literacy

Communicating alternative behaviors that support self-management of healthy BP in addition to medication adherence is important. This should be done both verbally and in writing. Today, mobile phones have a recording option. For patients with mobile phones, the phone can be used to inform patients and family members of medical instructions after the doctor's visit as an additional level of communication. Inclusion of a family member or friend that can help interpret and encourage self-management treatment goals is suggested when appropriate. Examples of needed communication for alternative behaviors include a specific regimen relating to physical activity; a specific sodium-reduced meal plan indicating selections for breakfast, lunch, and dinner; lifestyle recommendations relating to sleep, rest, and relaxation; and finally, suggestions and alternatives to environmental barriers, such as barriers that prevent healthy food shopping or limit reliable transportation to and from appointments with health providers and pharmacy visits.

13.2. Access to Health Insurance and Medication Assistance Plans

Health insurance and medication plan assistance for patients is especially important to improving access to and affordability of medical care and BP medications. Learning how the patient financially supports and budgets for his or her medical care and medications offers the opportunity to share additional insight relating to cost reductions, including restructured payment plans. Ideally, this would improve the patient's compliance with medication adherence and treatment goals.

13.3. Social and Community Services

Health care can be strengthened through local partnerships. Hypertensive patients, particularly patients with lower incomes, have more opportunity to achieve treatment goals with the assistance of strong local partnerships. In patients with low socioeconomic status or patients who are challenged by social situations, integration of social and community services offers complementary reinforcement of clinically identified treatment goals. Social and community services are helpful when explicitly related to medical care.

However, additional financial support and financial services are incredibly beneficial to patients, some of whom may choose to skip a doctor's appointment to pay a residential utility bill.

14. Summary of BP Thresholds and Goals for Pharmacological Therapy

Table 23. BP Thresholds for and Goals of Pharmacological Therapy in Patients With Hypertension According to Clinical Conditions

Clinical Condition(s)	BP Threshold, mm Hg	BP Goal, mm Hg
General		
Clinical CVD or 10-year ASCVD risk ≥10%	≥130/80	<130/80
No clinical CVD and 10-year ASCVD risk <10%	≥140/90	<130/80
Older persons (≥65 years of age; noninstitutionalized, ambulatory, community-living adults)	≥130 (SBP)	<130 (SBP)
Specific comorbidities		
Diabetes mellitus	≥130/80	<130/80
Chronic kidney disease	≥130/80	<130/80
Chronic kidney disease after renal transplantation	≥130/80	<130/80
Heart failure	≥130/80	<130/80
Stable ischemic heart disease	≥130/80	<130/80
Secondary stroke prevention	≥140/90	<130/80
Peripheral artery disease	≥130/80	<130/80

ASCVD indicates atherosclerotic cardiovascular disease; BP, blood pressure; CVD, cardiovascular disease; and SBP, systolic blood pressure.

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KEY WORDS: AHA Scientific Statements ■ ambulatory care ■ antihypertensive agents ■ behavior modification ■ blood pressure ■ chronic kidney disease ■ diabetes ■ hypertension ■ hypertension emergency ■ lifestyle measures ■ measurement ■ nonpharmacologic treatment ■ resistant hypertension ■ risk reduction ■ secondary hypertension ■ systems of care ■ treatment adherence ■ treatment outcomes

Appendix 1. Author Relationships With Industry and Other Entities (Relevant)—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 (October 2017)

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Paul K. Whelton, Chair	Tulane University School of Hygiene and Tropical Medicine—Show Chwan Professor of Global Public Health	None	None	None	None	None	None	None
Robert M. Carey, Vice Chair	University of Virginia School of Medicine—Dean, Emeritus, and Professor of Medicine	None	None	None	• Daiichi Sankyo Inc†	None	None	None
Wilbert S. Aronow	Westchester Medical Center and New York Medical College—Professor of Medicine	None	None	None	None	None	None	None
Donald E. Casey, Jr	Thomas Jefferson College of Population Health—Adjunct Faculty; Alvarez & Marsal Ipo4health—Principal and Founder	None	None	None	None	None	None	None
Karen J. Collins	Collins Collaboration—President	None	None	None	None	None	None	None
Cheryl Dennison Himmelfarb	John Hopkins University—Professor of Nursing and Medicine, Institute for Clinical and Translational Research	None	None	None	None	None	None	None
Sondra M. DePalma	PinnacleHealth CardioVascular Institute—Physician Assistant; American Academy of PAs—Director, Regulatory and Professional Practice	None	None	None	None	None	None	None
Samuel Gidding	Alfred I. Dupont Hospital for Children—Chief, Division of Pediatric Cardiology, Nemours Cardiac Center	None	None	None	None	None	None	None
David C. Goff, Jr*	Colorado School of Public Health—Professor and Dean, Department of Epidemiology	None	None	None	None	None	None	None
Kenneth A. Jamerson	University of Michigan Health System—Professor of Internal Medicine and Frederick G.L. Huetwell Collegiate Professor of Cardiovascular Medicine	None	None	None	None	None	None	None
Daniel W. Jones	University of Mississippi Medical Center—Professor of Medicine and Physiology; Metabolic Diseases and Nutrition—University Sanderson Chair in Obesity Mississippi Center for Obesity Research—Director, Clinical and Population Science	None	None	None	None	None	None	None
Eric J. MacLaughlin	Texas Tech University Health Sciences Center—Professor and Chair, Department of Pharmacy Practice, School of Pharmacy	None	None	None	None	None	None	None
Paul Muntner	University of Alabama at Birmingham—Professor, Department of Epidemiology	None	None	None	None	None	None	None

(*Continued*)

Appendix 1. Continued

Committee Member	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Bruce Ovbiagele	Medical University of South Carolina—Pihl Professor and Chairman of Neurology	None	• Boehringer Ingelheim Korea Ltd	None	None	None	None	None
Sidney C. Smith, Jr	University of North Carolina at Chapel Hill—Professor of Medicine; Center for Cardiovascular Science and Medicine—Director	None	None	None	None	None	None	None
Crystal C. Spencer	Spencer Law, PA—Attorney at Law	None	None	None	None	None	None	None
Randall S. Stafford	Stanford Prevention Research Center—Professor of Medicine; Program on Prevention Outcomes—Director	None	None	None	None	None	None	None
Sandra J. Taler	Mayo Clinic—Professor of Medicine, College of Medicine	None	None	None	None	None	None	None
Randal J. Thomas	Mayo Clinic—Medical Director, Cardiac Rehabilitation Program	None	None	None	None	None	None	None
Kim A. Williams, Sr	Rush University Medical Center—James B. Herrick Professor; Division of Cardiology—Chief	None	None	None	None	None	None	None
Jeff D. Williamson	Wake Forest Baptist Medical Center—Professor of Internal Medicine; Section on Gerontology and Geriatric Medicine—Chief	None	None	None	None	None	None	None
Jackson T. Wright, Jr	Case Western Reserve University—Professor of Medicine; William T. Dahms MD Clinical Research Unit—Program Director; University Hospitals Case Medical Center—Director, Clinical Hypertension Program	None	• Amgen†	None	None	None	None	None

This table represents the relationships of committee members with industry and other entities that were determined to be relevant to this document. These relationships were reviewed and updated in conjunction with all meetings and/or conference calls of the writing committee during the document development process. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of ≥5% of the voting stock or share of the business entity, or ownership of ≥$5000 of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted.

According to the ACC/AHA, a person has a *relevant* relationship IF: a) the *relationship or interest* relates to the same or similar subject matter, intellectual property or asset, topic, or issue addressed in the *document*; or b) the *company/entity* (with whom the relationship exists) makes a drug, drug class, or device addressed in the document, or makes a competing drug or device addressed in the *document*; or c) the *person or a member of the person's household*, has a reasonable potential for financial, professional or other personal gain or loss as a result of the issues/content addressed in the *document*.

We gratefully acknowledge the contributions of Dr. Lawrence Appel, who served as a member of the Writing Committee from November 2014 to September 2015.

*Dr. David C. Goff resigned from the writing committee in December 2016 because of a change in employment before the recommendations were balloted. The writing committee thanks him for his contributions, which were extremely beneficial to the development of the draft.

†Significant relationship.

AAPA indicates American Academy of Physician Assistants; ACC, American College of Cardiology; ACPM, American College of Preventive Medicine; AGS, American Geriatrics Society; AHA, American Heart Association; APhA, American Pharmacists Association; ASH, American Society of Hypertension; ASPC, American Society for Preventive Cardiology; ABC, Association of Black Cardiologists; NMA, National Medical Association; and PCNA, Preventive Cardiovascular Nurses Association.

Appendix 2. Reviewer Relationships With Industry and Other Entities (Comprehensive)—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 (October 2017)

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Kim K. Birtcher	Official Reviewer—TFPG Lead Reviewer	University of Houston College of Pharmacy—Clinical Professor, Department of Pharmacy Practice and Translational Research	• Jones & Bartlett Learning	None	None	None	• Accreditation Council for Clinical Lipidology†	None	• Walgreens*
Roger Blumenthal	Official Reviewer—Prevention Subcommittee	Johns Hopkins Hospital—Kenneth Jay Pollin Professor of Cardiology; Ciccarone Center for the Prevention of Heart Disease—Director	None	None	None	None	None	None	None
Anna Dominiczak	Official Reviewer—AHA	University of Glasgow—Regius Professor of Medicine; Vice-Principal and Head of College of Medical, Veterinary and Life Sciences	None	None	None	None	None	None	None
Carlos M. Ferrario	Official Reviewer—AHA	Wake Forest School of Medicine—Professor, of Physiology and Pharmacology; Hypertension and Vascular Disease Center—Director	None	None	None	None	None	None	None
Eugene Yang	Official Reviewer—ACC-BOG	University of Washington School of Medicine—Associate Clinical Professor of Medicine; UW Medicine Eastside Specialty Center—Medical Director	• RubiconMD* • Regeneron*	None	None	• Amgen Inc.* • Gilead Sciences, Inc. (DSMB)*	None	• Third party, CAD, 2016*	None
Robert Jay Amrien	Organizational Reviewer—AAPA	Massachusetts General Hospital—Clinical Physician Assistant, Chelsea Health Center; Bryant University—Physician Assistant Program	None	None	None	None	None	• Defendant, aortic dissection, 2016*	None
Greg Holzman	Organizational Reviewer—ACPM	Montana Department of Public Health and Human Services—State Medical Officer	None	None	None	None	• American Academy of Family Medicine† • American College of Preventive Medicine†	None	None
Martha Gulati	Organizational Reviewer—ASPC	University of Arizona College of Medicine—Professor of Medicine; Chief, Division of Cardiology; University Medicine Cardiovascular Institute in Phoenix—Physician Executive Director, Banner	None	None	None	None	• REATA (spouse)*	None	None
Wallace Johnson	Organizational Reviewer—NMA	University of Maryland Medical Center—Assistant Professor of Medicine	None	None	None	Amgen†	None	None	None
Nancy Houston Miller	Organizational Reviewer—PCNA	The Lifecare Company—Associate Director	• Moving Analytics*	None	None	None	None	None	None

(*Continued*)

Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Aldo J. Peixoto	Organizational Reviewer—ASH	Yale University School of Medicine—Professor of Medicine (Nephrology); Associate Chair for Ambulatory Services Operations and Quality, Department of Internal Medicine; Clinical Chief, Section of Nephrology	• Lundbeck Inc.	None	None	• Bayer Healthcare Pharmaceuticals†	• Bayer Healthcare Pharmaceuticals	None	None
Carlos Rodriguez	Organizational Reviewer—ABC	Wake Forest University—Professor, Epidemiology and Prevention	• Amgen Inc.	None	None	None	None	None	None
Joseph Saseen	Organizational Reviewer—APhA	University of Colorado Anschutz Medical Campus—Vice-Chair, Department of Clinical Pharmacy, Skaggs School of Pharmacy and Pharmaceutical Sciences	None	None	None	None	• National Lipid Association†	• Defendant, statin use, 2016	None
Mark Supiano	Organizational Reviewer—AGS	University of Utah School of Medicine—D. Keith Barnes, MD, and Dottie Barnes Presidential Endowed Chair in Medicine; Chief, Division of Geriatrics; VA Salt Lake City Geriatric Research—Director, Education, and Clinical Center; University of Utah Center on Aging Executive—Director	None	None	None	None	• American Geriatrics Society† • Division Chief† • McGraw-Hill Medical	None	None
Sana M. Al-Khatib	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Duke Clinical Research Institute—Professor of Medicine	None	None	None	• AHRQ* • FDA* • PCORI* • VA Health System (DSMB)	• Elsevier* • NIH, NHLBI	• Third party, implantable cardioverter defibrillators, 2017	None
George Bakris	Content Reviewer	University of Chicago Medicine—Professor of Medicine; Director, Hypertensive Diseases Unit	None	None	None	• AbbVie, Inc. • Janssen, Bayer, Relypsa	None	None	None
Jan Basile	Content Reviewer	Medical University of South Carolina—Professor of Medicine, Seinsheimer Cardiovascular Health Program; Ralph H Johnson VA Medical Center—Internist	None	• Amgen Inc. • Arbor • Janssen Pharmaceuticals, Inc	None	• Eli Lilly and Company • NHLBI	None	None	None
Joshua A. Beckman	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Vanderbilt University Medical Center: Director, Cardiovascular Fellowship Program	• AstraZeneca* • Merck* • SANOFI*	None	• EMX† • JanaCare†	• Bristol Myers Squibb*	• Vascular Interventional Advances*	None	• 2015 Defendant; Venous thromboembolism*
John Bisognano	Content Reviewer	University of Rochester Medical Center—Cardiologist	• CVRx	None	None	• CVRx* • NIH*	None	None	None
Biykem Bozkurt	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Baylor College of Medicine—Medical Care Line Executive, Cardiology Chief, Gordon Cain Chair, Professor of Medicine, Debakey	None	None	None	• Novartis Corporation	None	None	None

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Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
David Calhoun	Content Reviewer	University of Alabama, Birmingham School of Medicine—Professor, Department of Cardiovascular Disease	• Novartis • Valencia Technologies*	None	None	• MEDTRONIC* • ReCor Medical*	None	None	None
Joaquin E. Cigarroa	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Oregon Health and Science University—Clinical Professor of Medicine	None	None	None	• NIH	• ACC/AHA Taskforce on Clinical Practice Guidelines† • AHA, Board of Directors, Western Affiliate† • American Stroke Association, Cryptogenic Stroke Initiative Advisory Committee† • Catheterization and Cardiovascular Intervention† • SCAI Quality Interventional Council†	• Defendant, CAD, 2011† • Defendant, sudden death/ CAD, 2010†	None
William Cushman	Content Reviewer	Memphis VA Medical Center—Chief, Preventive Medicine Section; University of Tennessee College of Medicine—Professor, Medicine, Preventive Medicine, and Physiology	None	None	None	• Lilly	• Novartis Corporation† • Takeda†	None	None
Anita Deswal	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Baylor College of Medicine—Associate Professor of Medicine	None	None	None	• NIH*	• bAurora Health Care Inc. • American Heart Association† • AHA Committee on Heart Failure and Transplantation – Chair† • Heart Failure Society of America†	None	None
Dave Dixon	Content Reviewer—Cardiovascular Team	Virginia Commonwealth University School of Pharmacy—Associate Professor	None	None	None	None	None	None	None
Ross Feldman	Content Reviewer	Winnipeg Regional Health Authority—Medical Director, Cardiac Sciences Program; University of Manitoba—Professor of Medicine	• GSK* • Servier* • Valeant Pharmaceuticals International*	None	None	None	None	None	None
Keith Ferdinand	Content Reviewer	Tulane University School of Medicine—Professor of Clinical Medicine	• Amgen Inc.* • Boehringer Ingelheim* • Eli Lilly* • Sanofi-Aventis* • Novartis • Quantum Genomics • Sanofi-Aventis*	None	None	None	• Novartis	None	None
Stephan Fihn	Content Reviewer	University of Washington—Professor of Medicine, Heath Services; Division Head, General Internal Medicine; Director, Office of Analytics and Business Intelligence for the Veterans Health Administration; VA Puget Sound Health Care System—General Internist	None	None	None	None	• University of Washington	None	None

(*Continued*)

Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Lawrence Fine	Content Reviewer	National Heart, Lung and Blood Institute—Chief, Clinical Applications and Prevention Branch, Division of Prevention and Population Sciences	None	None	None	None	• NIH*	None	None
John Flack	Content Reviewer	Southern Illinois University School of Medicine—Chair and Professor Department of Internal Medicine; Chief, Hypertension Specialty Services	• Regeneron* • NuSirt	None	None	• Bayer Healthcare Pharmaceuticals† • GSK†	• American Journal of Hypertension* • CardioRenal Medicine† • International Journal of Hypertension† • Southern Illinois University Department of Medicine*	None	None
Joseph Flynn	Content Reviewer	Seattle Children's Hospital—Chief of the Division of Nephrology; University of Washington School of Medicine—Professor of Pediatrics	• Ultragenyx, Inc. (DSMB)	None	None	None	• UpToDate, Springer*	None	None
Federico Gentile	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Centro Cardiologico	None	None	None	None	None	None	None
Joel Handler	Content Reviewer	Kaiser Permanente—Physician; National Kaiser Permanente Hypertension—Clinical Leader	None	None	None	None	None	None	None
Hani Jneid	Content Reviewer—ACC/AHA Task Force on Clinical Data Standards	Baylor College of Medicine—Associate Professor of Medicine, MEDVAMC	None	None	None	None	None	None	None
José A. Joglar	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	UT Southwestern Medical Center—Professor of Internal Medicine; Cardiovascular Clinical Research Center—Director	None	None	None	None	None	None	None
Amit Khera	Content Reviewer	University of Texas Southwestern Medical Center—Assistant Professor of Medicine	None	None	None	None	None	None	None
Glenn N. Levine	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Baylor College of Medicine—Professor of Medicine; Director, Cardiac Care Unit	None	None	None	None	None	• Defendant, catheterization laboratory procedure, 2016 • Defendant, interpretation of ECG of a patient, 2014 • Defendant, interpretation of angiogram (non-ACS), 2014 • Defendant, out-of-hospital death, 2016	None

(*Continued*)

Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Giuseppe Mancia	Content Reviewer	University of Milan-Bicocca—Professor of Medicine; Chairman, Department of Clinical Medicine, Prevention and Applied Biotechnologies	• Boehringer Ingelheim* • CVRx • Ferrer • MEDTRONIC • Menarini International* • Recordati • Servier International* • Actavis	None	None	None	• Novartis*	None	None
Andrew Miller	Content Reviewer—Geriatric Cardiology Section	Cardiovascular Associates—Cardiologist	None	None	None	• Novartis Corporation† • Pfizer Inc†	• Bristol-Myers Squibb Company • Janssen Pharmaceuticals, Inc. • NIH	None	None
Pamela Morris	Content Reviewer—Prevention Council, Chair	Seinsheimer Cardiovascular Health Program—Director; Women's Heart Care Medical University of South Carolina—Co-Director	• Amgen Inc. • AstraZeneca • Sanofi Regeneron	None	None	• Amgen Inc.	None	None	None
Martin Myers	Content Reviewer	Sunnybrook Health Sciences Centre—Affiliate Scientist; University of Toronto—Professor, Cardiology	• Ideal Life Inc*	None	None	None	None	None	None
Rick Nishimura	Content Reviewer	Mayo Clinic College of Medicine—Judd and Mary Morris Leighton Professor of Medicine; Mayo Clinic—Division of Cardiovascular Diseases	None	None	None	None	None	None	None
Patrick T. O'Gara	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	Harvard Medical School—Professor of Medicine; Brigham and Women's Hospital—Director, Strategic Planning, Cardiovascular Division	None	None	None	None	• MEDTRONIC • NIH*	None	None
Suzanne Oparil	Content Reviewer	University of Alabama at Birmingham—Distinguished Professor of Medicine; Professor of Cell, Developmental and Integrative Biology, Division of Cardiology	• Actelion • Lundbeck • Novo Nordisk, Inc.	None	None	• AstraZeneca (Duke University)* • Bayer Healthcare Pharmaceuticals, Inc.* • Novartis* • NIH*	• NIH/NHLBI, • Takeda WHF/ESH/EPH	None	None
Carl Pepine	Content Reviewer—CV Disease in Women Committee	Shands Hospital at University of Florida—Professor of Medicine, Chief of Cardiovascular Medicine	None	None	None	• Capricor, Inc. • NIH • Cytori Therapeutics, Inc. • Sanofi-Aventis • InVentive Health Clinical. LLC	None	None	None
Mahboob Rahman	Content Reviewer	Case Western Reserve University School of Medicine—Professor of Medicine	None	None	None	None	None	None	None
Vankata Ram	Content Reviewer	UT Southwestern Medical Center; Apollo Institute for Blood Pressure Clinics	None	None	None	None	None	None	None
Barbara Riegel	Content Reviewer—ACC/AHA Task Force on Clinical Practice Guidelines	University of Pennsylvania School of Nursing- Professor	None	None	None	• Co-Investigator-mentor† • Co-investigator NIH • NIH grant • PCORI	• Novartis Corp†	None	None

(*Continued*)

Appendix 2. Continued

Reviewer	Representation	Employment	Consultant	Speakers Bureau	Ownership/ Partnership/ Principal	Personal Research	Institutional, Organizational, or Other Financial Benefit	Expert Witness	Salary
Edward Roccella	Content Reviewer	National Heart, Lung, and Blood Institute—Coordinator, National High Blood Pressure Education Program	• Medical University of South Carolina	None	None	None	• American Society of Hypertension† • Consortium for Southeast Hypertension Control† • Consortium Southeast Hypertension Control • Inter American Society of Hypertension†	None	None
Ernesto Schiffrin	Content Reviewer	Jewish General Hospital—Physician-in-Chief, Chief of the Department of Medicine and Director of the Cardiovascular Prevention Centre; McGill University—Professor, Department of Medicine, Division of Experimental Medicine	• Novartis • Servier	• Novartis	None	• Servier* • Canadian Institutes for Health Research*	• CME Medical Grand Rounds	None	None
Raymond Townsend	Content Reviewer	University of Pennsylvania School of Medicine—Professor of Medicine; Director, Hypertension Section, Department of Internal Medicine/Renal; Institute for Translational Medicine and Therapeutics—Member	• MEDTRONIC	None	None	• NIH*	• ASN • UpToDate	None	None
Michael Weber	Content Reviewer	SUNY Downstate College of Medicine—Professor of Medicine	• Ablative Solutions* • Allergan, Inc • Astellas Pharma US* • Boston Scientific* • Eli Lilly and Company • MEDTRONIC* • Novartis • Recor	• Menarini* • Merck & Co., Inc.*	None	None	None	None	None

This table represents the relationships of reviewers with industry and other entities that were disclosed at the time of peer review, including those not deemed to be relevant to this document, at the time this document was under review. The table does not necessarily reflect relationships with industry at the time of publication. A person is deemed to have a significant interest in a business if the interest represents ownership of ≥5% of the voting stock or share of the business entity, or ownership of ≥$5 000 of the fair market value of the business entity; or if funds received by the person from the business entity exceed 5% of the person's gross income for the previous year. Relationships that exist with no financial benefit are also included for the purpose of transparency. Relationships in this table are modest unless otherwise noted. Names are listed in alphabetical order within each category of review. Please refer to http://www.acc.org/guidelines/about-guidelines-and-clinical-documents/relationships-with-industry-policy for definitions of disclosure categories or additional information about the ACC/AHA Disclosure Policy for Writing Committees.

*Significant relationship.

†No financial benefit.

AHRQ indicates Agency for Healthcare Research and Quality; AAPA, American Academy of Physician Assistants; ACC, American College of Cardiology; ACPM, American College of Preventive Medicine; AGS, American Geriatrics Society; AHA, American Heart Association; APhA, American Pharmacists Association; ASH, American Society of Hypertension; ASPC, American Society for Preventive Cardiology; ABC, Association of Black Cardiologists; BOG, Board of Governors; CME, continuing medical education; DSMB, Data and Safety Monitoring Board; FDA, US Food and Drug Administration; NHLBI, National Heart, Lung, and Blood Institute; NIH, National Institutes of Health; NMA, National Medical Association; PCNA, Preventive Cardiovascular Nurses Association; PCORI, Patient-Centered Outcomes Research Institute; SCAI, Society for Cardiovascular Angiography and Interventions; SUNY, State University of New York; TFPG, Task Force on Practice Guidelines; and UT, University of Texas.