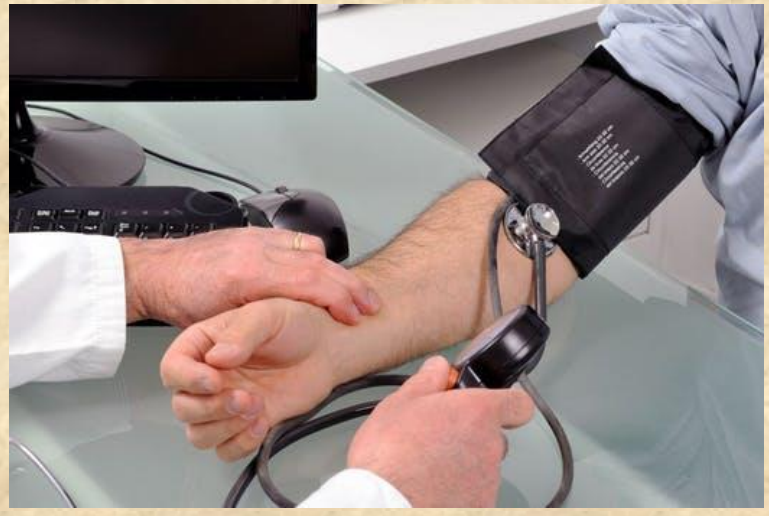
Blood Pressure

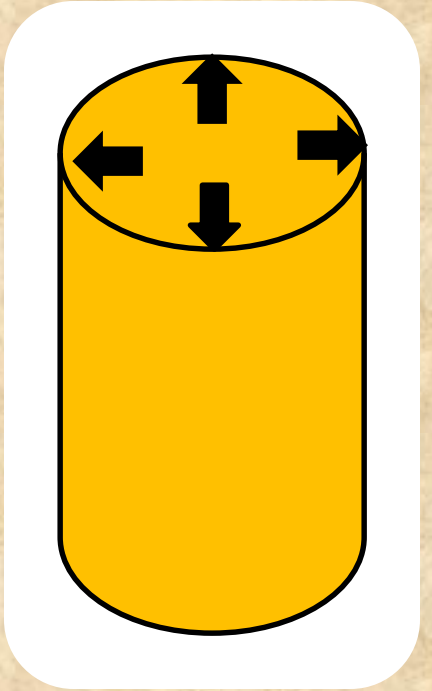


Prof. Deepthi de Silva
Department of Physiology

Definition

- Blood pressure is the pressure exerted on a unit area of the blood vessel

- Usually refers to *arterial blood pressure*



Blood pressure

'Systolic'

- Highest pressure in the aorta
- Occurs during systole of the cardiac cycle
- Usually 120mmHg (SI units 16kPa)

'Diastolic'

- Lowest pressure in he aorta
- Occurs during diastole of the cardiac cycle
- Usually 70mmHg (SI units 9.3kPa)

Determination of blood pressure

Pressure = Flow x Resistance

Blood pressure =
Cardiac output x Total peripheral resistance

BP = CO x TPR

Determination of blood pressure

Cardiac output

= Stroke volume x Heart rate

CO = SV x HR

Mainly determined by the SV

Rise in SV increase mainly systolic BP

Total peripheral resistance

- Determined by the arteriolar tone **($R \propto 1/r^4$)**
- **Constriction increases mainly diastolic BP**
- **Dilatation reduces diastolic BP**

Blood pressure evaluation

- Conveniently written as systolic pressure over diastolic pressure - e.g. 120/70 mmHg

- Usually measured in the *brachial artery* at the level of the right atrium.

Pulse pressure

Pulse pressure (PP)=

Systolic pressure – Diastolic pressure

Around 50mmHg (120-70 = 50 mmHg)

Increases >50mmHg physiologically during aerobic exercise

Abnormalities of the pulse pressure

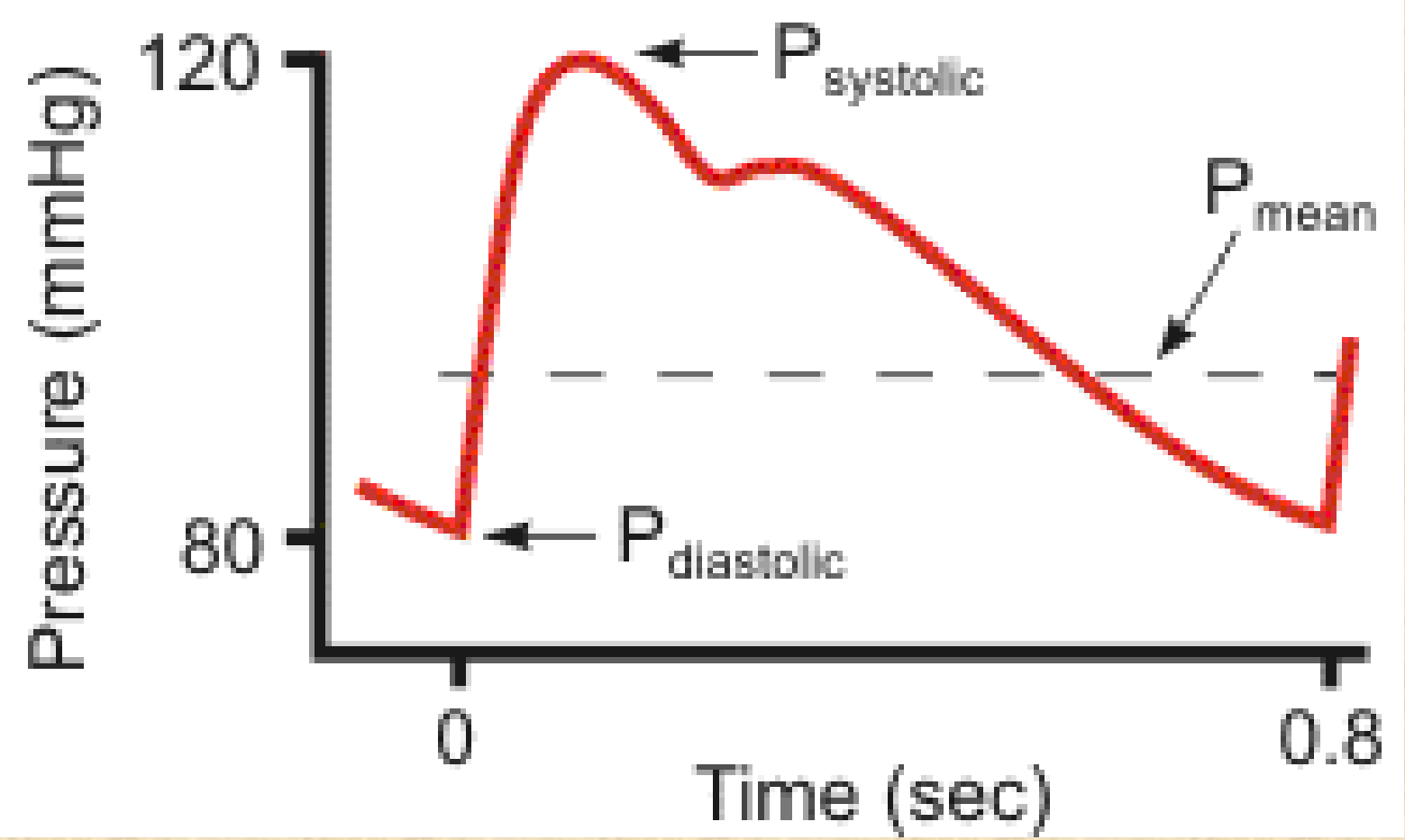
Increase	Decrease
• Arteriosclerosis – hardening of arteries leads to reduced compliance – Rise in systolic and fall in diastolic pressure • Aortic regurgitation	• Aortic stenosis

Mean blood pressure (MBP)

- This is the average pressure during the cardiac output
- Closer to the value of diastole
  - Period of diastole is longer than systole

MBP = Diastolic pressure + 1/3 of pulse pressure

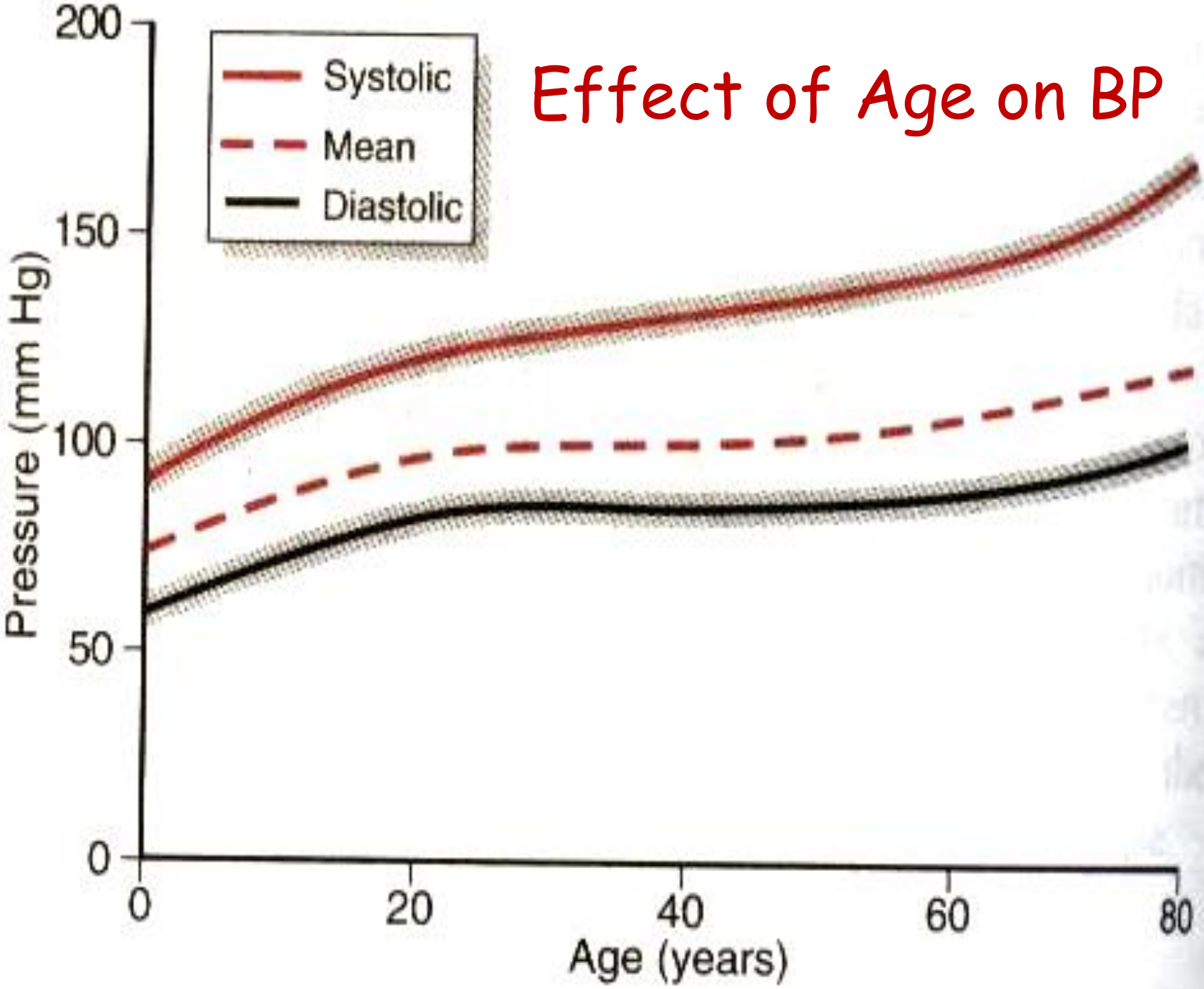
MBP is the main determinant of adequate blood flow through tissues


120
80
Pressure (mmHg)
$P_{systolic}$
P_{mean}
$P_{diastolic}$
0
0.8
Time (sec)

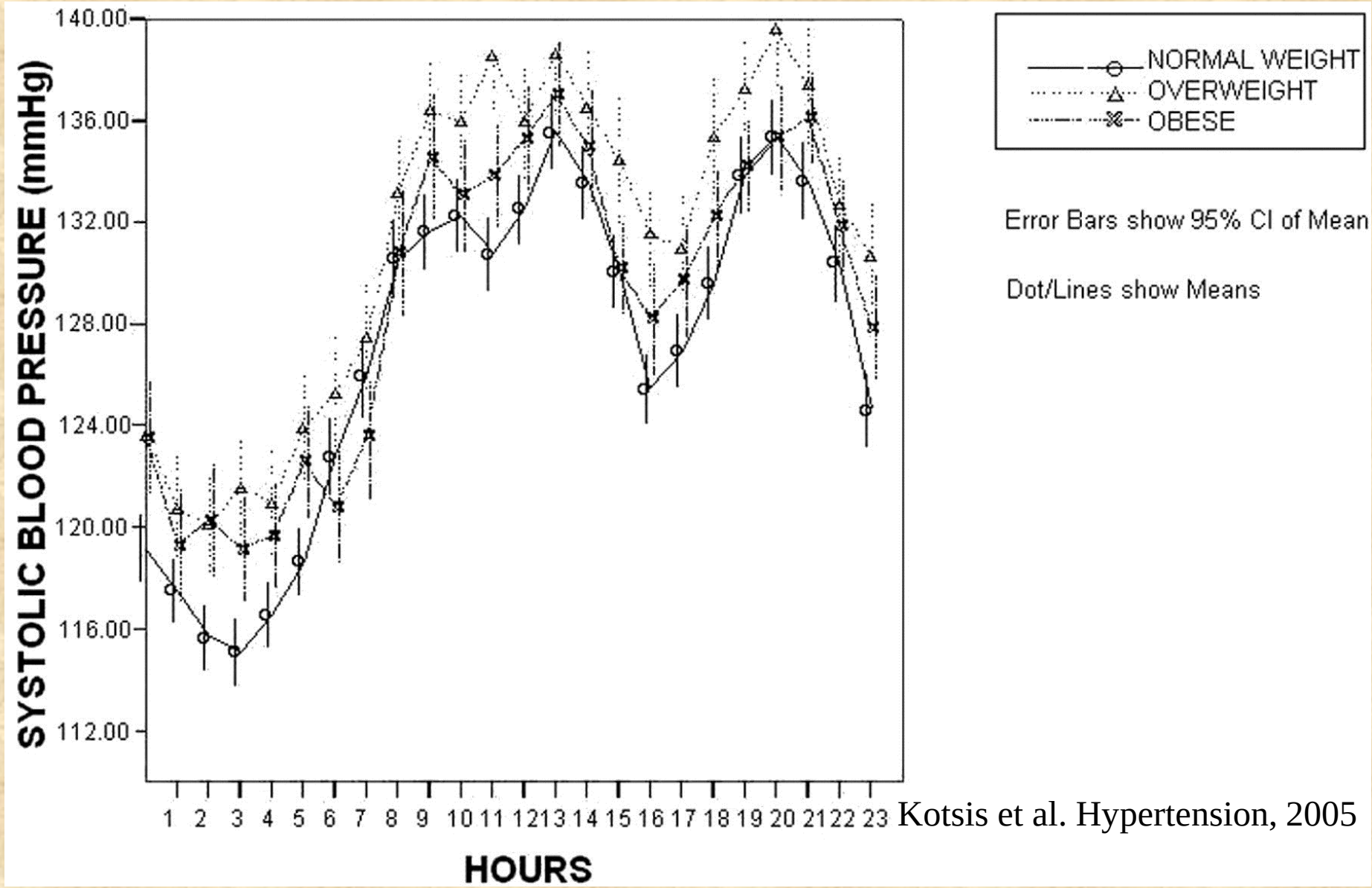
Physiological variations in the blood pressure

Increase BP	Reduce BP
• Age – older people have higher BP • Males • Rise in cardiac output (e.g. Anxiety) • Raised TPR • Arteriosclerosis • 'white coat hypertension'	• Age- children have lower BP than adults • Females • Sleep

Effect of Age on BP



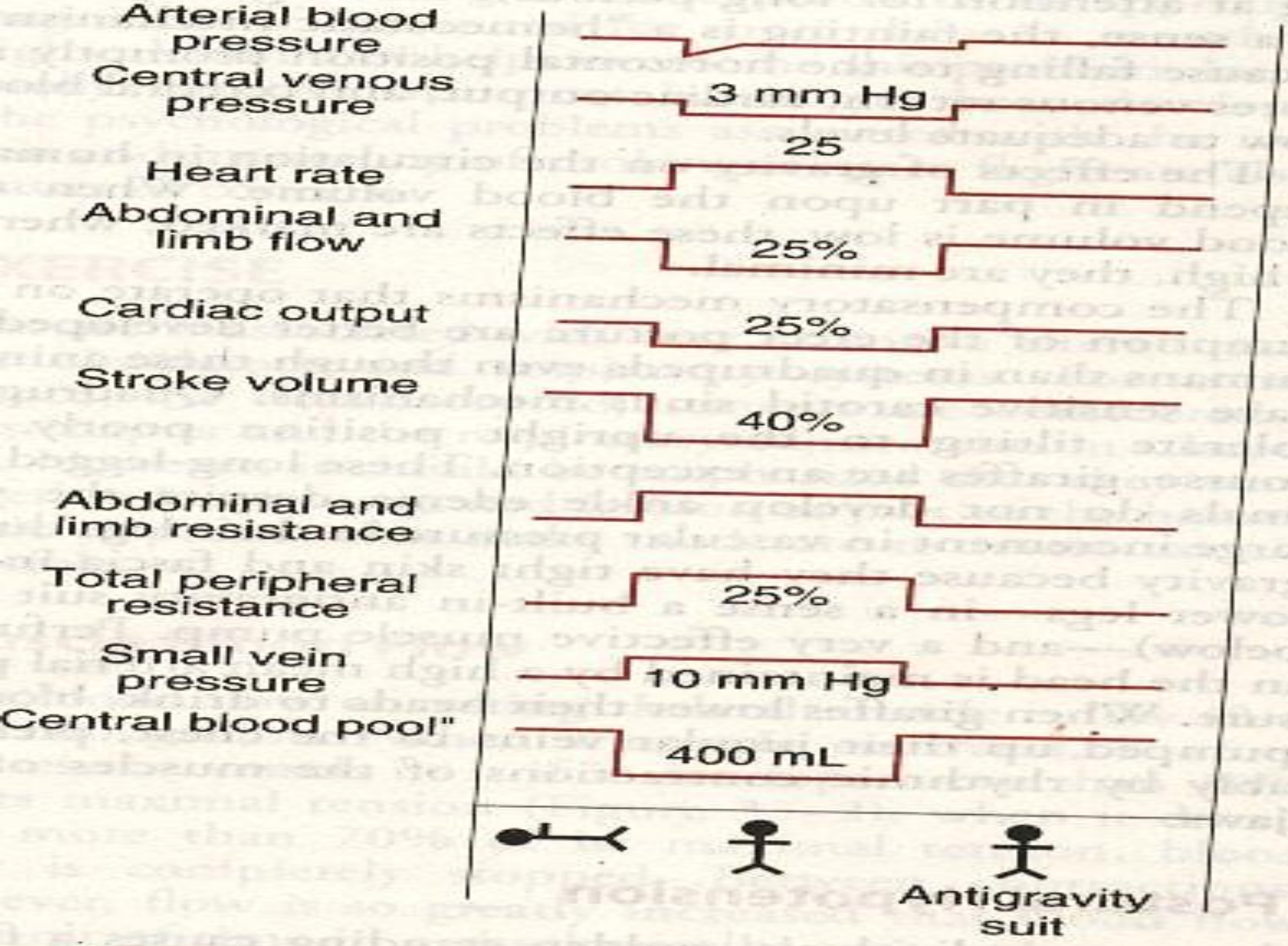
Diurnal Variations in BP



Kotsis et al. Hypertension, 2005

Effects of gravity

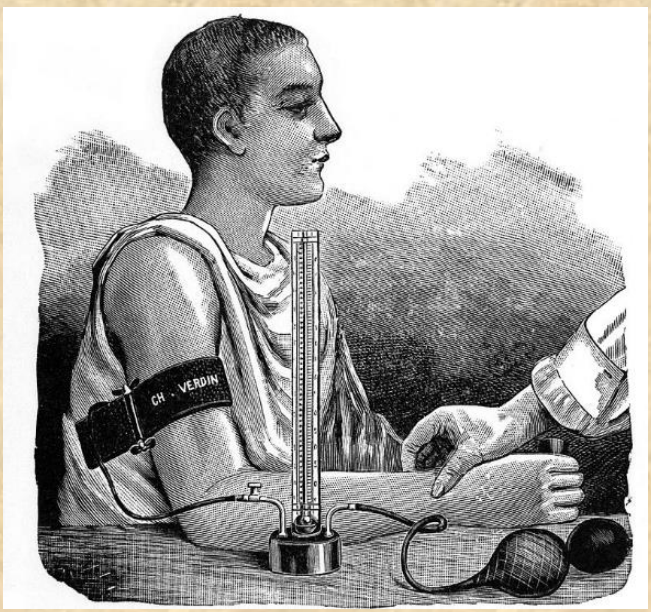
- BP falls above the level of the heart
- BP rises below the level of the heart
- Proportional to the vertical distance from the heart


Arterial blood pressure
Central venous pressure
3 mm Hg
Heart rate
25
Abdominal and limb flow
25%
Cardiac output
25%
Stroke volume
40%
Abdominal and limb resistance
Total peripheral resistance
25%
Small vein pressure
10 mm Hg
Central blood pool"
400 mL
Antigravity suit

Recording blood pressure

- Direct method
  - An artery may be catheterized and connected to a pressure-sensitive device
- Indirect method
  - Sphygmomanometry

Scipione Riva-Rocci
1863-1937



History

- Designed blood pressure cuff
- Never patented it!

Sphygmomanometry

- Position the patient
  - Relaxed & sitting
  - Back and arm supported
  - No tight clothing over arm
- Explain the procedure and seek consent
  - Warn them that there may be slight discomfort

The blood pressure cuff

- Has to be selected correctly
  - large cuff gives a low reading; small cuff - false high reading
- Cover 80% of the arm
- Length : width ratio of 2: 1

Cuff size selection

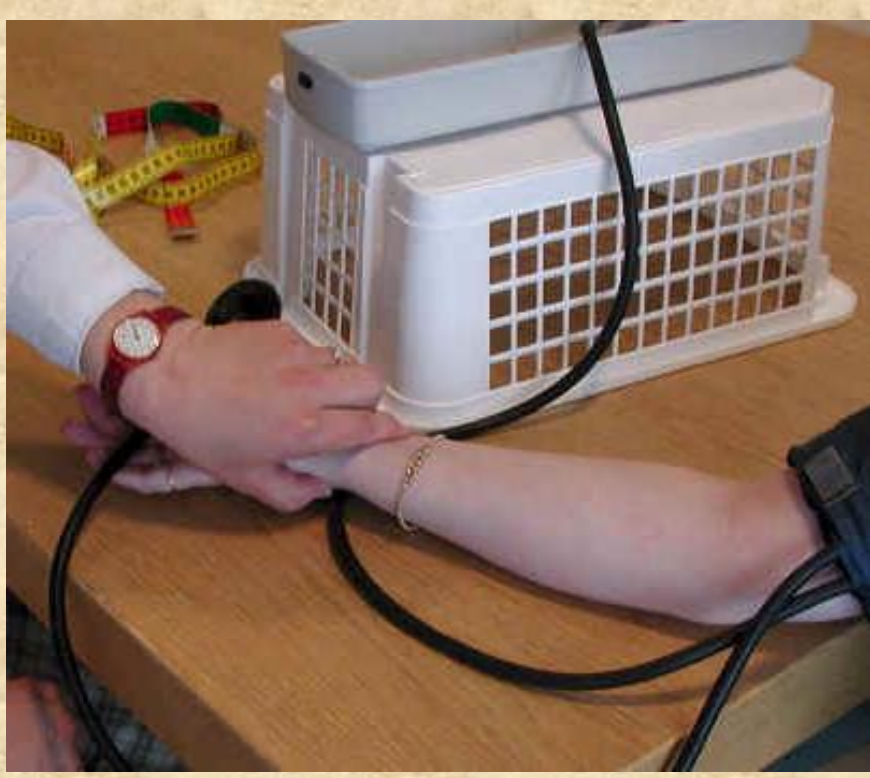
Arm circumference (cm)	Cuff size (cm)	Classification
22 - 26	12x 22	Small adult
27 - 34	16 x 30	Adult
35 - 44	16x 36	Large adult
45 - 52	16 x 42	Adult thigh

Placement of the cuff

- Should be placed with the centre of the bladder above the brachial artery
- The cuff should be 2-3 cm above the pulsation of the brachial artery

Measuring the blood pressure 1 – Palpatory method

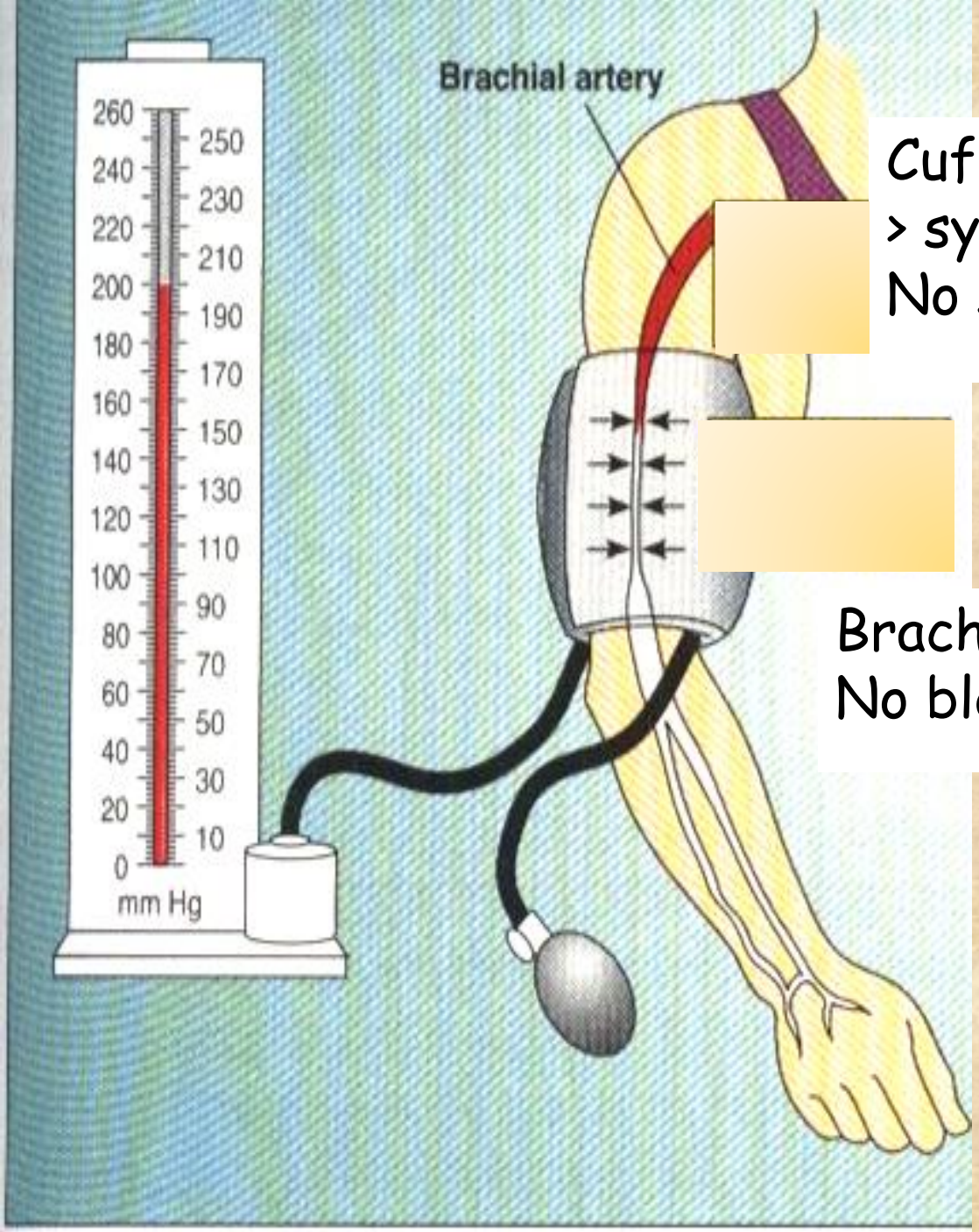
- Palpate radial artery pulsation
- Inflate cuff until pulsation vanishes
- Deflate cuff
- Estimate systolic pressure



Auscultatory measurement

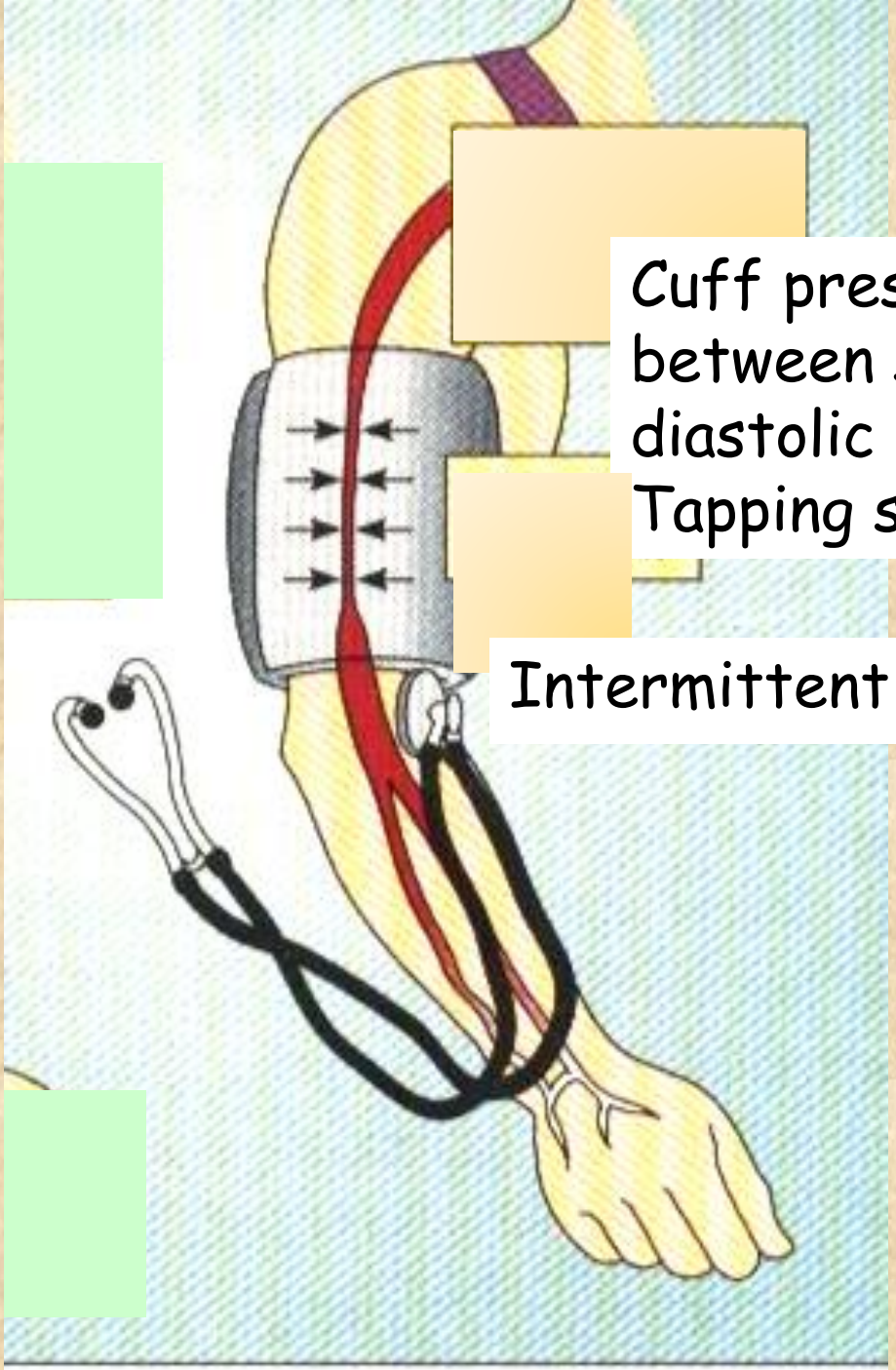
- Place bell of stethoscope over brachial artery
- Inflate cuff to 30 mm Hg above estimated systolic pressure
- Reduce pressure at rate of 2-3 mm Hg per second or per pulse beat

- Take reading of systolic pressure when repetitive, clear tapping sounds appear for two consecutive beats
  - **Korotkoff** Phase 1
- Take reading of diastolic pressure when repetitive sounds disappear (Phase 5)
- Use phase 4 (muffling) for pregnant women and children



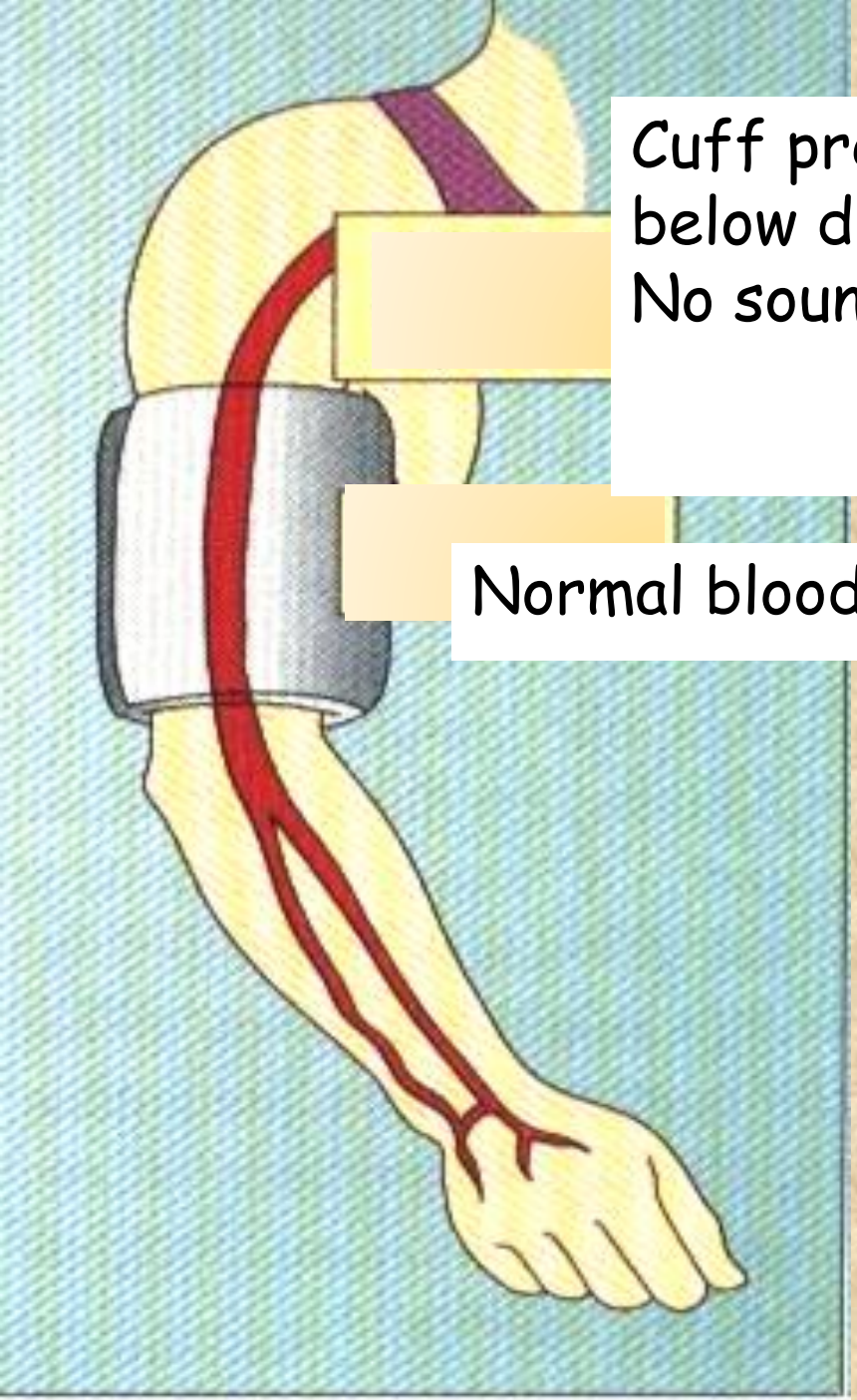
Cuff pressure
> systolic
No sounds

Brachial artery closed
No blood flow



Cuff pressure
between systolic &
diastolic pressure
Tapping sounds

Intermittent blood flow



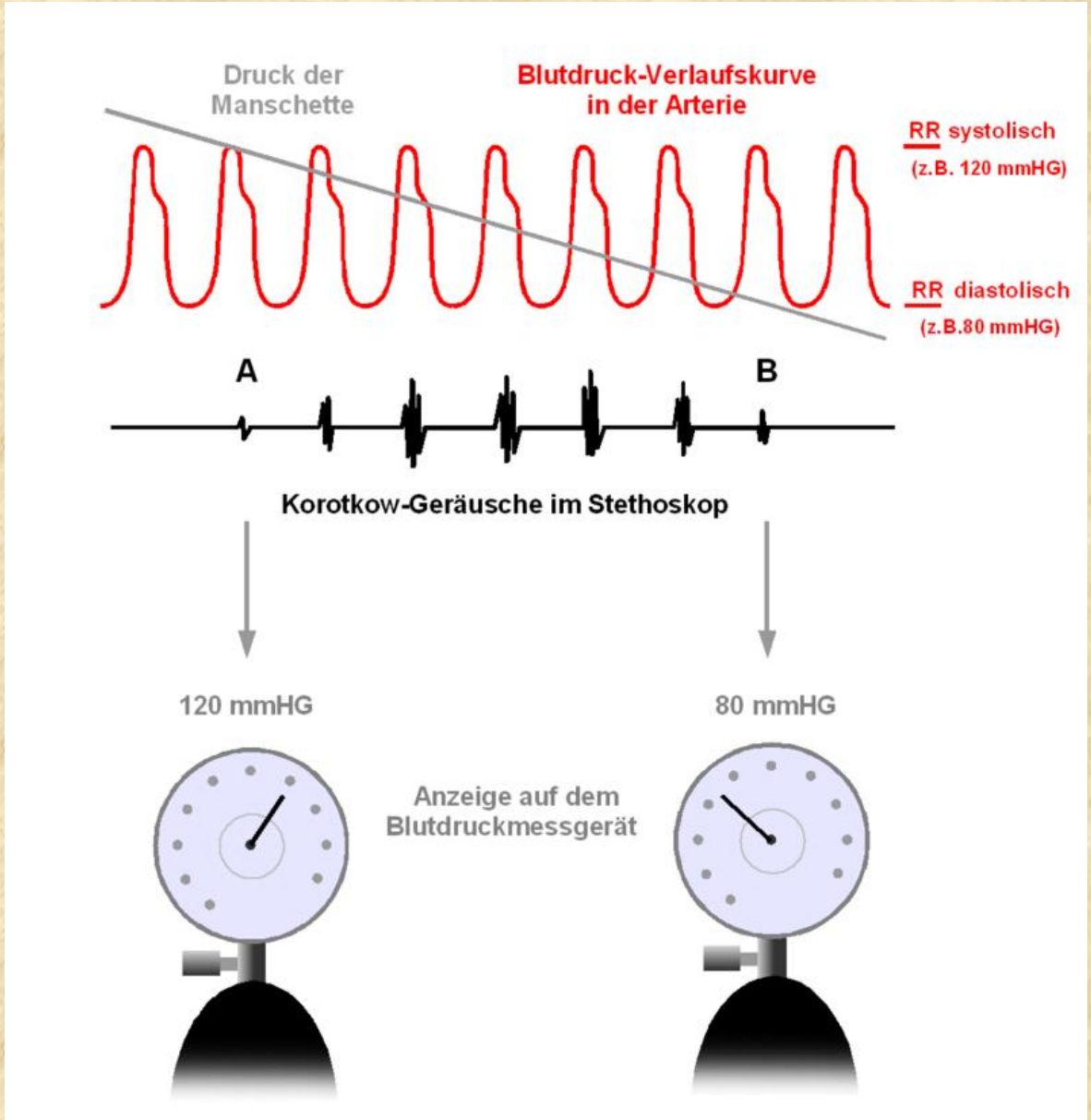
Cuff pressure
below diastolic pressure
No sounds

Normal blood flow

Korotkov Sounds

Nikolai Korotkov
1874- 1920

- Described that sounds were from blood vessel



Hypertension

- The BP rises with age
  - upper limit 150/90
- Mainly idiopathic
- Secondary hypertension
  - Renal diseases
  - Endocrine causes excess of
  - Aldosterone (Conn syndrome)
  - Glucocorticoids (Cushing syndrome)
  - Catecholamine (pheochromocytoma)