

## THE IMPORTANCE OF LAMINAR AND TURBULENT FLOWS IN MEDICINE. DETERMINING BLOOD FLOW VELOCITY AND ITS IMPORTANCE IN MEDICINE

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**Abstract.** *This article extensively covers the theoretical foundations of laminar and turbulent flows, which are basic concepts of fluid mechanics, and their practical importance in medicine.*

*The manifestation of these types of flow in the human body during blood circulation, the fact that in a healthy state the blood moves mainly in laminar flow and the occurrence of turbulent flow in pathological conditions, has been scientifically analyzed. The influence of narrowing of blood vessels, heart valve defects and changes in blood pressure on the nature of the flow has been considered. Also, the diagnostic value of determining the types of flow by the Reynolds number, methods for measuring blood flow velocity - Doppler ultrasound, angiography, MRI and CT methods - is described. The article reveals the important role of flow mechanics in the diagnosis and assessment of diseases of the cardiovascular system.*

**Keywords:** *Laminar flow, turbulent flow, blood flow, blood flow velocity, Reynolds number, cardiovascular system, Doppler ultrasound, biophysics, medical.*

### **Enter**

The study of fluid flow is important in medicine and biophysics. In the human body, blood, lymph, air, and other biological fluids move according to certain laws. In particular, the concepts of laminar and turbulent flow play a key role in understanding the cardiovascular system, the respiratory system, and diagnostic methods. This article discusses the essence of laminar and turbulent flows, methods for determining blood flow velocity, and their practical importance in medicine. **The concept of laminar flow**

Laminar flow is a type of flow in which fluid particles move in parallel layers without mixing. The flow is calm, orderly, and steady.

Characteristics of laminar flow:

The layers of fluid move by sliding relative to each other.

Energy loss will be less

The flow velocity is greatest in the center and smallest near the walls.

Importance in medicine:

In healthy blood vessels, blood moves mainly in laminar flow.

The mechanical pressure on the blood vessel walls is normal.

The heart works efficiently

No noise (e.g. audible through a stethoscope) is produced.

### **The concept of turbulent flow**

Turbulent flow is a type of flow in which the fluid particles move in an irregular, swirling, and uneven manner. This condition usually occurs when the flow velocity increases or the diameter of the vessel changes abruptly.

Characteristics of turbulent flow:

The movement of particles is uneven and mixed.

Energy loss is large

Noise and vibrations occur during the flow

Importance in medicine:

It is also observed in narrowing of blood vessels (atherosclerosis, stenosis)

Occurs in heart valve defects

Blood flow noises (heart murmurs) are the result of turbulent flow

Serves as a diagnostic marker in identifying pathological conditions

### **Reynolds number and flow types**

The Reynolds number (Re) is an important indicator in differentiating between laminar and turbulent flow:

$$Re = (\rho v d) / \eta$$

Here:

$\rho$  liquid density

V is the flow rate

d - vessel diameter

$\eta$  is the viscosity of the liquid

If  $Re < 2000$ , laminar flow occurs, if  $Re > 2000$ , turbulent flow occurs.

### **Determination of blood flow rate**

Blood flow velocity is the speed of blood flowing through a blood vessel in a given time and is important in assessing the condition of the cardiovascular system. Methods of determining blood flow rate:

#### 1. Doppler ultrasound method

Based on the change in the return frequency of ultrasonic waves

Widely used to determine blood flow velocity in arteries and veins

Used to assess placental circulation in pregnancy

#### 2. Angiography

Imaging of blood vessels using contrast medium

Allows assessment of blood flow velocity and vascular permeability

#### 3. MRI and CT angiography

Identifies blood flow and vascular pathologies based on high-resolution images.

### **The importance of blood flow velocity in medicine**

Blood flow rate determines the supply of oxygen and nutrients to the body's tissues.

Main importance:

Diagnosis of heart failure

Assessment of hypertension and atherosclerosis

Predicting the risk of stroke and thrombosis

Postoperative blood circulation control

A decrease in blood flow velocity can lead to ischemia and necrosis in tissues, while an increase can damage the vessel walls.

### **Summary**

The concepts of laminar and turbulent flow are of great theoretical and practical importance in medicine. In a healthy organism, blood moves mainly in laminar flow, while turbulent flow is often a sign of pathological conditions. Methods for determining blood flow velocity serve as an important tool in the early diagnosis, treatment and prevention of diseases.