REGULATION/DYSREGULATION in BLOOD PRESSURE

Blood pressure – the most important parameter in cardiovascular system – „high-profile“ parameter

- Blood pressure (BP) – pressure of the blood to the wall of the vessels

- Systolic BP, diastolic BP, pulse pressure, mean arterial pressure (MAP)

BP = CO x R CO – cardiac output, R – resistance

CO = SV x HR SV – stroke volume, HR – heart rate

ESH AND ESC GUIDELINES

2013 ESH/ESC Guidelines for the management of arterial hypertension

The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC)

Authors/Task Force Members: Giuseppe Mancia (Chairperson) (Italy) * , Robert Fagard (Chairperson)

Classification BP values

category	Systolic BP	Diastolic BP
	(mmHg)	(mmHg)
optimal	< 120	< 80
normal	120 – 129	80 – 84
high normal pressure	130 – 139	85 – 89
Hypertension - mild	140 – 159	90 – 99
Hypertension - moderate	160 – 179	100 – 109
Hypertension - severe	≥ 180	≥ 110
Isolated systolic hypertension	≥ 140	< 90

According the Guidelines of European Society of Cardiology 2013

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 (ESC) and the European Society of Hypertension (ESH)

Authors/Task Force Members: **Bryan Williams* (ESC Chairperson**) (UK), **Giuseppe Mancia* (ESH Chairperson**) (Italy), Wilko Spiering (The Netherlands), Enrico Agabiti Rosei (Italy), Michel Azizi (France), Michel Burnier (Switzerland), Denis L. Clement (Belgium), Antonio Coca (Spain), Giovanni de Simone (Italy), Anna Dominiczak (UK), Thomas Kahan (Sweden), Felix Mahfoud (Germany), Josep Redon (Spain), Luis Ruilope (Spain), Alberto Zanchetti† (Italy), Mary Kerins (Ireland), Sverre E. Kjeldsen (Norway), Reinhold Kreutz (Germany), Stephane Laurent (France), Gregory Y. H. Lip (UK), Richard McManus (UK), Krzysztof Narkiewicz (Poland), Frank Ruschitzka (Switzerland), Roland E. Schmieder (Germany), Evgeny Shlyakhto (Russia), Costas Tsioufis (Greece), Victor Aboyans (France), and Ileana Desormais (France)

European Heart Journal (2018) 39, 3021–3104

Classification of BP

- **It is recommended that BP be classified as optimal, normal, high–normal, or grades 1–3 hypertension, according to office BP.**

- **Changes in recommendations**
- 2013
- Diagnosis: **Office BP** is recommended for screening and diagnosis of hypertension.

- 2018
- Diagnosis: It is recommended to base the diagnosis of hypertension on:

Repeated office BP measurements; or **Out-of-office BP** measurement **with ABPM and/or HBPM** if logistically and economically feasible.

Treatment thresholds

2013

- **Highnormal BP (130–139/85–89 mmHg):** Unless the necessary evidence is obtained, **it is not recommended to initiate antihypertensive drug therapy at high–normal BP.**

2018

- **Highnormal BP (130–139/85–89 mmHg): Drug treatment may be considered** when CV risk is very high due to established CVD, especially CAD.

- Definitions of hypertension according to office, ambulatory, and home blood pressure levels
- Category SBP(mmHg) DBP(mmHg)
- Office BP[a] >_140 and/or >_90
- Ambulatory BP

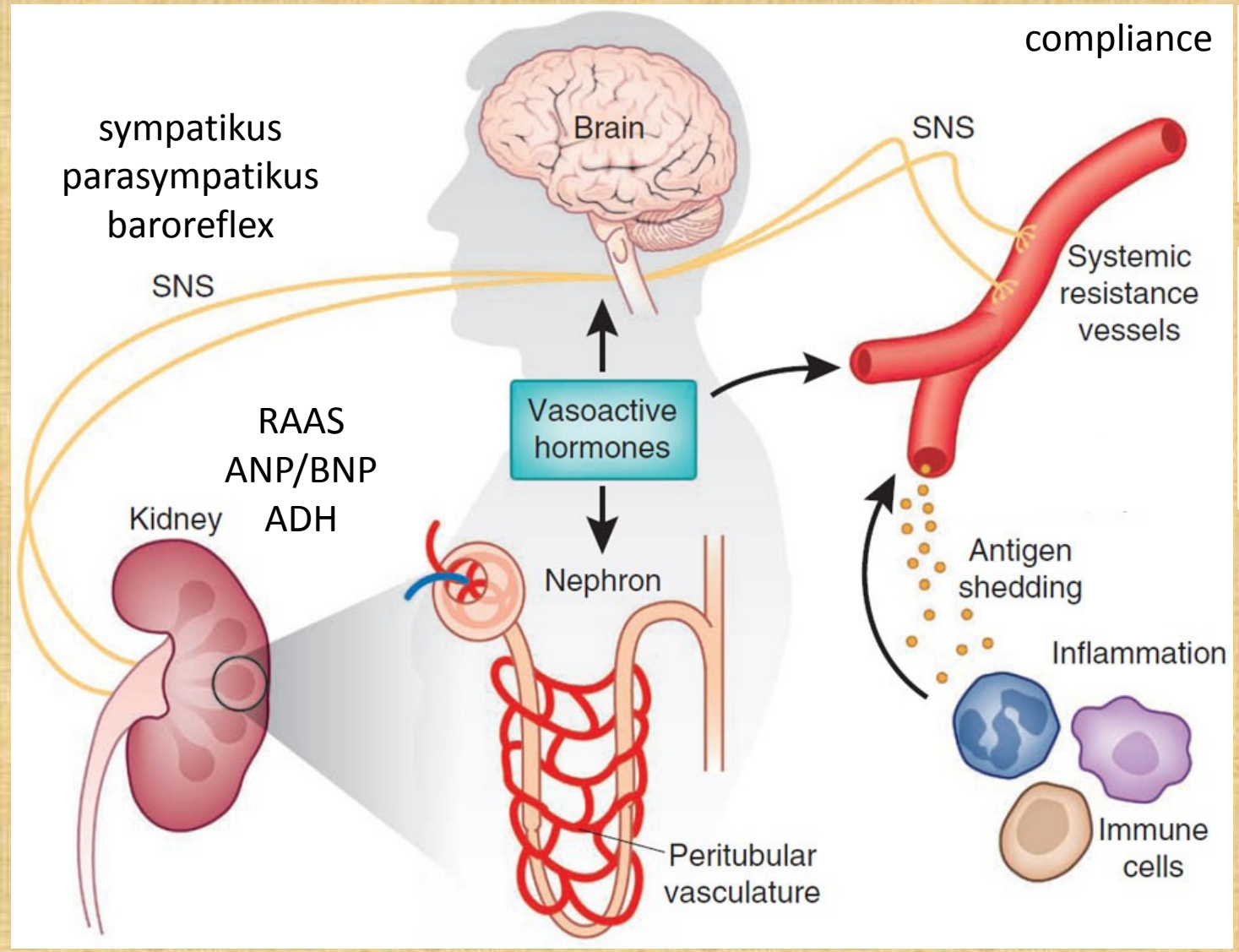
  Daytime (or awake) mean >_135 and/or >_85

  Night-time (or asleep) mean >_120 and/or >_70

  24 h mean >_130 and/or >_80
- Home BP mean >_135 and/or >_85

- BP = blood pressure; DBP = diastolic blood pressure; SBP = systolic blood
- pressure.
- aRefers to conventional office BP rather than unattended office BP.

Regulation of blood pressure – complex process



Vasoconstriction:
angiotensin II, vasopresin, epineprin (α_1), serotonin, PGF/TXA_2, endotelin, cofein, NPY

Vasodilatation:
NO, adrenalin (β_2), adenosin, acidosis, histamin, $PGD_2/PGE_2/PGI_2$, prostacyclins, VIP, bradykinin

Thomas M Coffman, **Under pressure: the search for the essential mechanisms of hypertension** , Nature Medicine 17, 1402–1409 (2011)


EXERCITATIO.
ANATOMICA DE
MOTV CORDIS ET SAN-
GVINIS IN ANIMALI-
BVS.
GVILIELMI HARVEI ANGLI,
Medici Regii, & Professoris Anatomiæ in Col-
legio Medicorum Londinensi.
FRANCOFVRTI,
Sumptibus GVILIELMI FITZERI.
ANNO M. DC. XXVIII.

Obr. 4.28. Titulná strana prvého vydania Harveyovho diela z roku 1628

let me remark that 400 years ago

REGULATION IN CARDIOVASCULAR SYSTEM

Main function:

- keep relatively constantaneous arterial blood pressure
- keep perfusion of tissues

Regulation of vessels tone

- Tone of the vessels = basic tension of the smooth muscle inside of the wall

  (vasoconstriction x vasodilatation)

- Regulation - local autoregulation

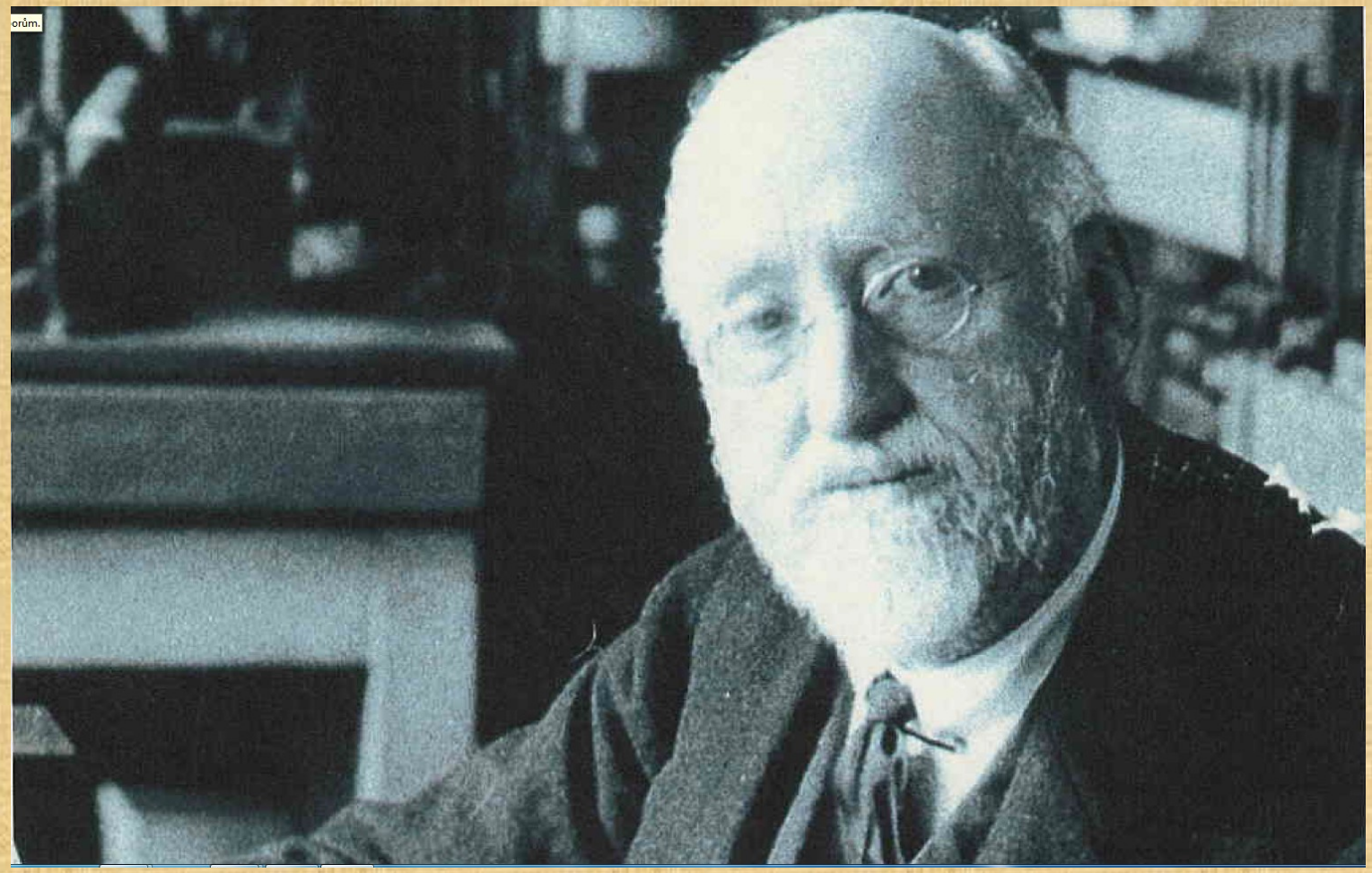
  - system regulation

Autoregulation

Autoregulation – the capacity of tissues to regulate their own blood flow

Myogenic theory – Bayliss phenomenon (as the pressure rises, the blood vessels are distended and the vascular smooth muscle fibres that surround the vessels contract; the wall tension is proportional to the distending pressure times the radius of the vessels – law of Laplace)

orům.



Autoregulation

- **Metabolic theory** – vasodilator substances tend to accumulate in active tissue, and these metabolites also contribute to autoregulation
  - ending products of energetic metabolism – CO_2, lactate acid, K^+
  - effect of hypoxia (circulation: vasodilatation x pulmonary circulation: vasoconstriction)
  - Adenosin – coronary circulation: vasodilatation

Autoregulation

- **by substances which releasing from:**
  - endothelium
  - tissues

Substances secreted by the ENDOTHELIUM

Vasodilatation:

Nitric oxide (NO) from endothelial cells

(originally called: EDRF)

Prostacyclin is produced by endothelial cells

Vazoconstriction:

Endothelins (polypeptids – 21peptides)

three isopeptides: ET 1, ET 2 , ET 3

Substances secreted by the tissues:

Histamine – primarily tissue hormones.

General affect: vasodilatation - decrease periphery resistence, blood pressure

KININS: 2 related vasodilated peptides

Bradykinin + lysylbradykinin (kallidin).

Sweat glands, salivary glands

10x strongers than histamine

Relaxation of smooth muscle, decrease blood pressure

Systemic regulation

By hormones

Catecholamines – epinephrine, norepinephrine - effect as activation of sympathetic system

RAAS - stress situation

ADH - general vasoconstriction

Natriuretic hormones - vasodilatation

Neural regulatory mechanism

Autonomic nervous system

Sympathetic: vasoconstriction

All blood vessels except capillaries and venules contain smooth muscle and receive motor nerve fibers from sympathetic division of ANS (noradrenergic fibers)

- Regulation of tissue blood flow
- Regulation of blood pressure

Parasympathetic part: vasodilatation

Only sacral parasympathetic cholinergic fibres (Ach) inervated arteriols from external sex organs

Sympathetic nervous system

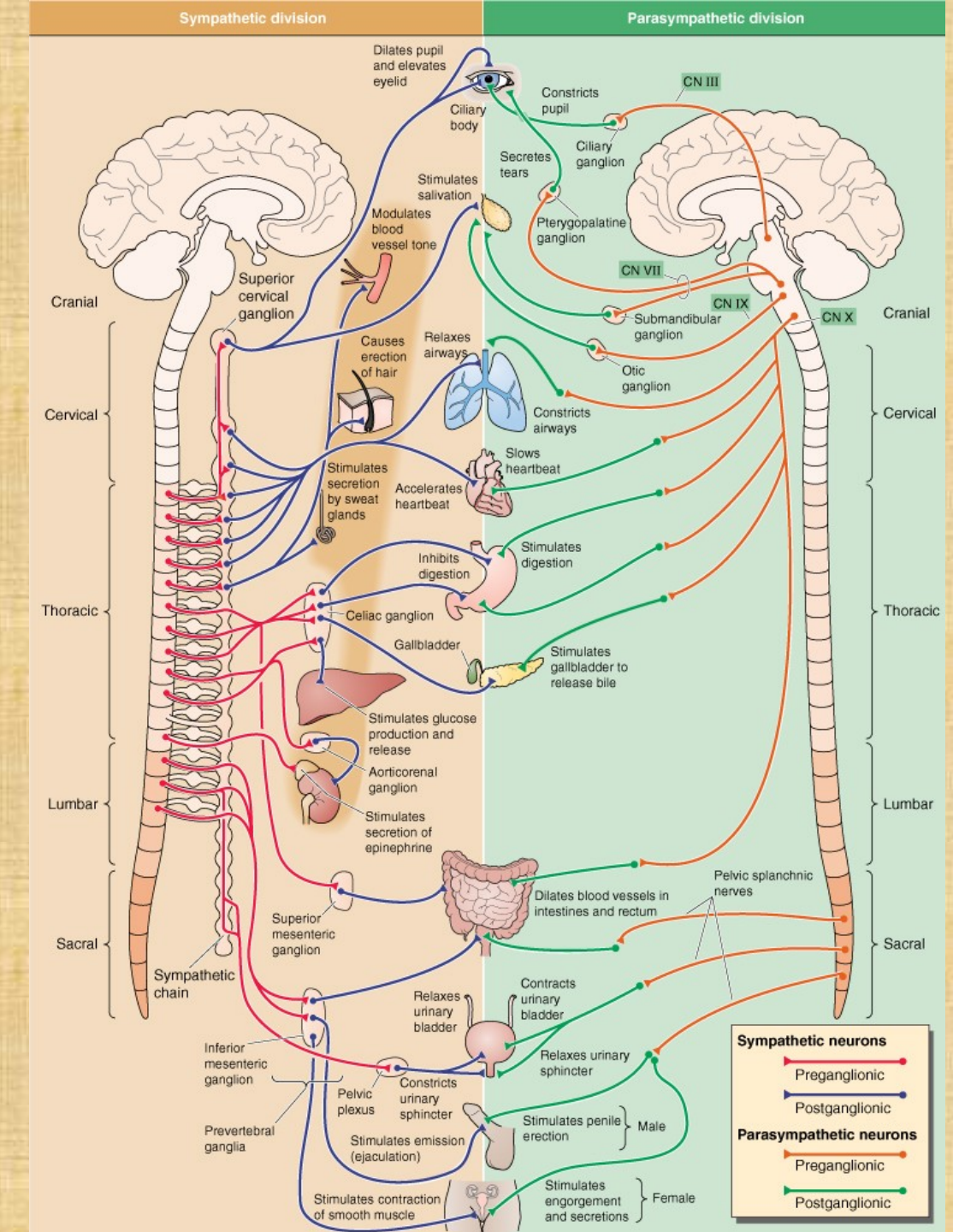
Fight or flight response

Energy/store consumption

Preganglionic neuron
– Spinal cord
-Thoraco - lumbar system

Ganglia
Paravertebral
-Truncus sympathicus
- Majority
Prevertebral
-Plexus aorticus

Mostly diffuse effect



Parasympathetic nervous system

Rest and digest response

Energy conservation/en. store production

Preganglionic neuron
– Brain stem and spinal cord
– cranio-sacral system

Ganglia
Close to target organs or intramurally

Mostly local effect

Sympatthetic nervous system

Parasympathetic nervous system

Fight c… resp… … digest … se

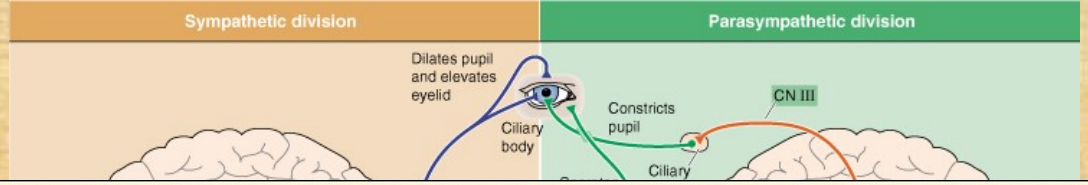
Energy consu… … y … n/energ … duction

Pregan… neu… – Spin… -Thoraco… sys… … ionic … n … nd spinal … l system

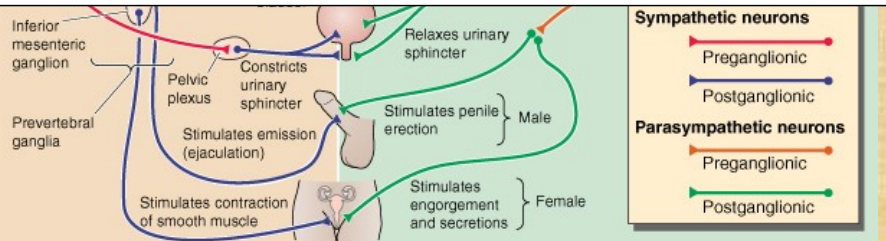
Gan… *Parave…* -Truncus sy… - Ma… *Prevel…* -Plexus aorticus … ia … *arget* … *or* … *rally*

Mostly diffuse effect

Mostly local effect



System/function	Parasympathetic	Sympathetic
Cardiovascular	Decreased cardiac output and heart rate	Increased contraction and heart rate; increased cardiac output
Pulmonary	Bronchial constriction	Bronchial dilatation
Musculoskeletal	Muscular relaxation	Muscular contraction
Pupillary	Constriction	Dilatation
Urinary	Increased urinary output; sphincter relaxation	Decreased urinary output; sphincter contraction
Gastrointestinal	Increased motility of stomach and gastrointestinal tract; increased secretions	Decreased motility of stomach and gastrointestinal tract; decreased secretions
Glycogen to glucose conversion	No involvement	Increased
Adrenal gland	No involvement	Release epinephrine and norepinephrine



INTEGRATION of regulation in cardiovascular system

The regulation of the heart:

- Rami cardiaci n. vagi

Cardiac decelerator center - medula oblongata (ncl.dorsalis, ncl. ambiguus) – parasympathetic fibres of nervus vagus

: vagal tone (tonic vagal discharge)

Negative chronotropic effect (on heart rate)

Negative inotropic effect (on contractility)

Negative dromotropic effect (on conductive tissue)

INTEGRATION of regulation in cardiovascular system

The regulation of the heart:

- nn. cardiaci

Cardiac accelerator center – spinal cord, sympathetic ganglia – sympathetic NS

Positive chronotropic effect (on heart rate)

Positive inotropic effect (on contractility)

Positive dromotropic effect (on conductive tissue)

INTEGRATION of regulation in cardiovascular system

Vasomotor centre (regulation for function of vessels)

Medula oblongata

- ✓ *presoric area* (rostral and lateral part –vasoconstriction – increase blood pressure

- ✓ *depresoric area* (medio-caudalis part – vasodilatation, decrease of blood pressure)

INTEGRATION of regulation in cardiovascular system

- Influence by central nervous system
  - cerebral cortex
  - limbic cortex
  - hypothalamus

Regulation of blood pressure

Short - term regulation

- baroreflex

Middle - term regulation

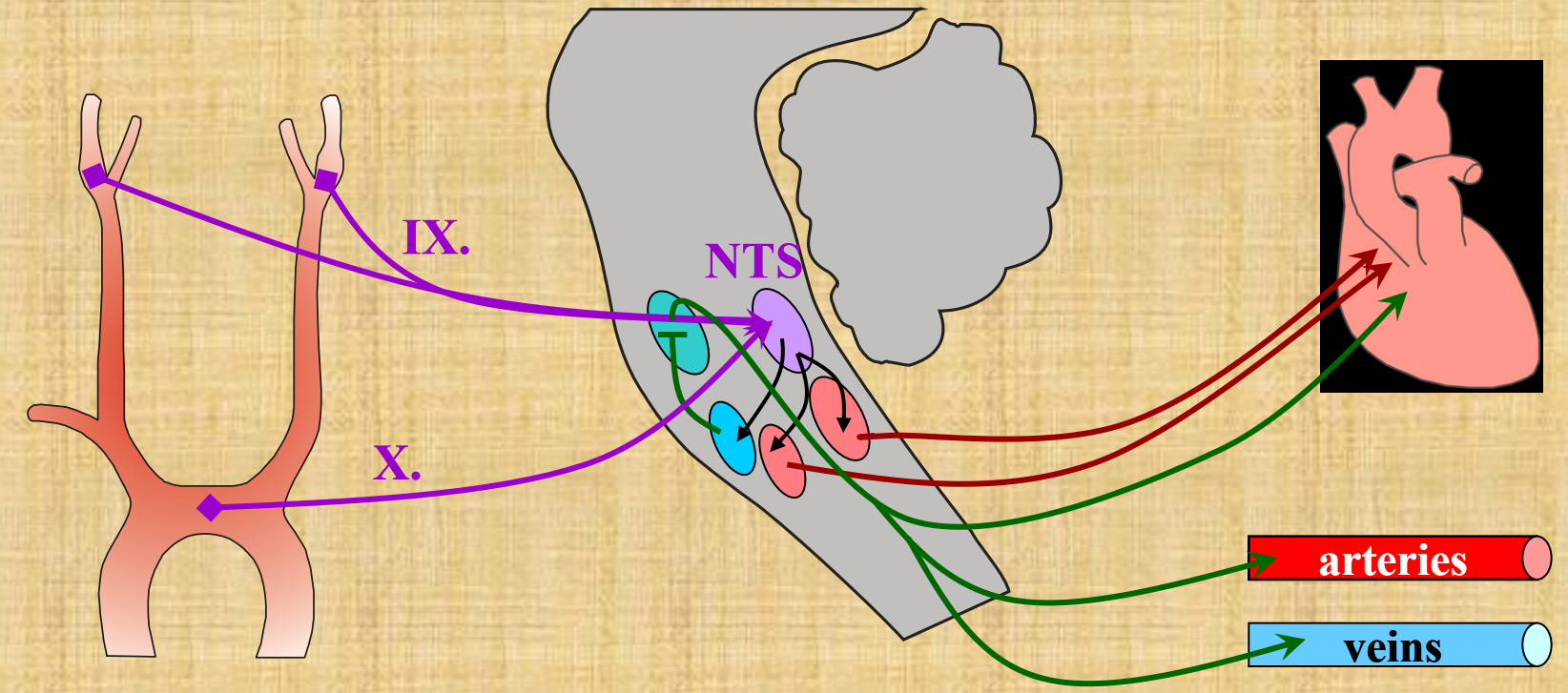
- humorals regulation

- sympathetic - catecholamines
- RAAS (decrease perfusion pressure in kidney – secretion of renin)
- ADH

Long – term regulation

- kidney regulation

BAROREFLEX



BAROREFLEX

- Baroreflex – in every day life
- Orthostatic – clinostatic reaction
- Valsalva maneuvre - defecation

CITLIVOST BAROREFLEXU

změna délky tepového intervalu vyvolaná změnou systolického krevního tlaku o 1 mmHg

Laboratorní metody:

- aplikace phenylephrinu
- neck suction
- Valsalvův manévr

Spontánní metody:

- **v časové doméně**
  - sekvenční analýza
- **ve spektrální doméně**
  - vzájemná spektrální analýza
  - α-index

BAROREFLEX SENSITIVITY

A change of duration of pulse interval (in ms) due to a change of systolic blood pressure by 1 mmHg

Laboratory methods:

- Phenylephrin aplication
- neck suction
- Valsalva manoever

Spontaneous methods:

- **in time-domain**
  - Sequence analysis
- **in frequency-domeain**
  - cross-spectral analysis
  - α-index

Bolus injections of vasoactive drugs

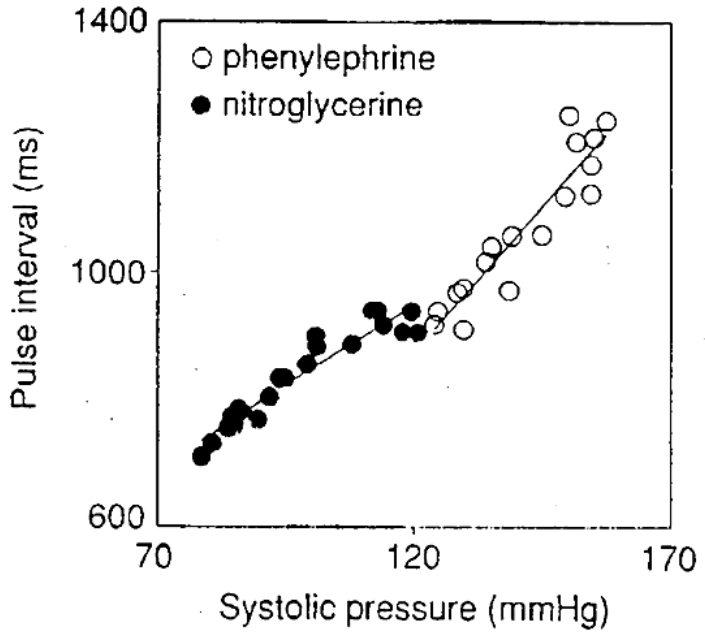
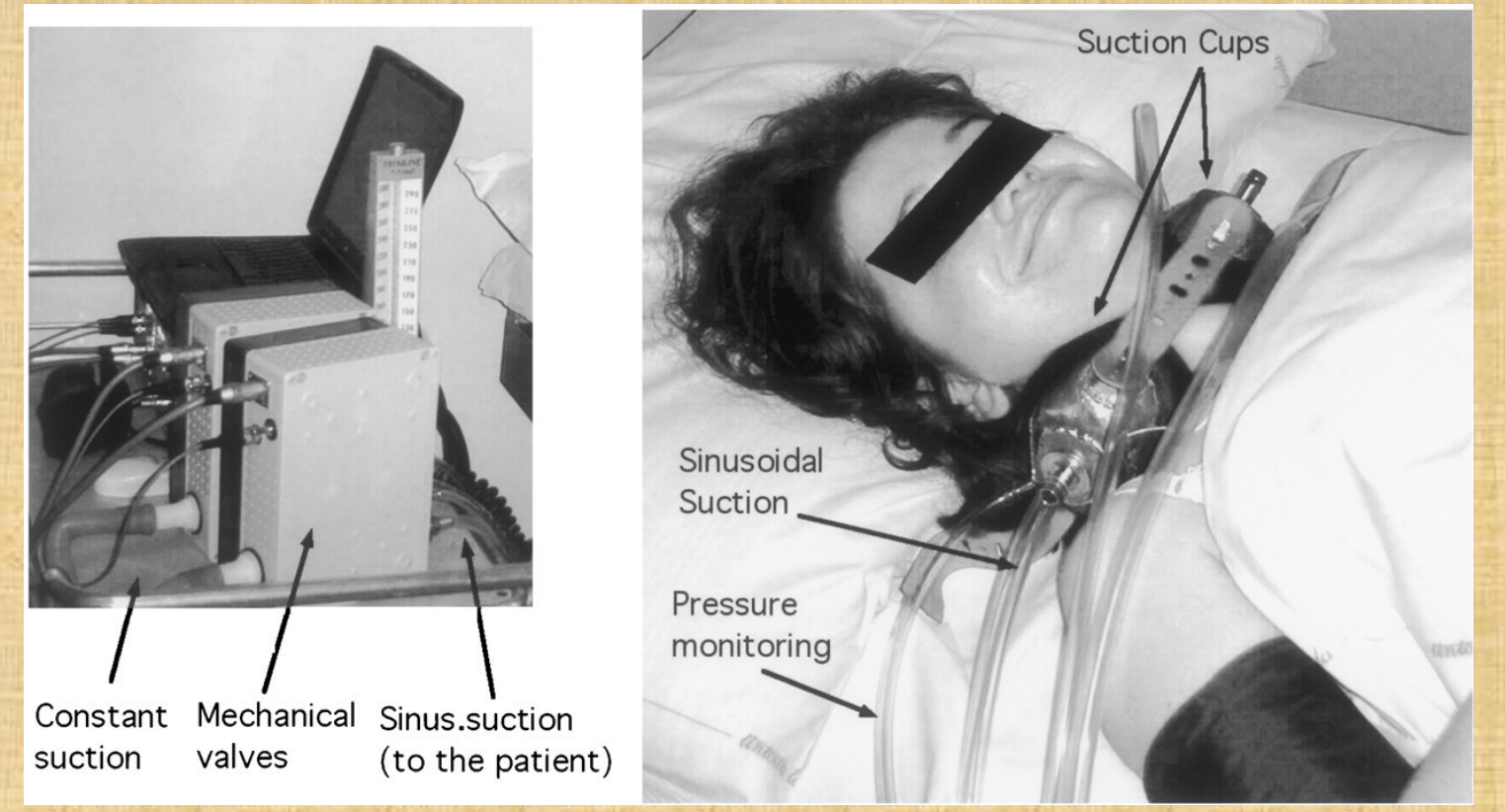


FIG. 5.4. Comparison of R–R interval responses of one subject to intra bolus injections of phenylephrine and nitroglycerine. Adapted with permissio Pickering *et al.* 1972*c*).

BAROREFLEX SENSITIVITY

- Phenylephrin aplication



Furlan R et al. Circulation 2003;108:717-723

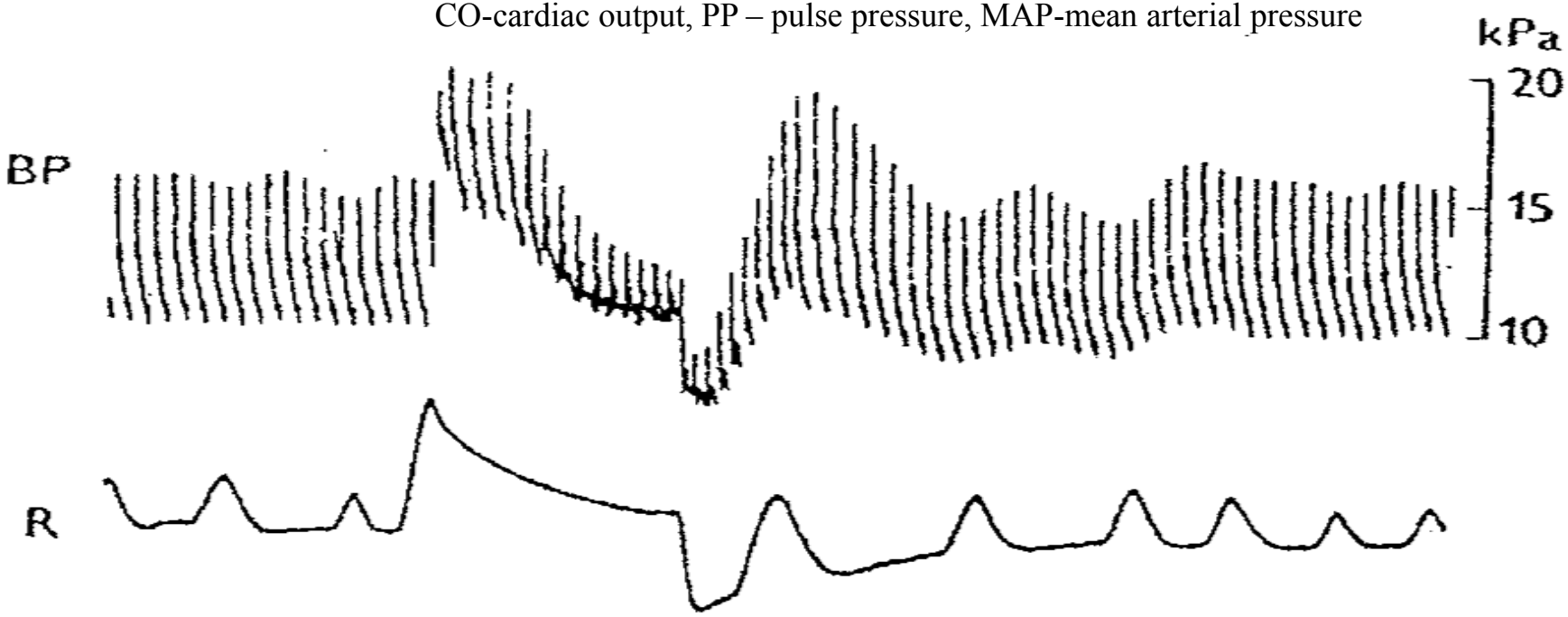
BAROREFLEX SENSITIVITY

- Neck suction

American Heart Association
Learn and Live

(↑BP)↓VR→↓CO→↓PP→↓MAP

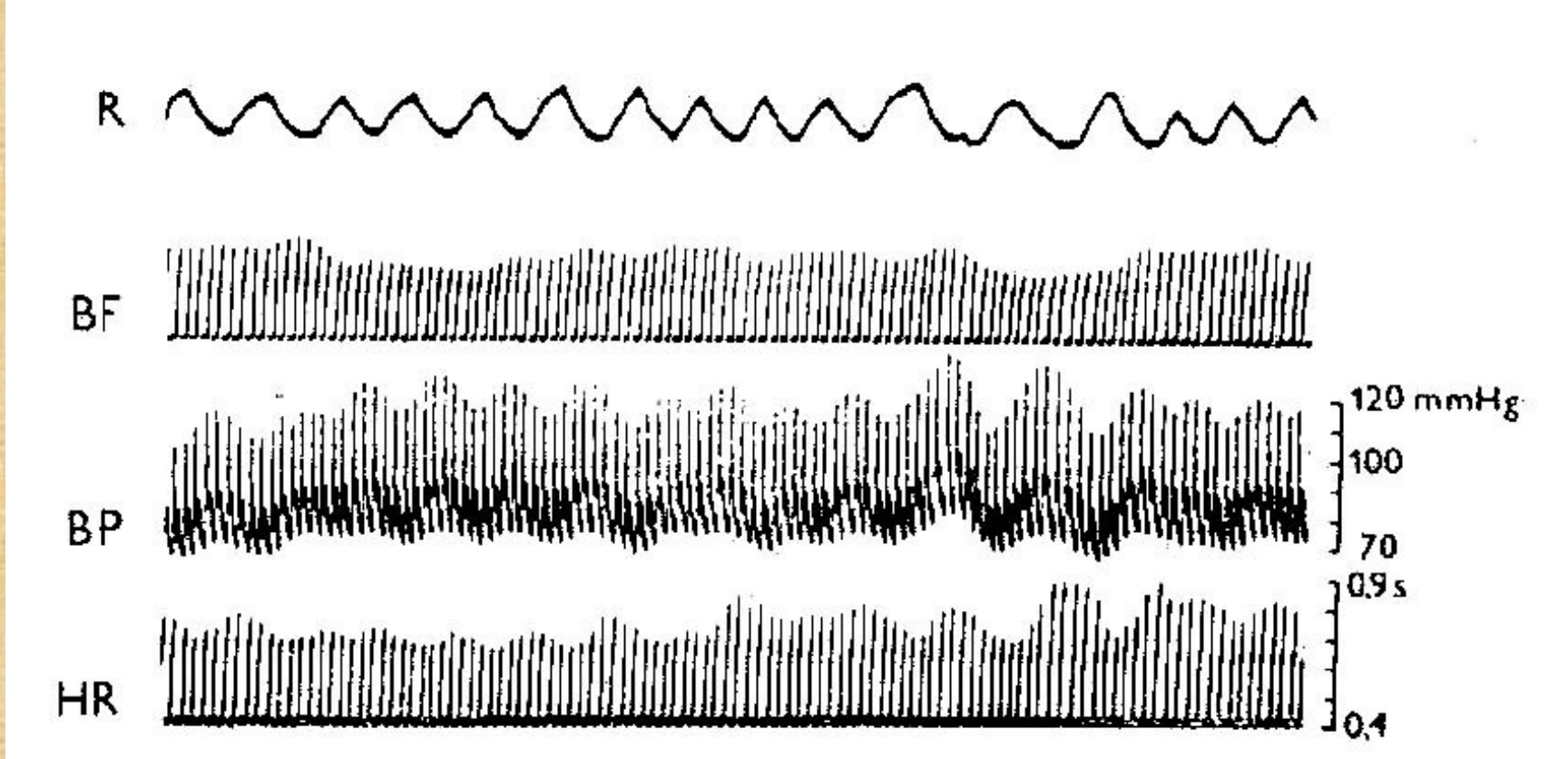
BP-blood pressure, VR-venous return, CO-cardiac output, PP – pulse pressure, MAP-mean arterial pressure



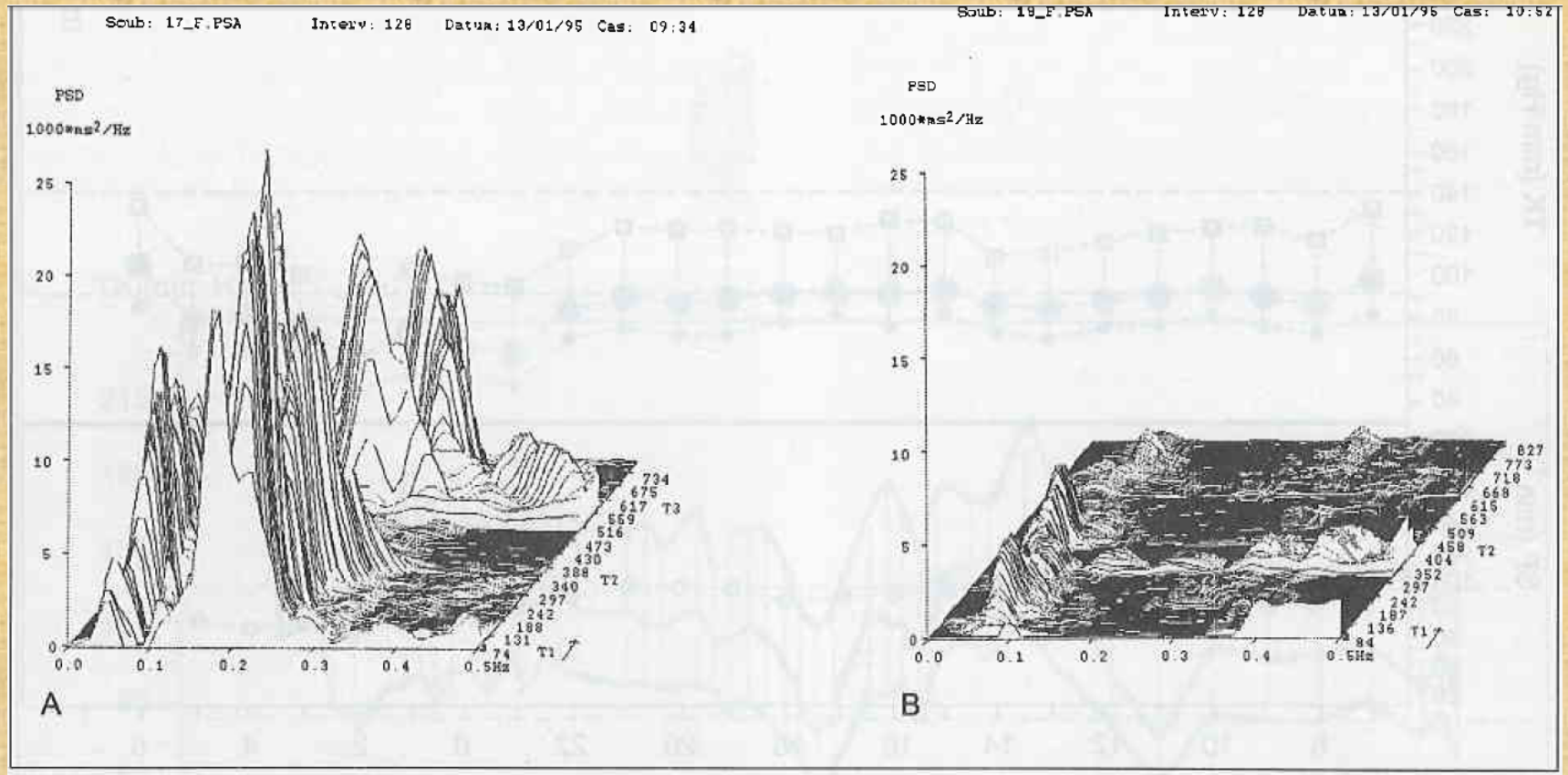
BAROREFLEX SENSITIVITY

- Valsalva manoever

Records of circulatory parameters



- **Spectral analysis:**
- Carried out under standard conditions at various maneuvers (supine, standing); evaluated with 300 representative intervals RR / NN /
- Another mathematical processing (Fourier transform) - length RR intervals are converted to cycles in Hz
- The spectrum is divided into several components – low (LF: the sympathetic modulation) and high frequency (HF: vagal modulation)
- People with reduced heart rate variability have a 5 times higher risk of death

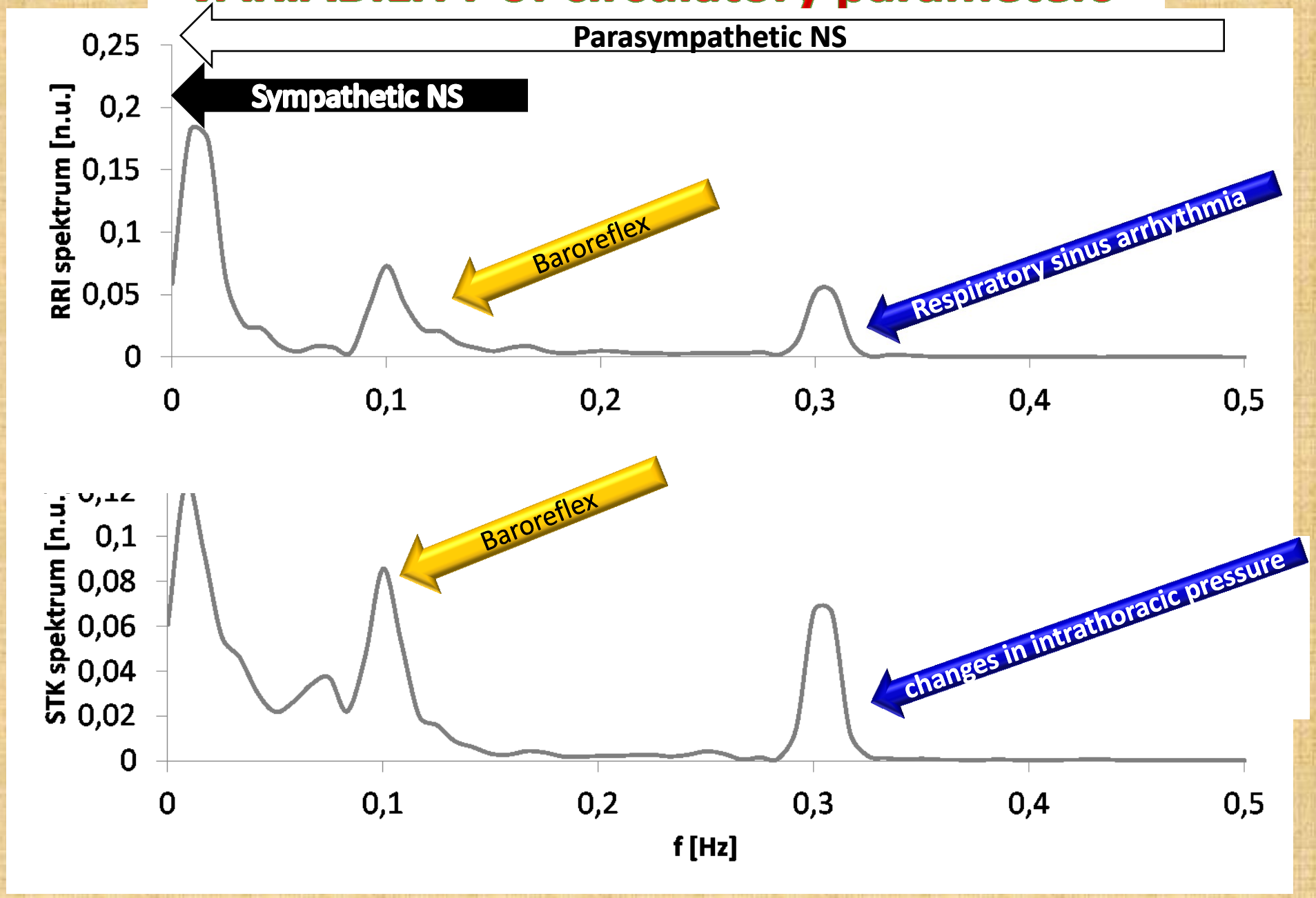


Obr. 9.22 *Spektrální analýza variability srdeční frekvence (VariaPulse TF3)*

Osa x – spektrum cyklů v Hz; osa y – PDS (ms^2 Hz^{-1}); osa z – čas trvání vyšetření v s (T_1 – první řada vleže; T_2 – druhá řada vstoje; T_3 – zadní řada po položení)

A – normální zdravý jedinec: vykazuje dobrou variabilitu vlivem sympatické aktivity v oblasti LF a vysokou variabilitu vlivem vagové tonizace v oblasti HF; B – starší nemocný po srdečních infarktech s komorovými arytmiemi: převažují LF-oscilace posunuté značně k nejnižším hodnotám (0,06 Hz) s nízkým PDS, které svědčí pro převahu sympatiku vzhledem k praktickému vymizení HF-oscilací (0,2 – 0,4 Hz) pro vagovou dysfunkci.

VARIABILITY of circulatory parameters



Resetting of baroreflex

- During repeated raising of blood pressure - **e.g. in chronic hypertension** - the force of baroreflex reaction on systemic blood pressure is lower
- ??? Why???mechanical changes in baroreceptors – decrease sensitivity due to structure changes on the vessels wall OR dysfunction of endotelium OR down-regulation in the brain center due to their increasing frequency of stimulation
- Resseting of baroreflex can regulate the changes in blood pressures, but the resseting is unable to go back on „normal“ level
- Resetting is a partially reversible – during a short-term influence of raising blood pressure

- *Notice: in clinical practice:*
  !start treatment of hypertension in time!

Middle – term regulation 1
catecholamines

- Mediators of sympathetic nerves for baroreceptors and chemoreceptors
- Sympathetic nervous system stimulates releasing of epinephrine and norepinephrine from adrenal medulla – main function: vasoconstriction – chronotropic effect – inotropic effect
- Its function start during minutes or hours

Middle – term regulation 2
Renin - angiotensin - aldosteron

- System in kidney

+

extrarenal system (in other tissues – brain, adrenal medulla, gonades, eyes)

+

Intermediate system – heart, smooth muscles

- Renin – in juxtaglomerular cells in kidney
- In liver – glycoprotein angiotensinogen – release angiotensin I (dekapeptid) – due to angiotensin converting ensyme to angiotensin II(oktapeptid) or angiotensin III (aminopeptidase)

- Angiotensin II – other way – chymase – in th heart and arterioles
- (it is reason why during treatment by ACE blocatores – the angiotensin level is not reduce)

Secretion of renin is modulated by

- Sympathetic nervous system – beta 1 receptors activation – main mechanism of secretion of renin
- Second way – by special mechanism due to sensitivity on sodium
  - exists a special intrarenal mechanism – negative sodium billance increase the renin secretion
  - ???? hypothesis – macula densa register of sodium concentration in renal tubular system – this information transports to juxtaglomerular cells where activated renin-angiotensin system (has an influence on secretion of renin – release angiotensin II);
  - Increse level of sodium – decrease releasing of renin (mediator – Nitric Oxide)
- ???Arterial pressure – stretch receptors (baroreceptory) in vas afferens (juxtaglomerular cells) – influence on blood pressure in kidney or also in systemic circulation???

Angiotensin II - Effects (Owerview)

- Vasoconstriction
- Change in renal hemodynamics – decrease of blood flow in kidney and glomerular filtration
- Influence on reabsorption of sodium in renal tubules
- It invokes or enhances the presynaptic release of noradrenaline
- Stimulates the release of ADH

Effect of ANGIOTENSIN III

- Stimulation of aldosterone secretion from the adrenal cortex

Middle – term regulation 3
ADH - vasopressin

- During a strong decline of blood pressure

  from posterior pituitary – vasoconstriction

May be: slowly effect – retention of water in distal tubule and proximal part of collecting ducts

Long – term regulation

- Little is known about how this occurs

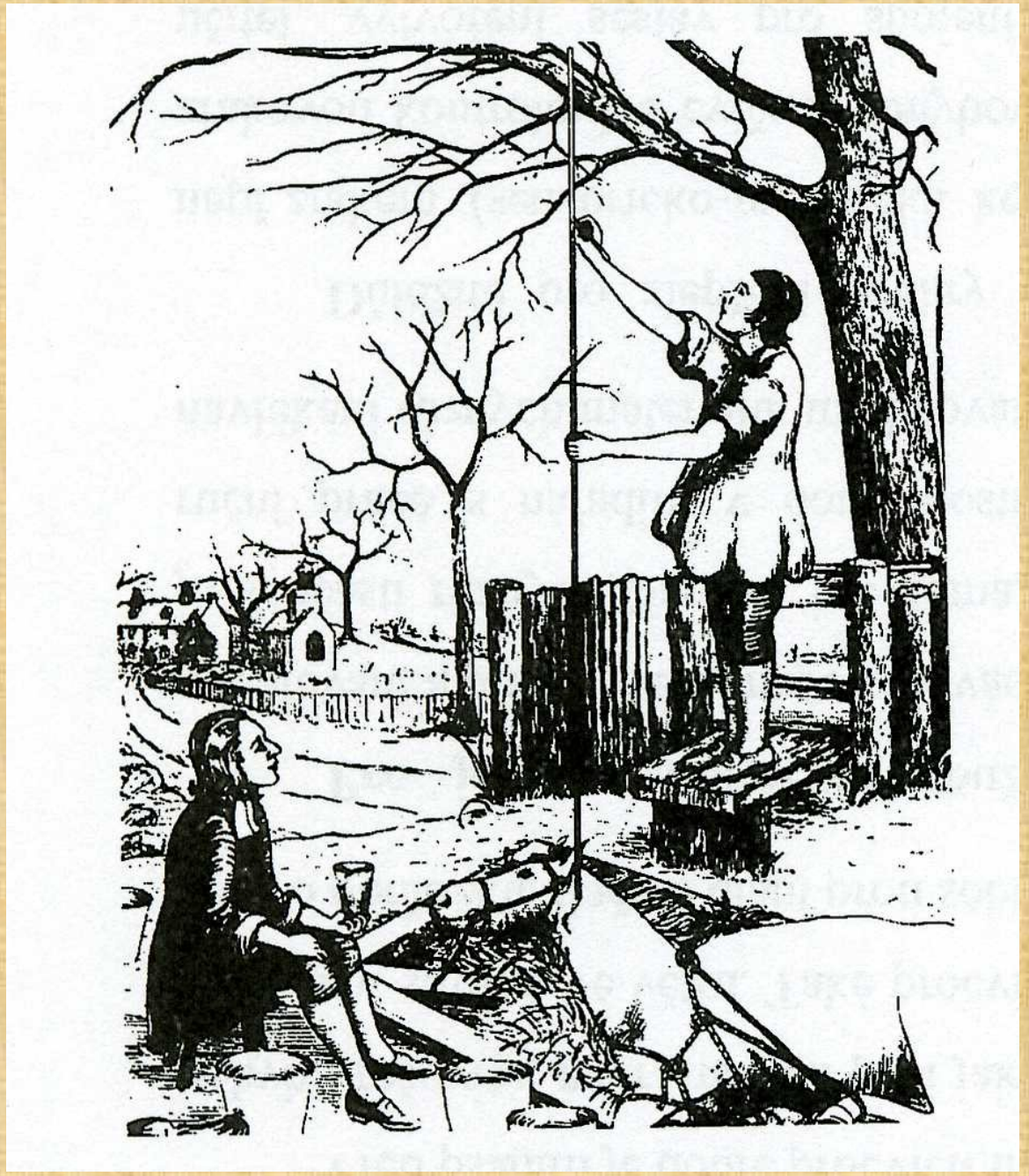
- **Pressure diuresis** regulates the volume in circulation and keep „pressure homeostasis“
- Blood pressure increases longer than 2 hours (persistant increase)– started pressure diuresis, its time duration a lot of days (increase blood pressure – increase excretion of sodium - osmotic activity – increase excretion of water ---decrease extravascular volume and decrease blood pressure)
- **a single control system which is not subject to adaptation** – the action takes as long as the pressure is returned to the original values (or if its action is not reversed by other mechanisms)
- With persistent decrease of BP - the opposite effect

Long – term
system of pressure natriuresis

- It is a **cascade of regulatory processes**:
- the mechanical effect of increased blood flow through the kidney ... increased blood flow in the kidney papilla - increased renal interstitial hydrostatic pressure - increased tight junction of epithelial cells of the renal tubules for sodium - increased sodium excretion - increased excretion water - decrease in volume of circulatory fluids - pressure drop in the systemic circulation
- System of internal renal baroreceptors ... pressure increase in vas afferens ... restriction of renin production - attenuation of renal sympathetic stimulation - decrease in sodium reabsorption, reduction of fluid volume - pressure drop
- Na^+- K^+ - ATPase inhibitory factor – released from adrenal medulla (steroid-like digitalis - possibly ouabain)
- Increased AT_2 receptor expression for angiotensin II (may antagonize the effects of inadequate AT_1 receptor stimulation, in rat experiments demonstrated - increased sodium and water excretion)
- Others: bradykinin, urodilatin, renal natriuretic peptides

Methodology of blood pressure measurement

Misinterpretation of values



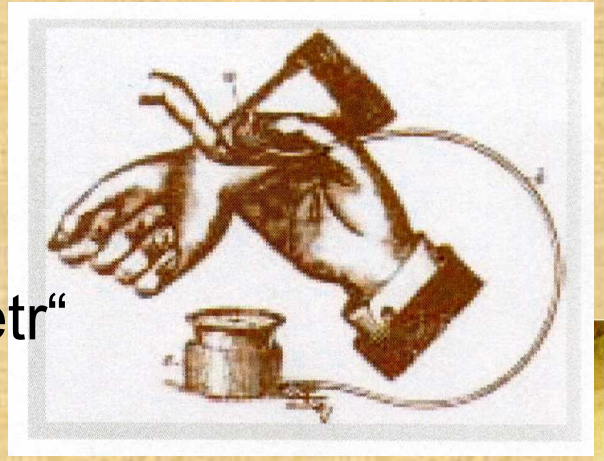
Blood pressure measurement

The system pressure values are, for technical reasons, dependent on:

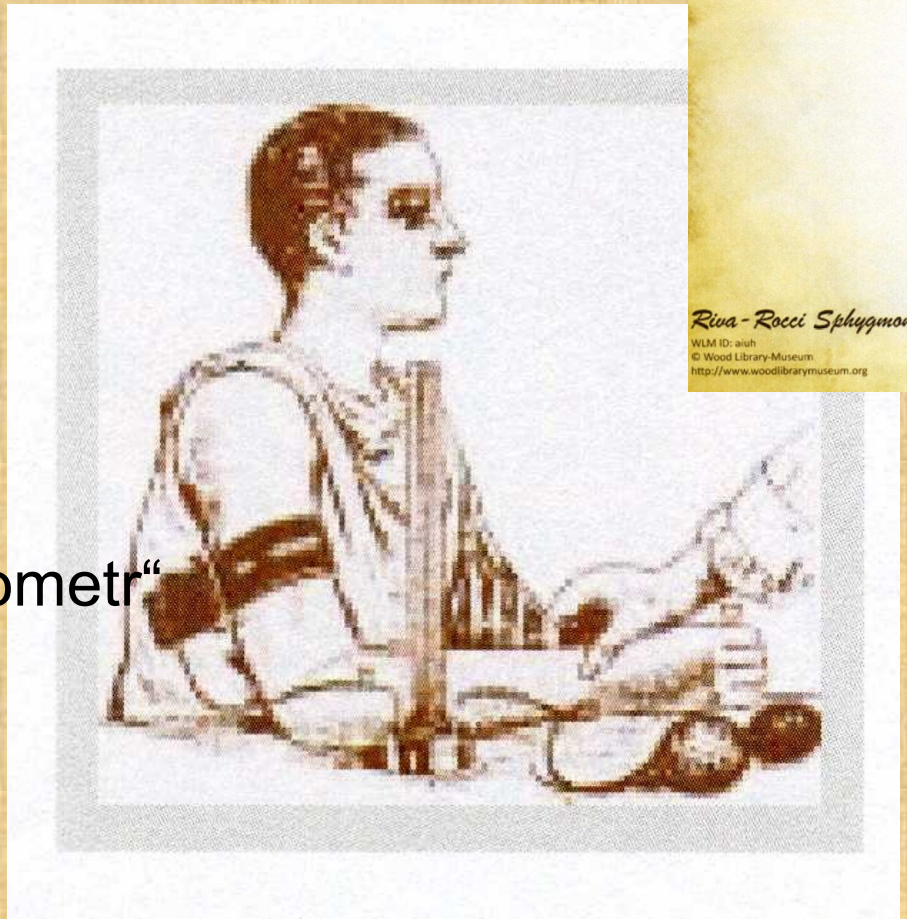
- Measuring method used
  - Non-invasive methods:
    - auscultatory
    - oscillometry
    - ultrasound
    - photopletysmography
  - Invasive methods
    - indirect – Swan-Ganz´s catheter
    - direct – catheter with a pressure sensor at the end
- Methodology
  - Clinical measurement – in ambulance - practitioner
  - Home measurement
  - 24hour ambulatory blood pressure monitoring

Palpatory method

Austrian Von Basch
„aneroid sfygmomanometr“
With baloon on wrist
1876



Italian physician
Riva Rocci
„mercury sfygmomanometr“
With cuff on the arm
1896



Auscultatory methods

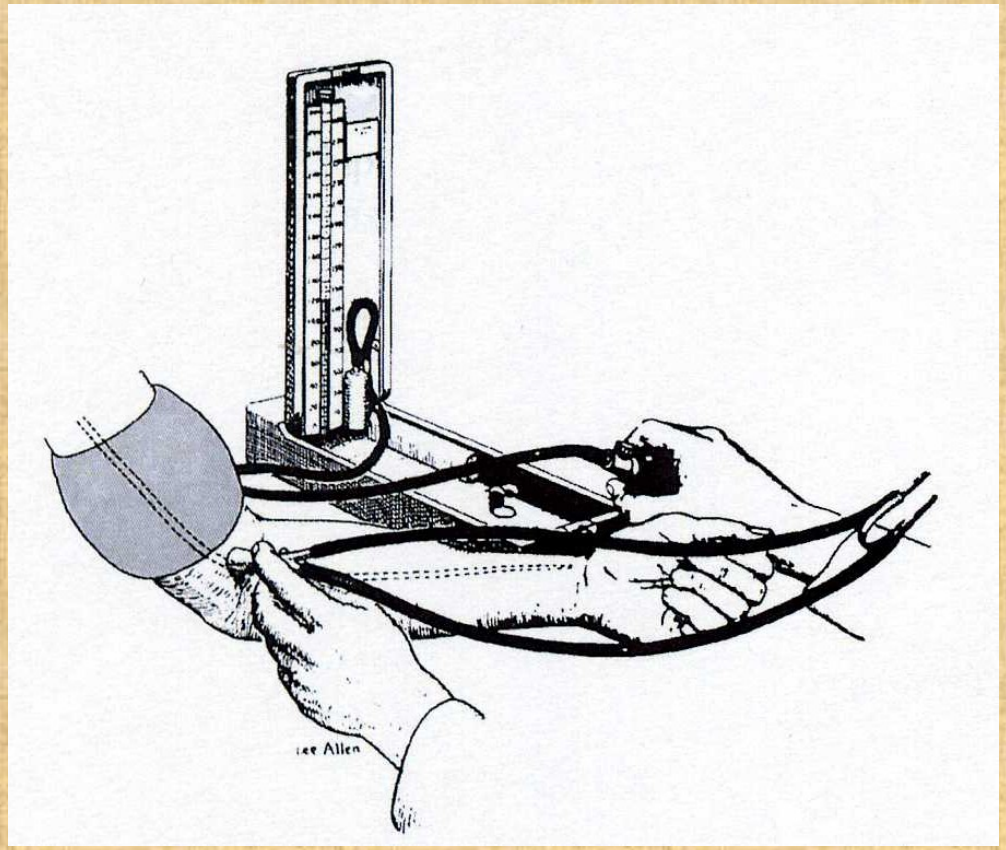
- based on detection of Korotkoff phenomenons
- „gold standard“
- with comparison on intra-arterial measurement of blood pressure – we will find: lower values for SBP and higher values of DBP

  /this is only technical systemic mistake – does not matter/
- According a guidelines for diagnostic of arterial hypertension: we diagnose arterial hypertension: **repeated blood pressure increase above 140/90mmHg, demonstrated at least in two out of three measurements using the auscultation method in the clinical setting**

Auscultatory method

Russian army surgeon
Nikolaj Korotkoff
1904

„mercury sfygmomanometr“
The cuff on the arm,
stethoscope in the area of
the elbow



Oscillometric method

- Author: Mr. Marey – the first describe on 1876
- It has been repeatedly demonstrated that the oscillation of BP in the sphygmomanometric cuff is measured during its gradual discharge - **the point of maximum oscillation corresponds to the mean arterial pressure measured invasively**
- Oscillations begin approximately around systolic pressure values and continue after deflation of the cuff = **both systolic and diastolic pressure is estimated only indirectly based on empirical derived algorithms**
  - Advantage: Less susceptible to external noise
    Disadvantage: definitely unreliability in physical activity - distortion by motion artifacts + susceptible to low-frequency mechanical vibrations

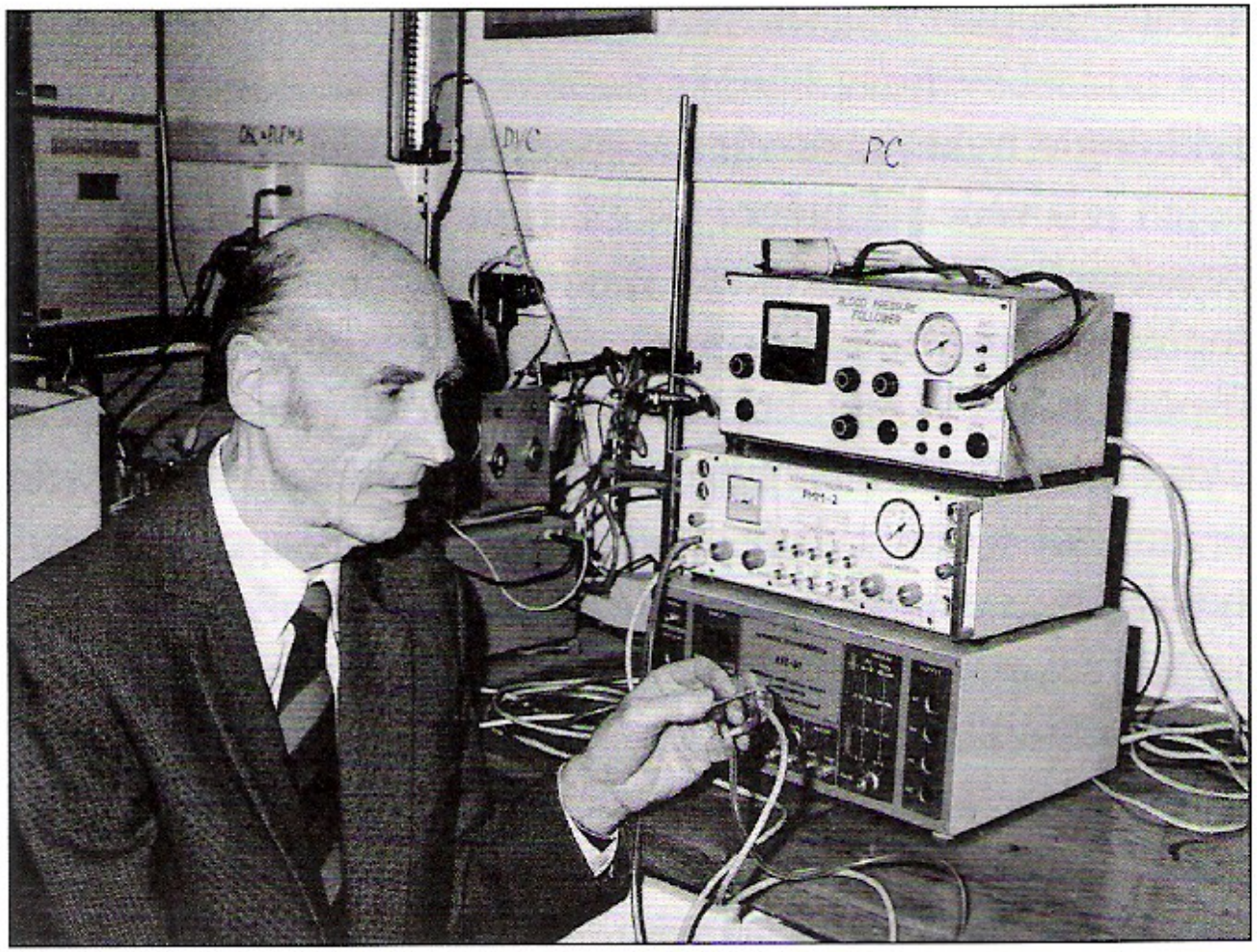
Ultrasound method

- The device includes an ultrasonic vibration generator and an ultrasonic sensor - placement via the brachial artery and under the sphygmomanometric cuff
  When deflate the cuff, it induces a systolic movement of the arterial wall that causes the Doppler phase shift in the transmitted ultrasound signal; diastolic BP is calculated by a significant reduction in arterial wall motions

- Other variant: systolic BP based on blood flow detection - in newborns and small children

Digital photoplethysmography

- Continuously blood pressure measurement - „beat to beat“ – from digital artery
- Profesor Jan Peňáz – Department of Physiology – Masaryk university in Brno - patent 1969
- Disadvantage: can not be used in conditions with peripheral vasoconstriction (shock states, vasoneurosis, diabetic angiopathy)

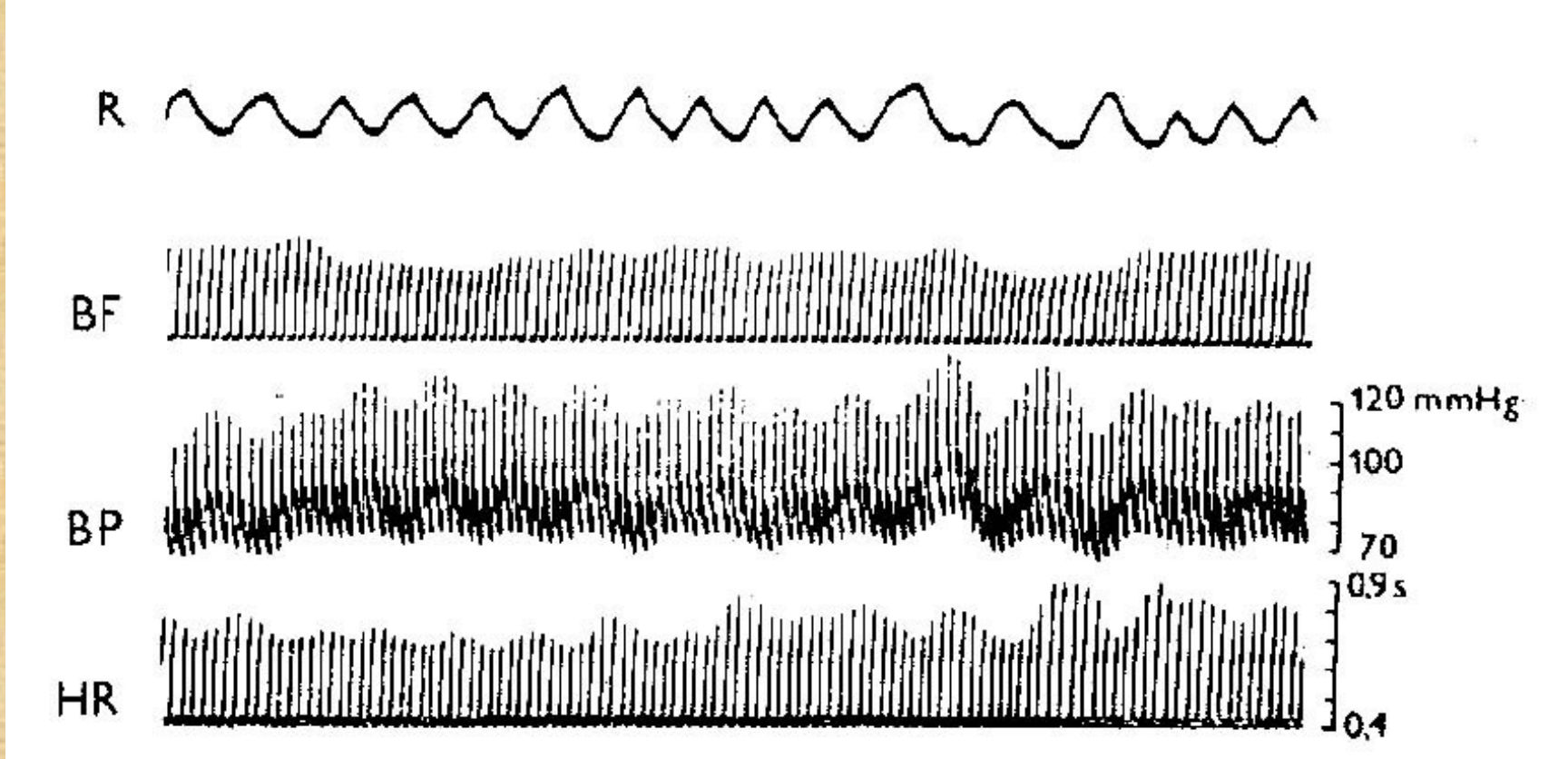

PC
BLOOD PRESSURE
FOLLOWER

- We need than **pressure in the cuff corresponded to the pressure of the digital artery**
- **Method: photopletysmography**
- Recorded photoelectric plethysmogram
- The new term: **Transmural pressure** – Pt (the pressure across the wall of the artery)
- BP (blood pressure inside artery), Pc (pressure in cuff), Pt (transmural pressure)
- We estimated: **BP=Pc ….Pt=0 …..**photoplethysmogram registered the highest amplitude of oscilation
- Step by step increase of Pc, in the moment of the highest amplitude – **feed-back loop** started for obtained(keeping) the constant volume of the finger

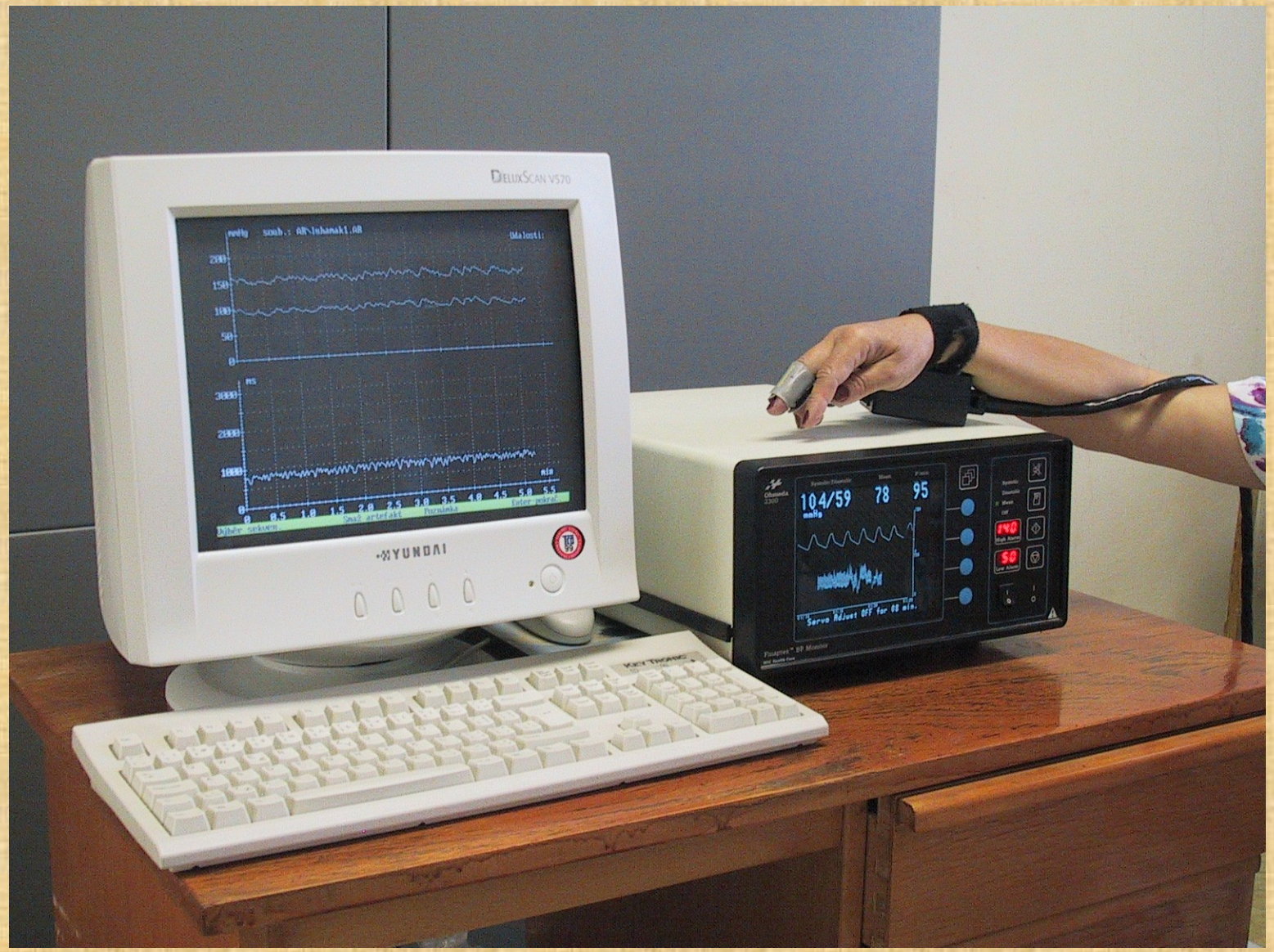
Penaz patent

- He used the signal from the photocell to control the external cuff pressure and that to keep the finger volume unchanged. This has achieved that pressure in the cuff monitors blood pressure in the artery.

Record of breathing and waves in circulatory parameters (Peňáz´s photoplethysmomanometr)



Finapres (Ohmeda, USA)




marx
start / stop
FMS Finometer

Invasive measurement of blood pressure

- The most accurate measurement method of BP – BUT HIGH RISK:
  - difficult accessibility, risk of infection diseases
  Usage: BP monitoring in critical states (coronary units, intensive care units); in more complex therapeutic procedures
  - Indirect - Swan-Ganze catheter - hollow tube, on the vessel side with a hole, the other side connected to the sensor - filled with physiological solution - transfer of pressure changes from the vessel's light towards the sensor – inaccurate
  - Direct – special sensor – special microsensor on the vessel side - the blood pressure signal is transmitted from it
  - up-to-date catheters - signal transmission via fiber optics
  - **Important for the diagnosis of all forms of pulmonary hypertension**

Methodology

Clinical statement

- **In keeping with a good practice is still auscultation method able to report reliable results**

- We must rely on *white-coat hypertension* versus *masked hypertension* in some patients

  There is always higher BP in the case of BP measurement by physician and lower values measured by nurse or technician

Methodology 2

„Home“ blood presure measurement

- Advantage: measurement by patients, elimination of white-coat hypertension effect, measurement in long period
- Disadvantage: technical problem, correct measurement by patient
- Classic oscillometry method – cuff on the arm
  - Attention on location of measurement on the wrist - in the vertical position - pressure above 15-20 mmHg higher than on the arm, even when in the heart position the SBP is higher by 2-3mmHg than on the arm
  - Finger position cuff (non digital photoplethysmography) - Higher values of 4 mmHg than on the arm (another characteristic of the pulse curve in the finger artery)

Values at home measurements are always lower than in the clinical setting – Hypertension society recommendation: BP higher than 135/85mmHg - are increased !

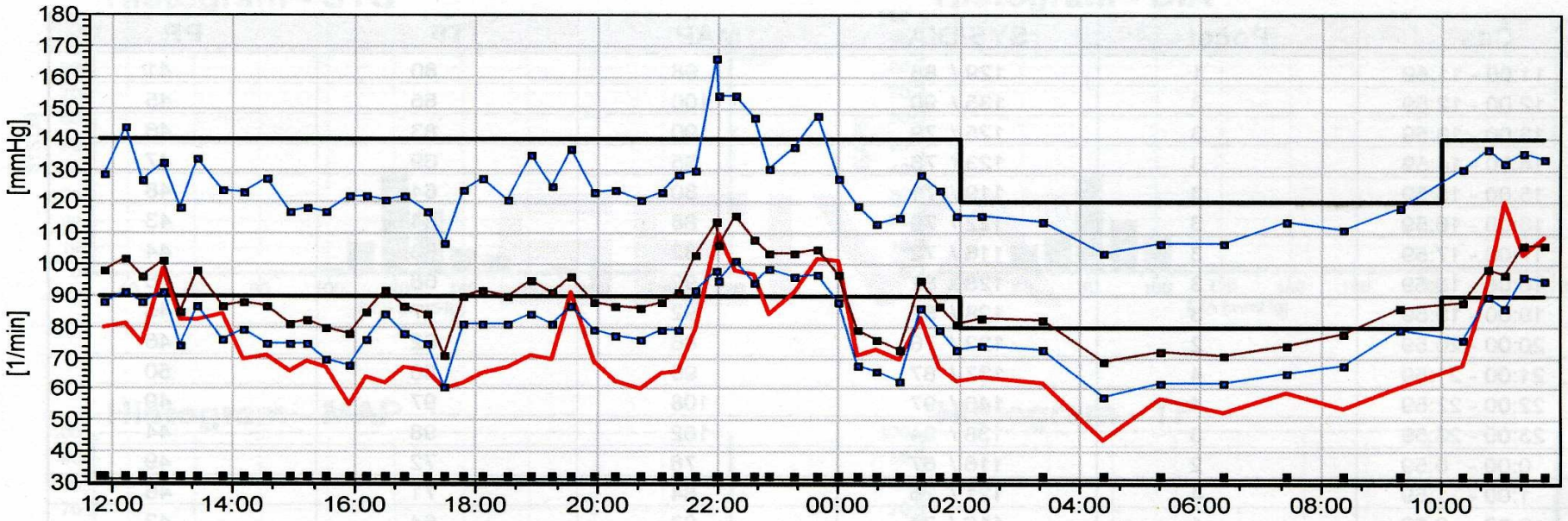
Methodology 3

24 hour ambulatory blood pressure monitoring

- Advantage: an overview of absolute values and variability in time-defined periods (! but still intermittent measurement!)
- Oscillometric method
- Information: SBP, DBP, pulse pressure, mean arterial pressure - profile of absolute values at monitored intervals; average and standard deviation for the period under review; % of the blood pressure parameters above the specified upper limit; calculation of different indexis; determination of variability of blood pressure fluctuation
- The number of BP increases in more than 40% of all values in either on night – or day-time interval – dg: arterial hypertension
- **ABPM values are lower than clinical values - recommendations:**

normal: below 135/85 daily and night under 120/70; 24 hour diameters 130/80 mmHg

Spojitý graf



Souhrnná statistika

Fáze	Celkem				Denní 10:00 - 2:00				Noční 2:00 - 10:00				Dopl.			
Doba	24h 0min				0h 0min				24h 0min				0h 0min			
Počet měření	59				0				59				0			
Uživatelská měření	2				0				2				0			
Chybná a vynechaná	2				0				2				0			
Překročení mezí	SYS >140: 11 % DIA > 90: 21 %				SYS >140: 0 % DIA > 90: 0 %				SYS >120: 68 % DIA > 80: 46 %				Noční pokles SYS=?% DIA=?%			
Statistika tlaků [mmHg]	min	avg	max	dev	min	avg	max	dev	min	avg	max	dev	min	avg	max	dev
SYS - systolický tlak	104	126	166	12	0	0	0	0	104	126	166	12	0	0	0	0
DIA - diastolický tlak	58	80	101	16	0	0	0	0	58	80	101	11	0	0	0	0
MAP - střední tlak	69	90	116	20	0	0	0	0	69	90	116	11	0	0	0	0
TF - tepová frekvence	44	75	120	26	0	0	0	0	44	75	120	17	0	0	0	0

Závěr vyšetření

Methodology 4

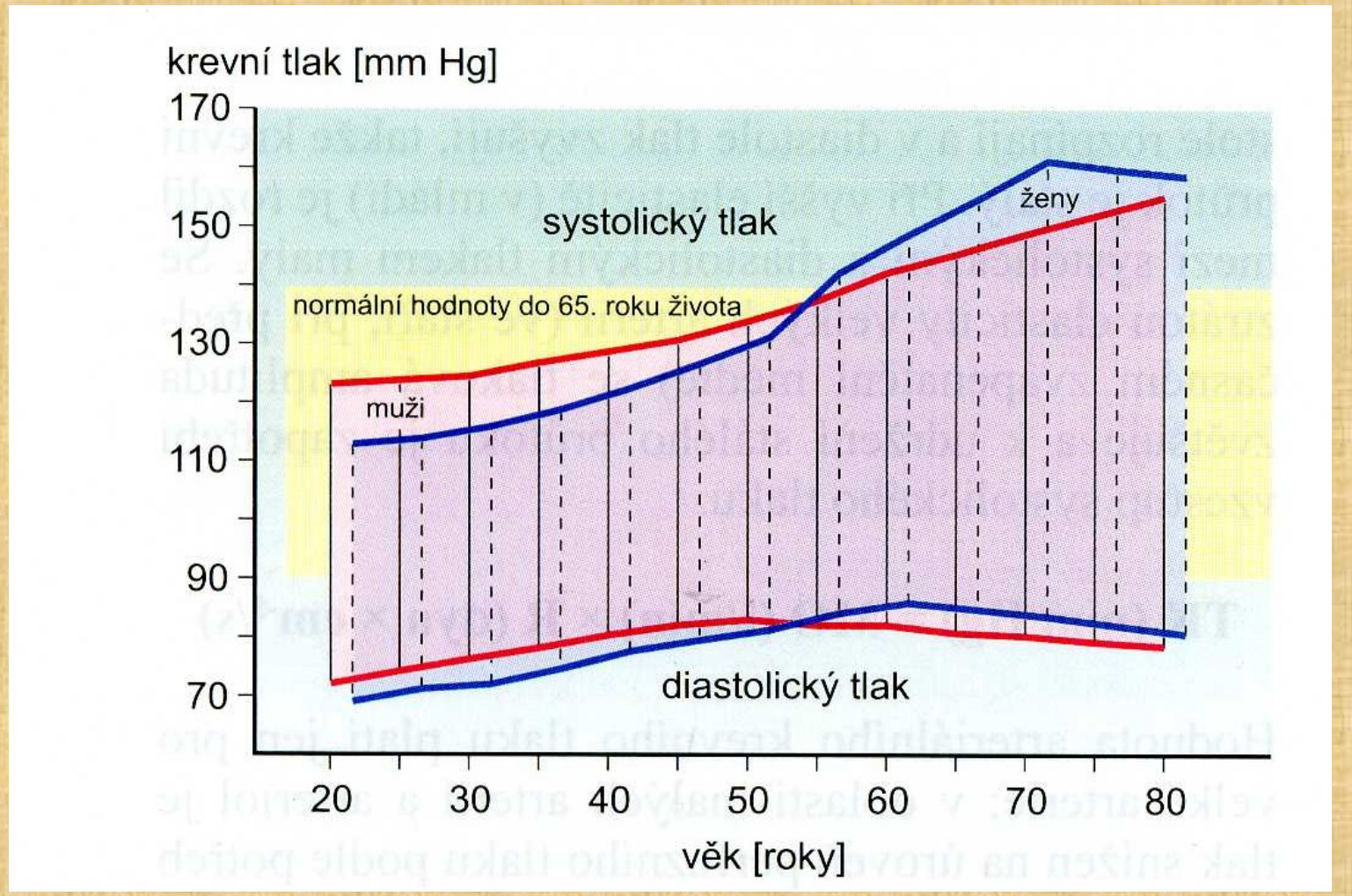
Continuously blood pressure measurement

- Beat to beat record by Penaz method
- BP is dynamic parameter
  - variability of fluctuation of heart rate and blood pressure – regulation by baroreflex – cooperation both parts of autonomic nervous system (symphathetic and parasymphathetic part)
  - Necessary component in clinical tests - head up table test (on inclined plane) and BP dysregulation in young subjects - dif.dg syncope
  - BP regulation research - maneuvers – Valsalva etc. ... ..
  - BP measurement in extreme situations: supersonic airplane pilots – overload condition, the cosmic program – weightlessness condition etc.

Blood pressure

in children

Age influence on blood pressure in man and female



Fölsch et al., Patologická fyziologie, Grada 2003

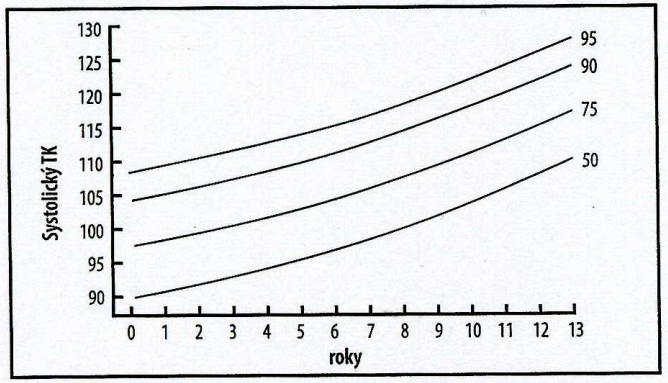
Classification BP values

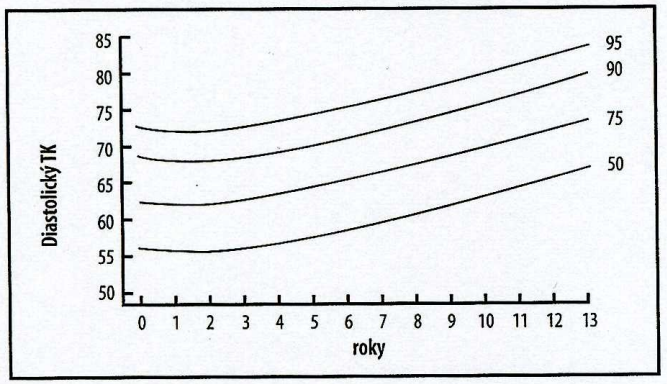
category	Systolic BP	Diastolic BP
	(mmHg)	(mmHg)
optimal	< 120	< 80
normal	120 – 129	80 – 84
high normal pressure	130 – 139	85 – 89
Hypertension - mild	140 – 159	90 – 99
Hypertension - moderate	160 – 179	100 – 109
Hypertension - severe	≥ 180	≥ 110
Izolated systolic hypertension	≥ 140	< 90

According the Guidelines of European Society of Cardiology 2013

Percentilové grafy krevního tlaku u chlapců

od 1 roku do 13 let



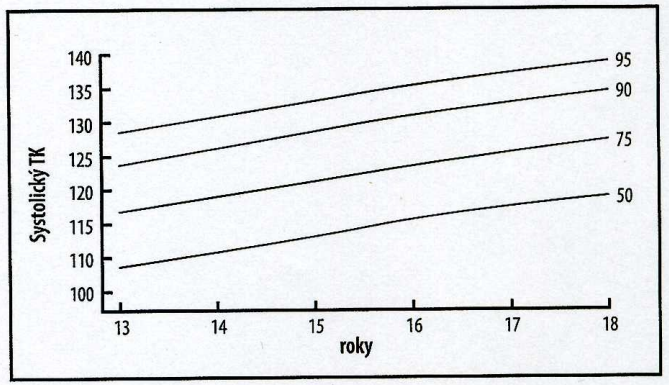


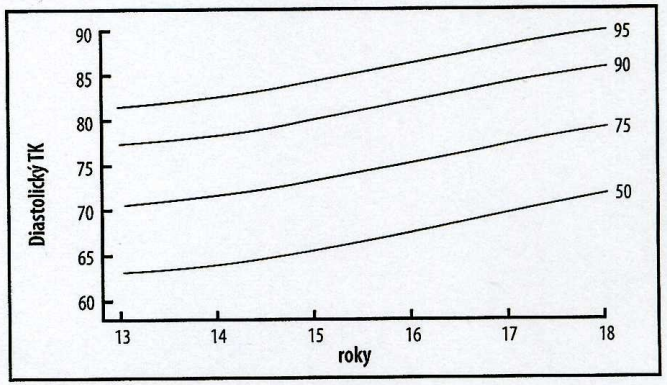
90. percentil

Systolický TK	105	106	107	108	109	111	112	114	115	117	119	121	124
Diastolický TK	69	68	68	69	69	70	71	73	74	75	76	77	79
Výška v cm	80	91	100	108	115	122	129	135	141	147	153	159	165
Váha v kg	11	14	16	18	22	25	29	34	39	44	50	55	62

Percentilové grafy krevního tlaku u chlapců

od 13 do 18 let





90. percentil

Systolický TK	124	126	129	131	134	136
Diastolický TK	77	78	79	81	83	84
Výška v cm	165	172	178	182	184	184
Váha v kg	62	68	74	80	84	86

- Current Hypertension Reports
- October 2017, 19:84 | Cite as
- **Updated Guideline May Improve the Recognition and Diagnosis of Hypertension in Children and Adolescents; Review of the 2017 AAP Blood Pressure Clinical Practice Guideline**
- **Janis M. Dionne**

For children aged 1 to 13 years/aged ≥13 years

- **Normal BP:** <90th percentile // <120/ <80 mmHg
- **Elevated BP:** ≥ 90th percentile to <95th percentile//120/ <80 to 129/ <80 mmHg
  - or 120/80 mmHg to <95th percentile (whichever is lower)
- **Stage 1 HTN**: : ≥ 95th percentile to <95th percentile+12 mmHg//130/80 to 139/89 mmHg
  - Or 130/80 to 139/89 mmHg (whichever is lower)
- **Stage 2 HTN:** ≥ 95th percentile +12 mmHg// ≥140/90 mmHg
  - Or ≥140/90 mmHg (whichever is lower)

Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al., for the Subcommittee on Screening and Management of High Blood Pressure in Children. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. **Pediatrics. 2017;140(3)**:e20171904. https://doi.org/10.1542/peds.2017-1904.

B Girls

Age (y)	Blood Pressure Percentile	Systolic Blood Pressure (mmHg) Height Percentile or Measured Height							Diastolic Blood Pressure (mmHg) Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	29.7	30.2	30.9	31.8	32.7	33.4	33.9	29.7	30.2	30.9	31.8	32.7	33.4	33.9
	Height (cm)	75.4	76.6	78.6	80.8	83	84.9	86.1	75.4	76.6	78.6	80.8	83	84.9	86.1
	50th	84	85	86	86	87	88	88	41	42	42	43	44	45	46
	90th	98	99	99	100	101	102	102	54	55	56	56	57	58	58
	95th	101	102	102	103	104	105	105	59	59	60	60	61	62	62
	95th + 12 mmHg	113	114	114	115	116	117	117	71	71	72	72	73	74	74
2	Height (in)	33.4	34	34.9	35.9	36.9	37.8	38.4	33.4	34	34.9	35.9	36.9	37.8	38.4
	Height (cm)	84.9	86.3	88.6	91.1	93.7	96	97.4	84.9	86.3	88.6	91.1	93.7	96	97.4
	50th	87	87	88	89	90	91	91	45	46	47	48	49	50	51
	90th	101	101	102	103	104	105	106	58	58	59	60	61	62	62
	95th	104	105	106	106	107	108	109	62	63	63	64	65	66	66
	95th + 12 mmHg	116	117	118	118	119	120	121	74	75	75	76	77	78	78
3	Height (in)	35.8	36.4	37.3	38.4	39.6	40.6	41.2	35.8	36.4	37.3	38.4	39.6	40.6	41.2
	Height (cm)	91	92.4	94.9	97.6	100.5	103.1	104.6	91	92.4	94.9	97.6	100.5	103.1	104.6
	50th	88	89	89	90	91	92	93	48	48	49	50	51	53	53
	90th	102	103	104	104	105	106	107	60	61	61	62	63	64	65
	95th	106	106	107	108	109	110	110	64	65	65	66	67	68	69
	95th + 12 mmHg	118	118	119	120	121	122	122	76	77	77	78	79	80	81
4	Height (in)	38.3	38.9	39.9	41.1	42.4	43.5	44.2	38.3	38.9	39.9	41.1	42.4	43.5	44.2
	Height (cm)	97.2	98.8	101.4	104.5	107.6	110.5	112.2	97.2	98.8	101.4	104.5	107.6	110.5	112.2
	50th	89	90	91	92	93	94	94	50	51	51	53	54	55	55
	90th	103	104	105	106	107	108	108	62	63	64	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
5	Height (in)	40.8	41.5	42.6	43.9	45.2	46.5	47.3	40.8	41.5	42.6	43.9	45.2	46.5	47.3
	Height (cm)	103.6	105.3	108.2	111.5	114.9	118.1	120	103.6	105.3	108.2	111.5	114.9	118.1	120
	50th	90	91	92	93	94	95	96	52	52	53	55	56	57	57
	90th	104	105	106	107	108	109	110	64	65	66	67	68	69	70
	95th	108	109	109	110	111	112	113	68	69	70	71	72	73	73
	95th + 12 mmHg	120	121	121	122	123	124	125	80	81	82	83	84	85	85
6	Height (in)	43.3	44	45.2	46.6	48.1	49.4	50.3	43.3	44	45.2	46.6	48.1	49.4	50.3
	Height (cm)	110	111.8	114.9	118.4	122.1	125.6	127.7	110	111.8	114.9	118.4	122.1	125.6	127.7
	50th	92	92	93	94	96	97	97	54	54	55	56	57	58	59
	90th	105	106	107	108	109	110	111	67	67	68	69	70	71	71
	95th	109	109	110	111	112	113	114	70	71	72	72	73	74	74
	95th + 12 mmHg	121	121	122	123	124	125	126	82	83	84	84	85	86	86
7	Height (in)	45.6	46.4	47.7	49.2	50.7	52.1	53	45.6	46.4	47.7	49.2	50.7	52.1	53
	Height (cm)	115.9	117.8	121.1	124.9	128.8	132.5	134.7	115.9	117.8	121.1	124.9	128.8	132.5	134.7
	50th	92	93	94	95	97	98	99	55	55	56	57	58	59	60
	90th	106	106	107	109	110	111	112	68	68	69	70	71	72	72
	95th	109	110	111	112	113	114	115	72	72	73	73	74	74	75
	95th + 12 mmHg	121	122	123	124	125	126	127	84	84	85	85	86	86	87
8	Height (in)	47.6	48.4	49.8	51.4	53	54.5	55.5	47.6	48.4	49.8	51.4	53	54.5	55.5
	Height (cm)	121	123	126.5	130.6	134.7	138.5	140.9	121	123	126.5	130.6	134.7	138.5	140.9
	50th	93	94	95	97	98	99	100	56	56	57	59	60	61	61
	90th	107	107	108	110	111	112	113	69	70	71	72	72	73	73
	95th	110	111	112	113	115	116	117	72	73	74	74	75	75	75
	95th + 12 mmHg	122	123	124	125	127	128	129	84	85	86	86	87	87	87
9	Height (in)	49.3	50.2	51.7	53.4	55.1	56.7	57.7	49.3	50.2	51.7	53.4	55.1	56.7	57.7
	Height (cm)	125.3	127.6	131.3	135.6	140.1	144.1	146.6	125.3	127.6	131.3	135.6	140.1	144.1	146.6
	50th	95	95	97	98	99	100	101	57	58	59	60	60	61	61
	90th	108	108	109	111	112	113	114	71	71	72	73	73	73	73
	95th	112	112	113	114	116	117	118	74	74	75	75	75	75	75
	95th + 12 mmHg	124	124	125	126	128	129	130	86	86	87	87	87	87	87

Age (y)	Blood Pressure Percentile	Systolic Blood Pressure (mmHg) Height Percentile or Measured Height							Diastolic Blood Pressure (mmHg) Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
10	Height (in)	51.1	52	53.7	55.5	57.4	59.1	60.2	51.1	52	53.7	55.5	57.4	59.1	60.2
	Height (cm)	129.7	132.2	136.3	141	145.8	150.2	152.8	129.7	132.2	136.3	141	145.8	150.2	152.8
	50th	96	97	98	99	101	102	103	58	59	59	60	61	61	62
	90th	109	110	111	112	113	115	116	72	73	73	73	73	73	73
	95th	113	114	114	116	117	119	120	75	75	76	76	76	76	76
	95th + 12 mmHg	125	126	126	128	129	131	132	87	87	88	88	88	88	88
11	Height (in)	53.4	54.5	56.2	58.2	60.2	61.9	63	53.4	54.5	56.2	58.2	60.2	61.9	63
	Height (cm)	135.6	138.3	142.8	147.8	152.8	157.3	160	135.6	138.3	142.8	147.8	152.8	157.3	160
	50th	98	99	101	102	104	105	106	60	60	60	61	62	63	64
	90th	111	112	113	114	116	118	120	74	74	74	74	74	75	75
	95th	115	116	117	118	120	123	124	76	77	77	77	77	77	77
	95th + 12 mmHg	127	128	129	130	132	135	136	88	89	89	89	89	89	89
12	Height (in)	56.2	57.3	59	60.9	62.8	64.5	65.5	56.2	57.3	59	60.9	62.8	64.5	65.5
	Height (cm)	142.8	145.5	149.9	154.8	159.6	163.8	166.4	142.8	145.5	149.9	154.8	159.6	163.8	166.4
	50th	102	102	104	105	107	108	108	61	61	61	62	64	65	65
	90th	114	115	116	118	120	122	122	75	75	75	75	76	76	76
	95th	118	119	120	122	124	125	126	78	78	78	78	79	79	79
	95th + 12 mmHg	130	131	132	134	136	137	138	90	90	90	90	91	91	91
13	Height (in)	58.3	59.3	60.9	62.7	64.5	66.1	67	58.3	59.3	60.9	62.7	64.5	66.1	67
	Height (cm)	148.1	150.6	154.7	159.2	163.7	167.8	170.2	148.1	150.6	154.7	159.2	163.7	167.8	170.2
	50th	104	105	106	107	108	108	109	62	62	63	64	65	65	66
	90th	116	117	119	121	122	123	123	75	75	75	76	76	76	76
	95th	121	122	123	124	126	126	127	79	79	79	79	80	80	81
	95th + 12 mmHg	133	134	135	136	138	138	139	91	91	91	91	92	92	93
14	Height (in)	59.3	60.2	61.8	63.5	65.2	66.8	67.7	59.3	60.2	61.8	63.5	65.2	66.8	67.7
	Height (cm)	150.6	153	156.9	161.3	165.7	169.7	172.1	150.6	153	156.9	161.3	165.7	169.7	172.1
	50th	105	106	107	108	109	109	109	63	63	64	65	66	66	66
	90th	118	118	120	122	123	123	123	76	76	76	76	77	77	77
	95th	123	123	124	125	126	127	127	80	80	80	80	81	81	82
	95th + 12 mmHg	135	135	136	137	138	139	139	92	92	92	92	93	93	94
15	Height (in)	59.7	60.6	62.2	63.9	65.6	67.2	68.1	59.7	60.6	62.2	63.9	65.6	67.2	68.1
	Height (cm)	151.7	154	157.9	162.3	166.7	170.6	173	151.7	154	157.9	162.3	166.7	170.6	173
	50th	105	106	107	108	109	109	109	64	64	64	65	66	67	67
	90th	118	119	121	122	123	123	124	76	76	76	77	77	78	78
	95th	124	124	125	126	127	127	128	80	80	80	81	82	82	82
	95th + 12 mmHg	136	136	137	138	139	139	140	92	92	92	93	94	94	94
16	Height (in)	59.9	60.8	62.4	64.1	65.8	67.3	68.3	59.9	60.8	62.4	64.1	65.8	67.3	68.3
	Height (cm)	152.1	154.5	158.4	162.8	167.1	171.1	173.4	152.1	154.5	158.4	162.8	167.1	171.1	173.4
	50th	106	107	108	109	109	110	110	64	64	65	66	66	67	67
	90th	119	120	122	123	124	124	124	76	76	76	77	78	78	78
	95th	124	125	125	127	127	128	128	80	80	80	81	82	82	82
	95th + 12 mmHg	136	137	137	139	139	140	140	92	92	92	93	94	94	94
17	Height (in)	60.0	60.9	62.5	64.2	65.9	67.4	68.4	60.0	60.9	62.5	64.2	65.9	67.4	68.4
	Height (cm)	152.4	154.7	158.7	163.0	167.4	171.3	173.7	152.4	154.7	158.7	163.0	167.4	171.3	173.7
	50th	107	108	109	110	110	110	111	64	64	65	66	66	66	67
	90th	120	121	123	124	124	125	125	76	76	77	77	78	78	78
	95th	125	125	126	127	128	128	128	80	80	80	81	82	82	82
	95th + 12 mmHg	137	137	138	139	140	140	140	92	92	92	93	94	94	94

A Boys

Age (y)	Blood Pressure Percentile	Systolic Blood Pressure (mmHg)							Diastolic Blood Pressure (mmHg)						
		Height Percentile or Measured Height							Height Percentile or Measured Height						
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	30.4	30.8	31.6	32.4	33.3	34.1	34.6	30.4	30.8	31.6	32.4	33.3	34.1	34.6
	Height (cm)	77.2	78.3	80.2	82.4	84.6	86.7	87.9	77.2	78.3	80.2	82.4	84.6	86.7	87.9
	50th	85	85	86	86	87	88	88	40	40	40	41	41	42	42
	90th	98	99	99	100	100	101	101	52	52	53	53	54	54	54
	95th	102	102	103	103	104	105	105	54	54	55	55	56	57	57
	95th + 12 mmHg	114	114	115	115	116	117	117	66	66	67	67	68	69	69
2	Height (in)	33.9	34.4	35.3	36.3	37.3	38.2	38.8	33.9	34.4	35.3	36.3	37.3	38.2	38.8
	Height (cm)	86.1	87.4	89.6	92.1	94.7	97.1	98.5	86.1	87.4	89.6	92.1	94.7	97.1	98.5
	50th	87	87	88	89	89	90	91	43	43	44	44	45	46	46
	90th	100	100	101	102	103	103	104	55	55	56	56	57	58	58
	95th	104	105	105	106	107	107	108	57	58	58	59	60	61	61
	95th + 12 mmHg	116	117	117	118	119	119	120	69	70	70	71	72	73	73
3	Height (in)	36.4	37	37.9	39	40.1	41.1	41.7	36.4	37	37.9	39	40.1	41.1	41.7
	Height (cm)	92.5	93.9	96.3	99	101.8	104.3	105.8	92.5	93.9	96.3	99	101.8	104.3	105.8
	50th	88	89	89	90	91	92	92	45	46	46	47	48	49	49
	90th	101	102	102	103	104	105	105	58	58	59	59	60	61	61
	95th	106	106	107	107	108	109	109	60	61	61	62	63	64	64
	95th + 12 mmHg	118	118	119	119	120	121	121	72	73	73	74	75	76	76
4	Height (in)	38.8	39.4	40.5	41.7	42.9	43.9	44.5	38.8	39.4	40.5	41.7	42.9	43.9	44.5
	Height (cm)	98.5	100.2	102.9	105.9	108.9	111.5	113.2	98.5	100.2	102.9	105.9	108.9	111.5	113.2
	50th	90	90	91	92	93	94	94	48	49	49	50	51	52	52
	90th	102	103	104	105	105	106	107	60	61	62	62	63	64	64
	95th	107	107	108	108	109	110	110	63	64	65	66	67	67	68
	95th + 12 mmHg	119	119	120	120	121	122	122	75	76	77	78	79	79	80
5	Height (in)	41.1	41.8	43.0	44.3	45.5	46.7	47.4	41.1	41.8	43.0	44.3	45.5	46.7	47.4
	Height (cm)	104.4	106.2	109.1	112.4	115.7	118.6	120.3	104.4	106.2	109.1	112.4	115.7	118.6	120.3
	50th	91	92	93	94	95	96	96	51	51	52	53	54	55	55
	90th	103	104	105	106	107	108	108	63	64	65	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83
6	Height (in)	43.4	44.2	45.4	46.8	48.2	49.4	50.2	43.4	44.2	45.4	46.8	48.2	49.4	50.2
	Height (cm)	110.3	112.2	115.3	118.9	122.4	125.6	127.5	110.3	112.2	115.3	118.9	122.4	125.6	127.5
	50th	93	93	94	95	96	97	98	54	54	55	56	57	57	58
	90th	105	105	106	107	109	110	110	66	66	67	68	68	69	69
	95th	108	109	110	111	112	113	114	69	70	70	71	72	72	73
	95th + 12 mmHg	120	121	122	123	124	125	126	81	82	82	83	84	84	85
7	Height (in)	45.7	46.5	47.8	49.3	50.8	52.1	52.9	45.7	46.5	47.8	49.3	50.8	52.1	52.9
	Height (cm)	116.1	118	121.4	125.1	128.9	132.4	134.5	116.1	118	121.4	125.1	128.9	132.4	134.5
	50th	94	94	95	97	98	98	99	56	56	57	58	58	59	59
	90th	106	107	108	109	110	111	111	68	68	69	70	70	71	71
	95th	110	110	111	112	114	115	116	71	71	72	73	73	74	74
	95th + 12 mmHg	122	122	123	124	126	127	128	83	83	84	85	85	86	86
8	Height (in)	47.8	48.6	50	51.6	53.2	54.6	55.5	47.8	48.6	50	51.6	53.2	54.6	55.5
	Height (cm)	121.4	123.5	127	131	135.1	138.8	141	121.4	123.5	127	131	135.1	138.8	141
	50th	95	96	97	98	99	99	100	57	57	58	59	59	60	60
	90th	107	108	109	110	111	112	112	69	70	70	71	72	72	73
	95th	111	112	112	114	115	116	117	72	73	73	74	75	75	75
	95th + 12 mmHg	123	124	124	126	127	128	129	84	85	85	86	87	87	87
9	Height (in)	49.6	50.5	52	53.7	55.4	56.9	57.9	49.6	50.5	52	53.7	55.4	56.9	57.9
	Height (cm)	126	128.3	132.1	136.3	140.7	144.7	147.1	126	128.3	132.1	136.3	140.7	144.7	147.1
	50th	96	97	98	99	100	101	101	57	58	59	60	61	62	62
	90th	107	108	109	110	112	113	114	70	71	72	73	74	74	74
	95th	112	112	113	115	116	118	119	74	74	75	76	76	77	77
	95th + 12 mmHg	124	124	125	127	128	130	131	86	86	87	88	88	89	89
10	Height (in)	51.3	52.2	53.8	55.6	57.4	59.1	60.1	51.3	52.2	53.8	55.6	57.4	59.1	60.1
	Height (cm)	130.2	132.7	136.7	141.3	145.9	150.1	152.7	130.2	132.7	136.7	141.3	145.9	150.1	152.7
	50th	97	98	99	100	101	102	103	59	60	61	62	63	63	64
	90th	108	109	111	112	113	115	116	72	73	74	74	75	75	76
	95th	112	113	114	116	118	120	121	76	76	77	77	78	78	78
	95th + 12 mmHg	124	125	126	128	130	132	133	88	88	89	89	90	90	90
11	Height (in)	53	54	55.7	57.6	59.6	61.3	62.4	53	54	55.7	57.6	59.6	61.3	62.4
	Height (cm)	134.7	137.3	141.5	146.4	151.3	155.8	158.6	134.7	137.3	141.5	146.4	151.3	155.8	158.6
	50th	99	99	101	102	103	104	106	61	61	62	63	63	63	63
	90th	110	111	112	114	116	117	118	74	74	75	75	75	76	76
	95th	114	114	116	118	120	123	124	77	78	78	78	78	78	78
	95th + 12 mmHg	126	126	128	130	132	135	136	89	90	90	90	90	90	90
12	Height (in)	55.2	56.3	58.1	60.1	62.2	64	65.2	55.2	56.3	58.1	60.1	62.2	64	65.2
	Height (cm)	140.3	143	147.5	152.7	157.9	162.6	165.5	140.3	143	147.5	152.7	157.9	162.6	165.5
	50th	101	101	102	104	106	108	109	61	62	62	62	62	63	63
	90th	113	114	115	117	119	121	122	75	75	75	75	75	76	76
	95th	116	117	118	121	124	126	128	78	78	78	78	78	79	79
	95th + 12 mmHg	128	129	130	133	136	138	140	90	90	90	90	90	91	91
13	Height (in)	57.9	59.1	61	63.1	65.2	67.1	68.3	57.9	59.1	61	63.1	65.2	67.1	68.3
	Height (cm)	147	150	154.9	160.3	165.7	170.5	173.4	147	150	154.9	160.3	165.7	170.5	173.4
	50th	103	104	105	108	110	111	112	61	60	61	62	63	64	65
	90th	115	116	118	121	124	126	126	74	74	74	75	76	77	77
	95th	119	120	122	125	128	130	131	78	78	78	78	80	81	81
	95th + 12 mmHg	131	132	134	137	140	142	143	90	90	90	90	92	93	93
14	Height (in)	60.6	61.8	63.8	65.9	68.0	69.8	70.9	60.6	61.8	63.8	65.9	68.0	69.8	70.9
	Height (cm)	153.8	156.9	162	167.5	172.7	177.4	180.1	153.8	156.9	162	167.5	172.7	177.4	180.1
	50th	105	106	109	111	112	113	113	60	60	62	64	65	66	67
	90th	119	120	123	126	127	128	129	74	74	75	77	78	79	80
	95th	123	125	127	130	132	133	134	77	78	79	81	82	83	84
	95th + 12 mmHg	135	137	139	142	144	145	146	89	90	91	93	94	95	96
15	Height (in)	62.6	63.8	65.7	67.8	69.8	71.5	72.5	62.6	63.8	65.7	67.8	69.8	71.5	72.5
	Height (cm)	159	162	166.9	172.2	177.2	181.6	184.2	159	162	166.9	172.2	177.2	181.6	184.2
	50th	108	110	112	113	114	114	114	61	62	64	65	66	67	68
	90th	123	124	126	128	129	130	130	75	76	78	79	80	81	81
	95th	127	129	131	132	134	135	135	78	79	81	83	84	85	85
	95th + 12 mmHg	139	141	143	144	146	147	147	90	91	93	95	96	97	97
16	Height (in)	63.8	64.9	66.8	68.8	70.7	72.4	73.4	63.8	64.9	66.8	68.8	70.7	72.4	73.4
	Height (cm)	162.1	165	169.6	174.6	179.5	183.8	186.4	162.1	165	169.6	174.6	179.5	183.8	186.4
	50th	111	112	114	115	115	116	116	63	64	66	67	68	69	69
	90th	126	127	128	129	131	131	132	77	78	79	80	81	82	82
	95th	130	131	133	134	135	136	137	80	81	83	84	85	86	86
	95th + 12 mmHg	142	143	145	146	147	148	149	92	93	95	96	97	98	98
17	Height (in)	64.5	65.5	67.3	69.2	71.1	72.8	73.8	64.5	65.5	67.3	69.2	71.1	72.8	73.8
	Height (cm)	163.8	166.5	170.9	175.8	180.7	184.9	187.5	163.8	166.5	170.9	175.8	180.7	184.9	187.5
	50th	114	115	116	117	117	118	118	65	66	67	68	69	70	70
	90th	128	129	130	131	132	133	134	78	79	80	81	82	82	83
	95th	132	133	134	135	137	138	138	81	82	84	85	86	86	87
	95th + 12 mmHg	144	145	146	147	149	150	150	93	94	96	97	98	98	99

Blood pressure

- Immediately after birth – high blood pressure:
  - Stress after delivery, increase concentration of catecholamine and cortizol
- After 1st day …….. 70/50 mmHg:
  - Open of pulmonary and intestine circulation
- During pubertas:
  - Development of regulatory mechanism
  - Stimulation of external world

• Newborn	**80/46 mmHg**	10.6/6.1 kPa
• 3 years	**100/67**	13.3/8.9
• 10-11 years	**111/58**	14.8/7.7
• 13-14 years	**118/60**	15.7/8.0

Blood presure measurement in newborn and children

- Korotkoff method – for children over 1 year – use a correct size of cuff
- In the newborns, auscultation phenomena are poorly audible - there may be an underestimation of SBP
- better use the ultrasound method of the blood flow detector

The size of cuff

Body weight	age	size of cuff
1 500 g	newborn	2.5 cm
5 kg	3 month	4.5 cm
10 kg	15 month	6 cm
30 kg	9 year	7.5 cm
more than 30 kg	10 and more years	12 cm

Specific features measurement

Pregnant women

- Physiological profile of pregnancy - decrease of BP with increase in cardiac output and large decrease of peripheral resistance = special hyperkinetic conditions - Korotkoff phenomena we auscultated even after deflation of the cuff - diastolic BP we estimated in IV phase of Korotkoff phenomena

Elderly people with atherosclerosis - poor compressibility of the artery wall by a compression cuff - we need to inflate more - so we measure falsely higher SBP values - **pseudohypertension**

Obese persons – using the right size of the cuff !!!!! using a standard cuff – overstocking of SBP

Dynamic physical exercise - auscultation method may underestimate SBP by 15 mmHg, during recovery phase - overstatement of up to 30mmHg SBP; DBP less frequently but falsely low - better use for DBP measurement reading from phase IV of Korotkoff sounds

Actual blood pressure values are dependent on:

- factors that are conditioned by the organism
- on the measurement method
- in which conditions the measurements are performed (methodology)
- even on accuracy and reliability of instruments (technical page - necessary tests and calibration of pressure device / 1 year)
- **THIS MUST BE ALLOWED TO CONSIDER AT THE MEASUREMENT IN CLINICAL PRACTICE**

THANK YOU FOR YOUR ATTENTION