University of Al-Mustaqbal
College of Science
Department of Medical Physics

BIOPHYSICS

first stage

(Pressure And Hydrostatic Pressure)

Lecture Two

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We will learn

- Importance of Pressure in Human Body
- Atmospheric Pressure
- Hydrostatic Pressure
- Osmotic Pressure
- Measurement of Pressures
- Applications of these Principles of Pressure in Nursing

Pressure

•Pressure is defined as follows:

“Pressure is the force acting on a unit surface area.” A/F=P.

• The pressure exerted by fluids is called **Fluid pressure**.

•The unit of pressure in the International System of Units is called **the pascal**, and is denoted by the symbol "Pa".

•Pressure does not have a fixed direction and is therefore a scalar quantity. Atmospheric pressure is about 10^5 Pa.

•In medical practice, the most common way to indicate pressure is the height of a column of mercury.

• Column pressure can be calculated and Liquid using the relationship:

P=h d g

• Where ‘d’ is the density of the liquid, ‘g’ is acceleration due to gravity and ‘h’ is the height of the liquid

column.

The importance of pressure in the human body

The human body. The cavities and organs of the body are affected by pressure, whether in health or disease. Pressure must be known to understand

performance. For example,

Differences in intrapulmonic and intrapleural pressures may lead to respiratory distress.

• Normal breathing depends in part

The effectiveness of treatments such as enemas and other types of irrigation depends on pressure.

- Many body functions depend on fluid pressure. For example, the heart pumps blood through the arteries at a very high pressure (100 to 140 mm Hg). The returning venous blood is at a very low pressure.

  It must be assisted to move from the legs to the heart. Some typical values for fluid pressure in the body are

given in Table 7.1.

Standard Pressure

◆ **Table 7.1: Typical pressure in a normal and healthy human body**

Body/organ pressure	*Typical value of pressure (in mm Hg)*
Arterial blood pressure	
Maximum	100-140
Minimum	60-90
Venous blood pressure	3-7
Intrathoracic pressure (between lung and chest wall)	10
Capillary blood pressure	
Arterial end	30
Venous end	10
Middle ear pressure	<1
Urinary bladder	<2
Eye pressure—aqueous humor	20
Cerebrospinal fluid pressure in brain	5-12
Gastrointestinal pressure	10-20

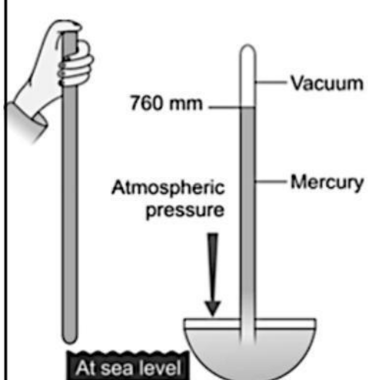

Fig. 7.1: Torricelli experiment

Atmospheric Pressure

There is a large amount of air above the Earth's surface, which is a mixture of many Gases, the atmosphere, that is, the surrounding air, which has mass and weight.

The weight of the atmosphere exerts a force on the surface of every object on or near the surface of the Earth. From him.

- At sea level, this force produces a pressure of 14.7 lb/in

Torricellian found that the atmospheric pressure at sea level is sufficient. Expressed to . maintain the mercury column at 76 cm above the surface of the mercury in the container. Atmospheric pressure is sometimes expressed in units of cm of mercury such as Hg mm 76 or Hg cm 76. This is equivalent to 14.7 lb/in pressure.

Hydrostatic pressure

A very important property of all fluids (gases and liquids) was discovered by Pascal. He observed that when pressure is applied to a confined fluid, It moves uniformly through its volume. He stated this observation in the form of a law known as Pascal's Law. We may state it as follows:

“Any change in pressure applied at any point in a closed fluid at rest is transmitted undiminished and uniformly to all its parts.”

Liquids in a vessel exert pressure by virtue of their weight. The pressure at any point below the surface is proportional to the weight of the column of liquid above that point. If the weight of the substance is twice that of water, the pressure will be doubled. The pressure at any point below the surface can be determined by knowing the height of the column of liquid and the density of

the liquid, i.e.:

$P = hdg$

- where, P = pressure h = height
- d = density,, g = acceleration due to gravity (is constant for a particular place) For example,

Applications of Pascal's Law

•Pascal's law has been used in a variety of applications in everyday life and business practices. Health care.

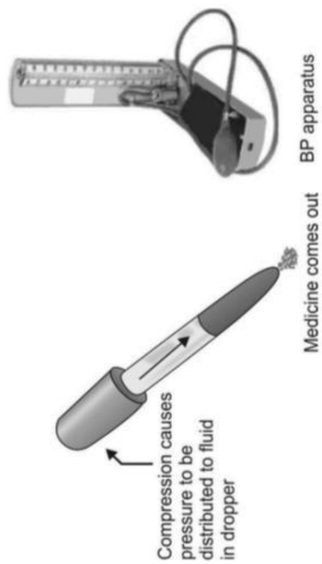

Fig. 7.3: Working Pascal's law

- The amniotic sac that surrounds the fetus in the uterus is filled with amniotic fluid, which is a confined fluid that acts as a protection for the fetus. Any pressure exerted on the abdominal wall will be transmitted to the amniotic fluid to all surfaces of the fetus. To avoid uneven pressure that may cause fetal deformity, the patient is usually warned against wearing tight clothing during pregnancy.

- In a sphygmomanometer, the mercury manometer works according to Pascal's law. The flow of blood is obstructed.

The blood in the artery is compressed by the air pressure enclosed in a sealed cuff. The pressure supports a column of mercury in the pressure gauge. When the air in the cuff is slowly released, the blood begins to flow again; the pressure is measured by the height of this column of mercury (Fig. 7.3).

Osmotic pressure

Osmosis is the process by which a solvent moves from an area of lower concentration of solutes to a higher concentration of solutes through a membrane. Semi-permeable It can be defined as the equivalent of the external pressure that must be applied to the solution in order to prevent the solvent from passing into it through a semi-permeable membrane.

• The osmotic pressure of a solution is proportional to the concentration of solute molecules that cannot cross the membrane. The higher the solute concentration, the higher the osmotic pressure.

For the solution.

In the case of substances that ionize, the osmotic pressure expected from concentration alone will actually be greater because there are a greater number of molecules.

For each molecule of one molecule. For example,

• A sodium chloride solution contains two particles, one sodium ion and one chloride ion, for each sodium chloride molecule. The osmotic pressure of substances such as sodium chloride that are strong electrolytes (i.e., they ionize to a large extent) will be higher than that of substances that, because the size of the molecules in the solution has an effect, ionize weakly or not at all, other things being equal. In addition, On osmotic pressure.

Pressure Osmotic Measuring

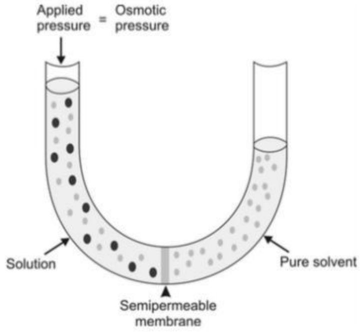

Fig. 7.4: Measurement of osmotic pressure

Sufficient pressure, if a piston is used to increase the pressure on the fluid in the right arm.
With the pressure in each arm to

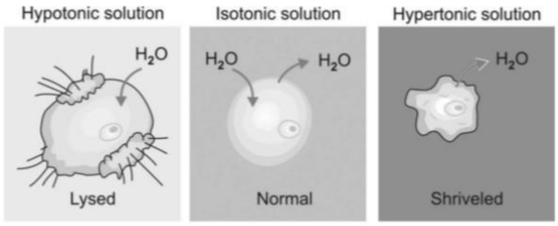

Fig. 7.5: Fate of RBC in different solutions

the starting volume and the solute concentration in the right arm being the same as it was at the beginning. The amount of pressure required to restore the starting condition is equal to the osmotic pressure (Figure 7.4).

• Any solution in which the cell is located, for example a red blood cell maintains its normal shape.

Its volume is an isotonic solution. In a hypotonic solution, the cell swells and in a hypertonic solution, the cell shrinks (Figure 7.5).

Applications of the Osmotic Pressure

• Blood albumin helps maintain colloidal blood pressure.
Effective in capillaries in maintaining normal fluid content in the blood. If the patient loses blood albumin which may

occur in the kidney, colloid osmotic pressure will decrease and fluid will remain in the tissues. This results in edema.

• Hypertonic solution infusion is useful in treating patients with cerebral edema or interstitial fluid.

Excess in the brain such as mannitol. It relieves such overload by causing water to osmosis from the interstitial fluid into the blood. The

kidneys then excrete the excess water from the blood into the urine.

• Hypotonic solutions can be used either intravenously or orally to treat

people who are dehydrated. Water in a hypotonic solution moves from the

blood into the interstitial fluid and then into the body's cells to rehydrate

them.

• In diffusion dialysis, osmosis also works.