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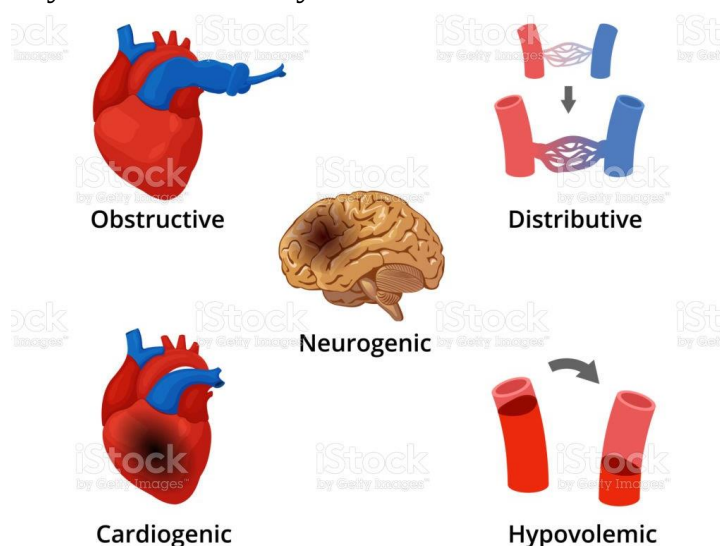


DEPARTMENT OF NORMAL AND PATHOLOGICAL PHYSIOLOGY
NAMED AFTER S. V. STOIANOVSKIY



PATHOPHYSIOLOGY OF THE CARDIOVASCULAR SYSTEM

educational and methodological instructions for conducting laboratory classes in the discipline "Veterinary Pathological Physiology" and independent work of students of specialty 211 "Veterinary Medicine"



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UDC

The educational and methodological guidelines were reviewed and recommended for publication by the methodological commission of the Faculty of Veterinary Medicine of the Lviv National University of Veterinary Medicine and Biotechnology named after S.Z. Gzytsky.

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Circulatory system diseases affect heart and blood vessels and make it harder for blood to flow throughout the body. Some conditions have symptoms, but others are silent. Common symptoms include chest pain, edema, heart palpitations and shortness of breath.

Circulatory system diseases are any conditions that affect ~~your~~ heart or blood vessels. Circulatory system, also called cardiovascular system, keeps blood moving in the body. The heart and ~~your~~ blood vessels work together ~~to~~ for supplying oxygen-rich blood to all ~~of~~ organs and tissues. That's why it's important to learn about circulatory system diseases.

Overall, circulatory system diseases can cause a range of issues, including:

- ~~problems~~ changes of heart's pumping action
- changes of the heart's structure
- inefficient blood flow
- blocked or narrowed blood vessels
- weakened blood vessels

Circulatory system diseases appear suddenly or develop gradually over years.

Learning about every possible condition that could affect ~~your~~ circulatory system ~~would~~ will take a long time. The gained knowledge will help ~~you~~ to notice symptoms and understand treatment options.

In this guide, students will learn ~~the~~ about main disorders of the circulatory system

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HYPERTENSION

It is a disorder in the regulation of the relationship between blood amount (flow) and the resistance to its flow, i.e. cardiac output on the one hand and peripheral resistance (resistance) on the other.

Increasing the value of blood pressure in the systemic (or pulmonary) circulation is possible by 3 mechanisms:

- increasing the amount of blood that flows through the bloodstream
- increasing the resistance of the blood vessels, which is placed in the flowing fluid (blood)
- combination of both

The established boundaries between still "normal pressure" and hypertension are artificially established and sometimes differ.

In this context, it is good to know that the main determinant of systolic pressure is the work of the relevant ventricle (depend on venous return, myocardial contractility, heart rate, or aortic elasticity in the systemic circulation); the "value" of peripheral resistance is the most important for diastolic pressure.

Systemic arterial hypertension is a condition where the pressure is higher than the above- mentioned limit values and according to the type of cause we divide it into:

1. Primary = essential (95% of cases) - with unknown etiology and poor clarified pathogenesis
2. Secondary hypertension (5% of cases)

PRIMARY (ESSENTIAL) HYPERTENSION

- Main cause unknown, diagnosis based on exclusion of secondary hypertension
- latent development initially, often an accidental finding on another examination
- relatively often systemic involvement (complications) - brain, heart, kidneys, retina

Probable etiopathogenetic mechanisms:

- genetics - polygenic heredity - the predisposition to the disease is inherited
- neurogenic - cortico-visceral and cortico-subcortical dysfunction (type of neurosis), effect of stress (increased activity, affect – an increase in blood pressure, tranquilizers – a decrease in blood pressure)
- influence of lifestyle - inappropriate diet, stress...

Pathophysiological consequences and complications of essential hypertension

- increased pulsations, mechanical irritation of the endothelium, predisposition to atherosclerosis
- risk of bleeding (including arterial) - epistaxis, brain, retina (hypertensive retinopathy), etc.
- increase in cardiac pressure work (afterload is increased), concentric hypertrophy, myocardial infarction, impaired oxygenation, predisposition to heart failure
- hyperfiltration in the glomeruli, sclerotization of nephrons, predisposition to chronic renal failure (hypertensive nephropathy)

SECONDARY HYPERTENSION (hypertension in the systemic circulation).

There is a primary disease that is complicated by hypertension; it is a heterogeneous group of diseases.

Pheochromocytoma

- tumor of the adrenal medulla or ganglia, a source of catecholamines (in 90 % noradrenaline)
- seizure hypertension

Renal artery stenosis (renovascular hypertension)

- activation of renin secretion, renin-angiotensin-aldosterone axis
- primarily vasoconstriction, then hypervolemia

Primary hyperaldosteronism (sodium and water retention)

Chronic renal failure (fluid retention)

Pregnancy hypertension

- new placental circulation
- influence of hypervolemia and placental metabolites causing vasoconstriction

PULMONARY HYPERTENSION (increase of pressure in the pulmonary circulation).

The disease is formed by identical mechanisms - imbalance between blood volume and bloodstream resistance. It is a low-pressure system - hypertension can easily occur acutely (pulmonary embolism).

Classification according to etiology:

- **Hyperkinetic hypertension** - left-right heart shunts - increased flow through the pulmonary system - part of the blood with pathological communication an atrial septal defect (ASD), ventricular septal defect (VSD), and patent ductus arteriosus returns to the right heart and from there back to the

pulmonary circulation. Compensation by morphological reconstruction of arterioles - muscle thickening, the result is total increase of resistance.

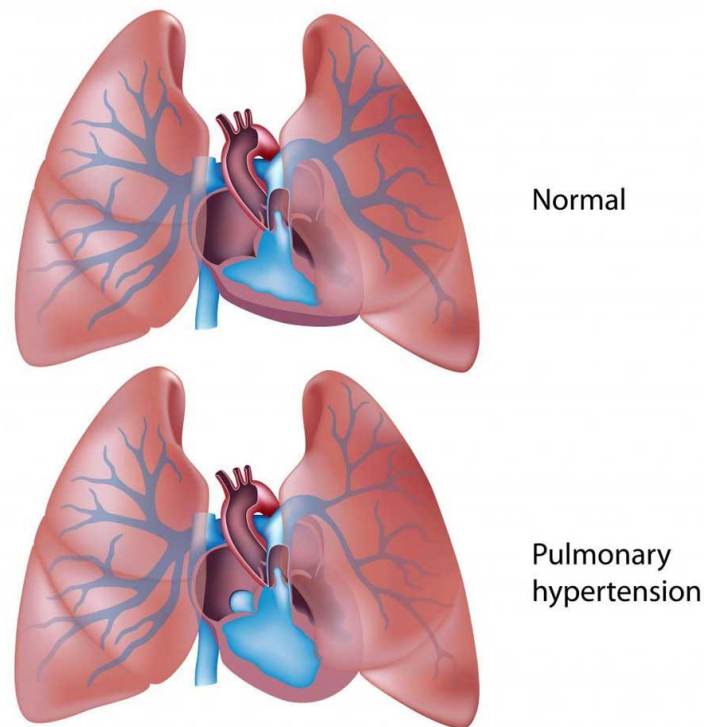
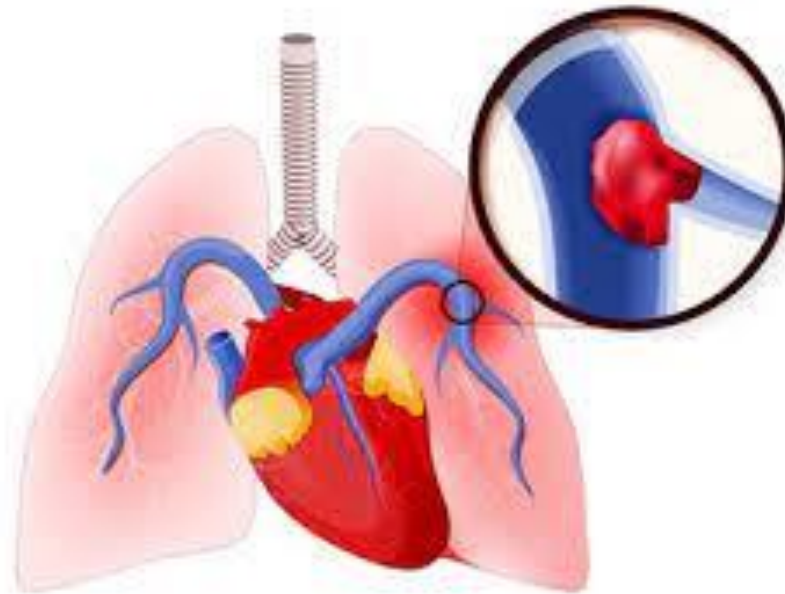


Fig. 1 Pulmonary hypertension

- **Postcapillar hypertension** - pressure increase in the left atrium (physiologically there is a very small pressure gradient between the pulmonary artery and the left atrium) - left heart failure, mitral stenosis and insufficiency, cardiomyopathy, etc.
- **Reactive hypertension** - consequence of vasoconstriction of arterioles as a reaction to hypoxia (physiological mechanism of optimization of perfusion of individual parts of the lungs according to their ventilation); this reaction is caused by conditions with reduced pO_2 in the alveolar air - chronic bronchitis, emphysema, obesity, neuromuscular diseases, sleep apnea syndrome.
- **Obstructive hypertension** - idiopathic primary pulmonary hypertension - cell proliferation in the vessel wall, mostly a congenital mutation of the morphogenic protein gene, progression, right heart failure
- **Parenchyma reduction** - emphysema (extinction of interalveolar septa in which pulmonary capillaries take place), pulmonary fibrosis, conditions after lung resection

➤ **Pulmonary embolism** - a precapillary type of increased lung resistance; thrombus embolization (most often from the veins of the lower limbs or pelvic plexuses), air embolism (air penetration into the veins), fat embolism (fat droplets in multiple fractures)



➤ *Fig. 2 Pulmonary embolism*

Massive embolism leads to acute pulmonary hypertension and acute right heart failure. Repeated minor embolizations cause chronic overloading of the right heart with its hypertrophy and later with possible decompensation (dilation and failure). The right ventricle without hypertrophy cannot compensate for the large increase of resistance in the pulmonary circulation. Simultaneously, output into the systemic circulation is decreasing.

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