SIGNS AND SYMPTOMS OF CARDIOVASCULAR SYSTEM DISEASES
(syndrome of arterial hypertension)

LECTURE IN INTERNAL MEDICINE PROPÆDEUTICS

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Plan of the lecture

Arterial hypertension
• Definition
• Classification
• Causes
• Clinical picture
• Diagnosis

The blood flowing inside vessels exerts a force against the walls – this is blood pressure

(Arterial) hypertension: definition

• Hypertension (HTN or HT), also known as high blood pressure or arterial hypertension, is a chronic medical condition in which the blood pressure in the arteries is elevated.

• Hypertension is having a blood pressure higher than 139 over 89 (≥ 140 and/or ≥ 90) mmHg for most adults; different criteria apply to children.

(Arterial) hypertension: types

• Primary (essential) hypertension (90% cases), defined as high blood pressure with no obvious underlying cause.

• Secondary hypertension (10% cases), defined as high blood pressure due to an identifiable cause, such as chronic kidney disease, narrowing of the aorta or kidney arteries; endocrine disorders such as excess aldosterone, cortisol, catecholamines overproduction, etc.

(Arterial) hypertension: classification of blood pressure (mm Hg) for adults

<table>
<thead>
<tr>
<th>Category</th>
<th>Systolic</th>
<th>Diastolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>90–119</td>
<td>60–79</td>
</tr>
<tr>
<td>High normal (Prehypertension)</td>
<td>120–139</td>
<td>80–89</td>
</tr>
<tr>
<td>Stage 1 hypertension</td>
<td>140–159</td>
<td>90–99</td>
</tr>
<tr>
<td>Stage 2 hypertension</td>
<td>160–179</td>
<td>100–109</td>
</tr>
<tr>
<td>Stage 3 hypertension (Hypertensive emergency)</td>
<td>≥180</td>
<td>≥110</td>
</tr>
<tr>
<td>Isolated systolic hypertension</td>
<td>≥140</td>
<td>&lt;90</td>
</tr>
</tbody>
</table>

https://en.wikipedia.org/wiki/Hypertension
(Arterial) hypertension: causes of primary hypertension

- Hypertension results from a complex interaction of genes and environmental factors.
- Numerous common genetic variants with small effects on blood pressure have been identified as well as some rare genetic variants with large effects on blood pressure, but the genetic basis of hypertension is still poorly understood.
(Arterial) hypertension: causes of secondary hypertension

- Kidney disease
- Cushing's syndrome
- Hyperthyroidism
- Hypothyroidism
- Acromegaly
- Conn's syndrome
- Hyperaldosteronism

(other causes)

- Hyperparathyroidism
- Pheochromocytoma
- Obesity
- Sleep apnea
- Pregnancy
- Drug-induced
- Etc.

(Arterial) hypertension: hypertensinogenic (risk) factors

- Age
- Race
- Sex
- Family history
- Obesity
- A sedentary lifestyle
- Insulin resistance
- Using tobacco
- High alcohol intake
- High salt intake
- Stress
- Dyslipidemia
- Low potassium intake
- Low calcium intake
- Too little vitamin D in diet
- Certain chronic
(Arterial) hypertension: SCORE and HeartScore (http://www.heartscore.org)

- SCORE (Systematic Coronary Risk Evaluation) is a cardiovascular disease risk assessment system initiated by the European Society of Cardiology
- SCORE is based on the risk factors: gender, age, smoking, systolic blood pressure and total cholesterol
- HeartScore is the interactive version of SCORE
- The threshold for high risk based on fatal cardiovascular events is defined as "higher than 5%", instead of the previous "higher than 20%" using a composite coronary endpoint

http://circ.ahajournals.org/content/101/3/329.long
(Arterial) hypertension: stratification of total cardiovascular disease risk

<table>
<thead>
<tr>
<th>Other risk factors, asymptomatic organ damage or disease</th>
<th>Blood Pressure (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High normal SBP 130–139 or DBP 85–89</td>
</tr>
<tr>
<td>No other RF</td>
<td>Low risk</td>
</tr>
<tr>
<td>1–2 RF</td>
<td>Low risk</td>
</tr>
<tr>
<td>≥3 RF</td>
<td>Low to Moderate risk</td>
</tr>
<tr>
<td>OD, CKD stage 3 or diabetes</td>
<td>Moderate to high risk</td>
</tr>
<tr>
<td>Symptomatic CVD, CKD stage ≥4 or diabetes with OD/RFs</td>
<td>Very high risk</td>
</tr>
</tbody>
</table>

BP = blood pressure; CKD = chronic kidney disease; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; HT = hypertension; OD = organ damage; RF = risk factor; SBP = systolic blood pressure.
(Arterial) hypertension: pathophysiology

Key factors:

- Abnormal Na transport
- Increased sympathetic nervous activity
- Increased renin-angiotensin-aldosterone system activity
- Vasodilator deficiency

AME - apparent mineralocorticoid excess; CNS - central nervous system; GRA - glucocorticoid-remediable aldosteronism

(Arterial) hypertension: signs and symptoms

- Most people with high blood pressure have no signs or symptoms, even if blood pressure readings reach dangerously high levels.
- A few people with high blood pressure may have headaches, shortness of breath or nosebleeds, but these signs and symptoms aren't specific and usually don't occur until high blood pressure has reached a severe or life-threatening stage.

http://www.webhealthjournal.com/common-symptoms-signs-of-high-blood-pressure/
http://http://www.mayoclinic.org/diseases-conditions/high-blood-pressure/basics/symptoms/con-20019580
https://en.wikipedia.org/wiki/Hypertension
(Arterial) hypertension: main complications

- Hypertensive heart disease
- Coronary artery disease
- Stroke
- Aortic aneurysm
- Peripheral artery disease
- Chronic kidney disease
- Chronic heart failure
- Hypertensive retinopathy

https://stanfordhealthcare.org/content/dam/SHC/conditions/blood-heart-circulation/images/abdominalaorticaneurysm-diagram-veinsaneurysms.gif
(Arterial) hypertension: medical history 1

- The known duration of hypertension and previously recorded levels
- Any history or symptoms of coronary artery disease (CAD), heart failure (HF)
- Other relevant coexisting disorders (e.g., stroke, renal dysfunction, peripheral arterial disease, dyslipidemia, diabetes, gout)
- Family history of any of these disorders

(Arterial) hypertension: medical history 2

- Social history includes exercise levels and use of tobacco, alcohol, and stimulant drugs (prescribed and illicit)
- A dietary history focuses on intake of salt and stimulants (e.g., tea, coffee, caffeine-containing sodas, energy drinks)
- Lifestyle factors
- Current and previous medications

(Arterial) hypertension: physical examination 1

• Height, weight, and waist circumference
• Funduscopic examination for retinopathy
• Auscultation for bruits in the neck and abdomen (a unilateral renal artery bruit may be heard in slim patients with renovascular hypertension)
• Full cardiac, respiratory, and neurologic examination

(Arterial) hypertension: physical examination 1

- Heart auscultation (a 4th heart sound is one of the earliest signs of hypertensive heart disease)
- The abdomen palpation for kidney enlargement and abdominal masses
- Peripheral arterial pulses investigation (diminished or delayed femoral pulses suggest aortic coarctation, particularly in patients < 30)

(Arterial) hypertension: hypertensive crisis

- Severely elevated blood pressure equal to or greater than a systolic 180 or diastolic of 110 is referred to as a hypertensive crisis.
- Hypertensive crisis is categorized as hypertensive urgency, according to the presence or absence of end organ damage.
- The most affected organs include the brain, kidney, heart, aorta and lungs.
(Arterial) hypertension: diagnosis 1

- Multiple measurements of blood pressure (BP) to confirm
- Urinalysis and urinary albumin: creatinine ratio
- Blood tests: fasting lipids, hematocrit, creatinine, serum potassium (K), creatinine (or the corresponding estimated glomerular filtration rate), calcium, lipid profile, glucose
- Renal ultrasonography if creatinine increased

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160
(Arterial) hypertension: diagnosis 2

- Evaluate for aldosteronism if K decreased
- ECG: If left ventricular hypertrophy, consider echocardiography
- Sometimes measurement of thyroid-stimulating hormone, T3-T4 hormones, cortisol
- Evaluation for pheochromocytoma or a sleep disorder if BP elevation sudden and labile or severe

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160
(Arterial) hypertension: office blood pressure monitoring 1

• The patient should be seated comfortably with the back supported and the upper arm bared without constrictive clothing
• The legs should not be crossed
• The arm should be supported at the level of the heart, and the bladder of the blood pressure (BP) cuff should encircle at least 80% of the arm circumference

http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/nephrology/arterial-hypertension/
(Arterial) hypertension: office blood pressure monitoring 2

- The BP measuring device should be deflated at the rate of 2 to 3 mm/sec, and the first and last audible sounds should be taken as the systolic and diastolic pressure respectively.
- Neither the patient nor the observer should talk during the measurement.

http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/nephrology/arterial-hypertension/
(Arterial) hypertension: office blood pressure monitoring 3

- Measurements may be both while seated and after standing, to look for orthostatic or postural hypotension
- At least the first measurement should be done on the right and left arms
(Arterial) hypertension: office blood pressure monitoring

Man getting his blood pressure taken at the doctor's office

http://www.cdc.gov/dhdsp/images/hbp_patient.jpg
(Arterial) hypertension: ambulatory blood pressure monitoring

- The National Institute of Health and Clinical Excellence (NICE) guidelines recommend that a diagnosis of primary hypertension should be confirmed with 24-hour ambulatory blood pressure monitoring or home blood pressure monitoring rather than by relying solely on office blood pressure measurement.

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160
(Arterial) hypertension: ambulatory blood pressure monitoring

- Twenty-four-hour ambulatory BP monitoring is indicated to rule out white-coat hypertension, to uncover apparent drug resistance (office resistance), to better define resistant hypertension, to identify hypotensive symptoms while the patient is being treated with anti-hypertensive medications, to monitor episodic hypertension, and to identify autonomic dysfunction states.

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160
(Arterial) hypertension: ambulatory blood pressure monitoring

- Twenty-four-hour ambulatory BP monitoring also helps identify abnormal patterns in blood pressure that could remain undetected if a patient is evaluated based on physician office blood pressure measurements alone.

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160
(Arterial) hypertension: ambulatory blood pressure monitoring

![Diagram of blood pressure monitoring]

(Arterial) hypertension: extent of the night time BP attenuation

• The extent of the nighttime BP attenuation has been mainly quantified through the so-called “sleep-time relative BP decline”, which is defined as the percent decrease in mean BP during nighttime sleep relative to the mean BP during daytime activity

(Arterial) hypertension: extent of the night time BP attenuation 2

• More recently, the classification has been extended by dividing individuals into four groups:
  • Extreme-dippers (sleep-time relative BP decline >20%)
  • Dippers (sleep-time relative BP decline >=10% but <20%)
  • Non dippers (sleep-time relative BP decline <10%)
  • Inverse-dippers or risers (sleep-time relative BP decline <0%, indicating asleep BP>awake BP mean)

(Arterial) hypertension: ambulatory blood pressure monitoring

24-h SBP pattern (dashed thick lines) of a normotensive dipper subject (left) and a hypertensive extreme-dipper patient (right), plotted with respect to circadian time-specified tolerance limits (continuous thin lines)

(Arterial) hypertension: ambulatory blood pressure monitoring

24-h SBP pattern (dashed thick lines) of a hypertensive non-dipper (left) and a hypertensive riser patient (right), plotted with respect to circadian time-specified tolerance limits (continuous thin lines), calculated from a reference population of normotensive individuals as a function of their rest-activity cycle and sex.

(Arterial) hypertension: home blood pressure monitoring 1

- The home BP is a better predictor of cardiovascular morbidity and mortality than are office BP measurements
- Hypertension is defined as a mean home blood pressure of ≥135/85 mmHg
- Home blood pressure monitoring provides an inexpensive alternative to 24-hour ambulatory BP monitoring which is not yet widely available

http://www.clevelandclinicmeded.com/medicalpubs/diseasemanagement/nephrology/arterial-hypertension/#figure01
(Arterial) hypertension: home blood pressure monitoring 2

- One of the main drawbacks in home blood pressure measurement when compared to 24-hour ambulatory BP monitoring, is that sleep time blood pressures cannot be recorded and therefore those patients with abnormal dipping pattern in blood pressure and nocturnal hypertension will be missed.
(Arterial) hypertension: ankle brachial index

The ankle brachial pressure index (ABPI or ankle brachial index (ABI)) is the ratio of the blood pressure in the lower legs to the blood pressure in the arms.

Compared to the arm, lower blood pressure in the leg is an indication of blocked arteries (peripheral artery disease or PAD) or secondary arterial hypertension due to aortic coarctation.
### (Arterial) hypertension: ankle brachial index interpretation

<table>
<thead>
<tr>
<th>ABPI value</th>
<th>Interpretation</th>
<th>Action</th>
<th>Nature of ulcers, if present</th>
</tr>
</thead>
<tbody>
<tr>
<td>above 1.2</td>
<td>Abnormal vessel hardening from PVD</td>
<td>Refer routinely</td>
<td></td>
</tr>
<tr>
<td>1.0 - 1.2</td>
<td>Normal range</td>
<td>None</td>
<td>Venous ulcer use full compression bandaging</td>
</tr>
<tr>
<td>0.9 - 1.0</td>
<td>Acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8 - 0.9</td>
<td>Some arterial disease</td>
<td>Manage risk factors</td>
<td></td>
</tr>
<tr>
<td>0.5 - 0.8</td>
<td>Moderate arterial disease</td>
<td>Routine specialist referral</td>
<td>Mixed ulcers use reduced compression bandaging</td>
</tr>
<tr>
<td>under 0.5</td>
<td>Severe arterial disease</td>
<td>Urgent specialist referral</td>
<td>Arterial ulcers no compression bandaging used</td>
</tr>
</tbody>
</table>

**ABPI** - the ankle brachial pressure index

https://en.wikipedia.org/wiki/Ankle_brachial_pressure_index
(Arterial) hypertension: patterns of blood pressure

The time of change color and model of coat
(Arterial) hypertension: white coat hypertension

- White coat hypertension, more commonly known as white coat syndrome, is a phenomenon in which patients exhibit a blood pressure level above the normal range, in a clinical setting, though they don't exhibit it in other settings.
- It is believed that the phenomenon is due to anxiety that those afflicted experience, during a clinic visit.
(Arterial) hypertension: masked hypertension

The term "masked hypertension" describes the contrasting to the white coat hypertension phenomenon.

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 1

- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
  1 - Arteriolar constriction/attenuation/sclerosis - "silver wiring" and vascular tortuosities

Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 2

- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
  2 - As grade 1 + Irregularly located, tight constrictions - known as `AV nicking` or `AV nipping`

Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 3

- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
  4 - As grade 2 + Retinal edema, cotton wool spots and flame-hemorrhages

Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: Keith Wagener Barker (KWB) grades of hypertensive retinopathy 4

- Hypertensive retinopathy is damage to the retina and retinal circulation due to high blood pressure
- KWB grades:
  - 4 - As grade 3 + swelling of the optic disc (papilloedema) + macular star

Peripapillary and periarteriolar retinal changes are apparent, including cotton wool spots, retinal hemorrhages, and exudates

(Arterial) hypertension: ophthalmoscopy

Normal Fundus
(Arterial) hypertension: renal sonography

The size of the left kidney is small (8.37 cm in length) and echogenicity of the kidney is increased in a patient with left renal artery stenosis.

http://numonthly.com/956.fulltext
(Arterial) hypertension: combine renal artery Doppler ultrasound and arteriography

Renal artery Doppler ultrasound (1) screening for renal artery stenosis shows very high velocity flow at the level of the left renal artery origin from the aorta; subsequent arteriogram (2) shows tight stenosis at the left renal artery ostium.
(Arterial) hypertension: renal color duplex sonography

Normal appearance of the right renal artery, right accessory real artery, single left renal artery (arrows), and abdominal aorta on longitudinal view of color flow image. LRA, left renal artery
(Arterial) hypertension: renal color duplex sonography

Remarkably turbulent flow at the stenosis of the right proximal renal artery on longitudinal view of color flow image
(Arterial) hypertension: renal color duplex sonography

Spectral Doppler demonstrated high peak systolic velocity (6.27 m/s) at the right renal artery with hemodynamically significant stenosis.
(Arterial) hypertension: renal magnetic resonance imaging

The stenosis at the right proximal renal artery.
(Arterial) hypertension: renal radionuclide imaging

Imaging of kidneys involves intravenous injection of tc mag3 (mercaptoacetyltriglycine) ets., and lying on table for hour or more while imaged by gamma camera.
(Arterial) hypertension: brain magnetic resonance imaging

Brain microbleeds (BMBs) in arterial hypertension patient are seen as small, homogeneous, round foci of low signal intensity.
(Arterial) hypertension: chest x-ray

The x-ray chest is suggesting a definite LV enlargement

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(Arterial) hypertension: indication for renal ultrasonography

- If urinalysis detects albuminuria (proteinuria), cylindruria, or microhемaturia or if serum creatinine is elevated ($\geq 1.4$ mg/dL [124 $\mu$mol/L] in men; $\geq 1.2$ mg/dL [106 $\mu$mol/L] in women), renal ultrasonography to evaluate kidney size may provide useful information

http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension#v932160