# Arterial Hypertension

*Chair of propaedeutics of internal medicine with care of patients*

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# Definitions and Classification of Blood Pressure Levels (mmHg)

| Category | Systolic | | Diastolic |
|---|---|---|---|
| Optimal | <120 | and | <80 |
| Normal | 120-129 | and/or | 80-84 |
| High Normal | 130-139 | and/or | 85-89 |
| **Grade 1 Hypertension** | **140-159** | **and/or** | **90-99** |
| **Grade 2 Hypertension** | **160-179** | **and/or** | **100-109** |
| **Grade 3 Hypertension** | **≥180** | **and/or** | **≥110** |
| **Isolated Systolic Hypertension** | **≥140** | **and** | **<90** |

# Stratification of CV risk in four categories

| | Blood pressure (mmHg) | | | | |
|---|---|---|---|---|---|
| Other risk factors, OD or disease | Normal SBP 120-129 or DBP 80-84 | High normal SBP 130-139 or DBP 85-89 | Grade 1 HT SBP 140-159 or DBP 90-99 | Grade 2 HT SBP 160-179 or DBP 100-109 | Grade 3 HT SBP ≥180 or DBP ≥110 |
| No other risk factors | Average risk | Average risk | Low added risk | Moderate added risk | High added risk |
| 1-2 risk factors | Low added risk | Low added risk | Moderate added risk | Moderate added risk | Very high added risk |
| 3 or more risk factors, MS, OD or diabetes | Moderate added risk | High added risk | High added risk | High added risk | Very high added risk |
| Established CV or renal disease | Very high added risk | Very high added risk | Very high added risk | Very high added risk | Very high added risk |

SBP: systolic blood pressure; DBP: diastolic blood pressure; CV: cardiovascular; HT: hypertension. Low, moderate, high, very high risa refer to 10year risk of a CV fatal or non-fatal event. The term “added” indicates that in all categories risk is greater than average. OD: subclinical organ damage; MS: metabolic syndrome.

# Factors influencing Prognosis

## Risk Factors

Systolic and diastolic BP levels

Levels of pulse pressure (in the elderly)

Age (M>55 years; W>65 years)

Smoking

Dyslipidaemia
- TC>5.0 mmol/l (190 mg/dL) or
- LDL-C >3.0 mmol/l (115 mg/dL) or
- HDL-C:M <1.0 mmol/l (40 mg/dL), W <1.2 mmol/l (46 mg/dL) or
- TG >1.7 mmol/l (150 mg/dL)

Fasting plasma glucose 5.6-6.9 mmol/L (102-125 mg/dL)

Abnormal glucose tolerance test

Abdominal obesity
(Waist circumference >102cm (M), 88cm (W))

Family history of premature CV disease
(M at age <55 years, W at age <65 years)

## Subclinical Organ Damage

Electrocardiographic LVH
(Sokolow-Lyon >38 mm; Cornell >2440 mm*ms) or

Echocardiographic LVH
(LVMI M≥ 125g/m², W ≥110 g/m²)

Carotid wall thickening (IMT >0.9 mm) or plaque

Carotid-femoral pulse wave velocity >12 m/sec

Slight increase in plasma creatinine:
M: 115-133 µmol/l (1.3-1.5 mg/dL);
W: 107-124 µmol/l (1.2-1.4 mg/dL)

Low estimated glomerular filtration rate (<60 ml/min/1.73 m ²) or creatinine clearance (<60 ml/min)

Ankle/Brachial BP index <0.9

Microalbuminuria 30-300 mg/24h or albumin-creatinine ratio: ≥22 (M), or ≥31 (W) mg/g creatinine

# Factors influencing Prognosis

## Diabetes Mellitus

**Fasting plasma** ≥7.0 mmol/l (126 mg/dL) on repeated measurement, or

**Postload plasma glucose** >11.0 mmol/l (198 mg/dL)

## Established CV or renal disease

**Cerebrovascular disease:** ischaemic stroke; cerebral haemorrhage; transient ischaemic attack

**Heart disease:** myocardial infarction; angina; coronary revascularization; heart failure

**Renal disease:** diabetic nephropathy; renal impairment (serum creatinine M >133, W >124 mmol/l); proteinuria (>300 mg/24 h)

**Peripheral artery disease**

**Advanced retinopathy:** haemorrhages or exudates, papilloedema

# High/ Very High Risk Subjects

- BP ≥180 mmHg systolic and/or ≥110 mmHg diastolic
- Systolic BP >160 mmHg with low diastolic BP (<70 mmHg)
- Diabetes mellitus
- Metabolic syndrome
- ≥3 cardiovascular risk factors

# High/ Very High Risk Subjects

- One or more of the following subclinical organ damages:
  - Electrocardiographic (particularly with strain) or echocardiographic (particularly concentric) left ventricular hypertrophy
  - Ultrasound evidence of carotid artery wall thickening or plaque
  - Increased arterial stiffness
  - Slight increase in serum creatinine
  - Reduced estimated glomerular filtration rate or creatinine clearance
  - Microalbuminuria or proteinuria
- Established cardiovascular or renal disease

# Availability, Prognostic Value and Cost of some markers of organ damage (scored from 0 to 4 pluses)

| Markers | CV predictive value | Availability | Cost |
|---|---|---|---|
| Electrocardiography | ++ | ++++ | + |
| Echocardiography | +++ | +++ | ++ |
| Carotid Intima-Media Thickness | +++ | +++ | ++ |
| Arterial stiffness (Pulse wave velocity) | +++ | + | ++ |
| Ankle-Brachial index | ++ | ++ | + |
| Coronary calcium content | + | + | ++++ |
| Cardiac/Vascular tissue composition | ? | + | ++ |
| Circulatory collagen markers | ? | + | ++ |
| Endothelial dysfunction | ++ | + | +++ |
| Cerebral lacunae/ White matter lesions | ? | ++ | ++++ |
| Est. Glomerular Filtration Rate or Creatinine Clearance | +++ | ++++ | + |
| Microalbuminuria | +++ | ++++ | + |

# Blood Pressure (BP) Measurement

When measuring blood pressure, care should be taken to:

- Allow the patients to sit for several minutes in a quiet room before beginning blood pressure measurement
- Take at least two measurements spaced by 1-2 minutes, and additional measurements if the first two are quite different
- Use a standard bladder (12-13 cm long and 35 cm wide) but have a larger and a smaller bladder available for fat and thin arms, respectively. Use the smaller bladder in children
- Have the cuff at the heart level, whatever the position of the patient

# Blood Pressure (BP) Measurement

- Use phase I and V (disappearance) Korotkoff sounds to identify systolic and diastolic blood pressure, respectively
- Measure blood pressure in both arms at first visit to detect possible differences due to peripheral vascular disease. In this instance, take the higher value as the reference one
- Measure blood pressure 1 and 5 min after assumption of the standing position in elderly subjects, diabetic patients and in other conditions in which postural hypotension may be frequent or suspected
- Measure heart rate by pulse palpation (at least 30 sec) after the second measurement in the sitting position

# Ambulatory BP Measurements

- Although office BP should be used as reference, ambulatory BP may improve prediction of cardiovascular risk
- Normal values are different for office and ambulatory BP
- 24-h ambulatory BP monitoring should be considered, in particular, when:
  - considerable variability of office BP is found over the same or different visits
  - high office BP is measured in subjects otherwise at low CV risk
  - there is a marked discrepancy between BP values measured in the office and at home
  - resistance to drug treatment is suspected
  - hypotensive episodes are suspected, particularly in elderly and diabetic patients
  - office BP is elevated in pregnant women and pre-eclampsia is suspected

# Home BP Measurements

- Self-measurement of BP at home is of clinical value and its prognostic significance is now demonstrated. These measurements should be encouraged in order to:
  - provide more information on the BP lowering effect of treatment at trough and thus on therapeutic coverage throughout the dose-to-dose time interval
  - improve patient's adherence to treatment regimens
  - there are doubts on technical reliability/ environmental conditions of ambulatory BP data
- Self-measurement of BP at home should be discouraged whenever:
  - it causes anxiety to the patient
  - it induces self-modification of the treatment regimen
- Normal values are different for office and home BP

# Blood Pressure Thresholds (mmHg) for Definition of Hypertension with Different Types of Measurement

| | SBP | DBP |
|---|---|---|
| Office or Clinic | 140 | 90 |
| 24-hour | 125-130 | 80 |
| Day | 130-135 | 85 |
| Night | 120 | 70 |
| Home | 130-135 | 85 |

# Guidelines for Family and Clinical History

1. **Duration and previous level of high blood pressure**
2. **Indications of secondary hypertension:**
   - family history of renal disease (polycystic kidney)
   - renal disease, urinary tract infection, haematuria, analgesic abuse (parenchymal renal disease)
   - drug/substance intake: oral contraceptives, liquorice, carbenoxolone, nasal drops, cocaine, amphetamines, steroids, non-steroidal anti-inflammatory drugs, erythropoietin, cyclosporine
   - episodes of sweating, headache, anxiety, palpitation (phaeochromocytoma)
   - episodes of muscle weakness and tetany (aldosteronism)

# Guidelines for Family and Clinical History

**3. Risk factors:**

- family and personal history of hypertension and cardiovascular disease
- family and personal history dyslipidaemia
- family and personal history of diabetes mellitus
- smoking habits
- dietary habits
- obesity; amount of physical exercise
- snoring; sleep apnoea ( information also from partner)
- personality

# Guidelines for Family and Clinical History

4. **Symptoms of organ damage:**
   - brain and eyes: headache, vertigo, impaired vision, transient ischaemic attacks, sensory or motor deficit
   - heart: palpitation, chest pain, shortness of breath, swollen ankles
   - kidney: thirst, polyuria, nocturia, haematuria
   - peripheral arteries: cold extremities, intermittent claudication
5. **Previous antihypertensive therapy:**
   - Drug(s) used, efficacy and adverse effects
6. **Personal, family and environmental factors**

# Physical Examination for Secondary Hypertension, Organ Damage and Visceral Obesity

**Signs suggesting secondary hypertension and organ damage**

- Features of Cushing Syndrome
- Skin stigmata of neurofibromatosis (phaeochromocytoma)
- Palpation of enlarged kidneys (polycystic kidney)
- Auscultation of abdominal murmurs (renovascular hypertension)
- Auscultation of precordial or chest murmurs (aortic coarctation or aortic disease)
- Diminished and delayed femoral pulses femoral blood pressure (aortic coarctation, aortic disease)

# Physical Examination for Secondary Hypertension, Organ Damage and Visceral Obesity

## Signs of organ damage

- Brain: murmurs over neck arteries, motor or sensory defects
- Retina: fundoscopic abnormalities
- Heart: location and characteristics of apical impulse, abnormal cardiac rhythms, ventricular gallop, pulmonary rates, peripheral oedema
- Peripheral arteries: absence, reduction, or asymmetry of pulses, cold extremities, ischaemic skin lesions
- Carotid arteries: systolic murmurs

# Physical Examination for Secondary Hypertension, Organ Damage and Visceral Obesity

**Evidence of visceral obesity**

- Body weight
- Increased waist circumference (standing position)
  M: >102 cm, W: >88 cm
- Increased body mass index [body weight (Kg)/ height ($m^2$)]
  Overweight ≥25 Kg/$m^2$, Obesity ≥30 Kg/$m^2$

# Laboratory Investigations

**Routine tests**

- Fasting plasma glucose
- Serum total cholesterol
- Serum LDL-cholesterol
- Serum HDL-cholesterol
- Fasting serum triglycerides
- Serum potassium
- Serum uric acid
- Serum creatinine
- Estimated creatinine clearance (Cockroft-Gault formula) or glomerular filtration rate (MDRD formula)
- Haemoglobin and haematocrit
- Urinalysis (complemented by microalbuminuria dipstick test and microscopic examination)
- Electrocardiogram

# Laboratory Investigations

**Recommended tests**

- Echocardiogram
- Carotid ultrasound
- Quantitative proteinuria (if dipstick test positive)
- Ankle-brachial BP index
- Fundoscopy
- Glucose tolerance test (if fasting plasma glucose >5.6 mmol/L (102 mg/dL)
- Home and 24h ambulatory BP monitoring
- Pulse wave velocity measurement (where available)

# Laboratory Investigations

**Extended evaluation (domain of the specialist)**

- Further search for cerebral, cardiac, renal and vascular disease, mandatory in complicated hypertension
- Search for secondary hypertension when suggested by history, physical examination or routine tests: measurement of renin, aldosterone, corticosteroids, catecholamines in plasma and/or urine; arteriographies; renal and adrenal ultrasound; computer-assisted tomography; magnetic resonance imaging

# Searching for subclinical organ damage

Due to the importance of subclinical organ damage as an intermediate stage in the continuum of vascular disease and as a determinant of total cardiovascular risk, signs of organ involvement should be sought carefully by appropriate techniques:

**Heart**

- Electrocardiography should be part of all routine assessment of subjects with high BP in order to defect left ventricular hypertrophy, patterns of “strain”, ischaemic condition defects and arrhythmias
- Echocardiography is recommended whenever a more sensitive detection of left ventricular hypertrophy is considered useful. Geometric patterns (concentric and eccentric hypertrophy, concentric remodeling) can be defined echocardiographically, of which concentric hypertrophy carries the worst prognosis
- Diastolic dysfunction can also be evaluated by Doppler measurement of transmitral blood pressure velocities

# Searching for subclinical organ damage

**Blood vessels**

- Ultrasound scanning of the extracranial carotid arteries is also recommended whenever detection of vascular hypertrophy (increased thickness of common carotid intima-media) or asymptomatic atherosclerosis (thickening of carotid bifurcation and internal carotid arteries, presence of plagues) is deemed useful
- Large artery stiffening (an important vascular alteration leading to isolated systolic hypertension in the elderly) can be measured in a relatively simple way by pulse wave velocity. It might be more widely recommended if its availability were greater
- A low ankle- brachial BP index signals advanced peripheral artery disease

# Searching for subclinical organ damage

## Kidney

- The diagnosis of hypertension- related renal damage is based on the finding of a reduced renal function or the detection of an elevated urinary excretion of albumin in hypertensive patients
- Measurement of serum creatinine as well estimation from serum creatinine values of glomerular filtration rate (MDRD formula also requiring age, gender, race) or creatinine clearance (Cockroft- Gault formula, requiring age, gender body weight) should be part of routine procedures. This allows classification of renal dysfunction and stratification of cardiovascular risk
- The presence of urinary protein should be sought in all hypertensives by dipstick. In dipstick negative patients low grade albuminuria (microalbuminuria) should also be determined in spot urine and related to creatinine excretion

# Searching for subclinical organ damage

## Fundoscopy

- Examination of eye grounds is recommended in hypertensive with severe disease, only. This is because the mildest retinal changes (grade 1: arteriolar narrowing; grade 2: arterio venous nipping) appear to be largely non-specific alterations except in young patients
- In contrast grade 3 (haemorrhages and exudates) and 4 (papilloedema), only present in severe hypertension, are associated with an increased risk of cardiovascular events
- More sensitive methods for quantitatively assessing retinal vascular changes are being developed

# Searching for subclinical organ damage

## Brain

- Silent brain infarcts, lacunar infarction, microbleeds and white matter lesions are not infrequent among hypertensives and can be detected by MRI or CT (MRI being generally superior to CT)
- Availability and costs do not allow asymptomatic use of these techniques, however
- In elderly hypertensive, cognitive tests may also help to detect initial brain deterioration

# Initiation of antihypertensive treatment

| Other risk factors, OD or disease | Normal<br>SBP 120-129 or DBP 80-84 | High normal<br>SBP 130-139 or DBP 85-89 | Grade 1 HT<br>SBP 140-159 or DBP 90-99 | Grade 2 HT<br>SBP 160-179 or DBP 100-109 | Grade 3 HT<br>SBP ≥180 or DBP ≥110 |
|---|---|---|---|---|---|
| No other risk factors | No BP intervention | No BP intervention | Lifestyle changes for several months then drug treatment if BP uncontrolled | Lifestyle changes for several weeks then drug treatment if BP uncontrolled | Lifestyle changes + immediate drug treatment |
| 1-2 risk factors | Lifestyle changes | Lifestyle changes | Lifestyle changes for several weeks then drug treatment if BP uncontrolled | Lifestyle changes for several weeks then drug treatment if BP uncontrolled | Lifestyle changes + immediate drug treatment |
| 3 or more risk factors, MS, OD or diabetes | Lifestyle changes | Lifestyle changes and consider drug treatment | Lifestyle changes + drug treatment | Lifestyle changes + drug treatment | Lifestyle changes + immediate drug treatment |
| Diabetes | Lifestyle changes | Lifestyle changes + drug treatment | | | |
| Established CV or renal disease | Lifestyle changes + immediate drug treatment | Lifestyle changes + immediate drug treatment | Lifestyle changes + immediate drug treatment | Lifestyle changes + immediate drug treatment | Lifestyle changes + immediate drug treatment |