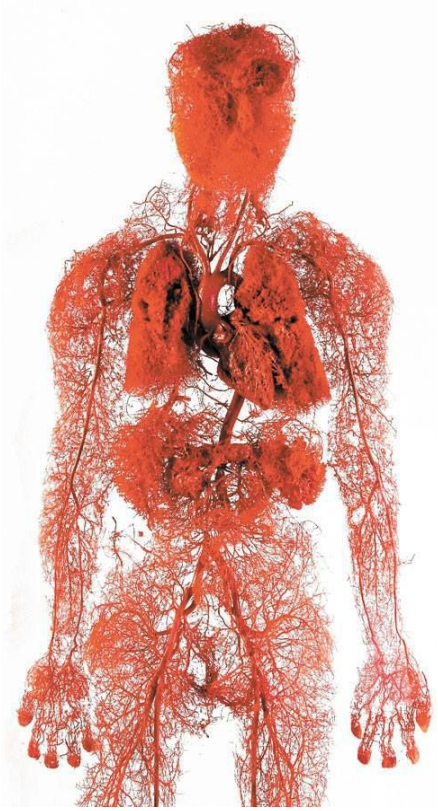
Hypertension

ROBBINS PAGE 332



Objectives:

- Know the aetiology, risk factors and complications of hypertension, so as to be able to identify patient risk factors amenable to treatment by lifestyle modification, and to investigate patients appropriately for causes of secondary hypertension.
- Raised systemic blood pressure is a major cause of morbidity and mortality.
- Hypertension can cause or contribute to: atherosclerosis, left ventricular hypertrophy, chronic renal failure, cerebrovascular disease and retinopathy.
- Normal values for blood pressure.
- Causes of secondary hypertension.
- Genetic and environmental factors contributing to the aetiology of essential hypertension.
- Pathology of blood vessels (blood vessels changes) in both primary and secondary hypertension.

Important note: During the previous blocks, we noticed some mistakes just before the exam and we didn't have the time to edit the files. To make sure that all students are aware of any changes, please check out this link before viewing the file to know if there are any additions or changes. The same link will be used for all of our work: Pathology Edit

Regulation of Blood Pressure (BP). ROBBINS PAGE 330 & 331

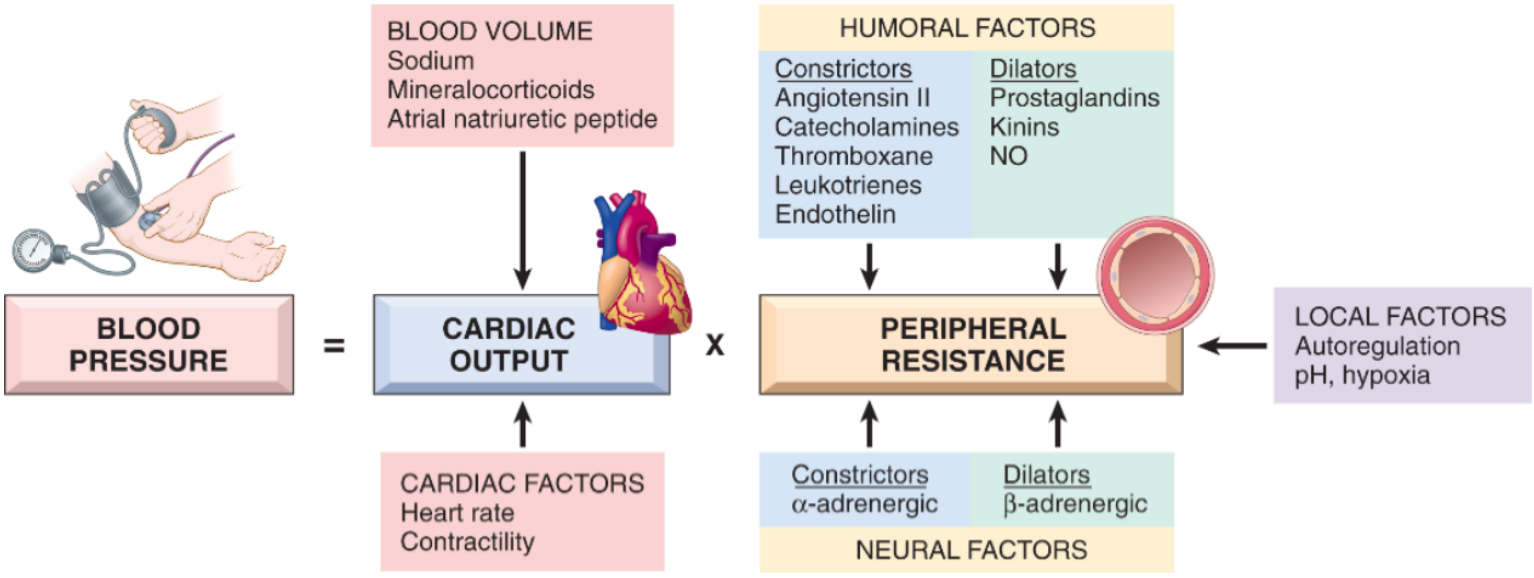
Hormonal regulation of BP: Part 1, Part 2.

What's Blood Pressure? Blood pressure is a measurement of the force against the walls of your arteries as your heart pumps blood through your body.

What are the risk factors of the change in blood pressure?
Low blood pressure (*hypotension*) results in inadequate organ perfusion, organ dysfunction, and sometimes tissue death. High blood pressure (*hypertension*) causes vessel and end-organ damage and is one of the major risk factors for atherosclerosis

There are two major factors that regulates BP (influenced by multiple genetic, environmental, and demographic factors)**:**

- **Cardiac output** = HR x SV.
  - HR is regulated by autonomic nervous system.
  - SV is regulated by sodium hemostasis and its affect on blood volume.
- **Peripheral resistance.** Regulated mostly at the level of the arterioles by hormonal (Renin, Angiotensin, ADH, Aldosterone) and neural input.



BP = Cardiac Output x Peripheral Resistance

- Reduced renal sodium excretion in the presence of normal arterial pressure is probably a key initiating event; it is a final common pathway for the pathogenesis of most forms of hypertension.

What happens when blood pressure is elevated?

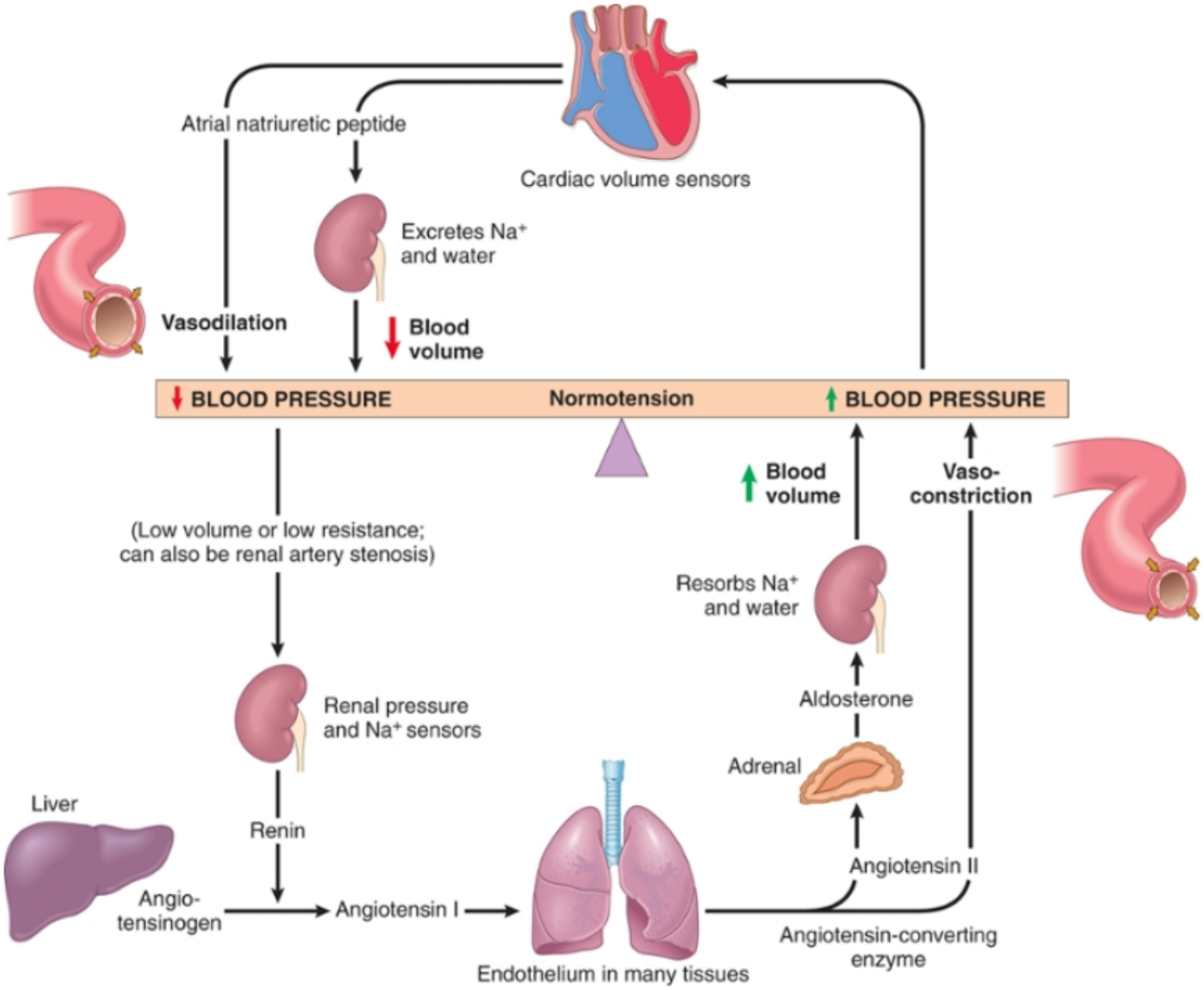
Atrial natriuretic peptide (ANP) (Cardionatrine, Cardiodilatine, Atriopeptin) is a powerful vasodilator, and a protein hormone secreted by muscle cells in the upper chambers of the heart (atrial myocytes) in response to high blood volume. ANP acts to reduce the water, sodium and adipose loads on the circulatory system, thereby reducing blood pressure.

What happens when blood pressure is low?

Renin-angiotensin-aldosterone system (RAAS) has a major role in elevating the blood pressure.

↓ **GFR** (glomerular filtration rate) → Renin secretion by **JGA** (Juxtaglomerular Apparatus):

1. **Aldosterone** (secreted by the *zona glomerulosa*)**:** Stimulated water retention.
2. **Angiotensin II:** Vasoconstriction → ↑ peripheral resistance.



Hypertension. ROBBINS PAGE 332.

Hypertension.

Hypertension (HTN): is usually consider when there is a sustained diastolic pressure greater than 90 mm Hg OR a sustained systolic pressure in excess of 140 mm Hg (**>140/90**).
It is a common problem (25% of population). HTN is much more often asymptomatic for many years until complications appear, so it's called Silent Killer.
Without appropriate treatment, some 50% of hypertensive patients die of ischemic heart disease (IHD), congestive heart failure or to stroke.

Risk factors for Hypertension (Pathogenesis). ROBBINS PAGE 333

- **Hereditary, Genetics, Age, Stress, Heavy alcohol consumption, Diabetes, Use of oral contraceptives [1].**
- **family** history High blood pressure tends to run in families.
- **Race,** higher in African Americans.
- **Gender,** Men & postmenopausal women.
- **Obesity,** The more you weigh the more blood you need to supply oxygen and nutrients to your tissues. As the volume of blood circulated through your blood vessels increases, so does the pressure on your artery walls.
- **Diet**, Too much sodium in diet can cause the body to *retain fluid, which increases blood pressure.*
- **Sedentary or inactive lifestyle,** People who are inactive tend to have higher heart rates.

Classification (based on etiology) ROBBINS PAGE 333

I. Primary/Essential Hypertension (90-95%).

Accounts for (90-95%) of population. Although It's Idiopathic, it appears that both altered *renal sodium handling* and *increased vascular resistance* contribute to essential hypertension.

Pathogenesis of primary (Essential) Hypertension:

1. **Reduced renal sodium excretion** in the presence of normal arterial pressure probably is a key pathogenic feature; indeed, this is a common etiologic factor in most forms of hypertension.
2. **Increased sympathetic response.**
3. **Defect in cell membrane function:**
    - Na/Ca transport, the amount of Na in ECF determines the volume of ECF, which in turn determines plasma volume, blood volume and blood pressure.
    - Increased vasoconstrictive response, the muscles could be more sensitive to vasoconstriction, which increase total peripheral resistance.
4. **Genetic factors:** polymorphisms of the renin-angiotensin system.
5. **Environmental factors:** stress, obesity, smoking, physical inactivity, and high levels of salt consumption, modify the impact of genetic determinants.

[1] موانع حمل.

II. Secondary Hypertension (5-10%).

Causes of Secondary Hypertension: Most of them are due to primary renal disease, renal artery narrowing **(renovascular hypertension),** or adrenal disorders.

Polycystic kidney.

A common complication of **polycystic kidney** disease is **high blood pressure**. It has been suggested that cyst expansion, leading to focal areas of renal ischemia and enhanced renin release.

Table 9–2 Types and Causes of Hypertension (Systolic and Diastolic)

Essential Hypertension
Accounts for 90% to 95% of all cases
Secondary Hypertension
Renal
Acute glomerulonephritis
Chronic renal disease
Polycystic disease
Renal artery stenosis
Renal vasculitis
Renin-producing tumors
Endocrine
Adrenocortical hyperfunction (Cushing syndrome, primary aldosteronism, congenital adrenal hyperplasia, licorice ingestion)
Exogenous hormones (glucocorticoids, estrogen [including pregnancy-induced and oral contraceptives], sympathomimetics and tyramine-containing foods, monoamine oxidase inhibitors)
Pheochromocytoma
Acromegaly
Hypothyroidism (myxedema)
Hyperthyroidism (thyrotoxicosis)
Pregnancy-induced (pre-eclampsia)
Cardiovascular
Coarctation of aorta
Polyarteritis nodosa
Increased intravascular volume
Increased cardiac output
Rigidity of the aorta
Neurologic
Psychogenic
Increased intracranial pressure
Sleep apnea
Acute stress, including surgery

Several relatively rare single-gene disorders cause hypertension (and hypotension) by affecting renal sodium reabsorption. Such disorders include:

- **Gene defects in enzymes involved in aldosterone metabolism:** leading to increased aldosterone secretion, increased salt and water resorption, and plasma volume expansion.
- **Mutations in proteins that affect sodium resorption,** as in ***Liddle syndrome***.

Liddle's syndrome is an autosomal dominant disorder characterized by early, and frequently severe, hypertension associated with low plasma renin activity, metabolic alkalosis, hypokalemia, and normal to low levels of aldosterone.

Hypertension classification based on clinical features. ROBBINS 333 & 332

Benign hypertension	Malignant hypertension
-	diastolic pressures over 120 mm Hg OR Systolic pressures over 200 mm Hg
Account for 95 percent of the caseses	Account for 5 percent of cases
It can be essential (idiopathic) HTN or secondary HTN	
Mild to Modest level.	There is rapidly rising BP which often leads to end organ damage.
Fairly stable over years to decades. (usually asymptomatic)	It can complicate any type of HTN (i.e. essential or secondary)
- Compatible with long life. - Cause end organ damage by damaging the arterioles. - Late manifestations include left ventricular hypertrophy and CHF - Major risk factor MI and chronic renal failure	● Widespread arterial necrosis and thrombosis ● Rapid development of renal failure ● Retinal hemorrhage and exudate, with/without papilledema. ● Hypertensive encephalopathy ● Left ventricular failure ● Leads to death in 1 or 2 years if untreated.

Other Complications:

- Atherosclerotic coronary heart disease.
- Cerebrovascular accidents (stroke).
- Cardiac hypertrophy.
- Congestive heart failure.
- Aortic dissection.
- Multi-infarct dementia.

Morphology. ROBBINS PAGE 333 & 334

Hypertension not only accelerates atherogenesis but also causes degenerative changes in the walls of large and medium-sized arteries that can lead to aortic dissection and cerebrovascular hemorrhage.
Two forms of small blood vessel disease are hypertension-related are **hyaline arteriolosclerosis** and **hyperplastic arteriolosclerosis**

- **Hyaline arteriolosclerosis:**

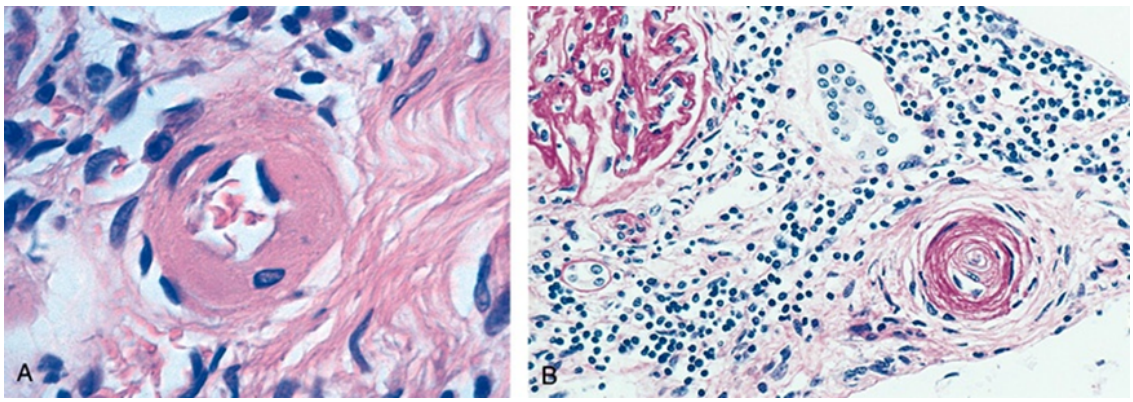
It is associated with **benign hypertension** and it can also seen in elderly without hypertension and in diabetic patients.
In the kidneys, the arteriolar narrowing caused by hyaline arteriosclerosis leads to **nephrosclerosis** (glomerular scarring).

- **Hyperplastic arteriolosclerosis:**

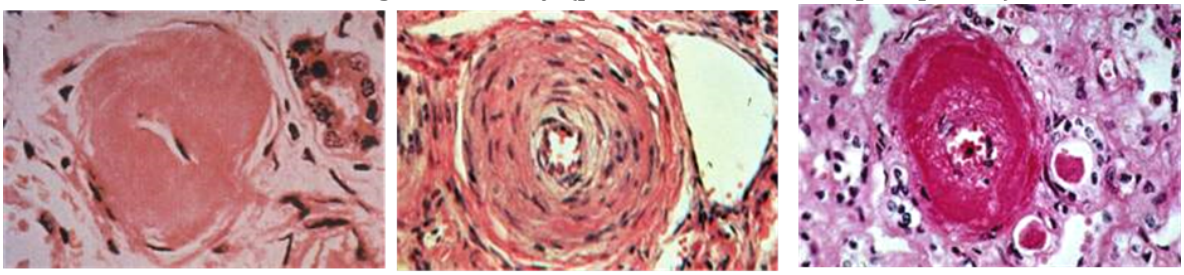
It is associated with **malignant hypertension** and these changes that occurs are accompanied by **fibrinoid deposits** and **vessel wall necrosis (necrotizing arteriolitis).** It is more typical of severe hypertension.

VASCULAR PATHOLOGY IN HYPERTENSION.

A. Hyaline arteriolosclerosis: It is marked by hyalinosis with pink hyaline thickening of the arteriolar walls, and loss of underlying structural detail, and luminal narrowing.



B. Hyperplastic arteriolosclerosis: Vessels exhibit "**onionskin**" concentric, laminated thickening of arteriolar walls and luminal narrowing detected by (periodic acid–Schiff [PAS] stain).



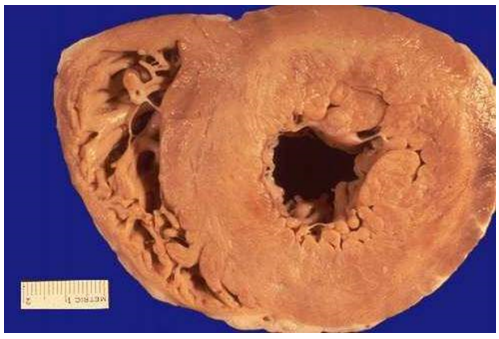
Hyaline/ Benign hypertension

Hyperplastic/ Malignant hypertension

Hyperplastic/ Malignant hypertension

LEFT VENTRICULAR CARDIAC HYPERTROPHY (LEFT SIDED HYPERTENSIVE CARDIOMYOPATHY, HYPERTENSIVE HEART DISEASE).

Hypertrophy of the heart (especially left side) is an adaptive response to pressure overload due to HTN.
The free LV wall is > 2 cm and the weight of the heart is > 500 grams. In time, the increased thickness of the left ventricular wall impairs diastolic filling. This often induces left atrial enlargement.



Complications, organ damage in Hypertension.

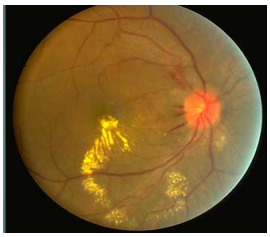
Cardiovascular.

- Left ventricular cardiac hypertrophy (left sided hypertensive cardiomyopathy/ hypertensive heart disease)
- Coronary heart disease
- Aortic dissection
- Heart Failure
- Hardening and thickening of the arteries (atherosclerosis), which can lead to a heart attack, stroke or other complications.

Kidney.

- Benign nephrosclerosis (photo on left)
- Renal failure in untreated or in malignant hypertension
- Weakened and narrowed blood vessels in your kidneys.

Eyes.

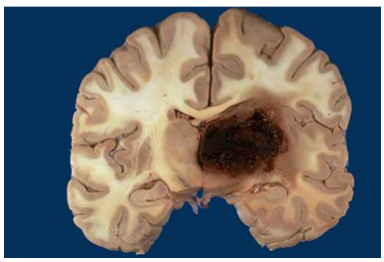


- Hypertensive retinopathy is especially seen in malignant hypertension.
- Thickened, narrowed or torn blood vessels in the eyes.This can result in vision loss.

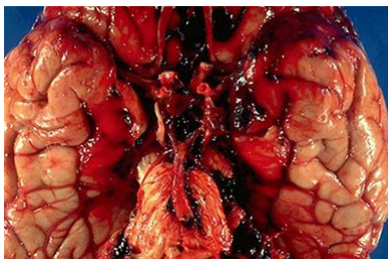
Brain.

- Haemorrhage, infarction leading to Cerebrovascular accidents
- **Trouble with memory or understanding.** Uncontrolled high blood pressure may also affect your ability to think, remember and learn.

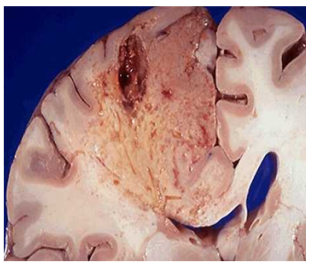
CEREBRAL HEMORRHAGE



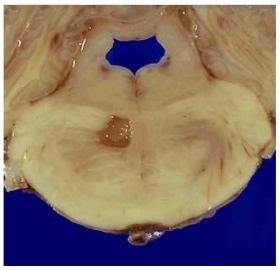
SUBARACHNOID HEMORRHAGE



CEREBRAL INFARCTION



LACUNAR INFARCT



Summary.

SUMMARY

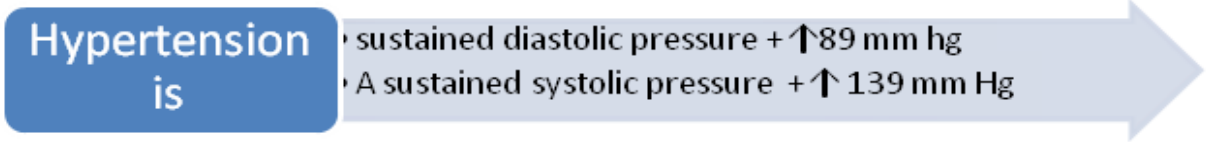
Blood Pressure Regulation

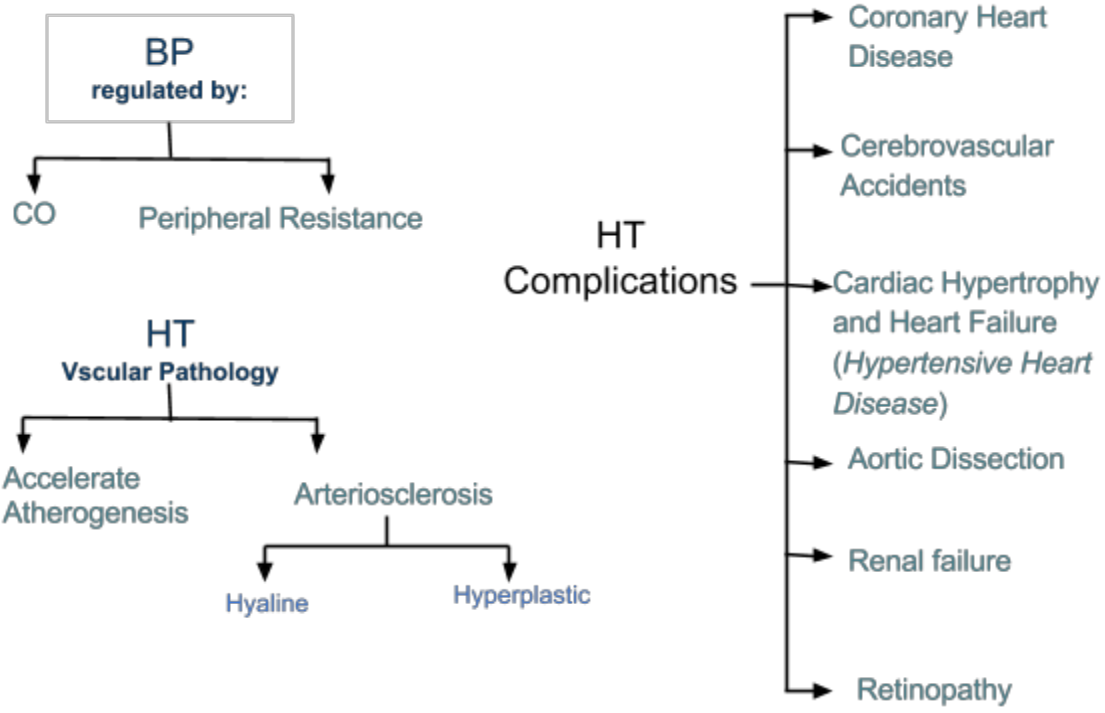
- Blood pressure is determined by vascular resistance and cardiac output.
- Vascular resistance is regulated at the level of the arterioles, influenced by neural and hormonal inputs.
- Cardiac output is determined by heart rate and stroke volume, which is strongly influenced by blood volume. Blood volume in turn is regulated mainly by renal sodium excretion or resorption.
- Renin, a major regulator of blood pressure, is secreted by the kidneys in response to decreased blood pressure in afferent arterioles. In turn, renin cleaves angiotensinogen to angiotensin I; subsequent peripheral catabolism produces angiotensin II, which regulates blood pressure by increasing vascular smooth muscle cell tone and by increasing adrenal aldosterone secretion and, consequently, renal sodium resorption.

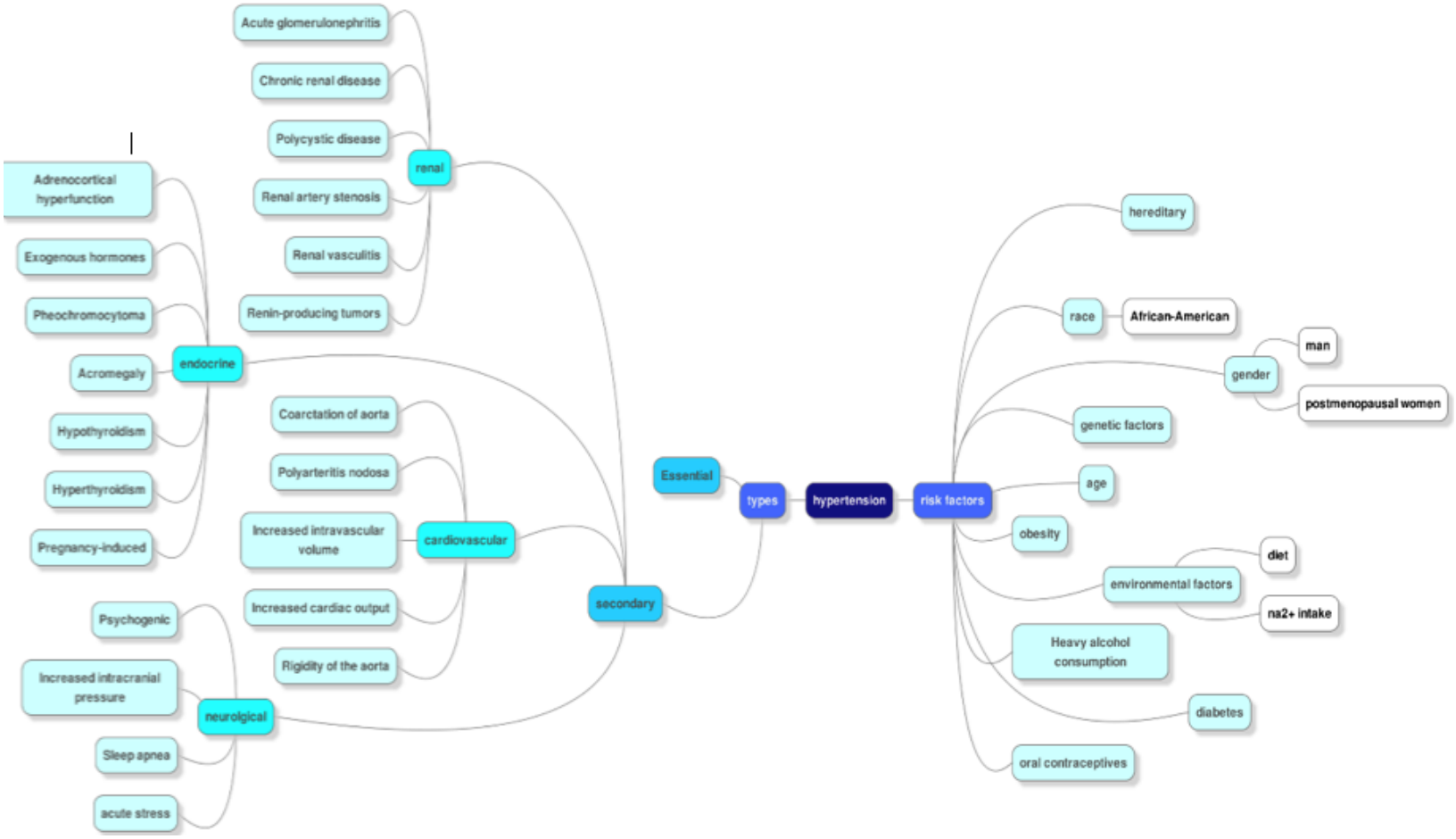
SUMMARY

Hypertension

- Hypertension is a common disorder affecting 25% of the population; it is a major risk factor for atherosclerosis, congestive heart failure, and renal failure.
- Essential hypertension represents 95% of cases and is a complex, multifactorial disorder, involving both environmental influences and genetic polymorphisms that may influence sodium resorption, aldosterone pathways, and the renin–angiotensin system.
- Hypertension occasionally is caused by single-gene disorders or is secondary to diseases of the kidney, adrenal, or other endocrine organs.




BP
regulated by:
CO
Peripheral Resistance
HT
Vscular Pathology
Accelerate Atherogenesis
Arteriosclerosis
Hyaline
Hyperplastic
HT Complications
Coronary Heart Disease
Cerebrovascular Accidents
Cardiac Hypertrophy and Heart Failure (Hypertensive Heart Disease)
Aortic Dissection
Renal failure
Retinopathy


hypertension
types
Essential
secondary
risk factors
hereditary
race
African-American
gender
man
postmenopausal women
genetic factors
age
obesity
environmental factors
diet
na2+ intake
Heavy alcohol consumption
diabetes
oral contraceptives
renal
Acute glomerulonephritis
Chronic renal disease
Polycystic disease
Renal artery stenosis
Renal vasculitis
Renin-producing tumors
endocrine
Adrenocortical hyperfunction
Exogenous hormones
Pheochromocytoma
Acromegaly
Hypothyroidism
Hyperthyroidism
Pregnancy-induced
cardiovascular
Coarctation of aorta
Polyarteritis nodosa
Increased intravascular volume
Increased cardiac output
Rigidity of the aorta
neurolgical
Psychogenic
Increased intracranial pressure
Sleep apnea
acute stress

MCQs.

1) On a routine visit to the physician, an otherwise healthy 51-year-old man has a blood pressure of 150/95 mm Hg. If his hypertension remains untreated for years, which of the following cellular alterations would most likely be seen in his myocardium?

(A) Atrophy
(B) Hyperplasia
(C) Metaplasia
(D) Hypertrophy

(D) The pressure load on the left ventricle results in an increase in myofilaments in the existing myofibers. The result of continued stress from hypertension is eventual heart failure with decreased contractility, but the cells do not decrease in size.

2) A 66-year-old woman died of an acute myocardial infarction. At autopsy, both kidneys were decreased in size (about 120 g each) with a finely granular cortical surface. The representative appearance of the kidney under high magnification showing hyaline arteriolosclerosis . Which of the following clinical abnormalities most likely accompanied this lesion?

(A) Oliguria
(B) Benign hypertension
(C) Malignant hypertension
(D) Hematuria

(B) hyaline arteriolosclerosis typically occurs in patients with benign hypertension. Similar changes can be seen with aging in the absence of hypertension.

3) A 49-year-old man is feeling well when he visits his physician for a routine health maintenance examination for the first time in 20 years. On physical examination, his vital signs are temperature, 37°C; pulse, 73/min; respirations, 14/min; and blood pressure, 155/95 mm Hg. He has had no serious medical problems and takes no medications. Which of the following is most likely to be the primary factor in this patient's hypertension?

(A) Increased catecholamine secretion
(B) Renal retention of excess sodium
(C) Gene defects in aldosterone metabolism
(D) Renal artery stenosis
(E) Increased production of atrial natriuretic factor

(B) This patient has essential hypertension (no obvious cause for his moderate hypertension). Renal retention of excess sodium, which is thought to be important in initiating this form of hypertension, leads to increased intravascular fluid volume, increase in cardiac output, and peripheral vasoconstriction. Increased catecholamine secretion (as can occur in pheochromocytoma), gene defects in aldosterone metabolism, and renal artery stenosis all can cause secondary hypertension. Hypertension secondary to all causes is much less common, however, than essential hypertension. Increased production of atrial natriuretic factor reduces sodium retention and reduces blood volume.

4) A 68-year-old man has had progressive dyspnea for the past year. On physical examination, extensive rales are heard in all lung fields. An echocardiogram shows that the left ventricular wall is markedly hypertrophied. A chest radiograph shows pulmonary edema and a prominent left-sided heart shadow. Which of the following conditions has most likely produced these findings?
(A) Centrilobular emphysema
(B) Systemic hypertension
(C) Tricuspid valve regurgitation
(D) Chronic alcoholism

(B) Hypertension is an important cause of left ventricular hypertrophy and failure. Left-sided heart failure leads to pulmonary edema with dyspnea. Obstructive (e.g., emphysema) and restrictive (e.g., silicosis) lung diseases lead to pulmonary hypertension with right-sided heart failure from cor pulmonale. Likewise, right-sided valvular lesions (tricuspid or pulmonic valves) predispose to right-sided heart failure. Alcoholism can lead to a dilated cardiomyopathy that affects heart function on both sides.

5**) A 58-year-old woman dies of a cerebral infarction. Laboratory findings before death included serum urea nitrogen level of 110 mg/dL and creatinine level of 9.8 mg/dL. At autopsy, the kidneys are small (75 g) and have a coarsely granular surface appearance. Microscopic examination shows sclerotic glomeruli, a fibrotic interstitium, tubular atrophy, arterial thickening, and scattered lymphocytic infiltrates. Which of the following clinical findings was most likely reported on the patient's medical history?**
(A) Pharyngitis
(B) Hypertension
(C) Hemoptysis
(D) Lens dislocation

(B) These findings describe end-stage renal disease, the appearance of which is similar regardless of the cause (e.g., vascular disease or glomerular disease). With advanced renal destruction, hypertension almost always supervenes, even if it was absent at the onset of renal disease.

6) A 68-year-old woman has had decreased visual acuity for the past 5 years. She has no ocular pain. Her intraocular pressure is normal. Findings on funduscopic examination include arteriolar narrowing, flame-shaped hemorrhages, and hard, waxy exudates. What is the most likely diagnosis?
(A) Chronic hypertension
(B) Retinitis pigmentosa
(C) Advanced atherosclerosis
(D) Diabetes mellitus
(E) Cerebral edema

(A) Hypertensive retinopathy results from long-standing hypertension, with progressive changes that begin with generalized narrowing of the arterioles and proceed to the changes seen in this case.

7) Hypertension can cause damage to the
A) Eye
B) Brain
C) Kidneys
D) All of above

8) The primary reason for hypertension is
A) Renal disease
B) Diabetes
C) Unknown
D) Cancer

9) Kidneys have a direct effect on which of the following:
A) Blood pressure
B) How much water a person excretes
C) Total blood volume
D) pH
E) All of the above

10) The primary anatomic site of pressure regulation in the vascular system is:
A) aorta
B) arteries
C) arterioles
D) capillaries

11) Which condition is diastolic pressure over 120 mmHg?
A) Benign Hypertension
B) Malignant hypertension
C) Hyaline hypertension
D) None of them

12) Which of the following is a mechanism of Essential Hypertension :
A) Increased parasympathetic response
B) Defect in potassium excretion
C) Defect in cell membrane function (Na/Ca transport)
D) Aortic dissection

13) True or false:
A) Hypertension is more common with age
B) normal blood pressure value is 120/80
C) Some pregnant women who are young can develop hypertension
D) Hypertension medications can be discontinued when the blood pressure returns to normal
E) You shouldn't exercise if you have high blood pressure
F) Obesity and high sodium intake decrease the risk of HTN

7) D
8) C
9) E
10) C
11) B
12) C
13)
A) T
B) T
C) T
D) F
E) F
F) F

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Good Luck!

عمر الرهبيني
أحمد الصالح
حسين الكاف

مها الربيعة
رغد العتيبي
منى المتعب
رزان الصبحي
نورة الهلالي
ملاك الخثلان
هديل السلمي