Lec1:Pressure

Dr. Fatima Abbas

Pressure is defined as the force per unit area in a gas or a liquid. For a solid the quantity force per unit area is referred to as stress. In the metric system the pressure is measured in dynes per square centimeter or Newton per square meter; the SI unit for the latter is thePascal (Pa).None of these units is in common use in medicine. The most common method of indicating pressure in medicine is by the height of a column of mercury (Hg).For example, a peak (systolic) blood pressure reading of 120 mmHg indicates that a column of mercury of this height has a pressure at its base equal to the patient's systolic blood pressure.

The pressure **P** under a column of liquid can be calculated from this formula:

$$P = p \times g \times h$$

Where **p** is the density of the liquid, **g** is the acceleration due to gravity, and **h** is the height ofthe column.

Example: What height of water will produce the same pressure as 120 mmHg?

$$P\ (120\ mmHg) = pgh = (13.6\ g/cm^3)\ (980\ cm/sec^2)\ (12\ cm)$$

$$= 1.6\times10^5\ dyne/cm^2$$

For water:

$$1.6\times10^5\ dynes/cm^2 = (1.0\ g/cm^3)\ (980\ cm/sec^2)\ (h\ cm\ H_2O)$$

$$h = 163\ Cm\ H_2O$$

Or

$P_{Hg} = P_{water}$

$(p\ gh)_{Hg} = (p\ gh)_{water}$

$p_{Hg} \times h_{Hg} = p_{water} \times h_{water}$

$h_{water} = (p_{Hg} \times h_{Hg}) / p_{water} = (13.6 \times 12)/1 = 163\ cmH_2O$

Note:-

1 atmosphere (atm) = $1.01\times10^5\ N/m^2$

1 atmosphere (atm) = 10^{33} cm H_2O

1 atmosphere (atm) =760 mmHg

1 cmH_2O =0.735 mmHg or 1 mmHg = 1.36 cm H_2O

Example: calculate the atmospheric pressure in N/m^2 and in

$dyne/cm^2$, where p_{Hg} =13.6 g/cm^3?

1 atm =760 mm = 76 cm =0.76m

p_{Hg} =13.6 g/cm^3 or 13600 Kg/m^3

The atmospheric pressure in N/m^2 is equal $P = p\ g\ h$ =13600 Kg/m^3 ×9.8m/sec^2 ×0.76m P=101292.8 N/m^2	The atmospheric pressure in $dyne/cm^2$ is equal $P = p\ g\ h$ =13.6 g/cm^3 ×980cm/sec^2 ×76cm P=1012928 $dyne/cm^2$

***PRESSURE** Depends on Force and Area

*** Pressure types** depending on what the reference pressure is gives us the three modes absolute, gauge, and differential.

***There are two type of pressure*:**

1.Absolute pressure

If a vessel were to be completely empty, containing no molecules whatsoever the pressure would be zero.

Using this zero as the pressure reference point it is called absolute pressure because there is no lower pressure than the absence of all molecules.

An example of something that is close to absolute zero would be outer space, but even there, there are some molecules.

2. Gauge pressure

There are many applications were measuring pressure is not really dependent on the absolute pressure but the difference between it and the pressure of the atmosphere.

When using the atmospheric pressure as the reference point we call the mode gauge pressure.

The classic example is a tire

Absolute pressure = Gauge pressure + Atmospheric pressure

3. Differential pressure

Knowledge of the pressure difference between two places or systems is needed, the reference pressure may not necessarily be either zero or atmospheric pressure but some other value. (differential pressures).For example, the flow of gas along a pipeline depends on the pressure difference between the ends of the pipe and in practice both ends.

There are a number of places in the body where the pressures are lower than the atmospheric pressure or negative .For example, When we breathe in (inspire) the pressure in the lung must be somewhat lower than atmospheric pressure or the air would not flow in.

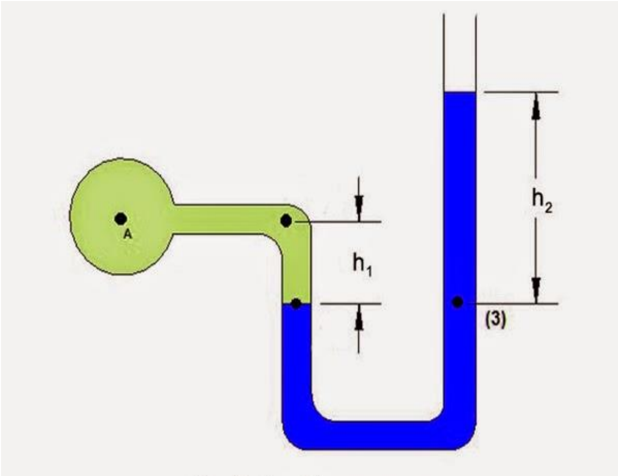
Typical pressures in the normal body

Different parts of the body	Typical pressure (mmHg)
Arterial blood pressure Maximum(systole) Minimum(diastole)	 100-140 60-90
Venous blood pressure	3-7
Great veins	<1
Capillary blood pressure Arterial end Venous end	 30 10
Middle ear pressure	20
Eye pressure-aqueous humor	20
Cerebrospinal fluid pressure in brain	5-12
Gastrointestinal pressure	10-20
Intrathoracic pressure (between lung & chest wall)	~10

Measurement of pressure in the body

The classical method of measuring pressure is to determine the height of a column of liquid that produces a pressure equal to the pressure being measured.

An instrument that measures pressures is called a *manometer*. A common type of manometer is a U-shaped tube containing a fluid that is connected to the pressure to be measured. The levels in the arms change until the difference in the levels is equal to the pressure. This type of manometer can measure both positive and negative pressures. The most common clinical instrument used in measuring pressure is the ***Sphygmomanometer***, which measures blood pressure.



U - Tube Manometer

Two types of pressure gauges are used in Sphygmomanometers:

1-*A mercury manometer type*: the pressure is indicated by the height of a column of mercury inside a glass tube.

***2- An aneroid type*:** the pressure changes the shape of a sealed flexible container, which causes a needle to move on a dial.