

## 2020 International Society of Hypertension Global Hypertension Practice Guidelines

Thomas Unger, Claudio Borghi, Fadi Charchar, Nadia A. Khan, Neil R. Poulter, Dorairaj Prabhakaran, Agustin Ramirez, Markus Schlaich, George S. Stergiou, Maciej Tomaszewski, Richard D. Wainford, Bryan Williams, Aletta E. Schutte

### Table of Contents

Section 1.	Introduction.....	1334
Section 2.	Definition of Hypertension .....	1336
Section 3.	Blood Pressure Measurement and Diagnosis of Hypertension .....	1336
Section 4.	Diagnostic and Clinical Tests .....	1337
Section 5.	Cardiovascular Risk Factors .....	1339
Section 6.	Hypertension-Mediated Organ Damage .....	1340
Section 7.	Exacerbators and Inducers of Hypertension .....	1341
Section 8.	Treatment of Hypertension .....	1341
	8.1 Lifestyle Modification.....	1341
	8.2 Pharmacological Treatment .....	1341
	8.3 Adherence to Antihypertensive Treatment .....	1341
Section 9.	Common and Other Comorbidities of Hypertension .....	1342
Section 10.	Specific Circumstances.....	1346
	10.1 Resistant Hypertension .....	1346
	10.2 Secondary Hypertension .....	1346
	10.3 Hypertension in Pregnancy .....	1347
	10.4 Hypertensive Emergencies .....	1348
	10.5 Ethnicity, Race and Hypertension .....	1350
Section 11.	Resources.....	1350
Section 12.	Hypertension Management at a Glance.....	1352
	Acknowledgments.....	1354
	References.....	1354

### Section 1: Introduction

#### Context and Purpose of This Guideline

##### Statement of Remit

To align with its mission to reduce the global burden of raised blood pressure (BP), the International Society of Hypertension (ISH) has developed worldwide practice guidelines for the management of hypertension in adults, aged 18 years and older.

The ISH Guidelines Committee extracted evidence-based content presented in recently published extensively reviewed guidelines and tailored **ESSENTIAL** and **OPTIMAL** standards of care in a practical format that is easy-to-use particularly in low, but also in high resource settings – by clinicians, but also nurses and community health workers, as appropriate. Although distinction between low and high resource settings often refers to high (HIC) and low- and middle-income countries (LMIC), it is well established that in HIC there are areas with low resource settings, and vice versa.

Herein optimal care refers to evidence-based standard of care articulated in recent guidelines<sup>1,2</sup> and summarized here, whereas **ESSENTIAL** standards recognize that **OPTIMAL** standards would not always be possible. Hence essential standards refer to minimum standards of care. To allow specification of essential standards of care for low resource settings, the Committee was often confronted with the limitation or absence in clinical evidence, and thus applied expert opinion.

Received March 6, 2020; first decision March 16, 2020; revision accepted March 27, 2020.

From the CARIM – School for Cardiovascular Diseases, Maastricht University, the Netherlands (T.U.); Department of Medical and Surgical Sciences, University of Bologna, Italy (C.B.); Federation University Australia, School of Health and Life Sciences, Ballarat, Australia (F.C.); University of Melbourne, Department of Physiology, Melbourne, Australia (F.C.); University of Leicester, Department of Cardiovascular Sciences, United Kingdom (F.C.); University of British Columbia, Vancouver, Canada (N.A.K.); Center for Health Evaluation and Outcomes Sciences, Vancouver, Canada (N.A.K.); Imperial Clinical Trials Unit, Imperial College London, United Kingdom (N.R.P.); Public Health Foundation of India, New Delhi, India (D.P.); Centre for Chronic Disease Control, New Delhi, India (D.P.); London School of Hygiene and Tropical Medicine, United Kingdom (D.P.); Hypertension and Metabolic Unit, University Hospital, Favaloro Foundation, Buenos Aires, Argentina (A.R.); Dobney Hypertension Centre, School of Medicine, Royal Perth Hospital Unit, University of Western Australia, Perth (M.S.); Neurovascular Hypertension & Kidney Disease Laboratory, Baker Heart and Diabetes Institute, Melbourne, Victoria, Australia (M.N.); Hypertension Center STRIDE-7, School of Medicine, Third Department of Medicine, Sotiria Hospital, National and Kapodistrian University of Athens, Greece (G.S.S.); Division of Cardiovascular Sciences, Faculty of Medicine, Biology and Health, University of Manchester, United Kingdom (M.T.); Division of Medicine and Manchester Academic Health Science Centre, Manchester University NHS Foundation Trust Manchester, United Kingdom (M.T.); Department of Pharmacology and Experimental Therapeutics, Boston University School of Medicine, MA (R.D.W.); The Whitaker Cardiovascular Institute, Boston University, MA (R.D.W.); Department of Health Sciences, Boston University Sargent College, MA (R.D.W.); University College London, NIHR University College London, Hospitals Biomedical Research Centre, London, United Kingdom (B.W.); Faculty of Medicine, University of New South Wales, Sydney, Australia (A.E.S.); The George Institute for Global Health, Sydney, Australia (A.E.S.); and Hypertension in Africa Research Team (A.E.S.) and South African MRC Unit for Hypertension and Cardiovascular Disease (A.E.S.), North-West University, Potchefstroom, South Africa.

This article has been copublished in the Journal of Hypertension.

Correspondence to Thomas Unger, CARIM-Maastricht University, P.O. Box 616, 6200 MD Maastricht, the Netherlands. Email thomas.unger@maastrichtuniversity.nl

(*Hypertension*. 2020;75:1334-1357. DOI: 10.1161/HYPERTENSIONAHA.120.15026.)

© 2020 American Heart Association, Inc.

*Hypertension* is available at <https://www.ahajournals.org/journal/hyp>

DOI: 10.1161/HYPERTENSIONAHA.120.15026

### Abbreviations

ABI	ankle-brachial index
ABPM	ambulatory blood pressure monitoring
ACE	angiotensin converting enzyme
ARB	angiotensin AT-1 receptor blocker
ARNI	angiotensin receptor-neprilysin inhibitors
BMI	body mass index
BP	blood pressure
CAD	coronary artery disease
CCBs	calcium channel blockers
CKD	chronic kidney disease
COPD	chronic obstructive pulmonary disease
CVD	cardiovascular disease
DBP	diastolic blood pressure
DHP-CCB	dihydropyridine calcium channel blocker
DM	diabetes mellitus
DRI	direct renin inhibitor
ECG	electrocardiogram
eGFR	estimated glomerular filtration rate
ESC-ESH	European Society of Cardiology, European Society of Hypertension
HBPM	home blood pressure measurement
HDL	high density lipoprotein
HELLP	hemolysis, elevated liver enzymes and low platelets
HF	heart failure
HFpEF	heart failure with preserved ejection fraction
HFREF	heart failure with reduced ejection fraction
HIC	high-income countries
HIIT	high intensity interval training
HIV	human immunodeficiency virus
HMOD	hypertension-mediated organ damage
IMT	intima media thickness
IRD	inflammatory rheumatic disease
ISH	International Society of Hypertension
LDH	lactate dehydrogenase
LDL-C	low-density lipoprotein cholesterol
LMIC	low- and middle-income countries
LV	left ventricular
LVH	left ventricular hypertrophy
MAP	mean arterial pressure
MRI	magnetic resonance imaging
MS	metabolic syndrome
NSAIDs	nonsteroidal anti-inflammatory drugs
PWV	pulse wave velocity
RAAS	renin angiotensin aldosterone system
RAS	renin-angiotensin system
RCT	randomized control trials
SBP	systolic blood pressure
SNRI	selective norepinephrine and serotonin reuptake inhibitors
SPC	single pill combination therapy

SRI	serotonin reuptake inhibitors
SSRI	selective serotonin reuptake inhibitors
s-UA	serum uric acid
T4	thyroxin 4
TIA	transient ischemic attack
TMA	thrombotic microangiopathy
TSH	thyroid stimulating hormone
TTE	two-dimensional transthoracic echocardiogram
UACR	urinary albumin creatinine ratio

In the Guidelines, differentiation between optimal and essential standards were not always possible, and were made in sections where it was most practical and sensible. The Guidelines Committee is also aware that some recommended essential standards may not be feasible in low resource settings, for example, out-of-office BP measurements, the requirement of multiple visits for the diagnosis of hypertension, or advising the use of single pill combination therapy. Although challenging to implement, these guidelines may aid in local initiatives to motivate policy changes and serve as an instrument to drive local improvements in standards of care. Every effort should be made to achieve essential standards of care to reduce hypertension-induced cardiovascular morbidity and mortality.

#### Motivation

Raised BP remains the leading cause of death globally, accounting for 10.4 million deaths per year.<sup>3</sup> When reviewing global figures, an estimated 1.39 billion people had hypertension in 2010.<sup>4</sup> However, BP trends show a clear shift of the highest BPs from high-income to low-income regions,<sup>5</sup> with an estimated 349 million with hypertension in HIC and 1.04 billion in LMICs.<sup>4</sup>

The large disparities in the regional burden of hypertension are accompanied by low levels of awareness, treatment and control rates in LMIC, when compared to HIC. In response to poor global awareness for hypertension (estimated 67% in HIC and 38% in LMIC),<sup>4</sup> the ISH launched a global campaign to increase awareness of raised BP, namely the May Measurement Month initiative.<sup>6,7</sup>

Despite several initiatives, the prevalence of raised BP and adverse impact on cardiovascular morbidity and mortality are increasing globally, irrespective of income.<sup>4,5</sup> It is therefore critical that population-based initiatives are applied to reduce the global burden of raised BP, such as salt-reduction activities and improving the availability of fresh fruit and vegetables. To improve the management of hypertension, the ISH has published in 2014 with the American Society of Hypertension, Clinical Practice Guidelines for the Management of Hypertension in the Community (See Section 11: Resources). Recently, we have observed a recent flurry of updated evidence-based guidelines arising mainly from high-income regions and countries, including the United States of America,<sup>2</sup> Europe,<sup>1</sup> United Kingdom,<sup>8</sup> Canada<sup>9</sup> and Japan.<sup>10</sup> New developments include redefining hypertension,<sup>2</sup> initiating treatment with a single pill combination therapy,<sup>1</sup>

**Table 1. Classification of Hypertension Based on Office Blood Pressure (BP) Measurement**

Category	Systolic (mm Hg)		Diastolic (mm Hg)
Normal BP	<130	and	<85
High-normal BP	130–139	and/or	85–89
Grade 1 hypertension	140–159	and/or	90–99
Grade 2 hypertension	≥160	and/or	≥100

advising wider out-of-office BP measurement,<sup>2,10</sup> and lower BP targets.<sup>1,2,8,11,12</sup>

Low- and middle-income regions often follow the release of guidelines from high-income regions closely, as their resources and health systems to develop and implement local guidelines remain challenging. In Africa only 25% of countries have hypertension guidelines<sup>13</sup> and in many instances these guidelines are adopted from those of high-income regions. However, the adoption of guidelines from high-income regions are sometimes impractical as low resource settings are confronted with a substantial number of obstacles including severe lack of trained health-care professionals, unreliable electricity in rural clinics, low access to basic office BP devices and limited ability to conduct basic recommended diagnostic procedures and poor access to affordable high-quality medications. In both low and high-income regions, the ambiguities of latest guidelines are often met with confusion among healthcare providers, anxiety among patients,<sup>14</sup> and they resulted in a call for global harmonization.<sup>15</sup> Guidelines from high-income regions may thus not fit global purpose.<sup>16</sup>

### Guideline Development Process

The 2020 ISH Global Hypertension Practice Guidelines were developed by the ISH Hypertension Guidelines Committee based on evidence criteria, (1) to be used globally; (2) to be fit for application in low and high resource settings by advising on essential and optimal standards; and (3) to be concise, simplified, and easy to use. They were critically reviewed and evaluated by numerous external hypertension experts from HIC and LMIC with expertise in the optimal management of hypertension and management in resource-constraint settings. These Guidelines were developed without any support from industry or other sources.

### Composition of the ISH Hypertension Guidelines Committee and Selection of External Reviewers

The ISH Hypertension Guidelines Committee was composed of members of the ISH Council; they were included on the basis of (1) specific expertise in different areas of hypertension; (2) previous experience with the generation of hypertension guidelines, as well as (3) representation of different regions of the world. A similar strategy was followed concerning the selection of external reviewers with particular consideration of representatives from LMICs.

## Section 2: Definition of Hypertension

- In accordance with most major guidelines it is recommended that hypertension be diagnosed when a person's systolic blood pressure (SBP) in the office or clinic is ≥140 mm Hg and/or their diastolic blood

**Table 2. Criteria for Hypertension Based on Office-, Ambulatory (ABPM)-, and Home Blood Pressure (HBPM) Measurement**

	SBP/DBP, mm Hg
Office BP	≥140 and/or ≥90
ABPM	
24-h average	≥130 and/or ≥80
Day time (or awake) average	≥135 and/or ≥85
Night time (or asleep) average	≥120 and/or ≥70
HBPM	≥135 and/or ≥85

pressure (DBP) is ≥90 mm Hg following repeated examination (see below, Section 3). Table 1 provides a classification of BP based on office BP measurement, Table 2 provides ambulatory and home BP values used to define hypertension; these definitions apply to all adults (>18 year old). These BP categories are designed to align therapeutic approaches with BP levels.

- High-normal BP is intended to identify individuals who could benefit from lifestyle interventions and who would receive pharmacological treatment if compelling indications are present (see Section 9).
- Isolated systolic hypertension defined as elevated SBP (≥140 mm Hg) and low DBP (<90 mm Hg) is common in young and in elderly people. In young individuals, including children, adolescents and young adults, isolated systolic hypertension is the most common form of essential hypertension. However, it is also particularly common in the elderly, in whom it reflects stiffening of the large arteries with an increase in pulse pressure (difference between SBP and DBP).
- Individuals identified with confirmed hypertension (grade 1 and grade 2) should receive appropriate pharmacological treatment.
- Details of home-, office- and ambulatory BP measurement techniques are addressed in Section 3.

## Section 3: Blood Pressure Measurement and Diagnosis of Hypertension

### ESSENTIAL

### Hypertension Diagnosis – Office BP Measurement

- The measurement of BP in the office or clinic is most commonly the basis for hypertension diagnosis and follow-up. Office BP should be measured according to recommendations shown in Table 3 and Figure 1.<sup>1,2,17,18</sup>
- Whenever possible, the diagnosis should not be made on a single office visit. Usually 2–3 office visits at 1–4-week intervals (depending on the BP level) are required to confirm the diagnosis of hypertension. The diagnosis might be made on a single visit, if BP is ≥180/110 mm Hg and there is evidence of cardiovascular disease (CVD).<sup>1,2,17,18</sup>
- The recommended patient management according to office BP levels is presented in Table 4.
- If possible and available, the diagnosis of hypertension should be confirmed by out-of-office BP measurement (see below).<sup>1,2,19–21</sup>

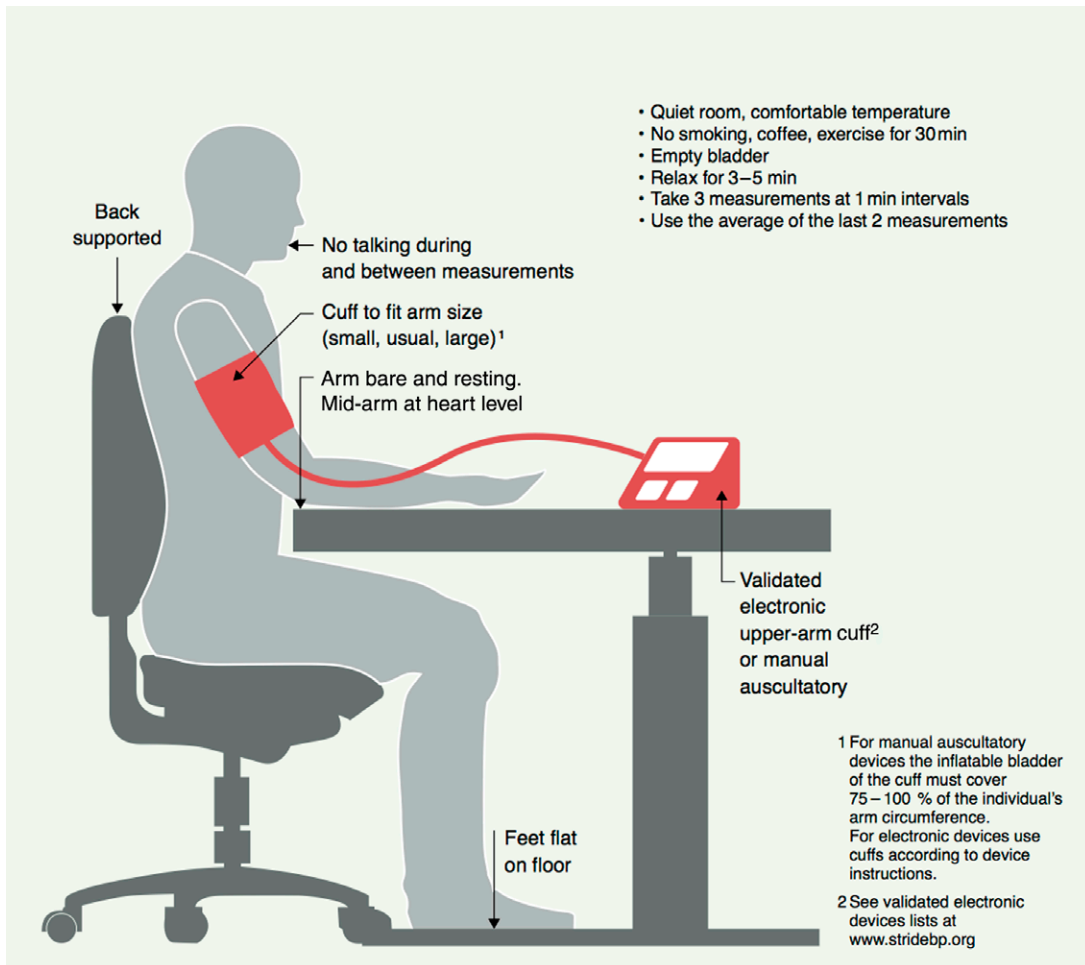
**Table 3. Recommendations for Office Blood Pressure Measurement**

Conditions	<ul style="list-style-type: none"> <li>• Quiet room with comfortable temperature.</li> <li>• Before measurements: Avoid smoking, caffeine and exercise for 30 min; empty bladder; remain seated and relaxed for 3–5 min.</li> <li>• Neither patient nor staff should talk before, during and between measurements.</li> </ul>
Positions	<ul style="list-style-type: none"> <li>• Sitting: Arm resting on table with mid-arm at heart level; back supported on chair; legs uncrossed and feet flat on floor (Figure 1).</li> </ul>
Device	<ul style="list-style-type: none"> <li>• Validated electronic (oscillometric) upper-arm cuff device. Lists of accurate electronic devices for office, home and ambulatory BP measurement in adults, children and pregnant women are available at <a href="http://www.stridebp.org">www.stridebp.org</a>.<sup>22</sup> (see also Section 11: Resources)</li> <li>• Alternatively use a calibrated auscultatory device, (aneroid, or hybrid as mercury sphygmomanometers are banned in most countries) with 1st Korotkoff sound for systolic blood pressure and 5th for diastolic with a low deflation rate.<sup>22</sup></li> </ul>
Cuff	<ul style="list-style-type: none"> <li>• Size according to the individual’s arm circumference (smaller cuff overestimates and larger cuff underestimates blood pressure).</li> <li>• For manual auscultatory devices the inflatable bladder of the cuff must cover 75%–100% of the individual’s arm circumference. For electronic devices use cuffs according to device instructions.</li> </ul>
Protocol	<ul style="list-style-type: none"> <li>• At each visit take 3 measurements with 1 min between them. Calculate the average of the last 2 measurements. If BP of first reading is &lt;130/85 mm Hg no further measurement is required.</li> </ul>
Interpretation	<ul style="list-style-type: none"> <li>• Blood pressure of 2–3 office visits <math>\geq 140/90</math> mm Hg indicates hypertension.</li> </ul>

**OPTIMAL**  
**Hypertension Diagnosis – Office Blood Pressure Measurement**

- **Initial evaluation:** Measure BP in both arms, preferably simultaneously. If there is a consistent difference between arms >10 mm Hg in repeated measurements,

- use the arm with the higher BP. If the difference is >20 mm Hg consider further investigation.
- **Standing blood pressure:** Measure in treated hypertensives after 1 min and again after 3 min when there are symptoms suggesting postural hypotension and at the first visit in the elderly and people with diabetes.



**Figure 1. ESSENTIAL** How to measure blood pressure.

- **Unattended office blood pressure:** Multiple automated BP measurements taken while the patient remains alone in the office provide a more standardized evaluation but also lower BP levels than usual office measurements with uncertain threshold for hypertension diagnosis.<sup>17,18,23,24</sup> Confirmation with out-of-office BP is again needed for most treatment decisions.

**Hypertension Diagnosis – Out-of-Office Blood Pressure Measurement**

- Out-of-office BP measurements (by patients at home or with 24-hour ambulatory blood pressure monitoring [ABPM]) are more reproducible than office measurements, more closely associated with hypertension-induced organ damage and the risk of cardiovascular events and identify the white coat and masked hypertension phenomena (see below).
- Out-of-office BP measurement is often necessary for the accurate diagnosis of hypertension and for treatment decisions. In untreated or treated subjects with office BP classified as high-normal BP or grade 1 hypertension (systolic 130–159 mmHg and/or diastolic 85–99 mmHg), the BP level needs to be confirmed using home or ambulatory BP monitoring (Table 5).<sup>1,2,17,21</sup>
- Recommendations for performing home and ambulatory BP measurement are presented in Table 5.

**White Coat and Masked Hypertension**

- The use of office and out-of-office (home or ambulatory) BP measurements identifies individuals with white coat hypertension, who have elevated BP only in the office (nonelevated ambulatory or home BP), and those with masked hypertension, who have nonelevated BP in the office but elevated BP out of the office (ambulatory or home).<sup>1,2,17–21,25–27</sup> These conditions are common among both untreated subjects and those treated for hypertension. About 10%–30% of subjects attending clinics due to high BP have white coat hypertension and 10%–15% have masked hypertension.
- **White coat hypertension:** These subjects are at intermediate cardiovascular risk between normotensives and sustained hypertensives. The diagnosis needs confirmation with repeated office and out-of-office BP measurements. If their total cardiovascular risk is low and there is no hypertension-mediated organ damage (HMOD), drug treatment may not be prescribed. However, they should be followed with lifestyle modification, as they

**Table 4. Blood Pressure Measurement Plan According to Office Blood Pressure Levels**

Office Blood Pressure Levels (mm Hg)		
<130/85	130–159/85–99	>160/100
Remeasure within 3 years (1 year in those with other risk factors)	If possible confirm with out-of-office blood pressure measurement (high possibility of white coat or masked hypertension). Alternatively confirm with repeated office visits.	Confirm within a few days or weeks

**Table 5. Clinical Use of Home and Ambulatory Blood Pressure (BP) Monitoring**

	Home Blood Pressure Monitoring	24-Hour Ambulatory Blood Pressure Monitoring
Condition	As for office blood pressure (see above).	Routine working day.
Position	As for office BP (see above).	Avoid strenuous activity. Arm still and relaxed during each measurement.
Device	Validated electronic (oscillometric) upper-arm cuff device (www.stridebp.org, and Section 11: Resources)	
Cuff	Size according to the individual’s arm circumference	
Measurement protocol	Before each visit to the health professional: <ul style="list-style-type: none"> <li>• 3–7-day monitoring in the morning (before drug intake if treated) and the evening.</li> <li>• Two measurements on each occasion after 5 min sitting rest and 1 min between measurements.</li> </ul> Long-term follow-up of treated hypertension: <ul style="list-style-type: none"> <li>• 1–2 measurements per week or month.</li> </ul>	<ul style="list-style-type: none"> <li>• 24-hour monitoring at 15–30 min intervals during daytime and nighttime.</li> <li>• At least 20 valid daytime and 7 nighttime BP readings are required. If less, the test should be repeated.</li> </ul>
Interpretation	<ul style="list-style-type: none"> <li>• Average home blood pressure after excluding readings of the first day <math>\geq 135</math> or 85 mmHg indicates hypertension.</li> </ul>	<ul style="list-style-type: none"> <li>• 24-hour ambulatory blood pressure <math>\geq 130/80</math> mmHg indicates hypertension (primary criterion).</li> <li>• Daytime (awake) ambulatory blood pressure <math>\geq 135/85</math> mmHg and nighttime (asleep) <math>\geq 120/70</math> mmHg indicates hypertension</li> </ul>

may develop sustained hypertension requiring drug treatment.<sup>1,2,17–21,25–27</sup>

- **Masked hypertension:** These patients are at similar risk of cardiovascular events as sustained hypertensives. The diagnosis needs confirmation with repeated office and out-of-office measurements. Masked hypertension may require drug treatment aiming to normalize out-of-office BP.<sup>1,2,17–21,25–27</sup>

**Section 4: Diagnostic / Clinical Tests**

**ESSENTIAL**

**Medical History**

Patients with hypertension are often asymptomatic, however specific symptoms can suggest secondary hypertension or hypertensive complications that require further investigation. A complete medical and family history is recommended and should include<sup>1</sup>:

- **Blood pressure:** New onset hypertension, duration, previous BP levels, current and previous antihypertensive medication, other medications/over-the-counter medicines that can influence BP, history of intolerance (side-effects) of antihypertensive medications, adherence to antihypertensive treatment, previous hypertension with oral contraceptives or pregnancy.
- **Risk factors:** Personal history of CVD (myocardial infarction, heart failure [HF], stroke, transient ischemic attacks [TIA], diabetes, dyslipidemia, chronic kidney disease [CKD], smoking status, diet, alcohol intake, physical activity, psychosocial aspects, history of depression). Family history of hypertension, premature CVD, (familial) hypercholesterolemia, diabetes.
- **Assessment of overall cardiovascular risk:** In line with local guidelines/recommendations (see risk scores in Section 11 at the end of the document).
- **Symptoms/signs of hypertension/coexistent illnesses:** Chest pain, shortness of breath, palpitations, claudication, peripheral edema, headaches, blurred vision, nocturia, hematuria, dizziness.
- **Symptoms suggestive of secondary hypertension:** Muscle weakness/tetany, cramps, arrhythmias (hypokalemia/primary aldosteronism), flash pulmonary edema (renal artery stenosis), sweating, palpitations, frequent headaches (pheochromocytoma), snoring, daytime sleepiness (obstructive sleep apnea), symptoms suggestive of thyroid disease (see Section 10 for full list of symptoms).

### Physical Examination

A thorough physical examination can assist with confirming the diagnosis of hypertension and the identification of HMOD and/or secondary hypertension and should include:

- **Circulation and heart:** Pulse rate/rhythm/character, jugular venous pulse/pressure, apex beat, extra heart sounds, basal crackles, peripheral edema, bruits (carotid, abdominal, femoral), radio-femoral delay.
- **Other organs/systems:** Enlarged kidneys, neck circumference >40 cm (obstructive sleep apnea), enlarged thyroid, increased body mass index (BMI)/waist circumference, fatty deposits and coloured striae (Cushing disease/syndrome).

### Laboratory Investigations and ECG

- **Blood tests:** Sodium, potassium, serum creatinine and estimated glomerular filtration rate (eGFR). If available, lipid profile and fasting glucose.
- **Urine test:** Dipstick urine test.
- **12-lead ECG:** Detection of atrial fibrillation, left ventricular hypertrophy (LVH), ischemic heart disease.

#### OPTIMAL

### Additional Diagnostic Tests

Additional investigations when indicated can be undertaken to assess and confirm suspicion of HMOD, coexistent diseases or/and secondary hypertension.

### Imaging Techniques

- **Echocardiography:** LVH, systolic/diastolic dysfunction, atrial dilation, aortic coarctation.

- **Carotid ultrasound:** Plaques (atherosclerosis), stenosis.
- **Kidneys/renal artery and adrenal imaging:** Ultrasound/renal artery Duplex; CT-/MR-angiography: renal parenchymal disease, renal artery stenosis, adrenal lesions, other abdominal pathology.
- **Fundoscopy:** Retinal changes, hemorrhages, papilloedema, tortuosity, nipping.
- **Brain CT/MRI:** Ischemic or hemorrhagic brain injury due to hypertension.

### Functional Tests and Additional Laboratory Investigations

- **Ankle-brachial index:** Peripheral (lower extremity) artery disease.
- **Further testing for secondary hypertension if suspected:** Aldosterone-renin ratio, plasma free metanephrines, late-night salivary cortisol or other screening tests for cortisol excess.
- Urinary albumin/creatinine ratio
- Serum uric acid (s-UA) levels
- Liver function tests

## Section 5: Cardiovascular Risk Factors

### Diagnostic Approach

- More than 50% of hypertensive patients have additional cardiovascular risk factors.<sup>28,29</sup>
- The most common additional risk factors are diabetes (15%–20%), lipid disorders (elevated low-density lipoprotein-cholesterol [LDL-C] and triglycerides [30%]), overweight-obesity (40%), hyperuricemia (25%) and metabolic syndrome (40%), as well as unhealthy lifestyle habits (eg, smoking, high alcohol intake, sedentary lifestyle).<sup>28–30</sup>
- The presence of one or more additional cardiovascular risk factors proportionally increases the risk of coronary, cerebrovascular, and renal diseases in hypertensive patients.<sup>1</sup>

#### ESSENTIAL

- An evaluation of additional risk factors should be part of the diagnostic workup in hypertensive patients particularly in the presence of a family history of CVD.
- Cardiovascular risk should be assessed in all hypertensive patients by easy-to-use scores based on BP levels and additional risk factors according to a simplified version of the approach proposed by ESC-ESH Guidelines (Table 6).<sup>1</sup>
- A reliable estimate of cardiovascular risk can be obtained in daily practice by including:
- **Other Risk Factors:** Age (>65 years), sex (male>female), heart rate (>80 beats/min), increased body weight, diabetes, high LDL-C/triglyceride, family history of CVD, family history of hypertension, early-onset menopause, smoking habits, psychosocial or socioeconomic factors. **HMOD:** LVH (LVH with ECG), moderate-severe CKD (CKD; eGFR <60 ml/min/1.73m<sup>2</sup>), any other available measure of organ damage. **Disease:** previous coronary heart disease (CHD), HF, stroke, peripheral vascular disease, atrial fibrillation, CKD stage 3+.

**Table 6. Simplified Classification of Hypertension Risk according to additional Risk Factors, Hypertension-Mediated Organ Damage (HMOD), and Previous Disease\***

Other Risk Factors, HMOD, or Disease	High-Normal SBP 130–139 DBP 85–89	Grade 1 SBP 140–159 DBP 90–99	Grade 2 SBP ≥160 DBP ≥100	
No other risk factors	Low	Low	Moderate	High
1 or 2 risk factors	Low	Moderate	High	
≥3 risk factors	Low	Moderate	High	High
HMOD, CKD grade 3, diabetes mellitus, CVD	High	High	High	

\*Example based on a 60 year old male patient. Categories of risk will vary according to age and sex.

- The therapeutic strategy must include lifestyle changes, BP control to target and the effective treatment of the other risk factors to reduce the residual cardiovascular risk.
- The combined treatment of hypertension and additional cardiovascular risk factors reduces the rate of CVD beyond BP control.

### Other Additional Risk Factors

- Elevated serum uric acid (s-UA) is common in patients with hypertension and should be treated with diet, urate influencing drugs (losartan, fibrates, atorvastatin) or urate lowering drugs in symptomatic patients (gout with s-UA >6 mg/dl [0.357 mmol/L]).
- An increase in cardiovascular risk must be considered in patients with hypertension and chronic inflammatory diseases, chronic obstructive pulmonary disease (COPD), psychiatric disorders, psychosocial stressors where an effective BP control is warranted.<sup>1</sup>

## Section 6: Hypertension-Mediated Organ Damage (HMOD)

### Definition and Role of HMOD in Hypertension Management

Hypertension-mediated organ damage (HMOD) is defined as the structural or functional alteration of the arterial vasculature and/or the organs it supplies that is caused by elevated BP. End organs include the brain, the heart, the kidneys, central and peripheral arteries, and the eyes.

While assessment of overall cardiovascular risk is important for the management of hypertension, additional detection of HMOD is unlikely to change the management of those patients already identified as high risk (ie, those with established CVD, stroke, diabetes, CKD, or familial hypercholesterolemia). However, it can provide important therapeutic guidance on (1) management for hypertensive patients with low or moderate overall risk through reclassification due to presence of HMOD, and (2) preferential selection of drug treatment based on the specific impact on HMOD.<sup>1</sup>

### Specific Aspects of HMOD and Assessment

- **Brain:** TIA or strokes are common manifestations of elevated BP. Early subclinical changes can be detected most sensitively by magnetic resonance imaging (MRI) and include white matter lesions, silent microinfarcts, microbleeds, and brain atrophy. Due to costs and limited availability brain MRI is not recommended for routine practice but should be considered in patients with neurologic disturbances, cognitive decline and memory loss.
- **Heart:** A 12-lead ECG is recommended for routine workup of patients with hypertension and simple criteria (Sokolow-Lyon index: SV1+RV5 ≥35 mm, Cornell index: SV3+RaVL >28 mm for men or >20 mm for women and Cornell voltage duration product: >2440 mm•ms) are available to detect presence of LVH. Sensitivity of ECG-LVH is very limited and a two-dimensional trans-thoracic echocardiogram (TTE) is the method of choice to accurately assess LVH (left ventricular mass index [LVMI]: men >115 g/m<sup>2</sup>; women >95 g/m<sup>2</sup>) and relevant parameters including LV geometry, left atrial volume, LV systolic and diastolic function and others.
- **Kidneys:** Kidney damage can be a cause and consequence of hypertension and is best assessed routinely by simple renal function parameters (serum creatinine and eGFR) together with investigation for albuminuria (dipstick or urinary albumin creatinine ratio [UACR]) in early morning spot urine).
- **Arteries:** Three vascular beds are commonly assessed to detect arterial HMOD: (1) the carotid arteries through carotid ultrasound to detect atherosclerotic plaque burden/stenosis and intima media thickness (IMT); (2) the aorta by carotid-femoral pulse wave velocity (PWV) assessment to detect large artery stiffening; and (3) the lower extremity arteries by assessment of the ankle-brachial index (ABI). Although there is evidence to indicate that all three provide added value beyond traditional risk factors, their routine use is currently not recommended unless clinically indicated, that is, in patients with neurologic symptoms, isolated systolic hypertension, or suspected peripheral artery disease, respectively.
- **Eyes:** Fundoscopy is a simple clinical bedside test to screen for hypertensive retinopathy although interobserver and intraobserver reproducibility is limited. Fundoscopy is particularly important in hypertensive urgencies and emergencies to detect retinal hemorrhage, microaneurysms, and papilledema in patients with accelerated or malignant hypertension. Fundoscopy should be performed in patients with grade 2 hypertension, ideally by experienced examiners or alternative techniques to visualize the fundus (digital fundus cameras) where available.

#### ESSENTIAL

The following assessments to detect HMOD should be performed routinely in all patients with hypertension:

- Serum creatinine and eGFR
- Dipstick urine test
- 12-lead ECG

#### OPTIMAL

All other techniques mentioned above can add value to optimize management of hypertension in affected individuals

**Table 7. Drug/Substance Exacerbators and Inducers of Hypertension**

Drug/Substance <sup>32-43</sup>	Comments on Specific Drugs and Substances*
Nonsteroidal anti-inflammatory drugs (NSAIDs)	No difference or an increase of up to 3/1 mm Hg with celecoxib 3/1 mm Hg increase with nonselective NSAIDs No increase in blood pressure with aspirin NSAIDs can antagonize the effects of RAAS-inhibitors and beta blockers
Combined oral contraceptive pill	6/3 mm Hg increase with high doses of estrogen (>50 mcg of estrogen and 1–4 mcg progestin)
Antidepressants	2/1 mm Hg increase with SNRI (selective norepinephrine and serotonin reuptake inhibitors) Increased odds ratio of 3.19 of hypertension with tricyclic antidepressant use No increases in blood pressure with SSRI (selective serotonin reuptake inhibitors)
Acetaminophen	Increased relative risk of 1.34 of hypertension with almost daily acetaminophen use
Other medications	Steroids Antiretroviral therapy: inconsistent study findings for increased blood pressure Sympathomimetics: pseudoephedrine, cocaine, amphetamines Antimigraine serotonergics Recombinant human erythropoietin Calcineurin inhibitors Antiangiogenesis and kinase inhibitors 11 $\beta$ -hydroxysteroid dehydrogenase type 2 inhibitors
Herbal and other substances <sup>44-45</sup>	Alcohol, ma-huang, ginseng at high doses, liquorice, St. John's wort, yohimbine

\*Average increase in blood pressure or risk of hypertension. However, the effect of these medications/ substances on blood pressure may highly vary between individuals.

and should be considered where clinically indicated and available. Serial assessment of HMOD (LVH and albuminuria) to monitor regression with antihypertensive treatment may be helpful to determine the efficacy of treatment in individual patients but this has not been sufficiently validated for most measures of HMOD.

## Section 7: Exacerbators and Inducers of Hypertension

### Background

Several medications and substances may increase BP or antagonize the BP-lowering effects of antihypertensive therapy in individuals (Table 7). It is important to note that the individual effect of these substances on BP can be highly variable with greater increases noted in the elderly, those with higher baseline BP, using antihypertensive therapy or with kidney disease.

### ESSENTIAL OPTIMAL

- Screen all patients (with hypertension and those at risk for hypertension) for substances that may increase BP or interfere with the BP-lowering effect of antihypertensive medications.
- Where appropriate, consider reducing or eliminating substances that raise BP. If these substances are required or preferred, then treat BP to target regardless. (See resource<sup>31</sup> on possible antihypertensive therapies that target mechanisms underlying the raised BP induced by these substances).

## Section 8: Treatment of Hypertension

### 8.1 Lifestyle Modifications

Healthy lifestyle choices can prevent or delay the onset of high BP and can reduce cardiovascular risk.<sup>46</sup> Lifestyle modification is also the first line of antihypertensive treatment. Modifications in lifestyle can also enhance the effects of antihypertensive treatment. Lifestyle modifications should include the following (Table 8).<sup>47-64</sup>

#### Seasonal BP Variation<sup>65</sup>

BP exhibits seasonal variation with lower levels at higher temperatures and higher at lower temperatures. Similar changes occur in people traveling from places with cold to hot temperature, or the reverse. A meta-analysis showed average BP decline in summer of 5/3 mmHg (systolic/diastolic). BP changes are larger in treated hypertensives and should be considered when symptoms suggesting over-treatment appear with temperature rise, or BP is increased during cold weather. BP below the recommended goal should be considered for possible downtitration, particularly if there are symptoms suggesting overtreatment.

### 8.2 Pharmacological Treatment

Contemporary data from over 100 countries<sup>66,67</sup> suggest that on average, less than 50% of adults with hypertension receive BP-lowering medication, with few countries performing better than this and many worse. This is despite the fact that a difference in BP of 20/10 mmHg is associated with a 50% difference in cardiovascular risk.<sup>68</sup>

The pharmacological treatment strategies recommended here (Figures 2–4) are largely compatible with those made in the most recent US<sup>2</sup> and European guidelines.<sup>1,8</sup>

### 8.3 Adherence to Antihypertensive Treatment

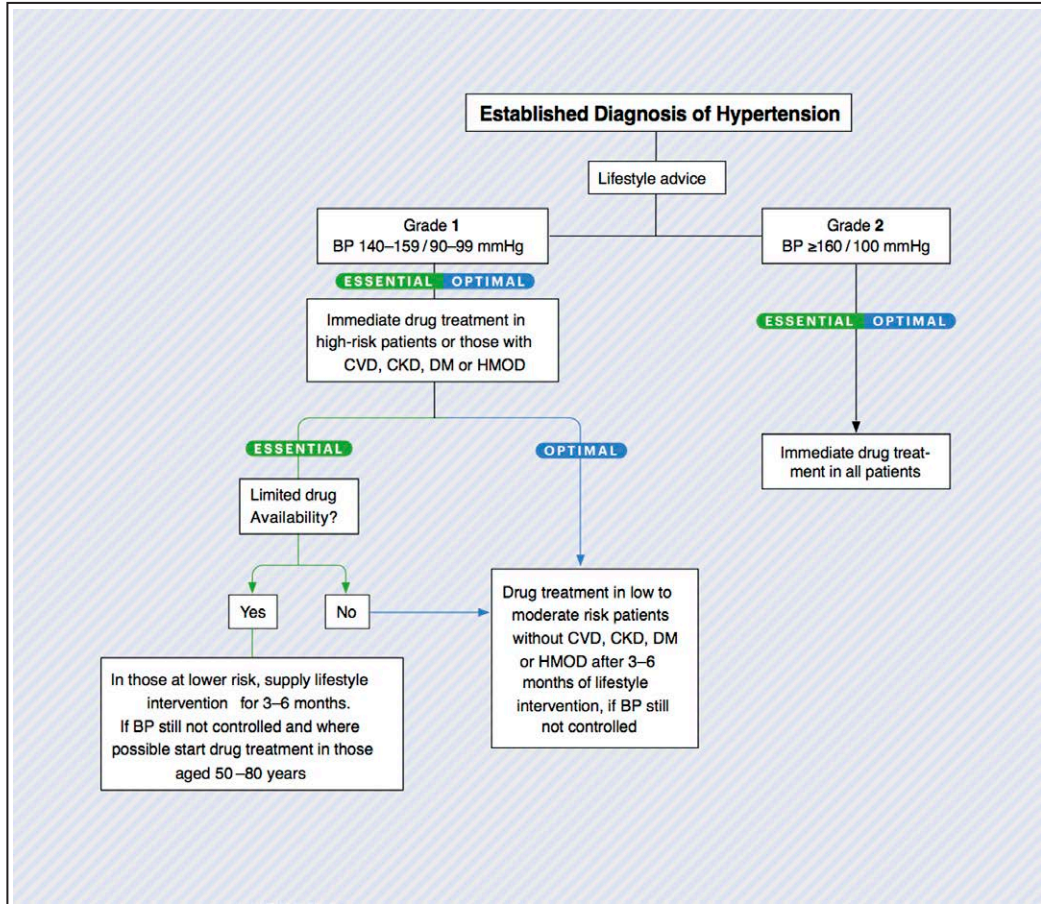
#### Background

Adherence is defined as to the extent to which a person's behaviors such as taking a medication, following a diet or executing lifestyle changes corresponds with agreed recommendations from a healthcare provider.<sup>74</sup> Nonadherence to antihypertensive treatment affects 10%–80% of hypertensive patients and is one of the key drivers of suboptimal BP control.<sup>75-77</sup> Poor adherence to antihypertensive treatment correlates with the magnitude of BP elevation and is an indicator of poor prognosis in hypertensive patients.<sup>78-81</sup> The etiology of nonadherence to antihypertensive treatment is multifactorial and includes causes associated with the healthcare system, pharmacological therapy, the disease, patients and their socioeconomic status.<sup>74</sup>



**Table 8. Lifestyle Modifications**

Salt reduction	There is strong evidence for a relationship between high salt intake and increased blood pressure. <sup>47</sup> Reduce salt added when preparing foods, and at the table. Avoid or limit consumption of high salt foods such as soy sauce, fast foods and processed food including breads and cereals high in salt.
Healthy diet	Eating a diet that is rich in whole grains, fruits, vegetables, polyunsaturated fats and dairy products and reducing food high in sugar, saturated fat and trans fats, such as the DASH diet ( <a href="http://www.dashforhealth.com">http://www.dashforhealth.com</a> ). <sup>48</sup> Increase intake of vegetables high in nitrates known to reduce BP, such as leafy vegetables and beetroot. Other beneficial foods and nutrients include those high in magnesium, calcium and potassium such as avocados, nuts, seeds, legumes and tofu. <sup>49</sup>
Healthy drinks	Moderate consumption of coffee, green and black tea. <sup>50</sup> Other beverages that can be beneficial include karkadé (hibiscus) tea, pomegranate juice, beetroot juice and cocoa. <sup>49</sup>
Moderation of alcohol consumption	Positive linear association exists between alcohol consumption, blood pressure, the prevalence of hypertension, and CVD risk. <sup>51</sup> The recommended daily limit for alcohol consumptions is 2 standard drinks for men and 1.5 for women (10 g alcohol/standard drink). Avoid binge drinking.
Weight reduction	Body weight control is indicated to avoid obesity. Particularly abdominal obesity should be managed. Ethnic-specific cut-offs for BMI and waist circumference should be used. <sup>52</sup> Alternatively, a waist-to-height ratio <0.5 is recommended for all populations. <sup>53,54</sup>
Smoking cessation	Smoking is a major risk factor for CVD, COPD and cancer. Smoking cessation and referral to smoking cessation programs are advised. <sup>55</sup>
Regular physical activity	Studies suggest that regular aerobic and resistance exercise may be beneficial for both the prevention and treatment of hypertension. <sup>56–58</sup> Moderate intensity aerobic exercise (walking, jogging, cycling, yoga, or swimming) for 30 minutes on 5–7 days per week or HIIT (high intensity interval training) which involves alternating short bursts of intense activity with subsequent recovery periods of lighter activity. Strength training also can help reduce blood pressure. Performance of resistance/strength exercises on 2–3 days per week.
Reduce stress and induce mindfulness	Chronic stress has been associated to high blood pressure later in life. <sup>59</sup> Although more research is needed to determine the effects of chronic stress on blood pressure, randomized clinical trials examining the effects of transcendental meditation/mindfulness on blood pressure suggest that this practice lowers blood pressure. <sup>60</sup> Stress should be reduced and mindfulness or meditation introduced into the daily routine.
Complementary, alternative or traditional medicines	Large proportions of hypertensive patients use complementary, alternative or traditional medicines (in regions such as Africa and China) <sup>61,62</sup> yet large-scale and appropriate clinical trials are required to evaluate the efficacy and safety of these medicines. Thus, use of such treatment is not yet supported.
Reduce exposure to air pollution and cold temperature	Evidence from studies support a negative effect of air pollution on blood pressure in the long-term. <sup>63,64</sup>



**Figure 2.** Pharmacological treatment of hypertension: general scheme. See Table 2 (Section 2) for equivalent BP levels based on ambulatory or home BP recordings.

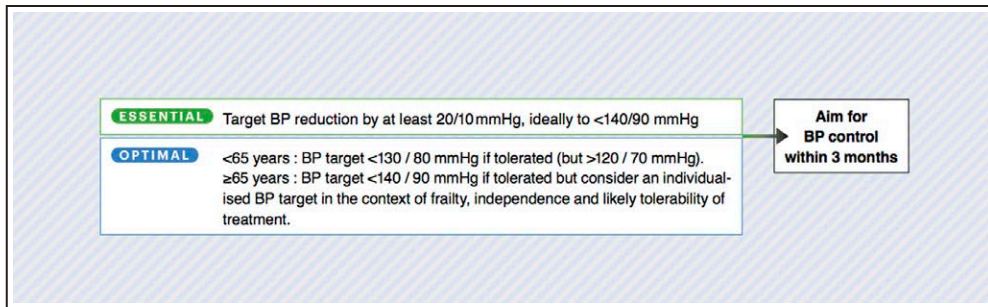


Figure 3. Office blood pressure targets for treated hypertension.

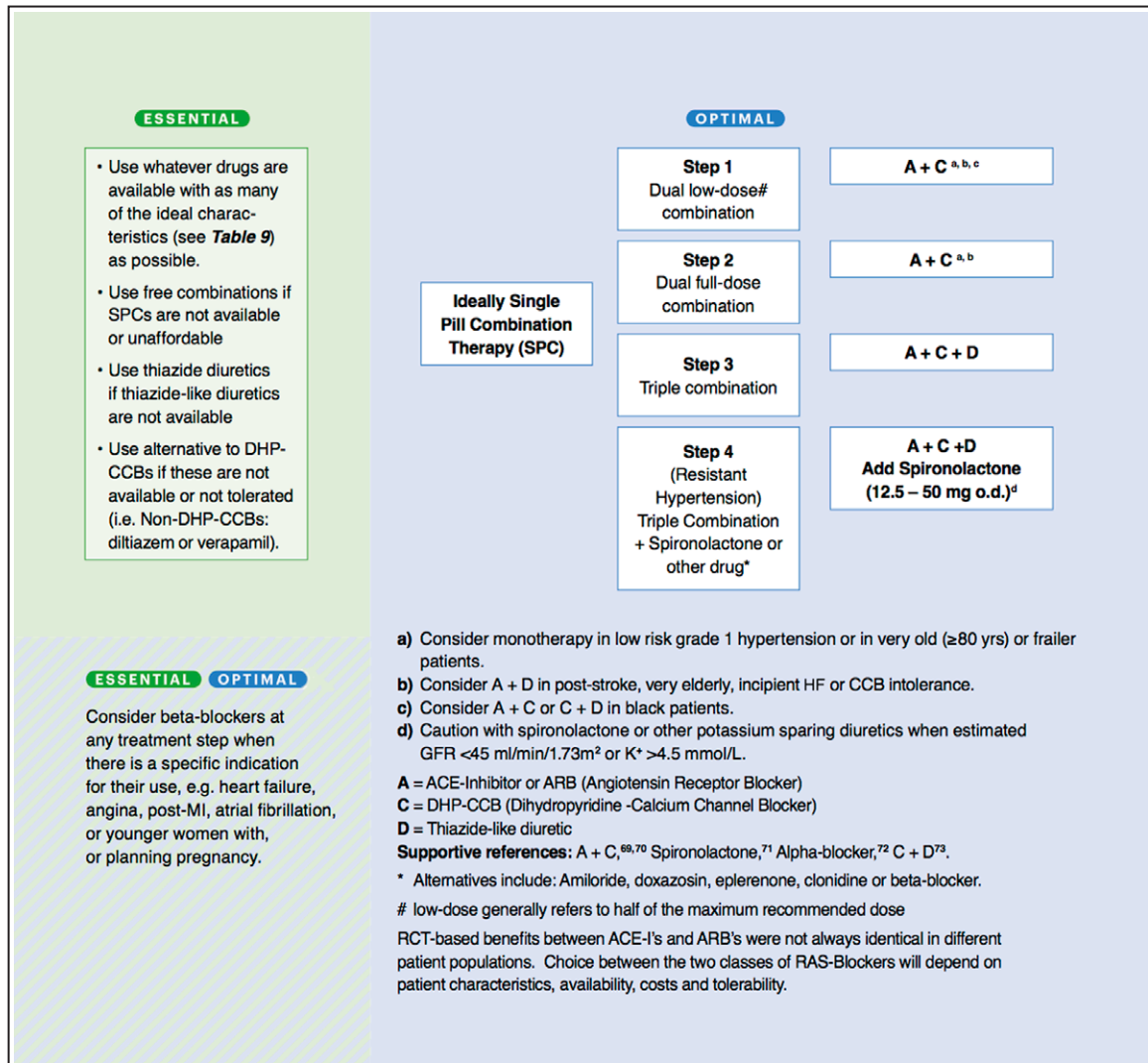


Figure 4. ISH core drug-treatment strategy. Data from references 69–73. Ideal characteristics of drug treatment (see Table 9).

Table 9. Ideal Characteristics of Drug Treatment

1.	Treatments should be evidence-based in relation to morbidity/mortality prevention.
2.	Use a once-daily regimen which provides 24-hour blood pressure control.
3.	Treatment should be affordable and/or cost-effective relative to other agents.
4.	Treatments should be well-tolerated.
5.	Evidence of benefits of use of the medication in populations to which it is to be applied.

**Recommendations: Adherence to Antihypertensive Therapy****ESSENTIAL**

- Evaluate adherence to antihypertensive treatment as appropriate at each visit and prior to escalation of antihypertensive treatment.
- Consider the following strategies to improve medication adherence<sup>82-87</sup>
  - a. reducing polypharmacy – use of single pill combinations
  - b. once-daily dosing over multiple times per day dosing
  - c. linking adherence behavior with daily habits
  - d. providing adherence feedback to patients
  - e. home BP monitoring
  - f. reminder packaging of medications
  - g. empowerment-based counseling for self-management
  - h. electronic adherence aids such as mobile phones or short messages services
  - i. multidisciplinary healthcare team approach (ie, pharmacists) to improve monitoring for adherence

**OPTIMAL**

- Objective indirect (ie, review of pharmacy records, pill counting, electronic monitoring devices) and direct (ie, witnessed intake of medications, biochemical detection of medications in urine or blood) are generally preferred over subjective methods to diagnose nonadherence to antihypertensive treatment.<sup>80,85</sup>
- The most effective methods for management of nonadherence require complex interventions that combine counseling, self-monitoring, reinforcements and supervision.

**Section 9: Common and Other Comorbidities and Complications of Hypertension****Background**

- Hypertensive patients have several common and other comorbidities that can affect cardiovascular risk and treatment strategies.
- The number of comorbidities increases with age, with the prevalence of hypertension and other diseases.
- Common comorbidities include coronary artery disease (CAD), stroke, CKD, HF, and COPD.
- Uncommon comorbidities include rheumatic diseases and psychiatric diseases.
- Uncommon comorbidities are largely underestimated by guidelines and frequently treated with drugs often self-prescribed and possibly interfering with BP control.
- Common and uncommon comorbidities should be identified and managed according to available evidence.

**Common Comorbidities and Complications****Hypertension and Coronary Artery Disease (CAD)**

- A strong epidemiological interaction exists between CAD and hypertension that accounts for 25%–30% of acute myocardial infarctions.<sup>88</sup>
- Lifestyle changes are recommended (smoking cessation, diet and exercise).
- BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg ( $< 140/80$  in elderly patients).
- RAS blockers, beta-blockers irrespective of BP levels with or without calcium channel blockers (CCBs) are

first-line drugs in hypertensive patients.<sup>1</sup>

- Lipid-lowering treatment with an LDL-C target  $< 55$  mg/dL (1.4 mmol/L).<sup>89</sup>
- Antiplatelet treatment with acetyl salicylic acid is routinely recommended.<sup>1</sup>

**Hypertension and Previous Stroke**

- Hypertension is the most important risk factor for ischemic or hemorrhagic stroke.<sup>90</sup>
- Stroke can be largely prevented by BP control.
- BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg ( $< 140/80$  in elderly patients).<sup>1</sup>
- RAS blockers, CCBs, and diuretics are first-line drugs.<sup>1</sup>
- Lipid-lowering treatment is mandatory with a LDL-C target  $< 70$  mg/dL (1.8 mmol/L) in ischemic stroke.<sup>1</sup>
- Antiplatelet treatment is routinely recommended for ischemic stroke, but not hemorrhagic stroke, and should be carefully considered in patients with hemorrhagic stroke only in the presence of a strong indication.<sup>1</sup>

**Hypertension and Heart Failure (HF)**

- Hypertension is a risk factor for the development of HF with reduced ejection fraction (HFrEF), and with preserved ejection fraction (HFpEF). Clinical outcome is worse and mortality is increased in hypertensive patients with HF.<sup>2</sup>
- Lifestyle changes are recommended (diet and exercise).
- Treating hypertension has a major impact on reducing the risk of incident HF and HF hospitalization. BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg but  $> 120/70$  mmHg.
- RAS blockers, beta-blockers, and mineralocorticoid receptor antagonists are all effective in improving clinical outcome in patients with established HFrEF, whereas for diuretics, evidence is limited to symptomatic improvement.<sup>1</sup> CCBs are indicated on in case of poor BP control.
- Angiotensin receptor-neprilysin inhibitor (ARNI; sacubitril-valsartan) is indicated for the treatment of HFrEF as an alternative to ACE inhibitors or ARBs also in hypertensive populations. The same treatment strategy can be applied to patients with HFpEF even if the optimal treatment strategy is not known.<sup>91</sup>

**Hypertension and Chronic Kidney Disease (CKD)**

- Hypertension is a major risk factor for the development and progression of albuminuria and any form of CKD.<sup>92</sup>
- A lower eGFR is associated with resistant hypertension, masked hypertension, and elevated nighttime BP values.<sup>92</sup>
- The effects of BP lowering on renal function (and albuminuria) are dissociated from cardiovascular benefit.<sup>1</sup>
- BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg ( $< 140/80$  in elderly patients).<sup>1</sup>
- RAS-inhibitors are first-line drugs because they reduce albuminuria in addition to BP control. CCBs and diuretics (loop-diuretics if eGFR  $< 30$  ml/min/1.73m<sup>2</sup>) can be added.<sup>1</sup>
- eGFR, microalbuminuria and blood electrolytes should be monitored.<sup>1</sup>

**Hypertension and Chronic Obstructive Pulmonary Disease (COPD)**

- Hypertension is the most frequent comorbidity in patients with COPD.

- BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg ( $< 140/80$  in elderly patients).
- Lifestyle changes (smoking cessation) are mandatory.<sup>93</sup>
- Environmental (air) pollution should be considered and avoided if possible.<sup>93</sup>
- The treatment strategy should include an angiotensin AT<sub>1</sub>-receptor blocker (ARB) and CCB and/or diuretic, while beta blockers ( $\beta_1$ -receptor selective) may be used in selected patients (eg, CAD, HF).
- Additional cardiovascular risk factors should be managed according to cardiovascular risk profile.

#### HIV/AIDS

- People living with HIV are at increased cardiovascular risk.<sup>40</sup>
- There may be a drug interaction with CCB under most of the antiretroviral therapies.
- Hypertension management should be similar to the general hypertensive populations.

#### Management of Comorbidities

##### ESSENTIAL OPTIMAL

- In addition to BP control, the therapeutic strategy should include lifestyle changes, body weight control and the effective treatment of the other risk factors to reduce the residual cardiovascular risk.<sup>1</sup>
- Lifestyle changes as in Table 8.
- LDL-cholesterol should be reduced according to risk profile: (1)  $> 50\%$  and  $< 70$  mg/dL (1.8 mmol/L) in hypertension and CVD, CKD, DM or no CVD and high risk; (2)  $> 50\%$  and  $< 100$  mg/dL (2.6 mmol/L) in high-risk patients; (3)  $< 115$  mg/dL (3 mmol/L) in moderate-risk patients.<sup>1,89</sup>
- Fasting serum glucose levels should be reduced below 126 mg/dL (7 mmol/L) or HbA1c below 7% (53 mmol/mol).<sup>1</sup>
- s-UA should be maintained below 6.5 mg/dL (0.387 mmol/L), and  $< 6$  mg/dL (0.357 mmol/L) in patients with gout.<sup>94</sup>
- Antiplatelet therapy should be considered in patients with CVD (secondary prevention only).<sup>95</sup>

#### Diabetes

- BP should be lowered if  $\geq 140/90$  mmHg and treated to a target  $< 130/80$  mmHg ( $< 140/80$  in elderly patients).<sup>96</sup>
- The treatment strategy should include an RAS inhibitor (and a CCB and/or thiazide-like diuretic).
- The treatment should include a statin in primary prevention if LDL-C  $> 70$  mg/dL (1.8 mmol/L) (diabetes with target organ damage) or  $> 100$  mg/dL (2.6 mmol/L) (uncomplicated diabetes).
- The treatment should include glucose and lipid lowering as per current guidelines (see Section 11: Resources).

#### Lipid Disorders

- BP should be lowered as done in the general population, preferentially with RAS-inhibitors (ARB, ACE-I) and CCBs.<sup>97</sup>
- Statins are the lipid-lowering treatment of choice with or without ezetimibe and/or PCSK9 inhibitor (in the optimal setting).<sup>98</sup>

- Serum triglyceride lowering should be considered if  $> 200$  mg/dL (2.3 mmol/L) particularly in patients with hypertension and DM. Possible additional benefits using fenofibrate in low HDL/high triglyceride subgroup.

#### Metabolic Syndrome (MS)

- Patients with hypertension and MS have a high-risk profile.
- The diagnosis of MS should be made by separate evaluation of single components.
- The treatment of MS is based on changes in lifestyle (diet and exercise).
- The treatment of hypertension and MS should include BP control as in the general population and treatment of additional risk factors based on level and overall cardiovascular risk (SCORE and/or ASCVD calculator).

#### Other Comorbidities

(See Table 10).

#### Hypertension and Inflammatory Rheumatic Diseases (IRD)

- IRD (rheumatoid arthritis, psoriasis-arthritis, etc) are associated with an increased prevalence of hypertension under diagnosed and poorly controlled.<sup>99,100</sup>
- IRD show an increase in cardiovascular risk only partially related to cardiovascular risk factors.<sup>99</sup>
- Rheumatoid arthritis is predominant among IRD.
- The presence of IRD should increase 1 step of cardiovascular risk.<sup>99</sup>
- BP should be lowered as in the general population, preferentially with RAS-inhibitors (evidence of an overactive RAAS)<sup>100</sup> and CCBs.
- Underlying diseases should be effectively treated by reducing inflammation and by avoiding high doses of NSAIDs.
- Lipid-lowering drugs should be used according to cardiovascular risk profile (SCORE/ASCVD calculator) also considering the effects of biologic drugs.<sup>100</sup>

#### Hypertension and Psychiatric Diseases

- The prevalence of hypertension is increased in patients with psychiatric disorders and in particular depression.<sup>101,102</sup>
- According to guidelines, psychosocial stress and major psychiatric disorders increase the cardiovascular risk.
- Depression has been associated with cardiovascular morbidity and mortality, suggesting the importance of BP control.<sup>101</sup>
- BP should be lowered as in the general population, preferentially with RAS-inhibitors and diuretics with a lesser rate of pharmacological interactions under antidepressants. CCBs and  $\alpha_1$ -blockers should be used with care in patients with orthostatic hypotension (eg, SRIs).
- The risk of pharmacologic interactions, ECG abnormalities and postural BP changes must be considered.
- Beta-blockers (not metoprolol) should be used in presence of drug-induced tachycardia (antidepressant, antipsychotic drugs).<sup>103</sup>
- Additional risk factors should be managed according to cardiovascular risk profile (SCORE/ASCVD calculator, see Section 11: Resources).

**Table 10. Outline of Evidence-Based Management of Other Comorbidities and Hypertension**

Additional Comorbidity	Recommended Drugs	Warning
Rheumatic disorders	<ul style="list-style-type: none"> <li>• RAS-inhibitors and CCBs±diuretics</li> <li>• Biologic drugs not affecting blood pressure should be preferred (where available)</li> </ul>	High doses of NSAIDs
Psychiatric disorders	<ul style="list-style-type: none"> <li>• RAS-inhibitors and diuretics</li> <li>• Beta-blockers (not metoprolol) if drug-induced tachycardia (antidepressant, antipsychotic drugs).</li> <li>• Lipid-lowering drugs/antidiabetic drugs according to risk profile</li> </ul>	Avoid CCBs if orthostatic hypotension (SRLs)

## Section 10: Specific Circumstances

### 10.1 Resistant Hypertension

#### Background

Resistant hypertension is defined as seated office BP >140/90 mmHg in a patient treated with three or more antihypertensive medications at optimal (or maximally tolerated) doses including a diuretic and after excluding pseudoresistance (poor BP measurement technique, white coat effect, nonadherence and suboptimal choices in antihypertensive therapy)<sup>104,105</sup> as well as the substance/drug-induced hypertension and secondary hypertension.<sup>79</sup> Resistant hypertension affects around 10% of hypertensive individuals, has a negative impact on well-being<sup>106</sup> and increases the risk of coronary artery disease, chronic HF, stroke, end-stage renal disease, and all-cause mortality.<sup>107</sup> Approximately 50% of patients diagnosed with resistant hypertension have pseudoresistance rather than true resistant hypertension.<sup>104,105,108</sup>

#### Recommendations

##### ESSENTIAL

- If seated office BP >140/90 mmHg in patients managed with three or more antihypertensive medications at optimal (or maximally tolerated) doses including a diuretic, first exclude causes of pseudoresistance (poor BP measurement technique, white coat effect, nonadherence and suboptimal choices in antihypertensive therapy), and substance-induced increases in BP.
- Consider screening patients for secondary causes as appropriate (refer to Section 10.2).
- Optimize the current treatment regimen including health behavior change and diuretic-based treatment (maximally tolerated doses of diuretics, and optimal choice of diuretic: use of thiazide-like rather than thiazide diuretics, and initiation of loop diuretics for eGFR <30 ml/min/1.73m<sup>2</sup> or clinical volume overload).<sup>109</sup>
- Add a low dose of spironolactone as the 4th line agent in those whose serum potassium is <4.5 mmol/L and whose eGFR is >45 ml/min/1.73m<sup>2</sup> to achieve BP targets.<sup>8,71,110</sup> If spironolactone is contraindicated or not

tolerated, amiloride, doxazosin, eplerenone, clonidine, and beta-blockers are alternatives, or any available antihypertensive class not already in use.<sup>1,111–114</sup>

##### OPTIMAL

- Resistant hypertension should be managed in specialist centers with sufficient expertise, and resources necessary to diagnose and treat this condition.<sup>115</sup>

### 10.2 Secondary Hypertension<sup>116–121</sup>

#### Background

A specific cause of secondary hypertension can be identified in 5%–10% of hypertensive patients (Table 11). Early diagnosis of secondary hypertension and the institution of appropriate targeted treatment have the potential to cure hypertension in some patients or improve BP control/reduce the number of prescribed antihypertensive medications in others. The most common types of secondary hypertension in adults are renal parenchymal disease, renovascular hypertension, primary aldosteronism, chronic sleep apnea, and substance/drug-induced.

#### Recommendations

##### ESSENTIAL

- Consider screening for secondary hypertension in (1) patients with early onset hypertension (<30 years of age) in particular in the absence of hypertension risk factors (obesity, metabolic syndrome, familial history etc.), (2) those with resistant hypertension, (3) individuals with sudden deterioration in BP control, (4) hypertensive urgency and emergency, (5) those presenting with high probability of secondary hypertension based on strong clinical clues.
- In patients with resistant hypertension, investigations for secondary hypertension should generally be preceded by exclusion of pseudoresistant hypertension and drug/substance-induced hypertension.
- Basic screening for secondary hypertension should include a thorough assessment of history, physical examination (see clinical clues), basic blood biochemistry (including serum sodium, potassium, eGFR, TSH), and dipstick urine analysis.

##### OPTIMAL

- Further investigations for secondary hypertension (additional biochemistry/imaging/others) should be carefully chosen based on information from history, physical examination and basic clinical investigations.
- Consider referring for further investigation and management of suspected secondary hypertension to a specialist center with access to appropriate expertise and resources.

### 10.3 Hypertension in Pregnancy<sup>122–126</sup>

Hypertension in pregnancy is a condition affecting 5%–10% of pregnancies worldwide. Maternal risks include placental abruption, stroke, multiple organ failure (liver, kidney), disseminated vascular coagulation. Fetal risks include intrauterine growth retardation, preterm birth, intrauterine death. Hypertension in pregnancy includes the following conditions:

- **Preexisting hypertension:** Starts before pregnancy or <20 weeks of gestation, and lasts >6 weeks postpartum with proteinuria.

Table 11. Features of Secondary Hypertension

Secondary Hypertension	Clinical History and Physical Examination	Basic Biochemistry and Urine Analysis	Further Diagnostic Tests
Renal parenchymal disease	<ul style="list-style-type: none"> <li>• Personal/familial history of CKD</li> </ul>	<ul style="list-style-type: none"> <li>• Proteinuria, hematuria, leukocyturia on dipstick urine analysis</li> <li>• Decreased estimated GFR</li> </ul>	<ul style="list-style-type: none"> <li>• Kidney ultrasound</li> </ul>
Primary aldosteronism	<ul style="list-style-type: none"> <li>• Symptoms of hypokalemia (muscle weakness, muscle cramps, tetany)</li> </ul>	<ul style="list-style-type: none"> <li>• Spontaneous hypokalemia or diuretic-induced hypokalemia on blood biochemistry (50%–60% of patients are normokalemic).</li> <li>• Elevated plasma aldosterone-renin activity ratio</li> </ul>	<ul style="list-style-type: none"> <li>• Confirmatory testing (eg, intravenous saline suppression test)</li> <li>• Imaging of adrenals (adrenal computed tomography)</li> <li>• Adrenal vein sampling</li> </ul>
Renal artery stenosis	<ul style="list-style-type: none"> <li>• Abdominal bruit</li> <li>• Bruits over other arteries (ie, carotid and femoral arteries)</li> <li>• Drop in estimated GFR &gt;30% after exposure to ACE-inhibitors/ARBs</li> <li>• For suspected atherosclerotic RAS, history of flash pulmonary edema or history of atherosclerotic disease or presence of cardiovascular risk factors</li> <li>• For suspected fibromuscular dysplasia, young women with onset of hypertension &lt;30 years</li> </ul>	<ul style="list-style-type: none"> <li>• Decrease in estimated GFR</li> </ul>	<ul style="list-style-type: none"> <li>• Imaging of renal arteries (duplex ultrasound, abdominal computed tomography or magnetic resonance angiograms depending on availability and patient's level of renal function)</li> </ul>
Pheochromocytoma	<ul style="list-style-type: none"> <li>• Headaches</li> <li>• Palpitations</li> <li>• Perspiration</li> <li>• Pallor</li> <li>• History of labile hypertension</li> </ul>	<ul style="list-style-type: none"> <li>• Increased plasma levels of metanephrines</li> <li>• Increased 24-hour urinary fractional excretion of metanephrines and catecholamines</li> </ul>	<ul style="list-style-type: none"> <li>• Abdominal/pelvic computational tomography or MRI</li> </ul>
Cushing's syndrome and disease	<ul style="list-style-type: none"> <li>• Central obesity</li> <li>• Purple striae</li> <li>• Facial rubor</li> <li>• Signs of skin atrophy</li> <li>• Easy bruising</li> <li>• Dorsal and supraclavicular fat pad</li> <li>• Proximal muscle weakness</li> </ul>	<ul style="list-style-type: none"> <li>• Hypokalemia</li> <li>• Increased late-night salivary cortisol</li> </ul>	<ul style="list-style-type: none"> <li>• Dexamethasone suppression tests<sup>118</sup></li> <li>• 24 hour urinary free cortisol</li> <li>• Abdominal/ pituitary imaging</li> </ul>
Coarctation of the aorta	<ul style="list-style-type: none"> <li>• Higher blood pressure in upper than lower extremities</li> <li>• Delayed or absent femoral pulses</li> </ul>		<ul style="list-style-type: none"> <li>• Echocardiogram</li> <li>• Computational tomography angiogram</li> <li>• Magnetic resonance angiogram</li> </ul>
Obstructive sleep apnea	<ul style="list-style-type: none"> <li>• Increased BMI</li> <li>• Snoring</li> <li>• Daytime sleepiness</li> <li>• Gasping or choking at night</li> <li>• Witnessed apneas during sleep</li> <li>• Nocturia</li> </ul>		<ul style="list-style-type: none"> <li>• Home sleep apnea testing (eg, level 3 sleep study)</li> <li>• Overnight polysomnography testing</li> </ul>
Thyroid disease	<ul style="list-style-type: none"> <li>• Symptoms of hyperthyroidism: heat intolerance, weight loss, tremor, palpitations</li> <li>• Symptoms of hypothyroidism: cold intolerance, weight gain, dry brittle hair</li> </ul>	<ul style="list-style-type: none"> <li>• TSH, Free T4</li> </ul>	

- **Gestational hypertension:** Starts >20 weeks of gestation, and lasts <6 weeks postpartum.
- **Preexisting hypertension plus superimposed gestational hypertension** with proteinuria.
- **Preeclampsia:** Hypertension with proteinuria (>300 mg/24 h or ACR >30 mg/mmol [265 mg/g]). Predisposing factors are preexisting hypertension, hypertensive disease during previous pregnancy, diabetes, renal disease, first- or multiple pregnancy,

- autoimmune disease (SLE). Risks are fetal growth restriction, preterm birth.
- **Eclampsia:** Hypertension in pregnancy with seizures, severe headaches, visual disturbance, abdominal pain, nausea and vomiting, low urinary output: Immediate treatment and delivery required.
- **HELLP (hemolysis, elevated liver enzymes, low platelets) syndrome:** Immediate treatment and delivery required.

**Blood Pressure Measurement in Pregnancy**

**ESSENTIAL** Office BP measurement following general guidelines. Take office BP measurement using a manual auscultatory device, or an automated upper-arm cuff device which has been validated specifically in pregnancy and preeclampsia (list of validated devices at [www.stridebp.org](http://www.stridebp.org)).

**OPTIMAL** ABPM or home BP monitoring using devices validated specifically in pregnancy and preeclampsia to evaluate white coat hypertension, DM, nephropathy.

**Investigation of Hypertension in Pregnancy**

**ESSENTIAL** Urine analysis, full blood count, liver enzymes, hematocrit, serum creatinine and s-UA. Test for proteinuria in early pregnancy (preexisting renal disease) and second half of pregnancy (preeclampsia). A dipstick test >1+ should be followed up with UACR in a single spot urine; UACR <30 mg/mmol excludes proteinuria.

**OPTIMAL** Ultrasound of kidneys and adrenals, free plasma metanephrines (if clinical features of pheochromocytoma); Doppler ultrasound of uterine arteries (after 20 weeks of gestation is useful to detect those at higher risk of gestational hypertension, preeclampsia, and intrauterine growth retardation).

**Prevention of Preeclampsia**

Women at high risk (hypertension in previous pregnancy, CKD, autoimmune disease, diabetes, chronic hypertension), or moderate risk (first pregnancy in a woman >40 years, pregnancy interval >10 years, BMI >35 kg/m<sup>2</sup>, family history of preeclampsia, multiple pregnancies): 75–162 mg aspirin at weeks 12–36. Oral calcium supplementation of 1.5–2 g/day is recommended in women with low dietary intake (<600 mg/day).

**Management of Hypertension in Pregnancy**

- **Mild hypertension:** Drug treatment at persistent BP >150/95 mmHg in all women. Drug treatment at persistent BP >140/90 mmHg in gestational hypertension, preexisting hypertension with superimposed gestational hypertension; hypertension with subclinical HMOD at any time during pregnancy. First choices: methyldopa, beta-blockers (labetalol), and dihydropyridine-calcium channel blockers (DHP-CCBs) (nifedipine [not capsular], nicardipine). Contraindicated: RAS blockers (ACE-I, ARB, direct renin inhibitors [DRI]) due to adverse fetal and neonatal outcomes.
- **Severe hypertension:** At BP >170 mmHg systolic and/or >110 mmHg diastolic: immediate hospitalization is indicated (emergency). Treatment with intravenous labetalol (alternative intravenous nicardipine, esmolol, hydralazine, urapidil), oral methyldopa or DHP-CCBs (nifedipine [not capsular] nicardipine). Add magnesium (hypertensive crisis to prevent eclampsia). In pulmonary edema: nitroglycerin intravenous infusion. Sodium-nitroprusside should be avoided due to the danger of fetal cyanide poisoning with prolonged treatment.
- **Delivery in gestational hypertension or preeclampsia:** At week 37 in asymptomatic women. Expedite delivery in women with visual disturbances, hemostatic disorders.
- **Blood pressure postpartum:** If hypertension persists, any of recommended drugs except methyldopa (postpartum depression).

- **Breastfeeding:** All antihypertensives excreted into breast milk at low concentrations. Avoid atenolol, propranolol, nifedipine (high concentration in milk). Prefer long acting CCBs. Refer to prescribing information.
- **Long-term consequences of gestational hypertension:** Increased risk of hypertension and CVD (stroke, ischemic heart disease) in later life.

**ESSENTIAL** Lifestyle adjustment

**OPTIMAL** Lifestyle adjustment and annual checkups (BP, metabolic factors)

**10.4 Hypertensive Emergencies****Definition of Hypertensive Emergencies and Their Clinical Presentation**

A hypertensive emergency is the association of substantially elevated BP with acute HMOD. Target organs include the retina, brain, heart, large arteries, and the kidneys.<sup>127</sup> This situation requires rapid diagnostic workup and immediate BP reduction to avoid progressive organ failure. Intravenous therapy is usually required. The choice of antihypertensive treatment is predominantly determined by the type of organ damage. Specific clinical presentations of hypertensive emergencies include:

- **Malignant hypertension:** Severe BP elevation (commonly >200/120 mmHg) associated with advanced bilateral retinopathy (hemorrhages, cotton wool spots, papilledema).
- **Hypertensive encephalopathy:** Severe BP elevation associated with lethargy, seizures, cortical blindness and coma in the absence of other explanations.
- **Hypertensive thrombotic microangiopathy:** Severe BP elevation associated with hemolysis and thrombocytopenia in the absence of other causes and improvement with BP-lowering therapy.
- Other presentations of hypertensive emergencies include severe BP elevation associated with cerebral hemorrhage, acute stroke, acute coronary syndrome, cardiogenic pulmonary edema, aortic aneurysm/dissection, and severe preeclampsia and eclampsia.

Patients with substantially elevated BP who lack acute HMOD are not considered a hypertensive emergency and can typically be treated with oral antihypertensive therapy.<sup>128</sup>

**Clinical Presentation and Diagnostic Workup**

The clinical presentation of a hypertensive emergency can vary and is mainly determined by the organ(s) acutely affected. There is no specific BP threshold to define a hypertensive emergency.

Symptoms include headaches, visual disturbances, chest pain, dyspnea, neurologic symptoms, dizziness, and more unspecific presentations.

Medical history: preexisting hypertension, onset and duration of symptoms, potential causes (nonadherence with prescribed antihypertensive drugs, lifestyle changes, concomitant use of BP elevating drugs [NSAIDs, steroids, immunosuppressants, sympathomimetics, cocaine, antiangiogenic therapy]).

**ESSENTIAL** **Thorough physical examination:** Cardiovascular and neurologic assessment. Laboratory analysis: hemoglobin,

**Table 12. Hypertensive Emergencies Requiring Immediate BP Lowering**

Clinical Presentation	Timeline and Target BP	First Line Treatment	Alternative
Malignant hypertension with or without TMA or acute renal failure	Several hours, MAP –20% to –25%	Labetalol Nicardipine	Nitroprusside Urapidil
Hypertensive encephalopathy	Immediate, MAP –20% to –25%	Labetalol Nicardipine	Nitroprusside
Acute ischaemic stroke and SBP >220 mmHg or DBP >120 mmHg	1 h, MAP –15%	Labetalol Nicardipine	Nitroprusside
Acute ischaemic stroke with indication for thrombolytic therapy and SBP >185 mmHg or DBP >110 mmHg	1 h, MAP –15%	Labetalol Nicardipine	Nitroprusside
Acute hemorrhagic stroke and SBP >180 mmHg	Immediate, 130<SBP<180 mmHg	Labetalol Nicardipine	Urapidil
Acute coronary event	Immediate, SBP <140 mmHg	Nitroglycerine Labetalol	Urapidil
Acute cardiogenic pulmonary edema	Immediate, SBP <140 mmHg	Nitroprusside or nitroglycerine (with loop diuretic)	Urapidil (with loop diuretic)
Acute aortic disease	Immediate, SBP <120 mmHg and heart rate <60 bpm	Esmolol and nitroprusside or nitroglycerine or nicardipine	Labetalol or metoprolol
Eclampsia and severe preeclampsia/HELLP	Immediate, SBP <160 mmHg and DBP <105 mmHg	Labetalol or nicardipine and magnesium sulphate	

Adapted from van den Born et al.<sup>127</sup>

platelets, creatinine, sodium, potassium, lactate dehydrogenase (LDH), haptoglobin, urinalysis for protein, urine sediment. **Examinations:** Fundoscopy, ECG.

**OPTIMAL** Additional investigations may be required and indicated depending on presentation and clinical findings and may be essential in the context: troponins (chest pain), chest x-ray (congestion/fluid overload), transthoracic echocardiogram (cardiac structure and function), CT/MRI brain (cerebral hemorrhage/stroke), CT-angiography thorax/abdomen (acute aortic disease). Secondary causes can be found in 20%–40% of patients presenting with malignant hypertension<sup>118</sup> and appropriate diagnostic workup to confirm or exclude secondary forms is indicated.

#### **Diagnostic Tests and Acute Therapeutic Management**

The overall therapeutic goal in patients presenting with hypertensive emergencies is a controlled BP reduction to safer levels to prevent or limit further hypertensive damage while avoiding hypotension and related complications. There is a lack of randomized controlled trial data to provide clear cut guidance on BP targets and times within which these should be achieved. Most recommendations are based on expert consensus. The type of acute HMOD is the main determinant of the preferred treatment choice. The timeline and magnitude of BP reduction is strongly dependent on the clinical context. For example, acute pulmonary edema and aortic dissection require rapid BP reduction, whereas BP levels not exceeding 220/120 mmHg are generally tolerated in acute ischemic stroke for certain periods. Table 12 provides a general overview of timelines and BP targets as well as preferred antihypertensive drug choices with most common clinical presentations. Availability of drugs and local experience with individual drugs are likely to influence the choice of drugs. Labetalol and nicardipine

are generally safe to use in all hypertensive emergencies and should be available wherever hypertensive emergencies are being managed. Nitroglycerin and nitroprusside are specifically useful in hypertensive emergencies including the heart and the aorta.

#### **Specific Situations**

- **Sympathetic hyperreactivity:** If intoxication with amphetamines, sympathomimetics or cocaine is suspected as cause of presentation with a hypertensive emergency use of benzodiazepines should be considered prior to specific antihypertensive treatment. Phentolamine, a competitive alpha-receptor blocking agent and clonidine, a centrally sympatholytic agent with additional sedative properties are useful if additional BP-lowering therapy is required. Nicardipine and nitroprusside are suitable alternatives.
- **Pheochromocytoma:** The adrenergic drive associated with pheochromocytoma responds well to phentolamine. Beta-blockers should only be used once alpha-blockers have been introduced to avoid acceleration of hypertension. Urapidil and nitroprusside are additional suitable options.
- **Preeclampsia/eclampsia:** See Section 10.3: Hypertension in Pregnancy.

#### **Follow-Up**

Patients who experienced a hypertensive emergency are at increased risk of cardiovascular and renal disease.<sup>129,130</sup> Thorough investigation of potential underlying causes and assessment of HMOD is mandatory to avoid recurrent presentations with hypertensive emergencies. Similarly, adjustment and simplification of antihypertensive therapy paired with advice for lifestyle modification



will assist to improve adherence and long-term BP control. Regular and frequent follow-up (monthly) is recommended until target BP and ideally regression of HMOD has been achieved.

### 10.5 Ethnicity, Race and Hypertension

Hypertension prevalence, treatment and control rates vary significantly according to ethnicity. Such differences are mainly attributed to genetic differences, but lifestyle and socioeconomic status possibly filters through into health behaviors such as diet – which appear to be major contributors.

#### Populations From African Descent

- Black populations, whether residing in Africa, the Caribbean, United States, or Europe, develop hypertension and associated organ damage at younger ages, have a higher frequency of resistant and nighttime hypertension, and a higher risk of kidney disease,<sup>131</sup> stroke, HF, and mortality,<sup>132</sup> than other ethnic groups.
- This increased cardiovascular risk may be due to physiological differences including a suppressed RAAS,<sup>133,134</sup> altered renal sodium handling,<sup>135</sup> increased cardiovascular reactivity,<sup>136</sup> and early vascular aging (large artery stiffness).<sup>137</sup>
- Management of hypertension:
  - Wherever possible, annual screening for hypertension is advised for adults 18 years and older.
  - Lifestyle modification should place additional focus on salt restriction, increased intake of vegetables and fruits (potassium intake), weight management, and reducing alcohol intake.
  - First-line pharmacological therapy is recommended as a single pill combination including a thiazide-like diuretic plus CCB or CCB plus ARB (see Sections 8 and 12).<sup>71,138</sup>
  - Among RAS-inhibitors, ARBs maybe preferred as angioedema is about 3 times more likely to occur with ACE inhibitors among black patients.<sup>139</sup>

#### Populations From Asia

- Ethnic-specific characteristics are recognized for East Asian populations. Hypertensive patients have a greater likelihood of salt-sensitivity accompanied with mild obesity. When compared to Western populations, East Asian people present a higher prevalence of stroke (particularly hemorrhagic stroke) and nonischemic HF.<sup>1</sup>
- Morning hypertension and nighttime hypertension<sup>140</sup> are also more common in Asia, compared with European populations.
- South Asian populations originating from the Indian subcontinent have a particularly high risk for cardiovascular and metabolic diseases, including CAD and type 2 DM. With large hypertensive populations residing in India and China, clinical trials in these populations are required to advise whether current treatment approaches are ideal.<sup>141,142</sup>
- Management of hypertension:
  - South East Asia: Standard treatment as indicated in these guidelines is advised, until more evidence becomes available.<sup>138</sup>

### Section 11: Resources

- 2018 European Society of Cardiology/European Society of Hypertension Guidelines [Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension: The Task Force for the management of arterial hypertension of the European Society of Cardiology and the European Society of Hypertension: The Task Force for the management of arterial hypertension of the European Society of Cardiology and the European Society of Hypertension. *J Hypertens* 2018; 36(10): 1953–2041.]: These comprehensive and evidence-based guidelines form a complete detailed resource.
- 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/AphA/ASH/ASPC/NMA/PCNA Guidelines [Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/AphA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High blood pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension* 2017; 71(6):e13–e115.]: The Guidelines from the United States of America, which attracted much comment on redefining hypertension, is very comprehensive and evidence-based, and largely in agreement with the 2018 European guidelines.
- Weber MA, Poulter NR, Schutte AE, et al. Is it time to reappraise blood pressure thresholds and targets? Statement from the International Society of Hypertension—a global perspective. *Hypertension* 2016; 68:266–268.
- Clinical Practice Guidelines for the Management of Hypertension in the Community A Statement by the American Society of Hypertension and the International Society of Hypertension. [Weber MA, Schiffrin EL, White WB et al. *The Journal of Clinical Hypertension* 2014; 16(1):14–26].
- NICE Guideline: Hypertension in adults: diagnosis and management. Published: 28 August 2019 [www.nice.org.uk/guidance/ng136](http://www.nice.org.uk/guidance/ng136).
- The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). *Hypertens Res* 2019; 42:1235–1481 <https://doi.org/10.1038/s41440-019-0284-9>.
- 2018 Chinese Guidelines for Prevention and Treatment of Hypertension – A report of the Revision Committee of Chinese Guidelines for Prevention and Treatment of Hypertension. Liu LS, Wu ZS, Wang JG, Wang W. *J Geriatr Cardiol* (2019) 16: 182–241.
- Guidelines on the management of arterial hypertension and related comorbidities in Latin America. Task Force of the Latin American Society of Hypertension. *J Hypertens* 2017, 35:1529–1545.
- 2019 ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. [Mach F, Baigent C, Catapano AL et al. *Eur Heart J* 2020;41:111–188. doi:10.1093/eurheartj/ehz455].
- 2019 ESC Guidelines on diabetes, prediabetes, and cardiovascular diseases developed in collaboration with

the EASD: The Task Force for diabetes, prediabetes, and cardiovascular diseases of the European Society of Cardiology (ESC) and the European Association for the Study of Diabetes (EASD). [Cosentino F, Peter J, Grant PJ, Aboyans V et al. *Eur Heart J* 2020; 41:255–323, <https://doi.org/10.1093/eurheartj/ehz486>].

- The HOPE Asia Network contributes largely to evidence for this region: [Kario K et al. HOPE Asia (Hypertension Cardiovascular Outcome Prevention and Evidence in Asia) Network. The HOPE Asia Network for “zero” cardiovascular events in Asia. *J Clin Hypertens* 2018; 20:212–214].
- World Health Organization, HEARTS Technical Package: [[https://www.who.int/cardiovascular\\_diseases/hearts/en/](https://www.who.int/cardiovascular_diseases/hearts/en/)]: The HEARTS package contains free modules (in English, French, Spanish, and Russian) on, for example, healthy-lifestyle counseling; Risk based charts, but particularly for Team-based care which is particularly relevant in low resource settings where task-sharing is highly relevant: <https://apps.who.int/iris/bitstream/handle/10665/260424/WHO-NMH-NVI-18.4-eng.pdf;jsessionid=7AC6EC215FEB390CBD93898B69C4705C?sequence=1>.
- Cardiovascular Risk Scores: Several scoring systems are available. Some are based only on European populations, for example, SCORE.
  - SCORE: [http://www.heartscore.org/en\\_GB/access](http://www.heartscore.org/en_GB/access) The following scores also take ethnicity into account.
  - QRISK2: <https://qrisk.org/2017/index.php>
  - ASCVD: [https://tools.acc.org/ldl/ascvd\\_risk\\_estimator/index.html#!/calculate/estimator/](https://tools.acc.org/ldl/ascvd_risk_estimator/index.html#!/calculate/estimator/)
- World Heart Federation Roadmap to the Management and Control of Raised Blood Pressure provides guidance on achieving the target of a relative reduction of the prevalence of raised blood pressure by 25% by 2025: <https://www.world-heart-federation.org/cvd-roadmaps/whf-global-roadmaps/hypertension/>

– Based on this Roadmap, an Africa-specific roadmap was also developed: [Dzudie A, Rayner B, Ojji D, Schutte AE, et al. Roadmap to achieve 25% hypertension control in Africa by 2025. *Global Heart* 2018; 13:45–59].

### Listings of Validated Electronic Blood Pressure Devices That Were Independently Assessed for Accuracy

- STRIDE BP: <https://stridebp.org/>
- British and Irish Hypertension Society: <https://bihsoc.org/bp-monitors/>
- German Hypertension Society: <https://www.hochdruckliga.de/messgeraete-mit-pruefsiegel.html>
- Hypertension Canada: <https://hypertension.ca/hypertension-and-you/managing-hypertension/measuring-blood-pressure/devices/>
- Japanese Society of Hypertension: [http://www.jpnh.jp/com\\_ac\\_wg1.html](http://www.jpnh.jp/com_ac_wg1.html).

### Blood Pressure Management in Pediatric Populations

- Flynn JT, Kaelber DC, Baker-Smith CM, et al. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. *Pediatrics* 2017; 140: e20171904.
- Lurbe E, Agabiti-Rosei E, Cruickshank JK, et al. 2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents. *J Hypertens* 2016; 34:1887–1920.
- Xi B, Zong X, Kelishadi R, Hong YM, et al. Establishing international blood pressure references among nonoverweight children and adolescents aged 6 to 17 years. *Circulation* 2016; 133:398–408.
- Dong Y, Ma J, Song Y, Dong B, et al. National blood pressure reference for Chinese Han children and adolescents aged 7 to 17 years. *Hypertension* 2017; 70:897–890.

Section 12: Hypertension Management at a Glance

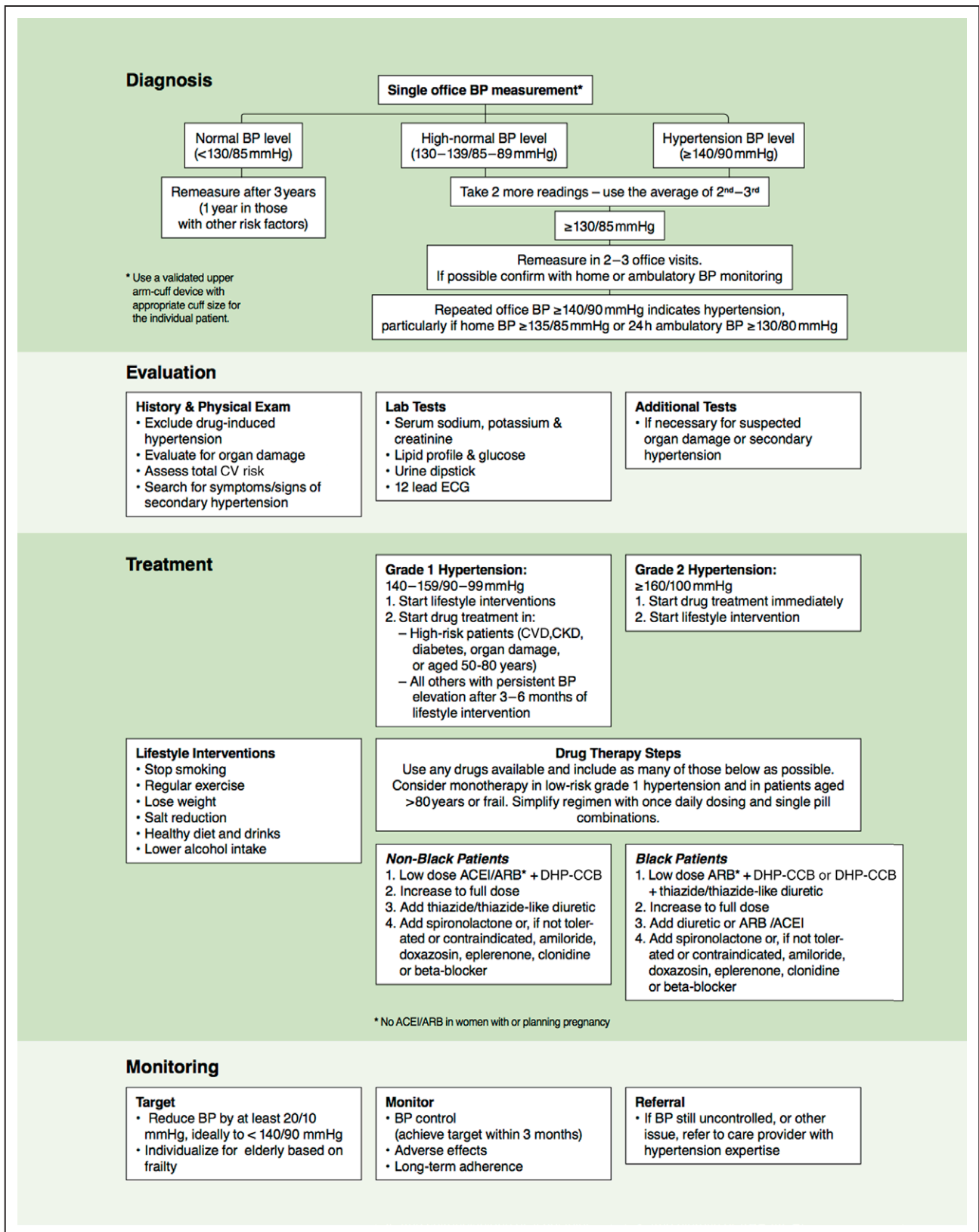


Figure 5. ISH 2020 **ESSENTIAL** recommendations (minimum standards of care).

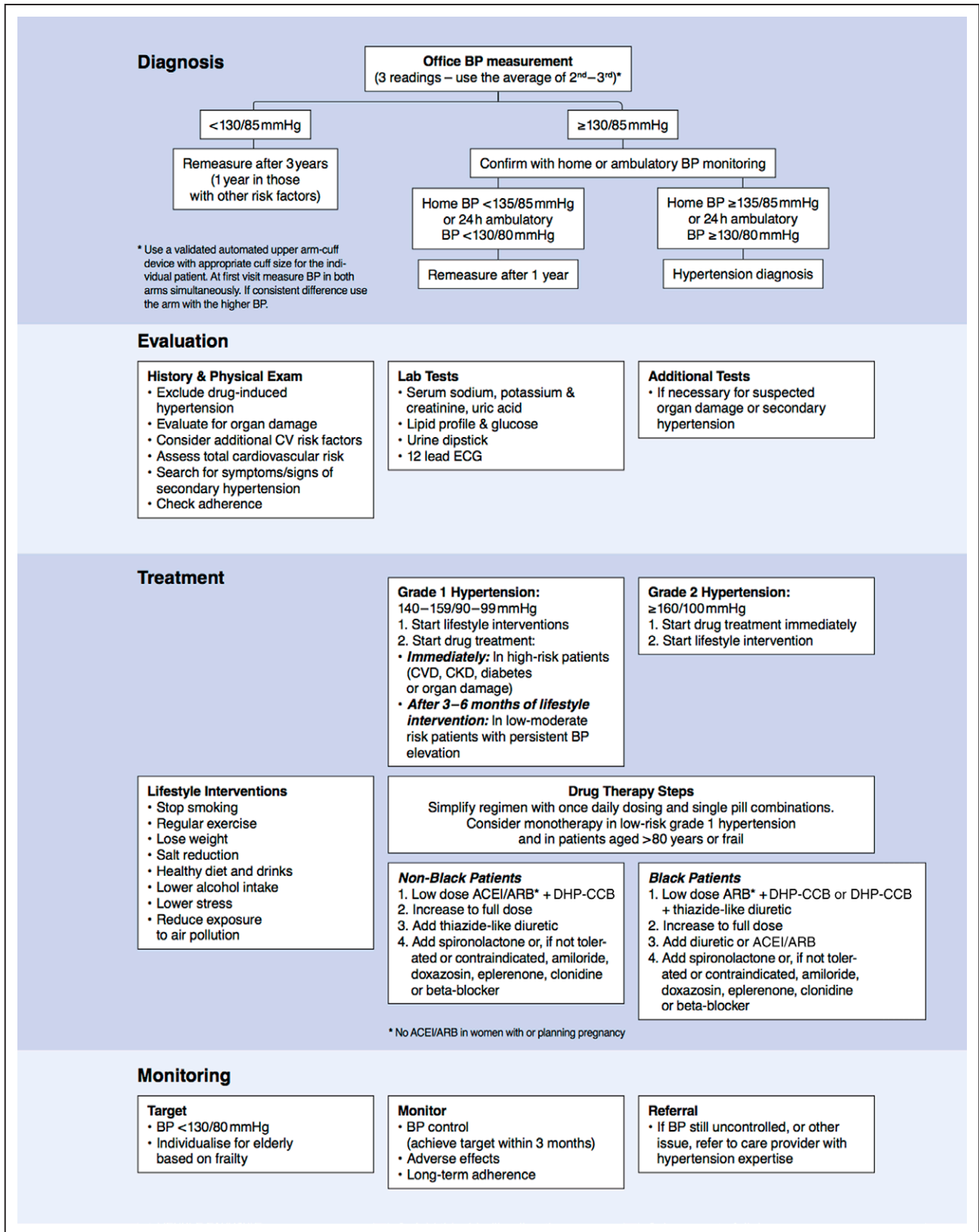


Figure 6. ISH 2020 OPTIMAL recommendations (evidence-based standards of care).

## Document Reviewers

Hind Beheiry (Sudan), Irina Chazova (Russia), Albertino Damasceno (Mozambique), Anna Dominiczak (United Kingdom), Anastase Dzudie (Cameroon), Stephen Harrap (Australia), Hiroshi Itoh (Japan), Tazeen Jafar (Singapore), Marc Jaffe (United States), Patricio Jaramillo-Lopez (Colombia), Kazuomi Kario (Japan), Giuseppe Mancia (Italy), Ana Mocumbi (Mozambique), Sanjeevi N. Narasingan (India), Elijah Ogola (Kenya), Srinath Reddy (India), Ernesto Schiffrin (Canada), Ann Soenarta (Indonesia), Rhian Touyz (United Kingdom), Yudah Turana (Indonesia), Michael Weber (United States), Paul Whelton (United States), Xin Hua Zhang, (Australia), Yuqing Zhang (China).

## Acknowledgements

The authors are grateful to Elena Kaschina and Michél Strauss-Kruger for their help in preparing and editing this article.

## Disclosures

The authors have no conflict of interest to declare, but declare lecture honoraria or consulting fees as follows: T.U., Bayer, Boehringer Ingelheim, Hexal, Vifor Pharma; C.B., Servier, Menarini, Merck Pharma, Novartis, Egis, Daichy Sankyo, Gilead; N.R.P., Servier, Pfizer, Sanofi, Eva Pharma; D.P., Torrent Pharmaceuticals; M.S., Medtronic, Abbott, Novartis, Servier, Pfizer, Boehringer-Ingelheim; G.S.S., AstraZeneca, Menarini, Pfizer, Servier; B.W., Vascular Dynamics USA, Inc, Relypsa, Inc, USA; Daiichi Sankyo, Pfizer, Servier, Novartis, Menarini, Omron; A.E.S., Omron, Novartis, Takeda, Servier, Abbott.

## References

- Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, Clement DL, Coca A, de Simone G, Dominiczak A, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension: The Task Force for the Management Of Arterial Hypertension of the European Society of Cardiology and the European Society of Hypertension. *J Hypertens*. 2018;36:1953–2041.
- Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, DennisonHimmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 2018;71:1269–1324.
- Global Burden of Disease Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392:1923–1994.
- Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, Chen J, He J. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. *Circulation*. 2016;134:441–450.
- Non-Communicable Disease Risk Factor Collaboration. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19.1 million participants. *Lancet*. 2017;389:37–55.
- Beaney T, Burrell LM, Castillo RR, Charchar FJ, Cro S, Damasceno A, Kruger R, Nilsson PM, Prabhakaran D, Ramirez AJ, et al. MMM Investigators. May Measurement Month 2018: a pragmatic global screening campaign to raise awareness of blood pressure by the International Society of Hypertension. *Eur Heart J*. 2019;40:2006–2017.
- Beaney T, Schutte AE, Tomaszewski M, Ariti C, Burrell LM, Castillo RR, Charchar FJ, Damasceno A, Kruger R, Lackland DT, et al. May Measurement Month 2017: an analysis of blood pressure screening results worldwide. *Lancet Glob Health*. 2018;6:e736–e743.
- Hypertension in adults: diagnosis and management. NICE guideline [NG136]. August 2019. <https://www.nice.org.uk/guidance/ng136>.
- Nerenberg KA, Zarnke KB, Leung AA, Dasgupta K, Butalia S, McBrien K, Harris KC, Nakhla M, Cloutier L, Gelfer M. Hypertension Canada's 2018 guidelines for diagnosis, risk assessment, prevention, and treatment of hypertension in adults and children. *Can J Cardiol*. 2018;34:506–525.
- Umemura S, Arima H, Arima S, Asayama K, Dohi Y, Hirooka Y, Horio T, Hoshida S, Ikeda S, Ishimitsu T, et al. The Japanese Society of Hypertension Guidelines for the management of hypertension (JSH 2019). *Hypertens Res*. 2019;42:1235–1481.
- Nakagawa N, Hasebe N. Impact of the 2017 American College of Cardiology/American Heart Association blood pressure guidelines on the next blood pressure guidelines in Asia. *Curr Hypertens Rep*. 2019;21:2.
- Kario K, Wang JG. Could 130/80 mm Hg Be Adopted as the diagnostic threshold and management goal of hypertension in consideration of the characteristics of Asian populations? *Hypertension*. 2018;71:979–984.
- Dzudie A, Rayner B, Ojji D, Schutte AE, Twagirumukiza M, Damasceno A, Ba SA, Kane A, Kramoh E, Anzouan Kacou JB, et al. Roadmap to achieve 25% hypertension control in Africa by 2025. *Glob Heart*. 2018;13:45–59.
- Messerli FH, Bangalore S. The blood pressure landscape: Schism among guidelines, confusion among physicians, and anxiety among patients. *J Am Coll Cardiol*. 2018;72:1313–1316.
- Rehan HS, Grover A, Hungin AP. Ambiguities in the guidelines for the management of arterial hypertension: Indian perspective with a call for global harmonization. *Curr Hypertens Rep*. 2017;19:17.
- Poulter NR, Castillo R, Charchar FJ, Schlaich MP, Schutte AE, Tomaszewski M, Touyz RM, Wang JG. Are the American Heart Association/American College of Cardiology high blood pressure guidelines fit for global purpose?: Thoughts from the International Society of Hypertension. *Hypertension*. 2018;72:260–262.
- Stergiou GS, Palatini P, Asmar R, Bilo G, de la Sierra A, Head G, Kario K, Mihailidou A, Wang J, Mancia G, O'Brien E, Parati G. Blood pressure monitoring: theory and practice. European Society of Hypertension Working Group on blood pressure monitoring and cardiovascular variability teaching course proceedings. *Blood Press Monit*. 2018;23:1–8.
- Muntner P, Einhorn PT, Cushman WC, Whelton PK, Bello NA, Drawz PE, Green BB, Jones DW, Juraschek SP, Margolis KL, et al. Blood pressure assessment in adults in clinical practice and clinic-based research: JACC scientific expert panel. *J Am Coll Cardiol*. 2019;73:317–335.
- O'Brien E, Parati G, Stergiou G, Asmar R, Beilin L, Bilo G, Clement D, de la Sierra A, de Leeuw P, Dolan E, et al. European Society of Hypertension position paper on ambulatory blood pressure monitoring. *J Hypertens*. 2013;31:1731–1768.
- Parati G, Stergiou GS, Asmar R, Bilo G, de Leeuw P, Imai Y, Kario K, Lurbe E, Manolis A, Mengden T, et al. European Society of Hypertension guidelines for blood pressure monitoring at home: a summary report of the Second International Consensus Conference on Home Blood Pressure Monitoring. *J Hypertens*. 2008;26:1505–1526.
- Kario K, Shin J, Chen CH, Buranakitjaroen P, Chia YC, Divinagracia R, Nailles J, Hoshida S, Siddique S, Sison J, et al. Expert panel consensus recommendations for ambulatory blood pressure monitoring in Asia: The HOPE Asia Network. *J Clin Hypertens*. 2019;21:1250–1283.
- Stergiou GS, O'Brien E, Myers M, Palatini P, Parati G, STRIDE BP Scientific Advisory Board. STRIDE BP: an international initiative for accurate blood pressure measurement. *J Hypertens*. 2019;38:395–399.
- Stergiou GS, Kyriakoulis KG, Kollias A. Office blood pressure measurement types: Different methodology-Different clinical conclusions. *J Clin Hypertens*. 2018;20:1683–1685.
- Myers MG, Asmar R, Staessen JA. Office blood pressure measurement in the 21st century. *J Clin Hypertens*. 2018;20:1104–1107.
- Mancia G, Facchetti R, Bombelli M, Grassi G, Sega R. Long-term risk of mortality associated with selective and combined elevation in office, home, and ambulatory blood pressure. *Hypertension*. 2006;47:846–853.
- Stergiou GS, Asayama K, Thijs L, Kollias A, Niiranen TJ, Hozawa A, Boggia J, Johansson JK, Ohkubo T, Tsuji I, Jula AM, Imai Y, Staessen JA, International Database on Home blood pressure in relation to Cardiovascular Outcome (IDHOCO) Investigators. Prognosis of white-coat and masked hypertension: International Database of Home blood pressure in relation to Cardiovascular Outcome. *Hypertension*. 2014;63:675–682.
- Asayama K, Thijs L, Li Y, Gu YM, Hara A, Liu YP, Zhang Z, Wei FF, Lujambio I, Mena LJ, et al; International Database on Ambulatory Blood Pressure in Relation to Cardiovascular Outcomes (IDACO) Investigators. Setting thresholds to varying blood pressure monitoring intervals differentially affects risk estimates associated with white-coat and masked hypertension in the population. *Hypertension*. 2014;64:935–942.
- Lopez AD, Mathers CD, Ezzati M, Jamison DT, Murray CJ. Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data. *Lancet*. 2006;367:1747–1757.
- Tunstall-Pedoe H, Chen R, Kramarz P. Prevalence of individuals with both raised blood pressure and raised cholesterol in WHO MONICA

- project population surveys 1989–1997. *Eur Heart J*. 2004;25(Suppl 1):234.
30. Neaton JD, Wentworth D. Serum cholesterol, blood pressure, cigarette smoking, and death from coronary heart disease. Overall findings and differences by age for 316,099 white men. Multiple Risk Factor Intervention Trial Research Group. *Arch Intern Med*. 1992;152:56–64.
  31. Rossi GP, Seccia TM, Maniero C, Pessina AC. Drug-related hypertension and resistance to antihypertensive treatment: a call for action. *J Hypertens*. 2011;29:2295–2309.
  32. Aw T-J, Haas SJ, Liew D, Krum H. Meta-analysis of Cyclooxygenase-2 inhibitors and their effects on blood pressure. *Arch of Intern Med*. 2005;165:490–496.
  33. Chasan-Taber L, Willett WC, Manson JE, Spiegelman D, Hunter DJ, Curhan G, Colditz GA, Stampfer MJ. Prospective study of oral contraceptives and hypertension among women in the United States. *Circulation*. 1996;94:483–489.
  34. Grossman E, Messerli FH. Drug-induced hypertension: an unappreciated cause of secondary hypertension. *Am J Med*. 2012;125:14–22.
  35. Robert N, Wong GW, Wright JM. Effect of cyclosporine on blood pressure. *Cochrane Database Syst Rev*. 2010;CD007893.
  36. Salerno SM, Jackson JL, Berbano EP. Effect of oral pseudoephedrine on blood pressure and heart rate: a meta-analysis. *Arch Intern Med*. 2005;165:1686–1694.
  37. Licht CM, de Geus EJ, Seldenrijk A, van Hout HP, Zitman FG, van Dyck R, Penninx BW. Depression is associated with decreased blood pressure, but antidepressant use increases the risk for hypertension. *Hypertension*. 2009;53:631–638.
  38. Zhong Z, Wang L, Wen X, Liu Y, Fan Y, Liu Z. A meta-analysis of effects of selective serotonin reuptake inhibitors on blood pressure in depression treatment: outcomes from placebo and serotonin and norepinephrine reuptake inhibitor controlled trials. *Neuropsychiatr Dis Treat*. 2017;13:2781–2796.
  39. Plummer C, Michael A, Shaikh G, Stewart M, Buckley L, Miles T, Ograbek A, McCormack T. Expert recommendations on the management of hypertension in patients with ovarian and cervical cancer receiving bevacizumab in the UK. *Br J Cancer*. 2019;121:109–116.
  40. Nduka CU, Stranges S, Sarki AM, Kimani PK, Uthman OA. Evidence of increased blood pressure and hypertension risk among people living with HIV on antiretroviral therapy: a systematic review with meta-analysis. *J Hum Hypertens*. 2016;30:355–362.
  41. Krapf R, Hulter HN. Arterial hypertension induced by erythropoietin and erythropoiesis-stimulating agents (ESA). *Clin J Am Soc Nephrol*. 2009;4:470–480.
  42. Vanmolkot FH, de Hoon JN. Acute effects of sumatriptan on aortic blood pressure, stiffness, and pressure waveform. *Clin Pharmacol Ther*. 2006;80:85–94.
  43. Forman JP, Stampfer MJ, Curhan GC. Non-narcotic analgesic dose and risk of incident hypertension in US women. *Hypertension*. 2005;46:500–507.
  44. Haller CA, Benowitz NL. Adverse cardiovascular and central nervous system events associated with dietary supplements containing ephedra alkaloids. *N Engl J Med*. 2000;343:1833–1838.
  45. Penninkilampi R, Eslick EM, Eslick GD. The association between consistent licorice ingestion, hypertension and hypokalaemia: a systematic review and meta-analysis. *J Hum Hypertens*. 2017;31:699–707.
  46. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, Cooney MT, Corra U, Cosyns B, Deaton C, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J*. 2016;37:2315–2381.
  47. He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. *BMJ*. 2013;346:f1325.
  48. Gay HC, Rao SG, Vaccarino V, Ali MK. Effects of different dietary interventions on blood pressure: systematic review and meta-analysis of randomized controlled trials. *Hypertension*. 2016;67:733–739.
  49. Cicero AFG, Grassi D, Tocci G, Galletti F, Borghi C, Ferri C. Nutrients and nutraceuticals for the management of high normal blood pressure: an evidence-based consensus document. *High Blood Press Cardiovasc Prev*. 2019;26:9–25.
  50. Xie C, Cui L, Zhu J, Wang K, Sun N, Sun C. Coffee consumption and risk of hypertension: a systematic review and dose-response meta-analysis of cohort studies. *J Hum Hypertens*. 2018;32:83–93.
  51. Roerecke M, Kaczorowski J, Tobe SW, Gmel G, Hasan OSM, Rehm J. The effect of a reduction in alcohol consumption on blood pressure: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2:e108–e120.
  52. Alberti G, Zimmet P, Shaw J, Grundy SM. The IDF consensus worldwide definition of the metabolic syndrome. Brussels: International Diabetes Federation. 2006. Available at: <https://www.idf.org/e-library/consensus-statements/60-idfconsensus-worldwide-definitio-nof-the-metabolic-syndrome.html>.
  53. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. *Obes Rev*. 2012;13:275–286.
  54. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutr Res Rev*. 2010;23:247–269.
  55. Global Burden of Disease Risk Factor Collaborators. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet*. 2017;390:1345–1422.
  56. Casonatto J, Goessler KF, Cornelissen VA, Cardoso JR, Polito MD. The blood pressure-lowering effect of a single bout of resistance exercise: a systematic review and meta-analysis of randomised controlled trials. *Eur J Prev Cardiol*. 2016;23:1700–1714.
  57. Costa EC, Hay JL, Kehler DS, Boreškie KF, Arora RC, Umpierre D, Sz wajcer A, Duhamel TA. Effects of high-intensity interval training versus moderate-intensity continuous training on blood pressure in adults with pre-established hypertension: a systematic review and meta-analysis of randomized trials. *Sports Med*. 2018;48:2127–2142.
  58. Cornelissen VA, Smart NA. Exercise training for blood pressure: a systematic review and meta-analysis. *J Am Heart Assoc*. 2013;2:e004473.
  59. Matthews KA, Katholi CR, McCreath H, Whooley MA, Williams DR, Zhu S, Markovitz JH. Blood pressure reactivity to psychosocial stress predicts hypertension in the CARDIA study. *Circulation*. 2004;110:74–78.
  60. Solano Lopez AL. Effectiveness of the mindfulness-based stress reduction program on blood pressure: a systematic review of literature. *Worldviews Evid Based Nurs*. 2018;15:344–352.
  61. Wang J, Xiong X. Evidence-based chinese medicine for hypertension. *Evid Based Complement Alternat Med*. 2013;2013:978398.
  62. Liwa AC, Smart LR, Frumkin A, Epstein HA, Fitzgerald DW, Peck RN. Traditional herbal medicine use among hypertensive patients in sub-Saharan Africa: a systematic review. *Curr Hypertens Rep*. 2014;16:437.
  63. Giorgini P, Di Giosia P, Grassi D, Rubenfire M, Brook RD, Ferri C. Air pollution exposure and blood pressure: an updated review of the literature. *Curr Pharm Des*. 2016;22:28–51.
  64. Fedak KM, Good N, Walker ES, Balmes J, Brook RD, Clark ML, Cole-Hunter T, Devlin R, L'Orange C, Luckasen G, Mehaffy J, Shelton R, Wilson A, Volckens J, Peel JL. Acute effects on blood pressure following controlled exposure to cookstove air pollution in the STOVES Study. *J Am Heart Assoc*. 2019;8:e012246.
  65. Stergiou GS, Palatini P, Modesti PA, Asayama K, Asmar R, Bilo G, de la Sierra A, Dolan E, Head G, Kario K, et al. Seasonal variation in blood pressure: evidence, consensus and recommendations for clinical practice. Consensus statement by the European Society of Hypertension Working Group on Blood Pressure Monitoring and Cardiovascular Variability. *J Hypertens*. 2020; In Print.
  66. Geldsetzer P, Manne-Goehler J, Marcus ME, Ebert C, Zhumadilov Z, Wesseh CS, Tsabedze L, Supiyev A, Sturua L, Bahendeka SK, et al. The state of hypertension care in 44 low-income and middle-income countries: a cross-sectional study of nationally representative individual-level data from 1.1 million adults. *Lancet*. 2019;394:652–662.
  67. Non-communicable Disease Risk Factor Collaboration. Long-term and recent trends in hypertension awareness, treatment, and control in 12 high-income countries: an analysis of 123 nationally representative surveys. *Lancet*. 2019;394:639–651.
  68. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R, Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet*. 2002;360:1903–1913.
  69. Dahlof B, Sever PS, Poulter NR, Wedel H, Beevers DG, Caulfield M, Collins R, Kjeldsen SE, Kristinsson A, McInnes GT, Mehlsen J, Nieminen M, O'Brien E, Ostergren J, Prospective Studies Collaboration. Prevention of cardiovascular events with an antihypertensive regimen of amlodipine adding perindopril as required versus atenolol adding bendroflumethiazide as required, in the Anglo-Scandinavian Cardiac Outcomes

- Trial-Blood Pressure Lowering Arm (ASCOT-BPLA): a multicentre randomised controlled trial. *Lancet*. 2005;366:895–906.
70. Jamerson K, Weber MA, Bakris GL, Dahlof B, Pitt B, Shi V, Hester A, Gupte J, Gatlin M, Velazquez EJ. Benazepril plus amlodipine or hydrochlorothiazide for hypertension in high-risk patients. *N Engl J Med*. 2008;359:2417–2428.
  71. Williams B, MacDonald TM, Morant S, Webb DJ, Sever P, McInnes G, Ford I, Cruickshank JK, Caulfield MJ, Salsbury J, Mackenzie I, Padmanabhan S, Brown MJ, British Hypertension Society's PATHWAY Studies Group. Spironolactone versus placebo, bisoprolol, and doxazosin to determine the optimal treatment for drug-resistant hypertension (PATHWAY-2): a randomised, double-blind, crossover trial. *Lancet*. 2015;386:2059–2068.
  72. Chapman N, Chang CL, Dahlof B, Sever PS, Wedel H, Poulter NR, ASCOT Investigators. Effect of doxazosin gastrointestinal therapeutic system as third-line antihypertensive therapy on blood pressure and lipids in the Anglo-Scandinavian Cardiac Outcomes Trial. *Circulation*. 2008;118:42–48.
  73. Ojji DB, Mayosi B, Francis V, Badri M, Cornelius V, Smythe W, Kramer N, Barasa F, Damasceno A, Dzudie A, et al. CREOLE Study Investigators. Comparison of dual therapies for lowering blood pressure in black Africans. *N Engl J Med*. 2019;380:2429–2439.
  74. Sabaté E. *Adherence to long-term therapies: evidence for action*. World Health Organization. Geneva. 2003.
  75. Tomaszewski M, White C, Patel P, Masca N, Damani R, Hepworth J, Samani NJ, Gupta P, Madira W, Stanley A, Williams B. High rates of non-adherence to antihypertensive treatment revealed by high-performance liquid chromatography-tandem mass spectrometry (HP LC-MS/MS) urine analysis. *Heart*. 2014;100:855–861.
  76. Mazzaglia G, Ambrosioni E, Alacqua M, Filippi A, Sessa E, Immordino V, Borghi C, Brignoli O, Caputi AP, Cricelli C, Mantovani LG. Adherence to antihypertensive medications and cardiovascular morbidity among newly diagnosed hypertensive patients. *Circulation*. 2009;120:1598–1605.
  77. Corrao G, Parodi A, Nicotra F, Zambon A, Merlino L, Cesana G, Mancina G. Better compliance to antihypertensive medications reduces cardiovascular risk. *J Hypertens*. 2011;29:610–618.
  78. Gupta P, Patel P, Strauch B, Lai FY, Akbarov A, Maresova V, White CMJ, Petrak O, Gulsin GS, Patel V, et al. Risk factors for nonadherence to antihypertensive treatment. *Hypertension*. 2017;69:1113–1120.
  79. Wei FF, Zhang ZY, Huang QF, Staessen JA. Diagnosis and management of resistant hypertension: state of the art. *Nat Rev Nephrol*. 2018;14:428–441.
  80. Gupta P, Patel P, Horne R, Buchanan H, Williams B, Tomaszewski M. How to screen for non-adherence to antihypertensive therapy. *Curr Hypertens Rep*. 2016;18:89.
  81. Abegaz TM, Shehab A, Gebreyohannes EA, Bhagavathula AS, Elnour AA. Nonadherence to antihypertensive drugs: a systematic review and meta-analysis. *Medicine*. 2017;96:e5641.
  82. Conn VS, Ruppert TM. Medication adherence outcomes of 771 intervention trials: systematic review and meta-analysis. *Prev Med*. 2017;99:269–276.
  83. Conn VS, Ruppert TM, Chase JA, Enriquez M, Cooper PS. Interventions to improve medication adherence in hypertensive patients: systematic review and meta-analysis. *Curr Hypertens Rep*. 2015;17:94.
  84. Verma AA, Khuu W, Tadrous M, Gomes T, Mamdani MM. Fixed-dose combination antihypertensive medications, adherence, and clinical outcomes: a population-based retrospective cohort study. *PLoS Med*. 2018;15:e1002584.
  85. Gupta P, Patel P, Strauch B, Lai FY, Akbarov A, Gulsin GS, Beech A, Maresova V, Topham PS, Stanley A, et al. Biochemical screening for non-adherence is associated with blood pressure reduction and improvement in adherence. *Hypertension*. 2017;70:1042–1048.
  86. Ruppert TM, Dunbar-Jacob JM, Mehr DR, Lewis L, Conn VS. Medication adherence interventions among hypertensive black adults: a systematic review and meta-analysis. *J Hypertens*. 2017;35:1145–1154.
  87. Costa E, Giardini A, Savin M, Menditto E, Lehane E, Laosa O, Pecorelli S, Monaco A, Marengoni A. Interventional tools to improve medication adherence: review of literature. *Patient Prefer Adherence*. 2015;9:1303–1314.
  88. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937–952.
  89. Mach F, Baigent C, Catapano AL, Koskinas KC, Casula M, Badimon L, Chapman MJ, De Backer GG, Delgado V, Ference BA, et al. 2019 ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. *Eur Heart J*. 2020;41:111–188.
  90. O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, Rangarajan S, Islam S, Pais P, McQueen MJ, et al. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *Lancet*. 2010;376:112–123.
  91. Bohm M, Young R, Jhund PS, Solomon SD, Gong J, Lefkowitz MP, Rizkala AR, Rouleau JL, Shi VC, Swedberg K, Zile MR, Packer M, McMurray JJV. Systolic blood pressure, cardiovascular outcomes and efficacy and safety of sacubitril/valsartan (LCZ696) in patients with chronic heart failure and reduced ejection fraction: results from PARADIGM-HF. *Eur Heart J*. 2017;38:1132–1143.
  92. Drawz PE, Alper AB, Anderson AH, Brecklin CS, Charleston J, Chen J, Deo R, Fischer MJ, He J, Hsu CY, et al. Masked hypertension and elevated nighttime blood pressure in CKD: prevalence and association with target organ damage. *Clin J Am Soc Nephrol*. 2016;11:642–652.
  93. Farsang C, Kiss I, Tykarski A, Narkiewicz K. Treatment of hypertension in patients with chronic obstructive pulmonary disease (COPD). *European Society of Hypertension Scientific Newsletter*. 2016;17:62.
  94. Borghi C, Rosei EA, Bardin T, Dawson J, Dominiczak A, Kielstein JT, Manolis AJ, Perez-Ruiz F, Mancina G. Serum uric acid and the risk of cardiovascular and renal disease. *J Hypertens*. 2015;33:1729–1741.
  95. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmelfarb CD, Khera A, Lloyd-Jones D, McEvoy JW, et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: a report of the American College of Cardiology/American Heart Association Task Force on clinical practice guidelines. *J Am Coll Cardiol*. 2019;74:1376–1414.
  96. American Diabetes Association. Standards of medical care in diabetes 2017. *Diabetes Care*. 2017;40 (Suppl 1):S1–135.
  97. Sever PS, Dahlof B, Poulter NR, Wedel H, Beevers G, Caulfield M, Collins R, Kjeldsen SE, Kristinsson A, McInnes GT, Mehlsen J, Nieminen M, O'Brien E, Ostergren J. Prevention of coronary and stroke events with atorvastatin in hypertensive patients who have average or lower-than-average cholesterol concentrations, in the Anglo-Scandinavian Cardiac Outcomes Trial–Lipid Lowering Arm (ASCOT-LLA): a multicentre randomised controlled trial. *Lancet*. 2003;361:1149–1158.
  98. Nordestgaard BG. Triglyceride-rich lipoproteins and atherosclerotic cardiovascular disease: new insights from epidemiology, genetics, and biology. *Circ Res*. 2016;118:547–563.
  99. Agca R, Heslinga SC, Rollefstad S, Heslinga M, McInnes IB, Peters MJ, Kvien TK, Dougados M, Radner H, Atzeni F, et al. EULAR recommendations for cardiovascular disease risk management in patients with rheumatoid arthritis and other forms of inflammatory joint disorders: 2015/2016 update. *Ann Rheum Dis*. 2017;76:17–28.
  100. Ikdahl E, Wibetoe G, Rollefstad S, Salberg A, Bergsmark K, Kvien TK, Olsen IC, Soldal DM, Bakland G, Lexberg A, Fevang BTS, Gulseth HC, Haugeberg G, Semb AG. Guideline recommended treatment to targets of cardiovascular risk is inadequate in patients with inflammatory joint diseases. *Int J Cardiol*. 2019;274:311–318.
  101. Musselman DL, Evans DL, Nemeroff CB. The relationship of depression to cardiovascular disease: epidemiology, biology, and treatment. *Arch Gen Psychiatry*. 1998;55:580–592.
  102. Patten SB, Williams JV, Lavorato DH, Campbell NR, Eliasziw M, Campbell TS. Major depression as a risk factor for high blood pressure: epidemiologic evidence from a national longitudinal study. *Psychosom Med*. 2009;71:273–279.
  103. Siwek M, Woron J, Gorostowicz A, Wordliczek J. Adverse effects of interactions between antipsychotics and medications used in the treatment of cardiovascular disorders. *Pharmacol Rep*. 2020; doi: 10.1007/s43440-020-00058-6. [Epub ahead of print].
  104. Bhatt H, Siddiqui M, Judd E, Oparil S, Calhoun D. Prevalence of pseudo-resistant hypertension due to inaccurate blood pressure measurement. *J Am Soc Hypertens*. 2016;10:493–499.
  105. de Jager RL, van Maarseveen EM, Bots ML, Blankstijn PJ, SYMPATHY Investigators. Medication adherence in patients with apparent resistant hypertension: findings from the SYMPATHY trial. *Br J Clin Pharmacol*. 2018;84:18–24.
  106. Vongpatanasin W. Resistant hypertension: a review of diagnosis and management. *JAMA*. 2014;311:2216–2224.
  107. Ayala DE, Hermida RC, Mojon A, Fernandez JR. Cardiovascular risk of resistant hypertension: dependence on treatment-time regimen of blood pressure-lowering medications. *Chronobiol Int*. 2013;30:340–352.
  108. Nazarzadeh M, Pinho-Gomes AC, Rahimi K. Resistant hypertension in times of changing definitions and treatment recommendations. *Heart*. 2019;105:96–97.

109. Rossignol P, Massy ZA, Azizi M, Bakris G, Ritz E, Covic A, Goldsmith D, Heine GH, Jager KJ, Kanbay M, et al. The double challenge of resistant hypertension and chronic kidney disease. *Lancet*. 2015;386:1588–1598.

110. Williams B, MacDonald TM, Morant SV, Webb DJ, Sever P, McClines GT, Ford I, Cruickshank JK, Caulfield MJ, Padmanabhan S, Mackenzie IS, Salsbury J, Brown MJ. Endocrine and haemodynamic changes in resistant hypertension, and blood pressure responses to spironolactone or amiloride: the PATHWAY-2 mechanisms substudies. *Lancet Diabetes Endocrinol*. 2018;6:464–475.

111. Sinnott SJ, Tomlinson LA, Root AA, Mathur R, Mansfield KE, Smeeth L, Douglas IJ. Comparative effectiveness of fourth-line anti-hypertensive agents in resistant hypertension: A systematic review and meta-analysis. *Eur J Prev Cardiol*. 2017;24:228–238.

112. Krieger EM, Dräger LF, Giorgi DMA, Pereira AC, Barreto-Filho JAS, Nogueira AR, Mill JG, Lotufo PA, Amodeo C, Batista MC, et al, ReHOT Investigators. Spironolactone versus clonidine as a fourth-drug therapy for resistant hypertension: The ReHOT Randomized Study (Resistant Hypertension Optimal Treatment). *Hypertension*. 2018;71:681–690.

113. Brown MJ, Williams B, Morant SV, Webb DJ, Caulfield MJ, Cruickshank JK, Ford I, McClines G, Sever P, Salsbury J, Mackenzie IS, Padmanabhan S, MacDonald TM, British Hypertension Society's Prevention and Treatment of Hypertension with Algorithm-based Therapy (PATHWAY) Studies Group. Effect of amiloride, or amiloride plus hydrochlorothiazide, versus hydrochlorothiazide on glucose tolerance and blood pressure (PATHWAY-3): a parallel-group, double-blind randomised phase 4 trial. *Lancet Diabetes Endocrinol*. 2016;4:136–147.

114. Manolis AA, Manolis TA, Melita H, Manolis AS. Eplerenone versus spironolactone in resistant hypertension: an efficacy and/or cost or just a men's issue? *Curr Hypertens Rep*. 2019;21:22.

115. Denker MG, Haddad DB, Townsend RR, Cohen DL. Blood pressure control 1 year after referral to a hypertension specialist. *J Clin Hypertens*. 2013;15:624–629.

116. Funder JW, Carey RM, Mantero F, Murad MH, Reincke M, Shibata H, Stowasser M, Young WF, Jr. The management of primary aldosteronism: case detection, diagnosis, and treatment: An Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2016;101:1889–1916.

117. Gornik HL, Persu A, Adlam D, Aparicio LS, Azizi M, Boulanger M, Bruno RM, De Leeuw P, Fendrikova-Mahlay N, Froehlich J, et al. First international consensus on the diagnosis and management of fibromuscular dysplasia. *J Hypertens*. 2019;37:229–252.

118. Nieman LK, Biller BM, Findling JW, Newell-Price J, Savage MO, Stewart PM, Montori VM. The diagnosis of Cushing's syndrome: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab*. 2008;93:1526–1540.

119. Rimoldi SF, Scherrer U, Messerli FH. Secondary arterial hypertension: when, who, and how to screen? *Eur Heart J*. 2014;35:1245–1254.

120. Viera AJ, Neutze DM. Diagnosis of secondary hypertension: an age-based approach. *Am Fam Physician*. 2010;82:1471–1478.

121. Borgel J, Springer S, Ghafoor J, Arndt D, Duchna HW, Barthel A, Werner S, Van Helden J, Hanefeld C, Neubauer H, Bulut D, Mugge A. Unrecognized secondary causes of hypertension in patients with hypertensive urgency/emergency: prevalence and co-prevalence. *Clin Res Cardiol*. 2010;99:499–506.

122. Regitz-Zagrosek V, Roos-Hesselink JW, Bauersachs J, Blomström-Lundqvist C, Cifková R, De Bonis M, Iung B, Johnson MR, Kintscher U, Kranke P, et al, ESC Scientific Document Group. 2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy: the Task Force for the Management of Cardiovascular Diseases during Pregnancy of the European Society of Cardiology (ESC). *Eur Heart J*. 2018;39:3165–3241.

123. American College of Obstetricians and Gynecologists. Task Force on Hypertension in Pregnancy. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. *Obstet Gynecol*. 2013;122:1122–1131.

124. Lowe SA, Bowyer L, Lust K, McMahon LP, Morton MR, North RA, Paech MJ, Said JM. The SOMANZ Guidelines for the management of hypertensive disorders of pregnancy 2014. *Aust N Z J Obstet Gynaecol*. 2015;55:e1–e29.

125. Rolnik DL, Wright D, Poon LC, O'Gorman N, Syngelaki A, de Paco Matallana C, Akolekar R, Cicero S, Janga D, Singh M, et al. Aspirin versus placebo in pregnancies at high risk for preterm preeclampsia. *N Engl J Med*. 2017;377:613–622.

126. Abalos E, Duley L, Steyn DW, Henderson-Smart DJ. Antihypertensive drug therapy for mild to moderate hypertension during pregnancy. *Cochrane Database Syst Rev*. 2014;CD002252.

127. van den Born BH, Lip GYH, Brguljan-Hitij J, Cremer A, Segura J, Morales E, Mahfoud F, Amraoui F, Persu A, Kahan T, Agabiti Rosei E, de Simone G, Gosse P, Williams B. ESC Council on hypertension position document on the management of hypertensive emergencies. *Eur Heart J Cardiovasc Pharmacother*. 2019;5:37–46.

128. van den Born BJ, Koopmans RP, Groeneveld JO, van Montfrans GA. Ethnic disparities in the incidence, presentation and complications of malignant hypertension. *J Hypertens*. 2006;24:2299–2304.

129. Amraoui F, Van Der Hoeven NV, Van Valkengoed IG, Vogt L, Van Den Born BJ. Mortality and cardiovascular risk in patients with a history of malignant hypertension: a case-control study. *J Clin Hypertens*. 2014;16:122–126.

130. Gonzalez R, Morales E, Segura J, Ruilope LM, Praga M. Long-term renal survival in malignant hypertension. *Nephrol Dial Transplant*. 2010;25:3266–3272.

131. Tarver-Carr ME, Powe NR, Eberhardt MS, LaVeist TA, Kington RS, Coresh J, Brancati FL. Excess risk of chronic kidney disease among African-American versus white subjects in the United States: a population-based study of potential explanatory factors. *J Am Soc Nephrol*. 2002;13:2363–2370.

132. Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, Chamberlain AM, Chang AR, Cheng S, Das SR, et al, American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics-2019 update: a report from the American Heart Association. *Circulation*. 2019;139:e56–e528.

133. van Rooyen JM, Poglitsch M, Huisman HW, Mels C, Kruger R, Malan L, Botha S, Lammertyn L, Gafane L, Schutte AE. Quantification of systemic renin-angiotensin system peptides of hypertensive black and white African men established from the RAS-Fingerprint®. *J Renin Angiotensin Aldosterone Syst*. 2016;17.

134. Opie LH, Seedat YK. Hypertension in Sub-Saharan African populations. *Circulation*. 2005;112:3562–3568.

135. Bochud M, Staessen JA, Maillard M, Mazeko MJ, Kuznetsova T, Woodiwiss A, Richart T, Norton G, Thijs L, Elston R, Burnier M. Ethnic differences in proximal and distal tubular sodium reabsorption are heritable in black and white populations. *J Hypertens*. 2009;27:606–612.

136. Huisman HW, Schutte AE, Schutte R, van Rooyen JM, Fourie CM, Mels CM, Smith W, Malan NT, Malan L. Exploring the link between cardiovascular reactivity and end-organ damage in African and Caucasian men: the SABPA study. *Am J Hypertens*. 2013;26:68–75.

137. Mokwatsi GG, Schutte AE, Kruger R. Ethnic differences regarding arterial stiffness of 6-8-year-old black and white boys. *J Hypertens*. 2017;35:960–967.

138. Brewster LM, van Montfrans GA, Oehlers GP, Seedat YK. Systematic review: antihypertensive drug therapy in patients of African and South Asian ethnicity. *Intern Emerg Med*. 2016;11:355–374.

139. Kostis JB, Kim HJ, Rusnak J, Casale T, Kaplan A, Corren J, Levy E. Incidence and characteristics of angioedema associated with enalapril. *Arch Intern Med*. 2005;165:1637–1642.

140. Hoshida S, Kario K, de la Sierra A, Bilo G, Schillaci G, Banegas JR, Gorostidi M, Segura J, Lombardi C, Omboni S, Ruilope L, Mancia G, Parati G. Ethnic differences in the degree of morning blood pressure surge and in its determinants between Japanese and European hypertensive subjects: data from the ARTEMIS study. *Hypertension*. 2015;66:750–756.

141. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, Prabhakaran D. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *J Hypertens*. 2014;32:1170–1177.

142. Wang Z, Chen Z, Zhang L, Wang X, Hao G, Zhang Z, Shao L, Tian Y, Dong Y, Zheng C, Wang J, Zhu M, Weintraub WS, Gao R, China Hypertension Survey Investigators. Status of hypertension in China: results from the China Hypertension Survey, 2012–2015. *Circulation*. 2018;137:2344–2356.