The Phyll team

Arterial Blood Pressure

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First of all:

Why right leg is not attached in any one of the standard lead?

It is used for grounding.

Arterial Blood Pressure

It's the pressure exerted by blood against a vessel wall, by the blood contained inside it.

Remember!

Aorta & Artery never empty of blood

Most common place to record blood pressure is from the **brachial artery**

In the past, people used to take pressure from animals, the used cm water to measure blood pressure. Kilopascal is nowadays another unit of blood pressure measurement.

'That's for you - I've been a bit concerned about your blood pressure lately.'

Normal blood pressure

Systolic → 120/80 ←Diastolic

Systolic blood pressure: is the maximum pressure during systolic contraction of the heart, it depends on: stroke volume

Diastolic Blood pressure: Is due to recoil the vessel wall and peripheral resistance.

Why there is a diastolic blood pressure?

Arterioles maximum peripheral resistance

If there is no Diastolic pressure, what will happen?

If there is just systolic pressure, blood will not flow continuously.

Diastolic is important for tissue perfusion (unstop blood supply)

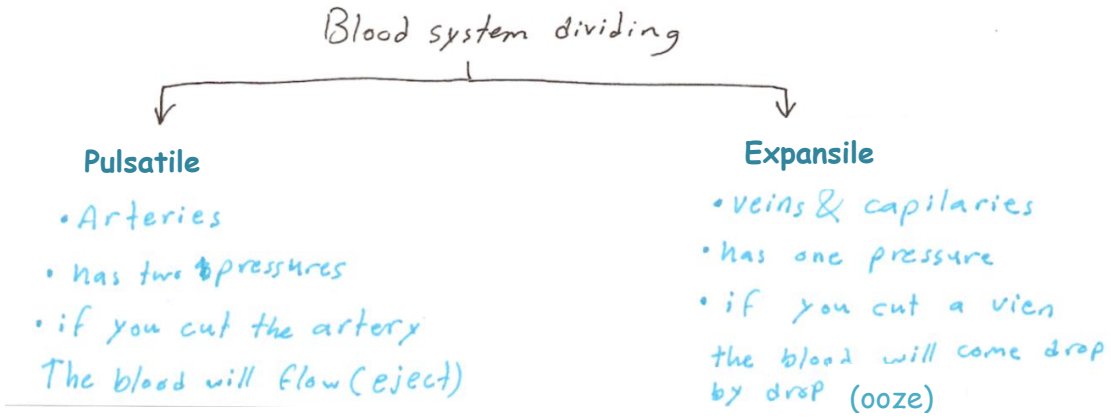
Pulse pressure: is the deference between systolic and diastolic blood pressure

- Pulse pressure reduced and become Zero half way to the arterioles
- The pressure transmitted to arteries during cardiac cycle and is responsible for tissue perfusion.

I can't feel veins pulse, why?

Because there is only one pressure so no pulse pressure

Ventricle pressure during diastolic is ZERO



 Mean arterial blood pressure: responsible for blood perfusion to body tissue

- **Perfusion: continuing of blood supply to the tissue.**

Mean arterial pressure = $\frac{1}{3}$ Pulse pressure + Diastolic pressure

Why we take $\frac{1}{3}$ of blood pressure?

Diastolic timing is longer and systolic is shorter,

If we want to take the average, we should take $\frac{1}{3}$ of pulse pressure.

Mean arterial blood pressure maintains the blood flow to all tissues and organs.

So, if the mean arterial blood pressure decreases, its perfusion will decreases, too

And the tissue will have less blood supply (less Oxygen)

Pressure in the right atrium known as CVP (Central venous pressure)

What are the factors affecting pulse pressure?

- Blood in artery
- Compliance: C = $\frac{\triangle \, Blood \;\; Volume}{\triangle \, Pressure}$ (how much you can stretch?)

↑volume=↑ compliance , vice versa "conversely"

Another way to calculate Mean arterial pressure:

Mean Arterial Pressure =

(Cardiac output x systemic vascular resistance) + central venous pressure

◘Blood pressure is affected by:

Blood volume: When blood volume decrees (hemorrhage), it will cause a Shock due to reduce blood pressure, and that will decrease the blood flow.

Compliance: Vessel's volume change due to a change in the pressure.

Whenever there is high compliance, the blood pressure will be low.

E.g. Aorta has high compliance, so it can handle high blood pressure without much change in blood pressure.

The compliance is decreased in getting old person.

Peripheral resistance in the vessels is maximum in the arterioles.

Why arterioles have Maximum Peripheral Resistance?

- **They have more sympathetic nerve supply which reduces the diameter of the arterioles.**
- **They have more smooth muscle cells (in the unit area , the aorta)**

Elastic tissues are more in the Aorta and become less in the arterioles.

How to measure Blood Pressure?

Blood pressure measured by an instrument known as: Sphygmomanometer

The size of the cuff depends on patient's:

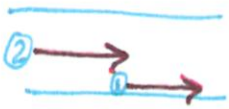
- Age
- Weight

The cuff is kept 3 fingers away from the elbow joint.

When we inflate the cuff it will narrow and close the artery →

When we release the air (deflate), we'll hear sound called "Koratkoff sound" due to turbulent flow.

Why we hear a sound?



① The flow of blood is solw
② Now the flow is faster
} Lamelal flow

When we inflate the cuff , that will narrow the artery
The bloof flow will be circling (high velocity) and that will called , "turbulent flow "

When we release the pressure , the turbolent
Floow will hit the slower blood , and that will called
"Koratokoff sound "

Physiology variation affects the Blood Pressure

❶Age

- Infant have more elastic tissues than older people.
- Whenever you get older, your blood pressure will increase slightly e.g. in normal state, a 20- year- old blood pressure is 120/80 and a 70 –year- old man blood pressure is 140/ 90. It's normal though. That's because of the compliance decreases when becoming older

❷Sex

- Female blood pressure low as compared to male before menopause period. Maybe because of the estrogen hormone.

❸Race

- Colored people are more often to get high blood pressure. More than race it is due to food habit.

❹Stress and emotions

- Stress increases blood pressure because the sympathetic system is stimulated.

❺Pregnancy

- Pregnancy doesn't change blood pressure significantly. During pregnancy the body holds water and salt and keeps it but blood pressure remains unaffected as the extra fluid go to the uterus wall and then there is no increase in the peripheral resistance.

❻Exercise

- blood pressure will increase because of the sympathetic stimulation
- There are 2 types of exercises :
    1. Isotonic : it increases the systolic blood pressure mostly.
    2. Isometric : increases both systolic and diastolic blood pressures.

✱Why patients with heart disease are not allowed to do Isometric exercise?

Because stress on the cardiac pump is increased specially during the diastole.

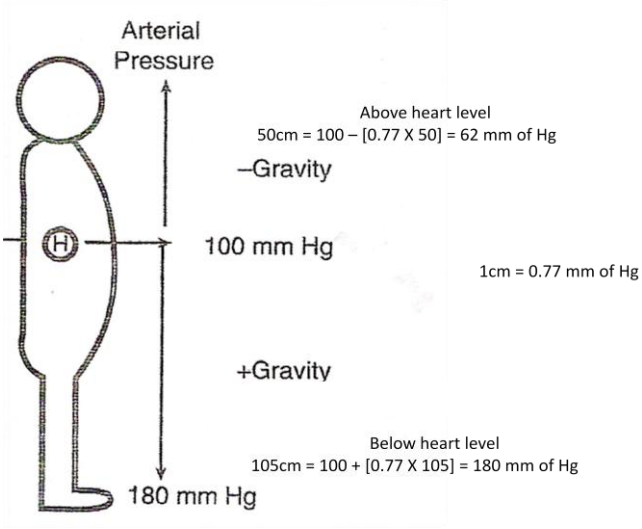
❼Sleeping

- While sleeping , the blood pressure decreases and in the afternoon it will increase.
- Also while sleeping, Nightmares could affect the blood pressure.

❽ Sitting standing position

- If someone stands up, the blood pressure will change because of the gravity.

❾Gravity



❿Respiratory movement

- During inspiration interthoracic pressure become negative , that will suck the blood into the pulmonary vessels =
  ↑pulmonary venous return to right atrium = ↑cardiac output = ↑blood pressure

Factors that determine the arterial blood pressure

Blood pressure = Cardiac output x Total peripheral resistance

- The right ventricle pump 5 L/min.
- The left ventricle pump 5 L/min separately.

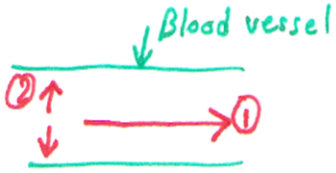
The factors that determine arterial blood pressure are:

Stroke volume

- If stroke volume increases, the systolic blood pressure will increase.

Elasticity

- There are two types of energy :
  A. potential energy
  B. Kinetic energy



①Is Kinetic energy , it's pushing the fluid in a straight line
②Is potential energy , Is stored in the vessel wall and during recoil it is used to push the blood ahead.

Notes :

Elasticity is responsible for pulse

Heart is called **primary pump**

Aorta also called **secondary pump.** Due to elastic recoil blood is pumped ahead.

Resistance (R) :

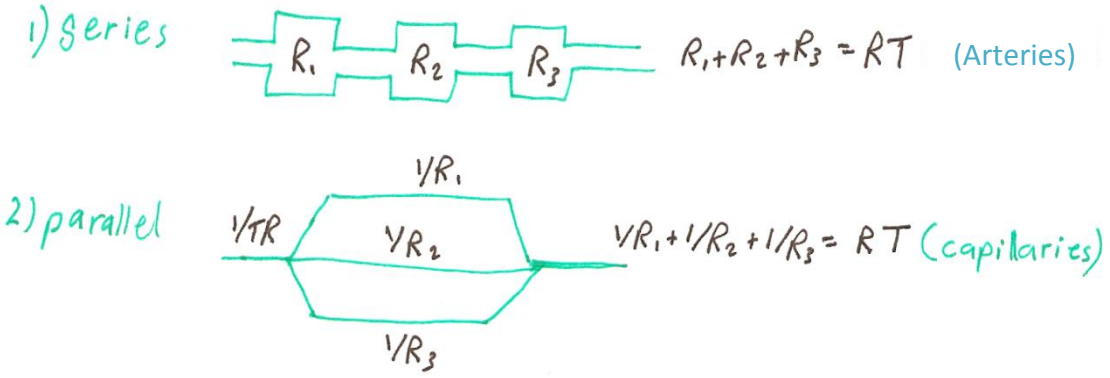
$$R=\frac{\triangle pressure}{\triangle volume}$$

Total Peripheral Resistance TPR =

$$\frac{Mean\ Arterial\ Pressure\ MAP - Mean\ Central\ Venous\ Pressure\ MCVP}{left\ ventricle\ output}$$

Normal right atrium pressure is (0-4 mmHg) , when it reaches 7 mmHg the venous return will stop and hence no cardiac output.

There are 2 types of resistance:



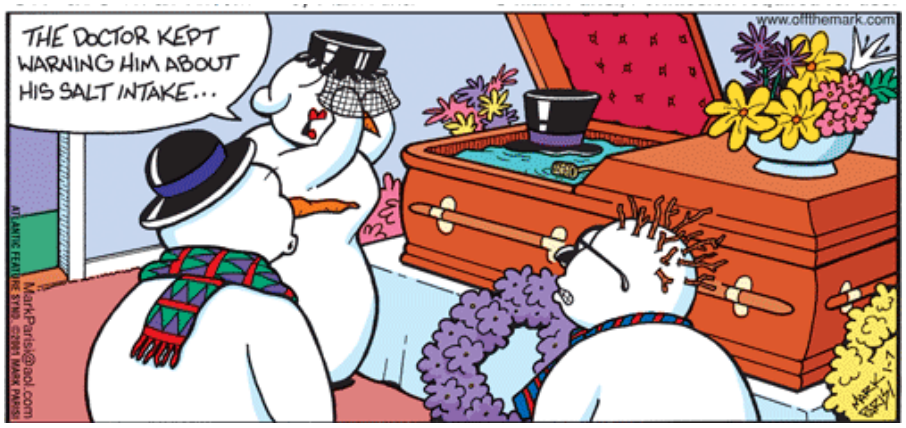
Resistance in series is higher than parallel

Arterioles size is bigger than capillaries, but they have more resistance than capillaries,

WHY ?

Because arterioles are supplied by sympathetic and they go for long distance

but capillaries' resistance are parallel and length is small.



Peripheral resistance depends on

POISEUILLE's law

$$R = \frac{8\,\mu}{\pi\, r^4}$$

μ = viscosity

What's viscosity?

It's the force directed by distance (displacement)

Factors affect viscosity:

❶Number of red blood cells RBC :

- Polycythemia (↑ RBC) has high viscosity
- Anemia (↓ RBC) has low viscosity and it causes : turbulence

❷Plasma protein :

- High plasma protein means high viscosity.
- Plasma viscosity is 1.8 times as water.
- Whole blood is 3-4 times as water in viscosity.

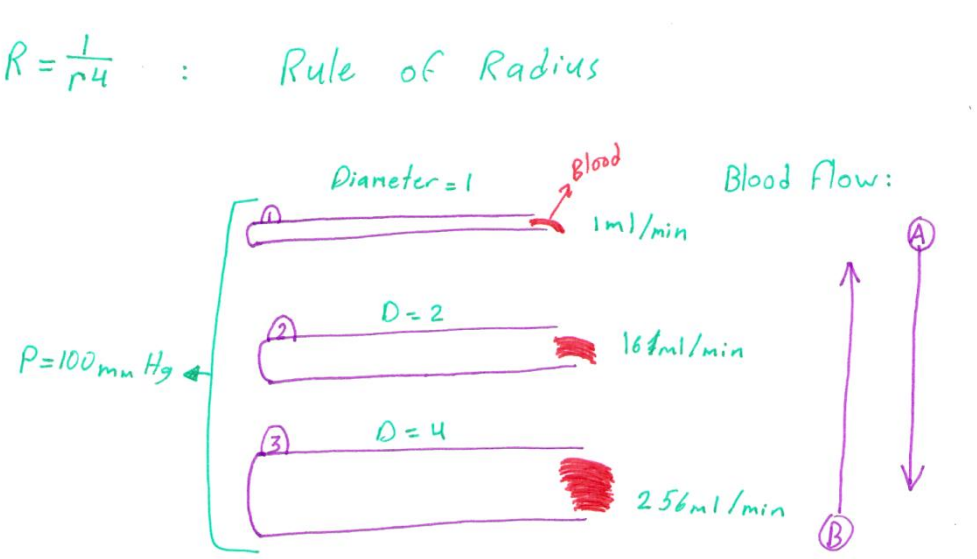
❸Temperature :

- Cooling increases viscosity
- Hypothermia viscosity is increased by 40 %

❹ diameter :

- large vessels has more RBC , and more viscosity
- Smaller vessels has less RBC and less viscosity

$$R = \frac{8\,\mu}{\pi\ r^4}$$



Vessel ① has a diameter of 1 , blood flow of 1 ml/min , how we get the (1 ml/ min) is by

$$\frac{1}{\mathbf{r^4}} = \frac{1}{\mathbf{1^4}} = 1\ ml/min$$

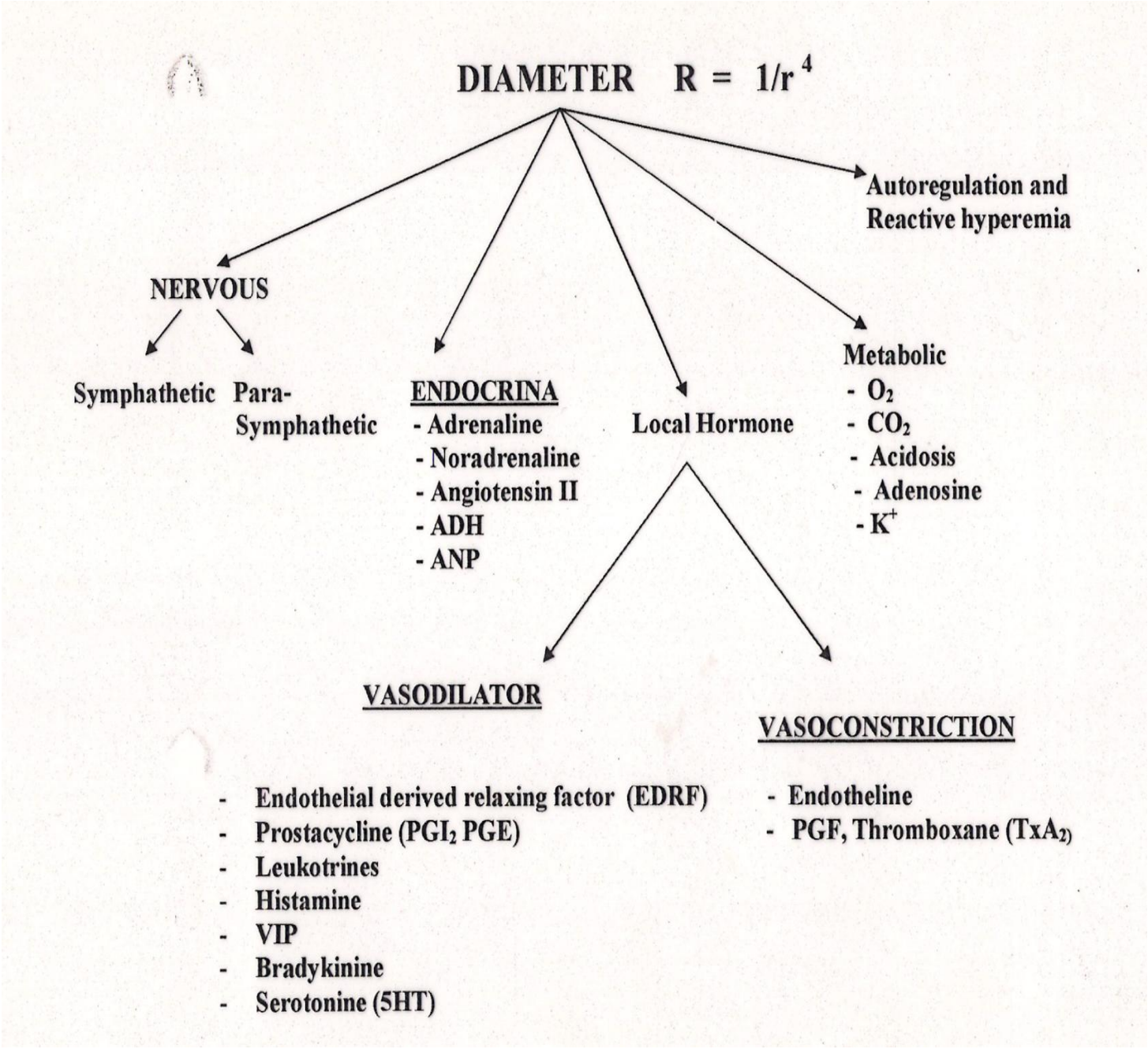
Vessel ② has a diameter of 2 , so blood flow is $\frac{1}{\mathbf{2^4}} = 16\ ml/min$

Vessel ③ has diameter of 4 , blood flow = $\frac{1}{\mathbf{4^4}} = 256\ ml/min$

As we go down (arrow **A**) , the diameter will increase and so the blood flow will increase, and that will mean the resistance will decrease

It's logic : more flow , less resistance

When we start from down (arrow **B**) , the blood flow will decrease, same as the diameter, and the resistance will increase


DIAMETER R = 1/r 4
Autoregulation and Reactive hyperemia
NERVOUS
Symphathetic
Para-Symphathetic
ENDOCRINA
- Adrenaline
- Noradrenaline
- Angiotensin II
- ADH
- ANP
Local Hormone
Metabolic
- O2
- CO2
- Acidosis
- Adenosine
- K+
VASODILATOR
- Endothelial derived relaxing factor (EDRF)
- Prostacycline (PGI2 PGE)
- Leukotrines
- Histamine
- VIP
- Bradykinine
- Serotonine (5HT)
VASOCONSTRICTION
- Endotheline
- PGF, Thromboxane (TxA2)

That's all :)