B.7.2. Hypertension

Definition: A too high pressure in the arteries of the systemic circulation.

A. What is hypertension?

1. Hypertension is, unfortunately, a very **common** disease. In industrialized countries (= western style), about 20% of the population suffer from this disease.	2. By definition, hypertension is present when the systolic pressure is higher than 160 mmHg and/or the diastolic pressure higher than 100 mmHg.
3. The start of hypertension is insidious (= silent / secret / stealthy) as it initially causes no symptoms.	4. But in the long run, it is very dangerous as it causes wear and tear of many organs such as heart, blood vessels, kidneys, brains etc.

B. What causes hypertension?

1. Remember that the blood pressure is determined by a) the heart and b) the peripheral resistance.	2. If the heart pumps too much, either by increasing the frequency or increasing the stroke volume (or both), then the blood pressure will increase. This is called **hyperdynamic hypertension**.
3. Or, the peripheral resistance (which is caused by the resistance of all the blood vessels together) can be too high, for example by vasoconstriction of the blood vessels. This is called **resistance hypertension**.	4. It is important to note that a **brief** increase in blood pressure is NOT hypertension. For example, during exercise, it is necessary to increase the blood pressure to get more blood to the exercising muscles.
5. But if the blood pressure is too high all the time (chronically), then this is hypertension.	6. Therefore, when making a diagnosis of hypertension, it is important to measure the blood pressure **several times**, on different days, to be sure that a patient suffers from hypertension.

C. Hyperdynamic Hypertension:

1. This can be caused by an increase in: a) the heart rate b) the extracellular volume c) the sympathetic nervous system d) responsiveness to catecholamines	2. An increase in **heart rate** will increase cardiac output and this will increase the blood pressure.

3. An increase in **extracellular volume** will increase venous blood, which increases the venous return to the heart, which increases the diastolic filling, stretching of the ventricles (Frank-Starling mechanism), and increase the cardiac output.	4. Increase in **sympathetic activity** will increase heart rate, stroke volume, vasoconstriction of the vessels (arteries & veins), and thus increase blood pressure.
5. Increase **sensitivity to catecholamine's** can be caused by an increase in cortisol (from the adrenal cortex) and/or an increase in the thyroid hormones (T3, T4) in the case of hyperthyroidism.	

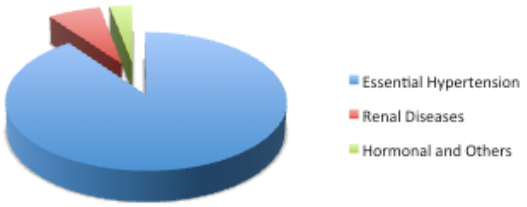
D. Resistance Hypertension:

1. Resistance hypertension is mainly caused by: a) vasoconstriction of the peripheral blood vessels b) an increase in blood viscosity	2. **Vasoconstriction** can be due to: a) increased sympathetic activity (either induced by increased nervous activity or by an increased adrenal medullary activity), b) increased sensitivity to catecholamine's (cortisol or thyroid hormones) or c) an increase in Angiotensin II (renin-angiotensin-aldosterone system)

E. Additional auto-regulatory damage:

1. An important point in hypertension is the damage that is caused by the **chronic** exposure to high blood pressure.	2. For example, because the heart is pumping more and against a higher pressure (after-load!), **hypertrophy** of the left ventricle will occur.
3. If this condition last too long, then the left ventricle will suffer (coronary arteries), possibly leading to **cardiac failure**.	4. Or, the pressure in the left atrium may increase, and then that of the pulmonary veins -> damage to the pulmonary system.
5. Furthermore, several organs, such as the kidneys, will "protect" themselves from this continuous high pressure by vaso-constricting the blood vessels to those organs.	6. As this is a chronic situation, **hypertrophy** of the muscles in the blood vessels will occur which will "fixate" the high peripheral resistance.

F. Mechanisms of Hypertension:

1. In contrast to all this knowledge, the reason why somebody develops hypertension are less well known.	2. In fact, in 90% of the patients, there is no detectable cause for their hypertension. This type is called **Primary** or **Essential Hypertension**.
	3. There are of course many theories why these patients develop hypertension. 4. Genetics? Indeed, women are slightly more affected than males.
5. Stress? Managers, pilots, personality ("frustrated fighter type"), salt-sensitive patient, sensitivity to catecholamine's are all possibilities but not yet proven or clarified.	6. In 10% of the patients, those that suffer from **Secondary Hypertension**, the cause of hypertension is due a definite disease (which makes it potentially treatable): a) 7% renal diseases b) 3% hormonal and other causes
7. **Renal diseases:** Many diseases of the kidney may induce renal ischaemia, which in turn induces the release of **renin** into the blood stream. This in turn will activate angiotensinogen into angiotensin I which leads to an increase in angiotensin II (in the lungs by ACE). This will constrict the blood vessels and increase the blood pressure.	**8. Hormonal diseases:** a) **Adrenogenital syndrome**: the formation of cortisol in the adrenal cortex is blocked, leading to an increase in ACTH (=adrenocorticotrophic hormone) which leads to an increase in mineral corticoid precursors, leading to retention of Na+, decrease in diuresis, increase in extracellular volume and hence hypertension.
8 b) Primary hyperaldosteronism: A tumour in the adrenal cortex releases unregulated amounts of aldosterone, leading to Na+ retention and increase in extracellular volume.	**8 c) Cushing's syndrome:** Inadequate ACTH release (neurogenic or tumour in the hypophyses) or a tumour in the adrenal cortex increase glucocorticoid in the plasma. This increases the catecholamine effect (increased cardiac output) and mineral corticoid effect (increased Na+ retention).
8 d) Pheochromocytoma: A tumour in the adrenal medulla produces uncontrolled catecholamine's, which increases epinephrine and norepinephrine, thereby inducing both **hyperdynamic** and	**9. Neurogenic Hypertension:** Overstimulation of the sympathetic system due to a disease in the brain such as a haemorrhage, brain tumour, cerebral oedema, encephalitis etc.

resistance hypertension.	

G. Other factors involved in Hypertension:

1. **Environmental factors:** a) obesity b) alcohol c) salt intake d) stress e) drugs (oral contraceptives etc)	2. **Foetal factors.** A low birth weight is often correlated with hypertension later in life.
3. **Diabetes**. Insulin resistance > metabolic syndrome > Hypertension	4. **Pregnancy**. Normally, cardiac output (CO) increases while peripheral resistance (PR) decreases, so blood pressure stays normal
5. But sometimes, hypertension develops with possibility of developing pre-eclampsia.	6. **Pre-eclampsia** is hypertension during pregnancy with proteinuria (loss of proteins in the urine). This can lead to **eclampsia**: convulsions, cerebral oedema, clotting abnormalities, foetal death, maternal death.

H. Long term complications of Hypertension:

Many! And serious complications:

a) peripheral vascular diseases (check the eye!-> blood vessels in the retina)
b) renal failure
c) stroke
d) cardiac death due to coronary events and/or cardiac failure.