

# BLOOD PRESSURE

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

- **Blood pressure (BP)** means the force exerted by the blood against any unit area of the vessel wall
- **Systolic blood pressure - SBP**
- **Diastolic blood pressure -DBP**
- **Mean arterial pressure - MAP**
- **Pulse pressure - PP**

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

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

# 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

## Classification BP values: „officer BP“

category	Systolic BP	Diastolic BP
	(mmHg)	(mmHg)
optimal	< 120	< 80
normal	120 – 129	80 – 84
high normal pressure	130 – 139	85 – 89
Hypertension – mild: grade 1	140 – 159	90 – 99
Hypertension – moderate: grade 2	160 – 179	100 – 109
Hypertension – severe: grade 3	≥ 180	≥ 110
Isolated systolic hypertension	≥ 140	< 90

According the Guidelines of European Society of Cardiology 2018

## Classification of BP

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

# 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)

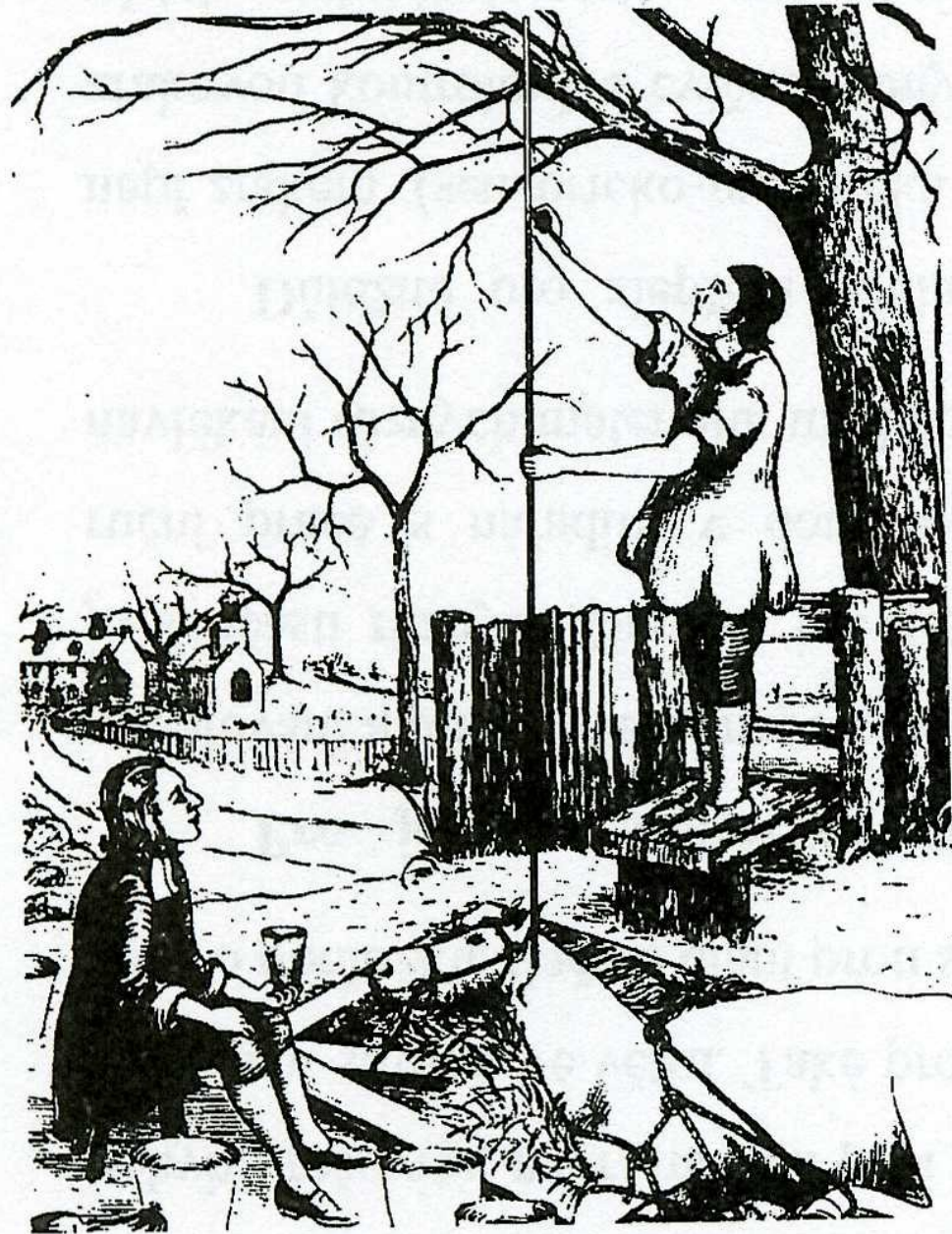
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# BLOOD PRESSURE MEASUREMENT

- **Direct invasive method**
  - 1726 Stephan Hales – horse
  - Today – during catheterization
  
- **Indirect non-invasive measurement**
  - Palpation method
  - Auscultation method
  - Oscilometric method







# Palpatory methods

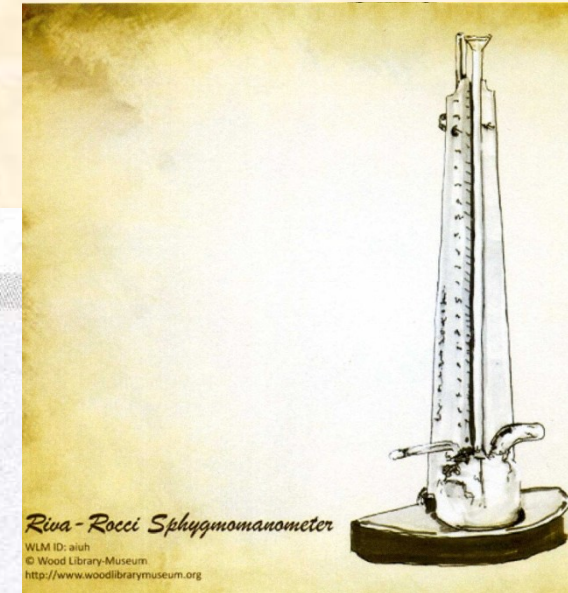
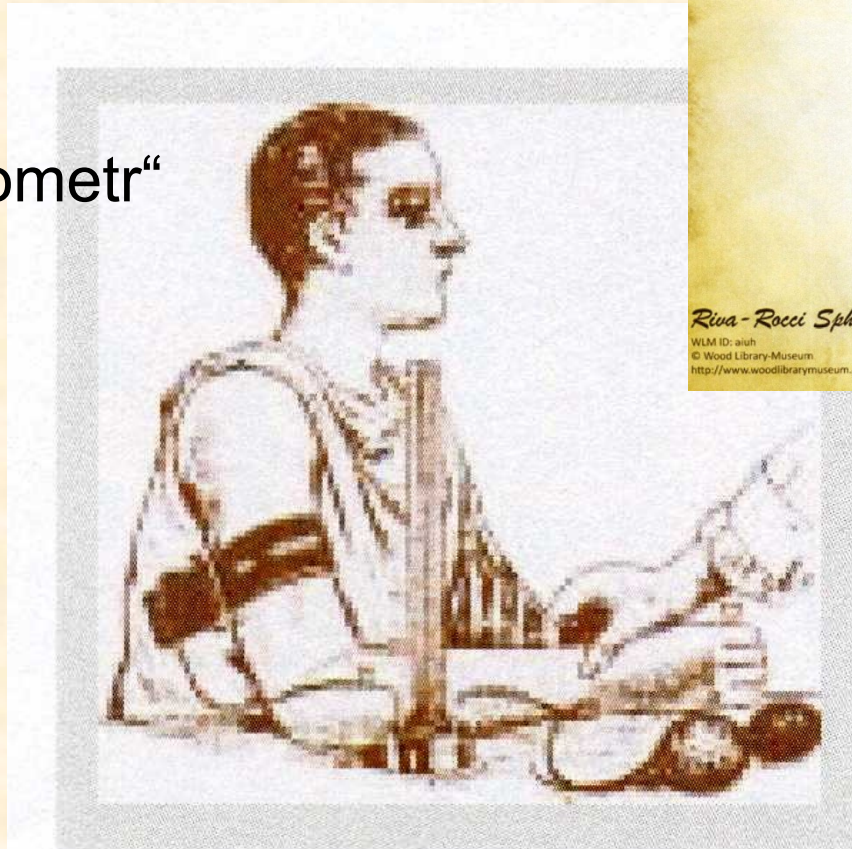
Italian physician

**Riva Rocci**

„mercury sphygmomanometer“

The cuff on the arm

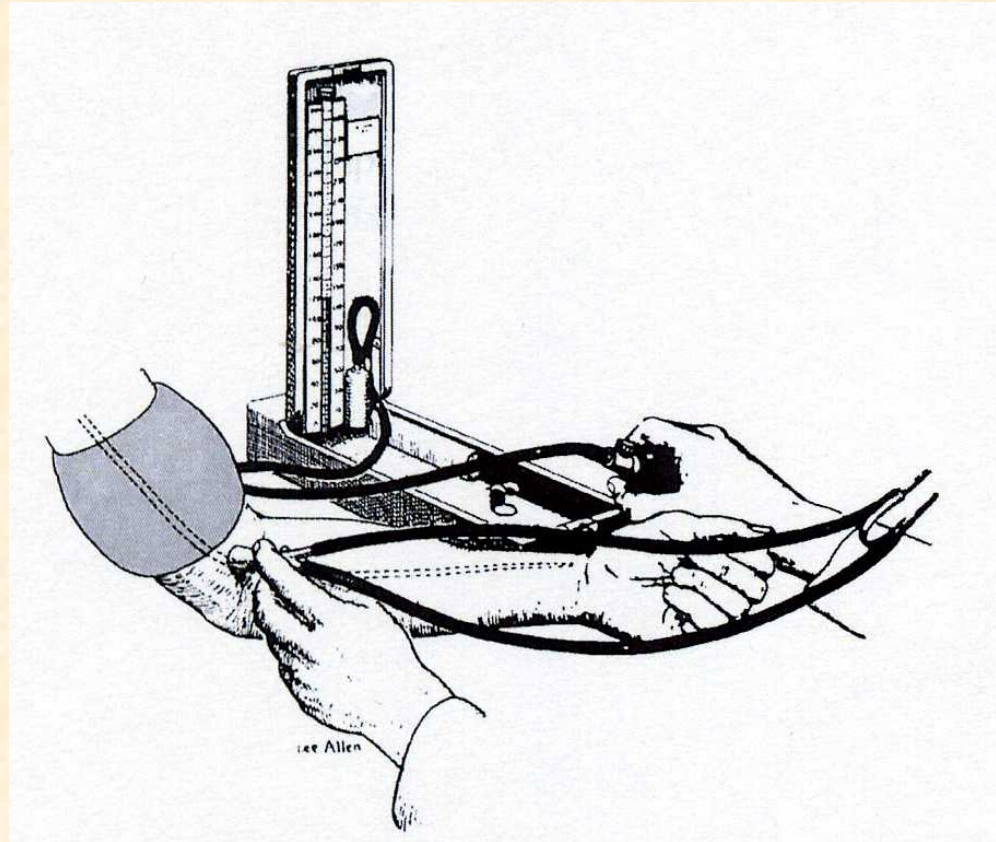
1896



# Auscultatory method

A Russian army surgeon  
**Nikolai Korotkoff**  
1904

„mercury sphygmomanometer“  
The cuff on the arm  
Stethoscope at the elbow



# Oscilometric method

Based on **the same principle** as auscultation: **changes of laminar to turbulent flow**

During instrument testing it has been repeatedly shown that **the point of maximum oscillations corresponds to the mean arterial pressure measured invasively.**

Oscillations begin around systolic pressure values and continue after cuff release = both **systolic and diastolic pressure are estimated only indirectly based on empirical derived algorithms**



# The size of the cuff in adults

Categories	Circumference of arm (cm)	Cuff width x length (cm)
Small adult cuff	22 - 26	10 x 24
Adult cuff	27 - 34	13 x 30
Large adult cuff	35 - 44	16 x 38
Tight adult cuff	45 - 52	20 x 42



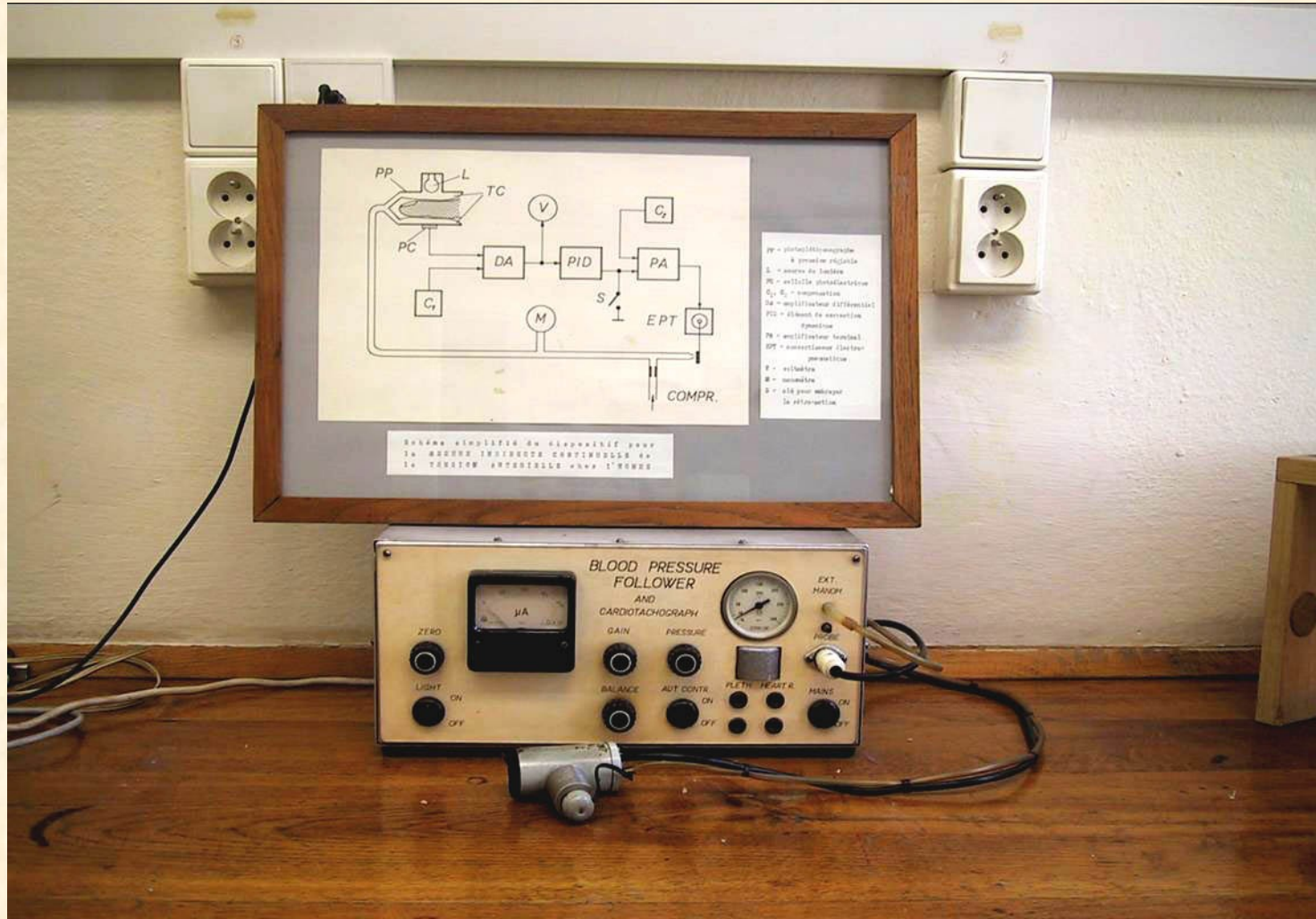
# Noninvasive continuously beat-to-beat measurement of finger arterial pressure

- Prof. Jan Peňáz, MD, PhD
- Teacher and researcher on the Department of Physiology, Masaryk university, Brno
- Patent 1969

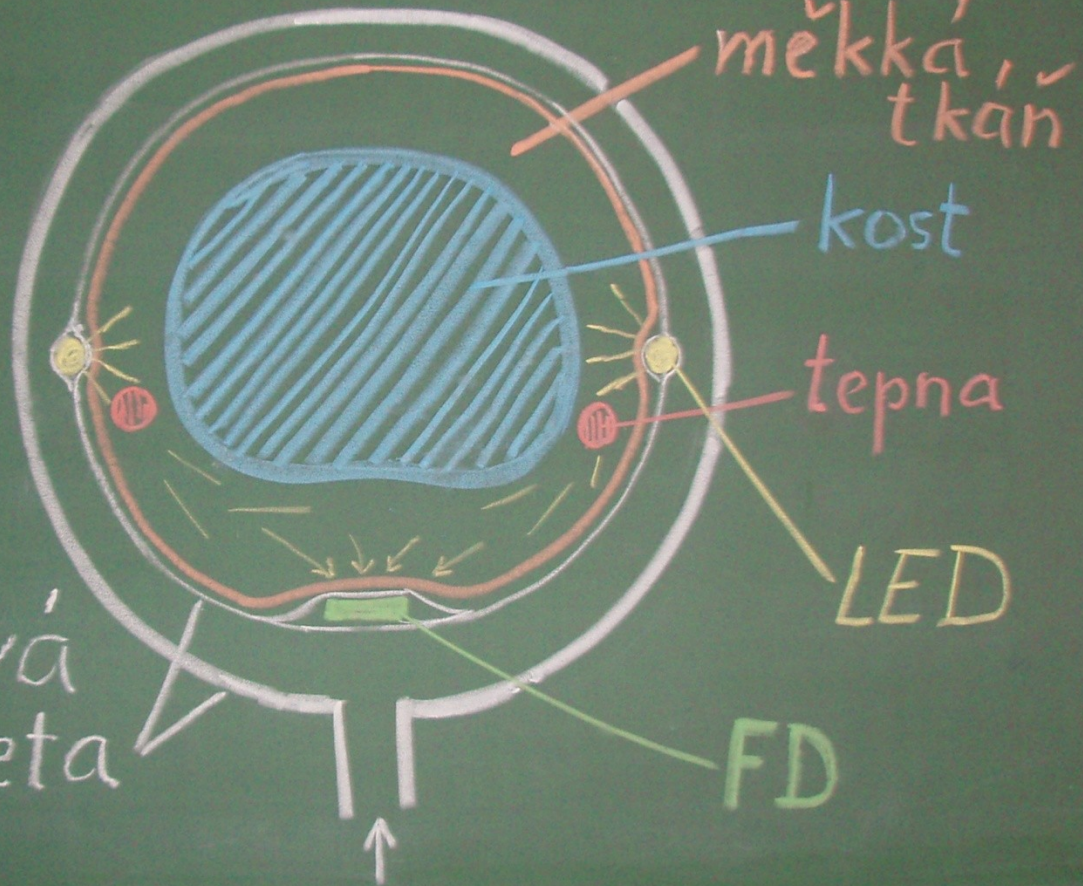




# Non-invasive continuously blood pressure measurement beat-to-beat by Peñáz

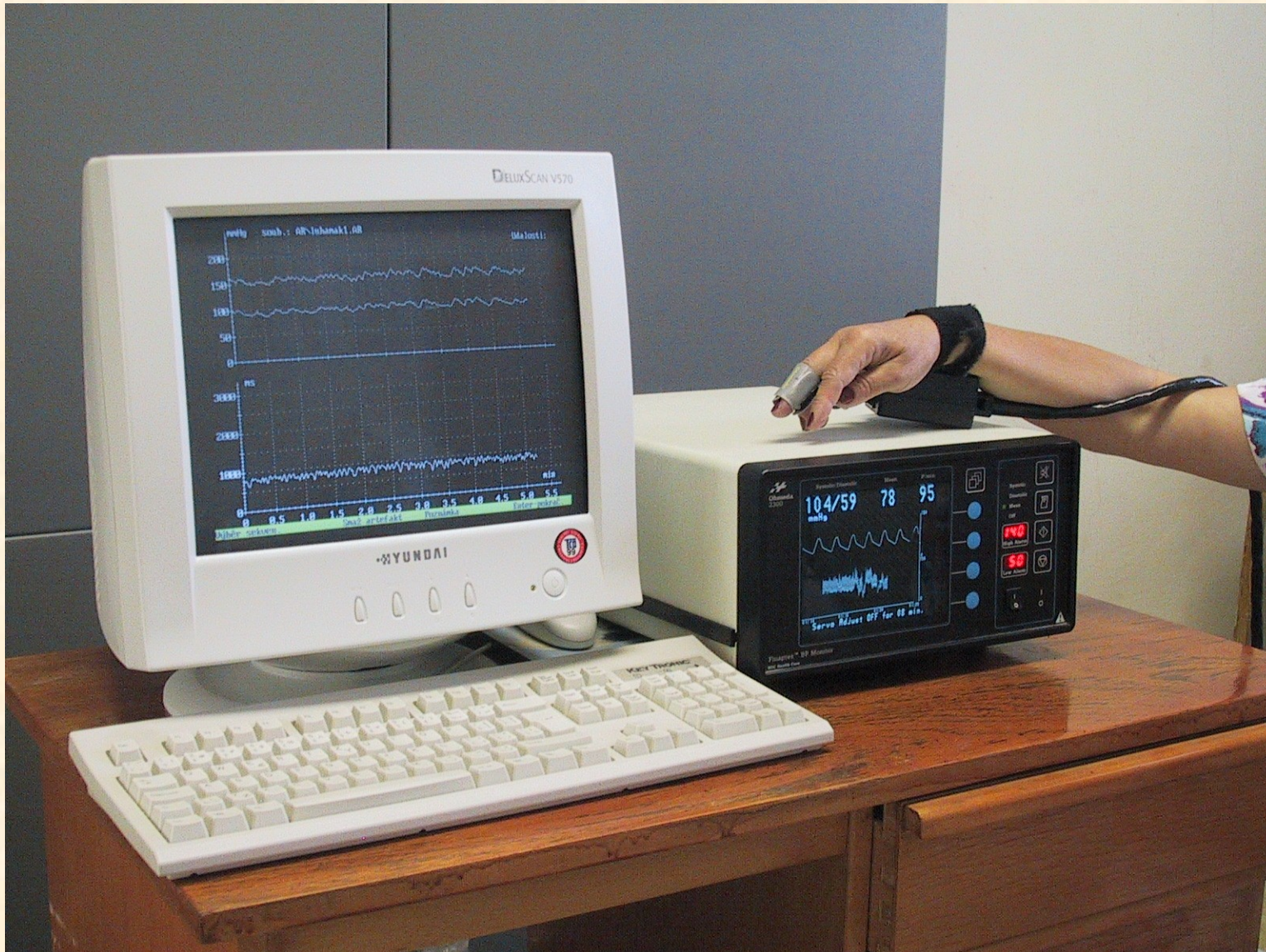








# Finapres (Ohmeda, USA)





# Finometr (FMS, Nizozemí)



- Peñáz method: based on the fact-
  - we need than **pressure in the cuff corresponded to the pressure of the digital artery**
- **Method: photoplethysmography** (Recorded photoelectric plethysmogram)

*The new term: **Transmural pressure** —  $P_t$  (the pressure across the wall of the artery)*

*So, we know following parameters:*

$BP$  = Blood pressure inside of digital artery,  $P_C$  = pressure in cuff,  $P_t$  = transmural pressure

We estimated:  **$BP = P_C$**  it is mean, that  **$P_t = 0$**  ... photoplethysmogram registered the highest amplitude of oscillation --- we measure the **MAP**

This situation coming at the beginning of measurement, when the cuff is inflated step by step (5 mmHg) and  $P_C$  increase. In the moment of the highest amplitude is registered – **feed-back loop** started for obtained the constant volume of the finger. This feed-back control is based on record amount of the light from photocells (see picture no. 16 and see bellow)

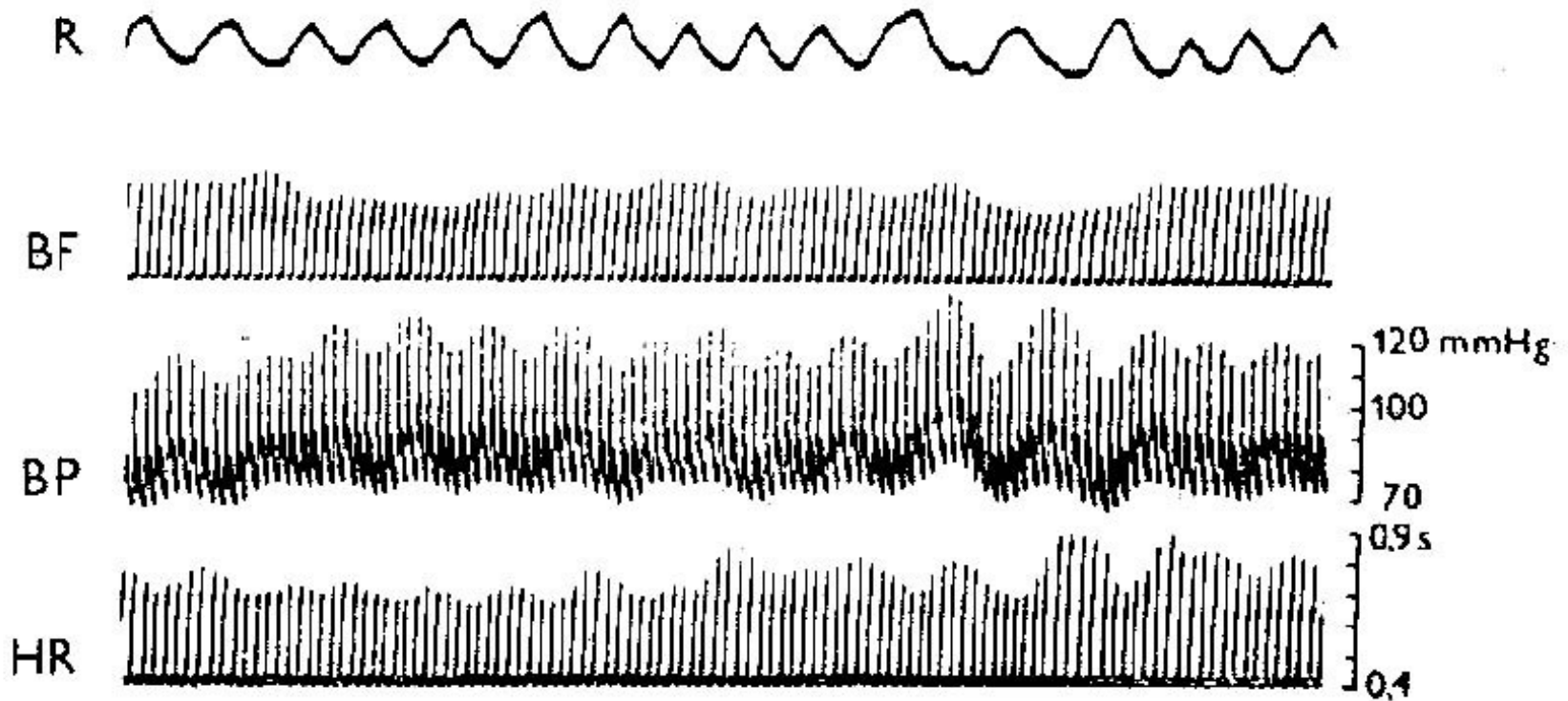


## Peňáz patent (1969)

- He used a photocell signal to control the outer cuff pressure so that the finger volume did not change



# Records of circulatory parameters



# 24-hour ambulatory blood pressure monitoring (ABPM)

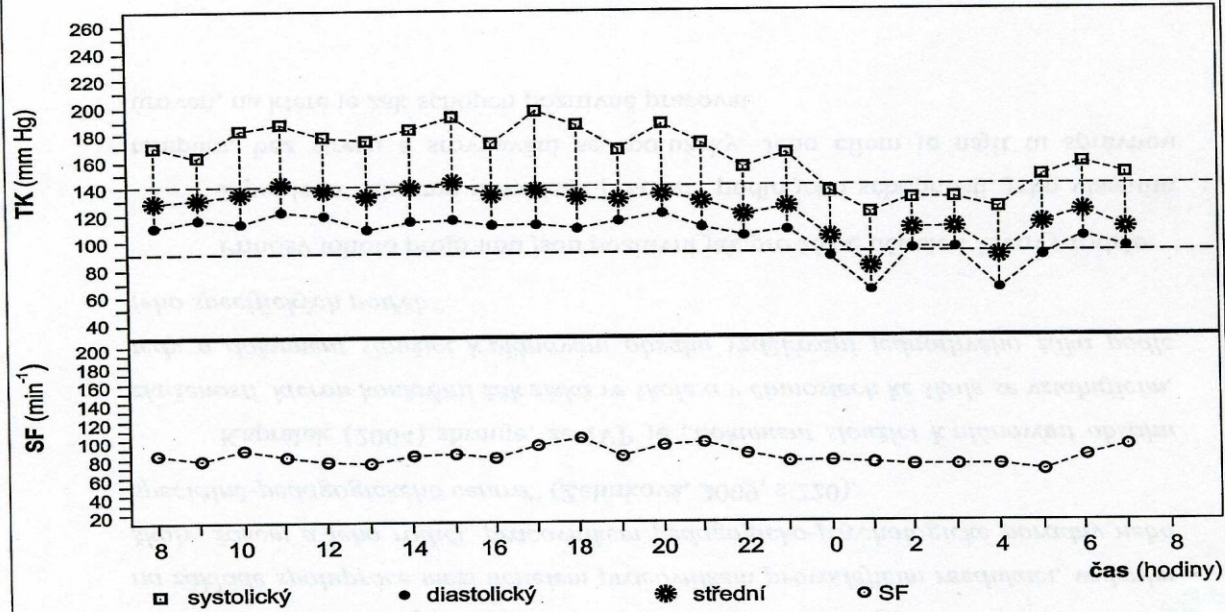
- **Circadian rhythm** – fluctuation of blood pressure during 24 h (physiological)
  - The highest values - the morning, 6 –10h a.m.
    - the afternoon, 4 – 6h p.m.
  - The lowest values – 3 – 4h a.m.
- **Diurnal rhythm** – differences between day – night - physiological

Dippers (at night comes physiological decreasing of BP)

Nondippers (there is no reduction of BP at night - pathological)

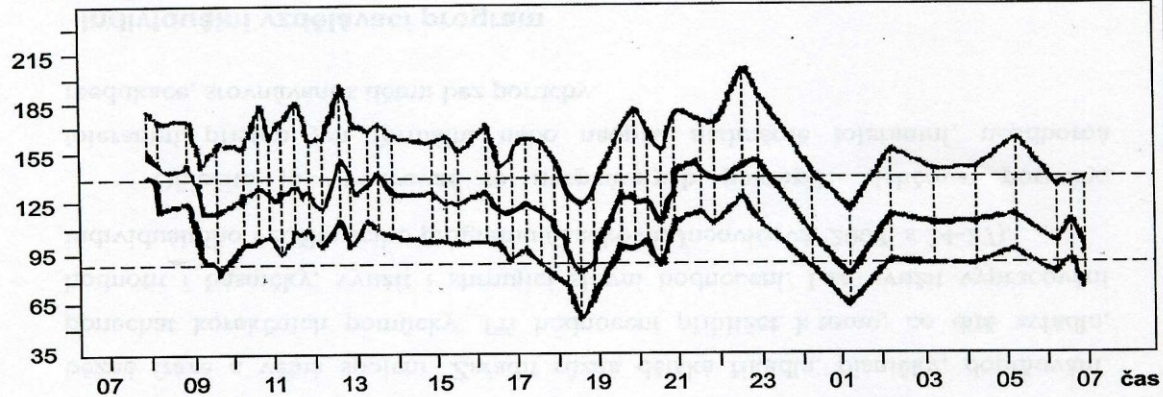
- ABPM - record of BP during 24 h (or 48h or 7 days is now also possible)
- Dif.dg. : **white coat hypertension or masked hypertension**  
**+ Control of treatment of hypertension**
- **Evaluation: Physiological values**
- Mean values during 24 h: less than 125/80mmHg
- Mean values during day period:less than 135/85mmHg
- Mean values during night period:less than 120/70mmHg
- **Hypertension:**
  - **More than 40% values above 140/90 at day, 120/80 at night**

průměrný hodinový TK



B

TK (mm Hg)



C



## numeric display of day / night phase

	overall time		day phase		night phase		Day -> Night
	08:15 - 08:00		06:00 - 22:00		22:00 - 06:00		
	mean	max	mean	max	mean	max	
Ps [mmHg]	127	160	129	160	118	152	-8 %
Pd [mmHg]	74	120	76	120	63	81	-17 %
Pm [mmHg]	91	133	93	133	81	104	
BP-Ampl.	53	95	52	95	55	76	
Pulse [1/min]	71	103	74	103	62	79	-16 %
measurement count	95		76		19		
repeat measurements	13		10		3		
error + ignored meas.	14		11		3		
	count	%	count	%	count	%	
Ps > 140 mmHg:	14	17	12	18	2	13	
Pd > 90 mmHg:	9	11	9	14			
Pulse > 100 / min:	2	2	2	3			

