Al-Mustaqbal University

College of Technology and Health Sciences

Medical physics Department

Medical Physics

First Semester

3rd stage

Lesson 7

Pressure

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Introduction

Pressure is defined as the force per unit area in a gas or liquid while for solids the quantity force per unit area is referred to as stress, the atmospheric pressure is about 10 N/m² (pa) or 760 mm Hg.

Since we live in a sea of air with pressure 1 atm., it is easier to measure pressure relative to atmospheric pressure. Table 1 lists some of the common units used to measure the pressure.

Table 1. the most common units of pressure

	atm.	N/m^2 (Pa)	cm H_2O	mm Hg	lb/in^2 (psi)
1 Atm.	1	1×10^5	1033	760	14.7
1 Pa	1×10^{-5}	1	0.0102	0.0075	0.145×10^{-3}
1 cm H_2O	9.68×10^{-4}	98.1	1	0.735	0.014
1 mm Hg	0.00132	133	1.36	1	0.0193
psi	0.068	6895	70.3	51.7	1

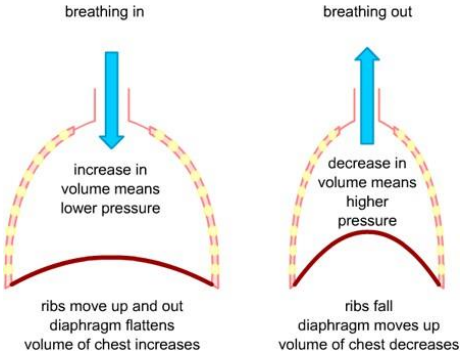
The most common method for indicating pressure in medicine is that the column of mercury (Hg). For example, the blood pressure 120/80 indicates that the ***systolic*** blood pressure is 120 mm Hg and the ***diastolic*** blood pressure is 80 mm Hg. The pressure P under a column of liquid can be calculated as;

$$P = \rho g h$$

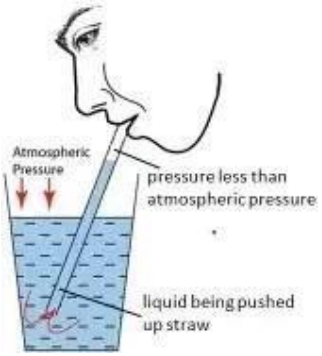
Where ρ is the density of liquid, g is acceleration due gravity, and h is the height of the column.

There are places in the body where the pressure are lower than atmospheric or negative for example:

- ***When we breathe (inhalation)*** the pressure in the lung must be lower than atmospheric pressure or the air would not flow to the lungs.



- ***When person drink through straw*** the pressure in his mouth must be negative by an amount equal to the height of his mouth above the level of the liquid he is drinking.



Blood pressure

The heart acts as a pump, producing high pressure (~100 to 140 mm Hg) to force the blood through the arteries.

The returning venous blood is at quite low pressure and need help to get from the legs to the heart. The failure of this return system in the legs results in ***varicose veins***.

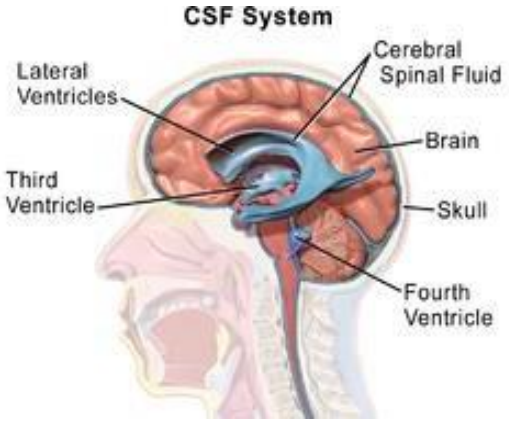
The classical method of measuring pressure is to determine the height of the column of mercury and the blood pressure meter is called sphygmomanometer.

There are different types of sphygmomanometer as in the following table;

Table 2. Sphygmomanometer types			
	Working principle	***Advantages***	***Disadvantages***
Mercury sphygmomanometer 	Consists of manually inflatable cuffs attached to mercury tube	• Can last for a lifetime • Most accurate • No need for recalibration	• should be kept on a flat surface • If dropped, there are high chances of risks
Aneroid sphygmomanometer. 	Consists of a stethoscope and a dial gauge with. To convert the cuff pressure to gauge pressure, the gauge has a mechanical part	• There is no use of mercury	• Needs to be recalibrated to avoid faulty readings • Less accurate
Digital sphygmomanometer 	consists of an electronic sensor and the readings are displayed on the digital monitor	• Technologically advanced • Easy to use	• Need to be checked using a mercury sphygmomanometer to avoid inaccurate readings • Least accurate

Pressure inside skull

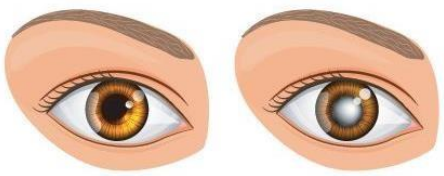
The brain contains approximately 150 cm^3 of cerebrospinal fluid (CSF) in series of interconnected cavities called ventricles, at birth if this opening is blocked for any reason, CSF is trapped inside skull and increase internal pressure. Pressure causes skull to enlarge, this called ***hydrocephalus*** and is common in infant. The crude method for detecting hydrocephalus is to measure circumference of the skull just above the ears, normal value of newborn infant are from (32-37)cm, larger value indicate hydrocephalus.



Eye Pressure

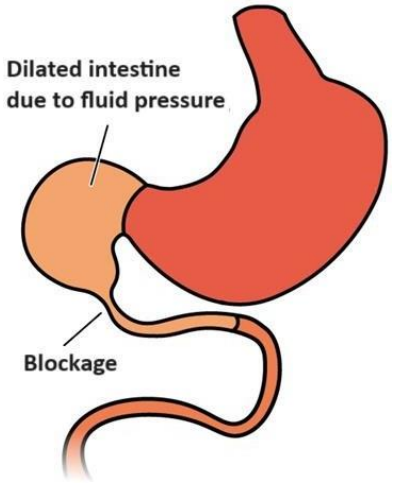
The fluids in the eye ball (aqueous and vitreous humors) that transmit light to retina. The dimensions of the eye are critical to good vision, a change of 0.1 mm in its diameter has effect on clarity of vision.

Pressure in normal eye is 12-33 mm Hg. The eye continuously produce aqueous humor and the drainage system allows surplus to escape. If partial blockage of this drain system occurs, the pressure increases and restrict the blood supply to retina, and thus effect vision, this condition called ***glaucoma*** producing tunnel vision in moderate cases, and blindness in severe cases.



healthy eyes glaucoma

Pressure in the Digestive System



The pressure is greater than atmospheric in most gastrointestinal system. The pylorus valve prevent the flow of food back into stomach from small intestine, occasionally a blockage forms in small or large intestine, and the pressure builds up between blockage and pylorus valve, this pressure become greater enough to restrict blood flow to critical organs, it can cause death. Intubations, the passing of hollow tube through the nose, stomach, and pylorus is usually used to relieve the pressure. If intubation does not work it is necessary to relive the pressure surgically.

The pressure gastrointestinal GI system is coupled to that in the lungs through flexible diaphragm.

Pressure in the Skeleton

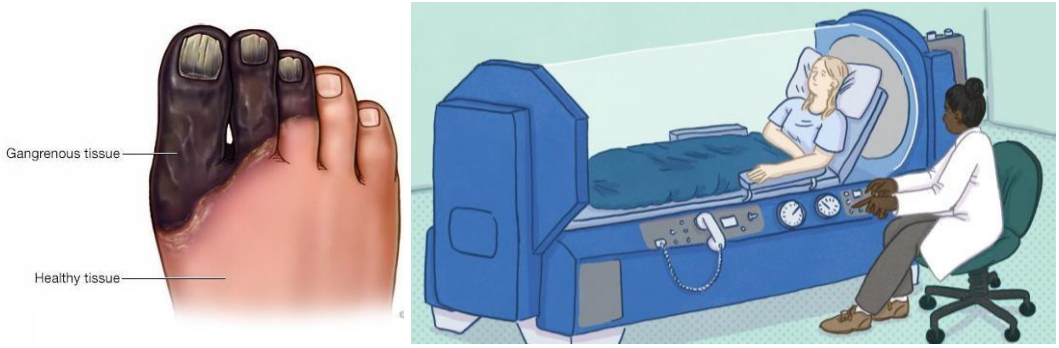
Since pressure is the force per unit area, the pressure is reduced as area increased. The surface area of bone at joint is larger than its area above or below the joint, thus reducing pressure.

Finger bones are flat rather than cylindrical on the griping side, and the force spread over large surface, this reduces pressure in the tissue over bones.

Hyperbaric Oxygen Therapy (HOT)

About one fifth oxygen and four fifth nitrogen in atmospheric, to greatly increases the amount of oxygen medical engineering have constructed special high pressure (hyper baric) oxygen chambers.

Gas gangrene is a disease that killed more than half of its victims before HOT was developed, since the bacteria that causes gas gangrene cannot survive in the presences of oxygen, almost all gas gangrene patients treated with HOT are cured without the need for amputation, the previous best method of treatment.



In carbon monoxide poisoning RBC cannot carry oxygen to the tissue because carbon monoxide fastens to the hemoglobin at the places normally used by oxygen.

The presence of few CO on RBC greatly reduces the ability of the cell to transport O_2. Normally the amount of O_2 dissolved in the blood is about 2% of that carried on the RBC with HOT the partial pressure of O_2 increased by a factor 15. Many victims of CO poisoning are saved with this technique.

Exercises

1 Pressure is defined as

(a) The density per unit volume

(b) The force per unit area

(c) The mass per unit volume

(d) The mass per unit area

(e) The force per unit volume

2 When we breathe (inhalation) the pressure in the lung must be…… or the air would not flow to the lungs.

(a) as same as atmospheric pressure

(b) higher than atmospheric pressure

(c) lower than atmospheric pressure

(d) the same as exhalation

(e) zero pressure

3 Hydrocephalus results from

(a) Increasing the internal pressure of the skull in newborn babies

(b) Decreasing the internal pressure of the skull in newborn babies

(c) A change in the diameter of the eye

(d) A blockage forms in small intestine

(e) Abnormal blood flow

4 The surface area of bone at joint is larger than its area above or below the joint

(a) To increase pressure on the joint

(b) To allow better move

(c) To avoid friction

(d) To produce more synovial fluid

(e) To reduce pressure on the joint

5 Hyperbaric oxygen technique was developed to treat;

(a) Gas gangrene
(b) Glaucoma
(c) Hydrocephalus
(d) Osteoporosis
(e) High blood pressure