(VIII.) Blood pressure in men
(IX.) Non-invasive methods of blood pressure measurement

Physiology I – practicals

Arterial blood pressure during heart cycle

Blood pressure (BP): pressure of blood on arterial wall
(arterial BP: portion of energy of LV contraction transformed into lateral pressure is put on arterial wall)

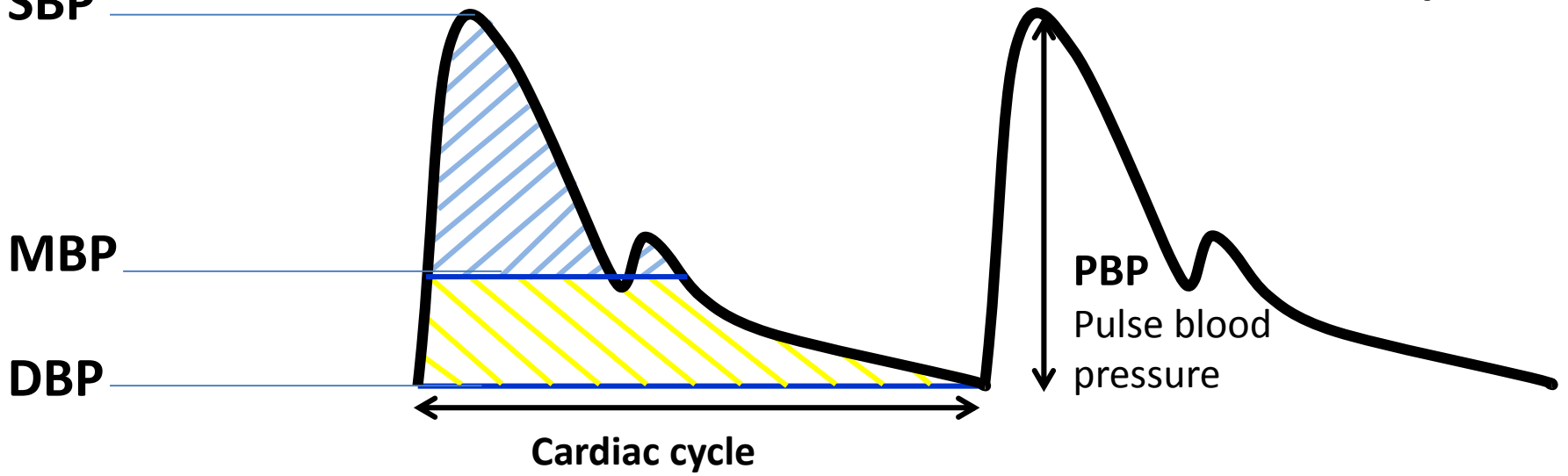
Mean BP (MBP): calculated MBP in the course of one heart cycle (integral of pressure curve)

Systolic BP - the highest value of BP during cardiac cycle

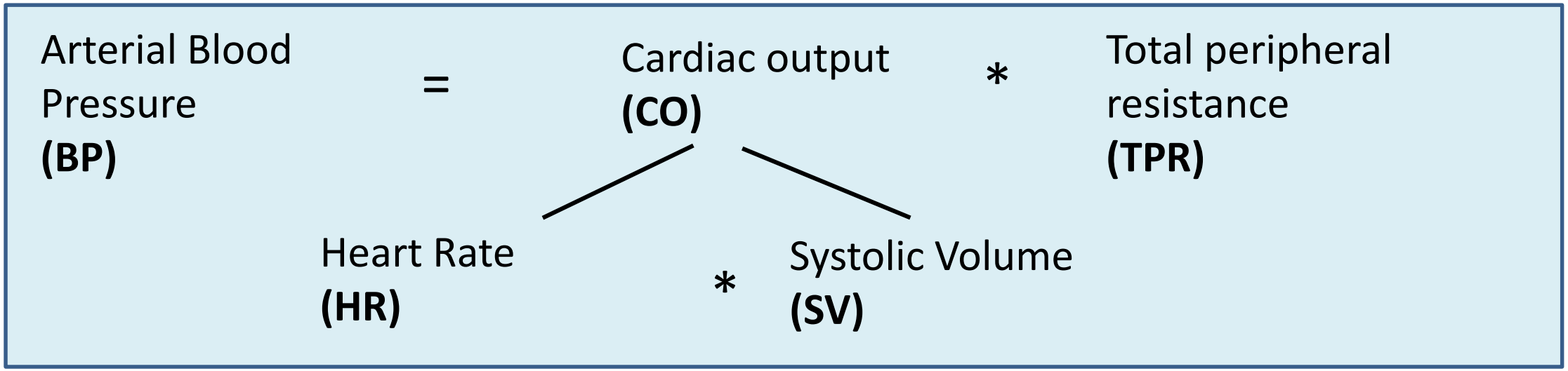
Diastolic BP – the lowest value of BP during cardiac cycle

PBP = SBP – DBP

MBP ≈ DBP + 1/3 PBP



Blood pressure depends on cardiac output and peripheral resistance



- Systolic BP depends mainly on CO
- Diastolic BP depends mainly on TPR

Regulation of blood pressure

- **Short-term** – baroreflex
- **Medium-term** – renin-angiotensin-aldosterone system (RAAS)
- **Long-term** – excretion of Na^+ via kidneys

Regulation of blood pressure – baroreflex

Autonomic nervous system

Sympathetic NS (↑ BP, HR, SV, TPR) **X** ***Parasympathetic NS*** (↓ BP, HR, SV, TPR)

Function: regulation of short-term changes of BP via modulation of HR and TPR

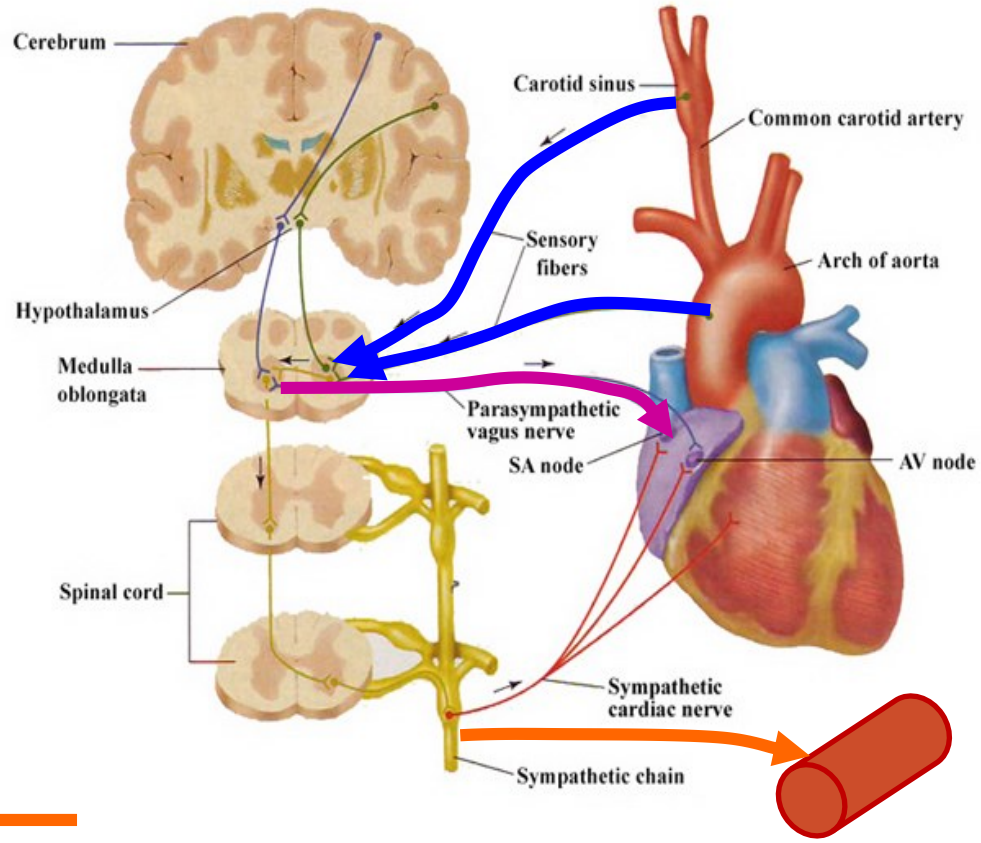
Baroreceptors – carotid sinus + aortic arch
Afferent nerve: vagus nerves, n.XI.

Cardiac branch of baroreflex: Decrease of BP induces increase c
HR and vice versa
Efferent nerve: vagus nerves (to SA node)

Peripheral branch of baroreflex: Decrease of BP induces increase of TPR

- Vasoconstriction of small arteries
- Venoconstriction – redistribution of blood volume

Efferent nerve: sympathetic nerve fibers to peripheral vessels



Changes of BP

Short-term effects

- Amount of blood – affects SV (haemorrhage, dehydration)
- External pressure on arteries – intrathoracic a intraabdominal pressure (coughing, defecation, childbirth, ventilation)
- Body position – orthostatic and clinostatic reaction
- Mental conditions – emotions, stress, …
- Physical activity
- External temperature
- Drugs, alcohol,…

Long-term effects

- Age (lower BP in small children than in elderly people
- Gender (higher BP in men)

Methods of BP measurement

Invasive vs. Non-invasive
Direct vs. Indirect

Palpatory method (tonometer + pulse palpation)

Oscillometric method

Auscultatory method (tonometer + stethoscope)

Other possibilities:

24-hours measurement

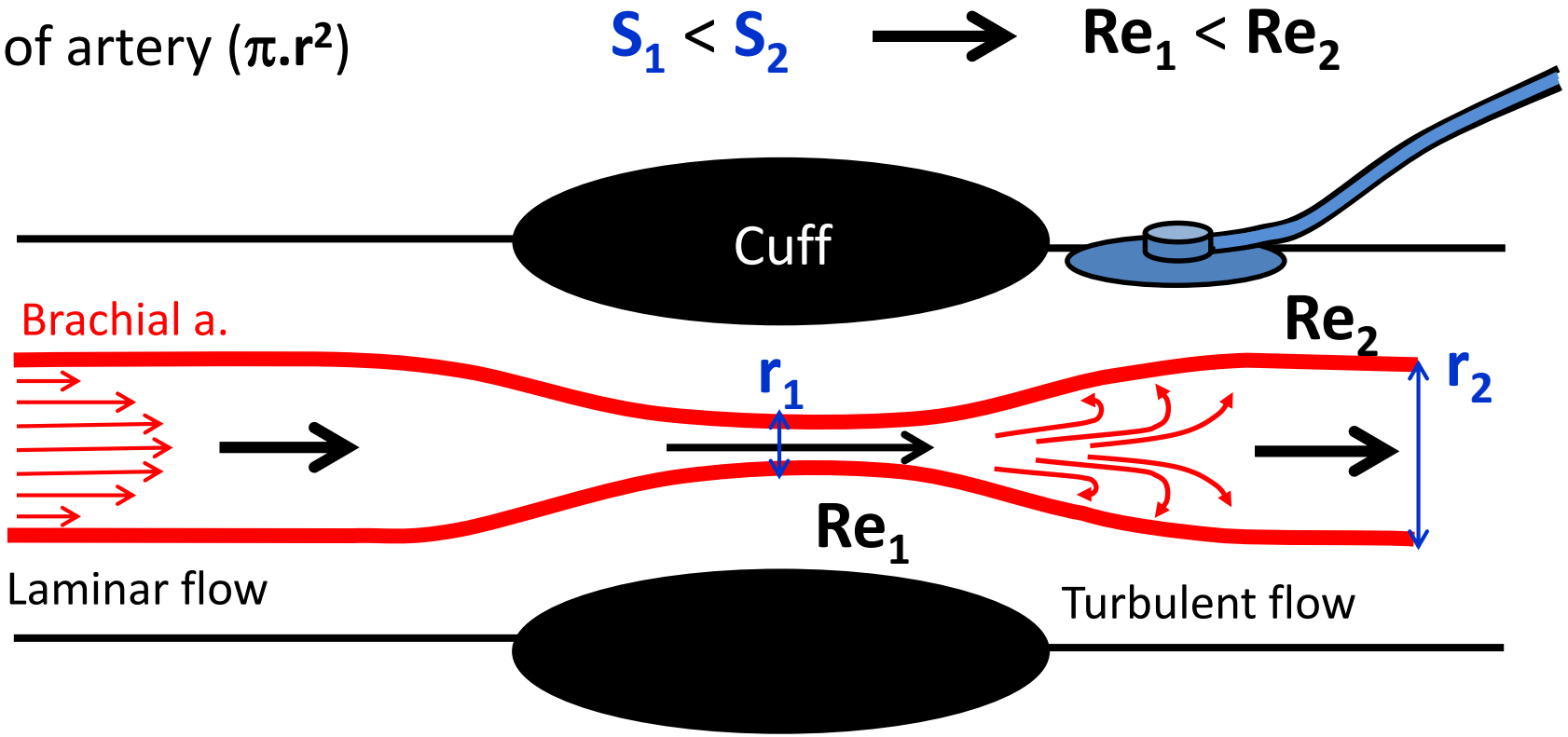
Photopletysmography (volume-clamp method – Prof. Peňáz)

Laminar / turbulent flow, Korotkow sound

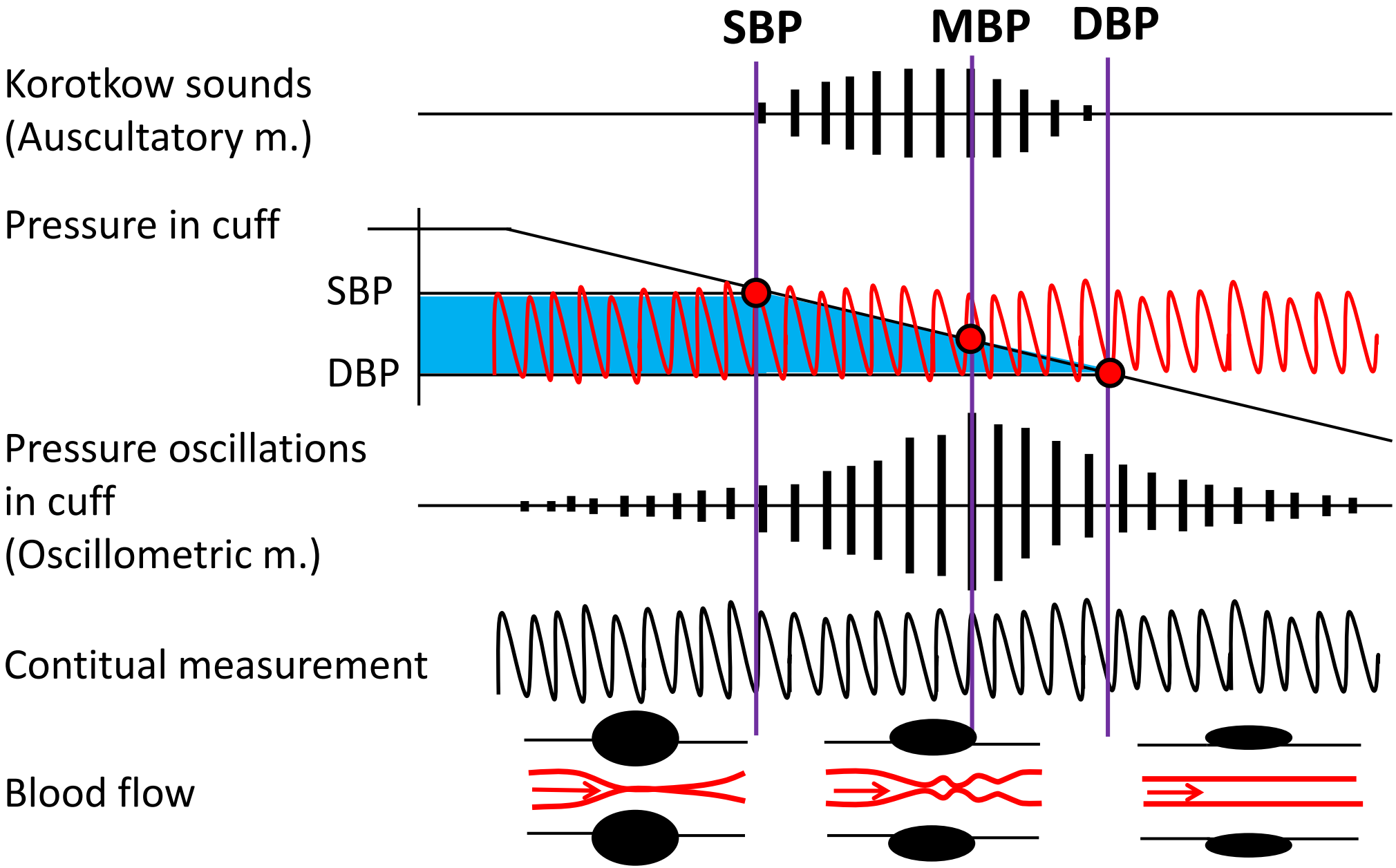
$$Re = \frac{v \cdot S \cdot \rho}{\eta}$$

Laminar flow Re < 2000
Turbulent flow Re > 3000

Reynold´s number Re: probability of turbulent flow
v: velocity of blood flow
S: area of cross-section of artery ($\pi.r^2$)
ρ: density of blood
η: viscosity of blood (increase viscosity in case of anaemia/ erythrocytopenia)

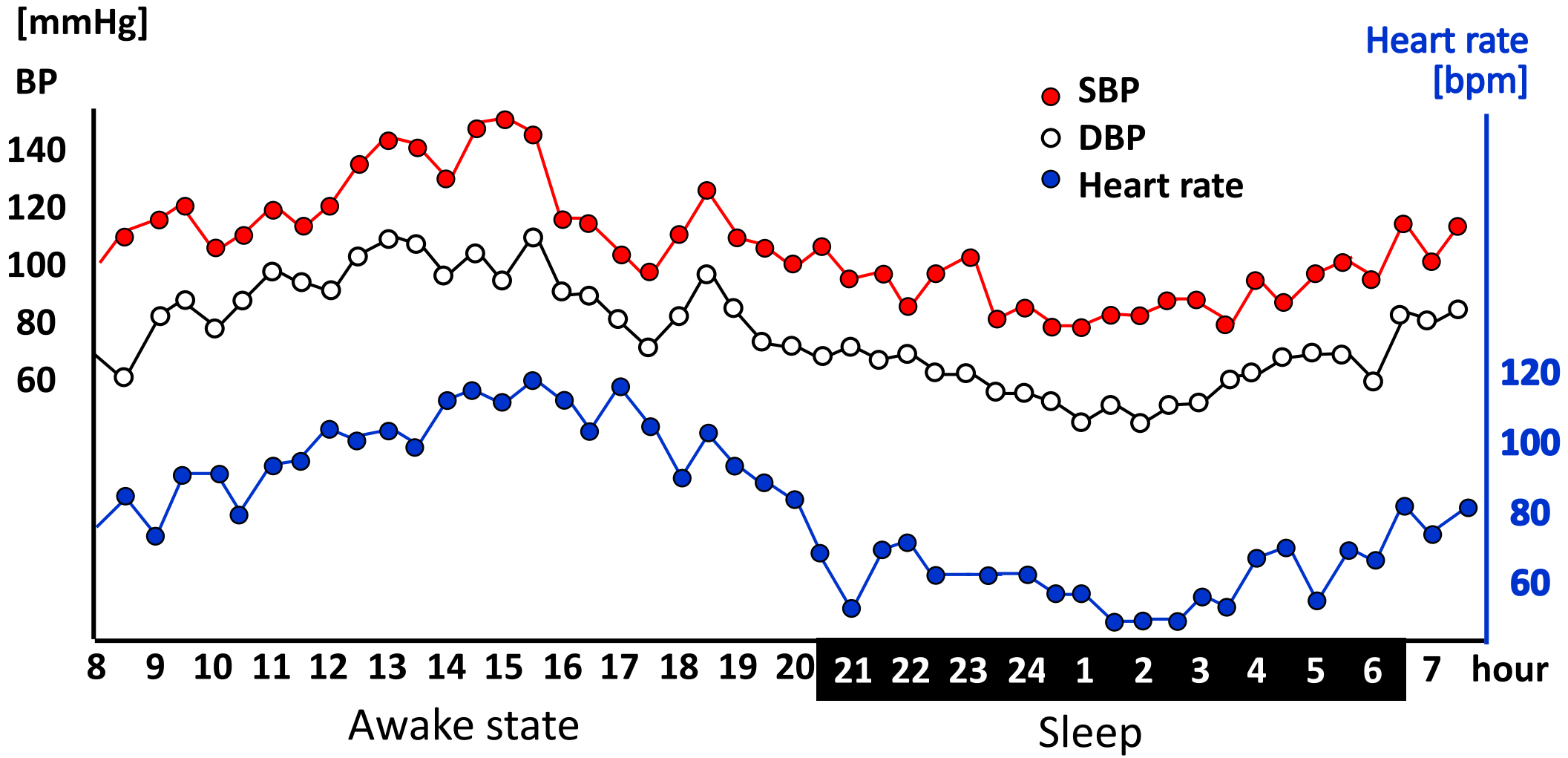


Principle of BP measurement



24-hours monitoring of BP

Decrease of BP (10 - 15%) at night



Rules for BP measurement

- Examined person is sitting for a few minutes before the measurement
- Only validated apparatus must be used
- Perform at least two measurements in the course of 1 – 2 minutes
- Use cuff of standard size (12 – 13 cm width and 35 cm long)
- Smaller or bigger cuffs must be available for patients with smaller or bigger size of arm
- Cuff must be always at the level of heart of examined person
- Pressure in the cuff must be decreased slowly (2 mmHg/s)

Methods	Benefits	Disadvantages	BP value
Auscultatory	• Accurate estimate of SBP/DBP • Simple, No electric supply is required	• Subjective, for accurate measurement practices is required • Accurate cuff is required	SBP + DBP
Oscillometric	• Accurate estimate of MBP • Automatic, fast • Low cost of device, good for measurements at home	• DBP/SBP is calculated • Inaccurate in case of arrhythmias	MBP
24 – hours monitoring	• Monitoring during whole day • Exclusion of white coat hypertension	• Disturbance by cuff inflation (especially at night)	
Photoplethys-mography	• Continual BP record • Analysis of BP variability	• Measurement on finger • Cost of device	Continually

Physiological values of BP, hypertension

	BP	SBP [mmHg]	DBP [mmHg]
Normal	Optimal	<120	<80
	Normal	120 – 129	80 – 84
	Higher normal	130 – 139	85 – 90
Hypertension	1. degree	140 – 159	90 – 99
	2. degree	160 – 179	100 – 109
	3. degree	> 180	> 110

Changes of BP during and after physical activity

- Increased of BP depends on character of physical activity
- Blood is distributed in the body according to metabolic needs – re-distribution during physical activity

- Increased CO → increased SBP
- Vasodilatation in working muscle, vasoconstriction in skin, GIT

→ Stability or light change of DBP during rhythmic work

→ Increase of DBP during and after isometric muscle contraction (e.g. weightlifting)

Vasoconstriction in skin is temporary – vasodilatation in skin due to heat production as a thermoregulatory mechanism

- After the physical activity BP decreases on/slightly under the previous level, blood flow through skeletal muscles may remain increased.
- Time required for recovery depends on parasympathetic activity (it is possible to improve it by training)