

## ➤ Blood Pressure (BP)

**Definition:** The force of blood applied on per unit area against the walls of blood vessels is called blood pressure. Blood pressure varies in various parts and is highest in aorta.

**Expression & Units:** Blood pressure numbers written with the systolic number above or before the diastolic number, such as 120/80 mmHg. (The mmHg is millimeters of mercury). BP is measured in mm of Hg.

**Types:** There are two types of blood pressures

- i. Systolic pressure
- ii. Diastolic pressure
- i. **Systolic Pressure:** The force of blood applied against the walls of blood vessels during contraction of left ventricle is called systolic pressure which is 120/80 mm of Hg.
- ii. **Diastolic Pressure:** The force of blood applied against the walls of blood vessels during relaxation of left ventricle is called diastolic pressure which is 70-90 mm of Hg. The lowest diastolic pressure experienced during ventricular relaxation for normal / healthy individual.

**Auscultator method:** The word is derived from Latin word Auscultate means listen.

**Sphygmomanometers:** There are three different types of sphygmomanometers: mercury, aneroid, and digital. Measuring blood pressure by auscultation is considered the gold standard.

**Subject:**

- i. Position: seated, standing.
- ii. In seated position, the subject's arm should be flexed.
- iii. The flexed elbow should be at the level of the heart.
- iv. If the subject is nervous, wait a few minutes before taking the pressure.

**Procedures:**

- Use a properly sized blood pressure cuff. The length of the cuff's bladder should be at least equal to 80% of the circumference of the upper arm.

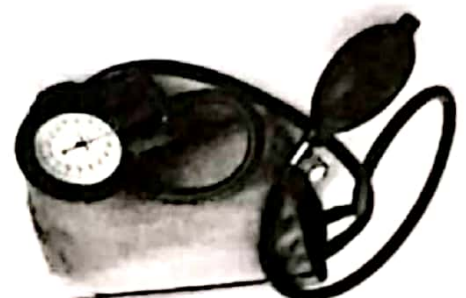
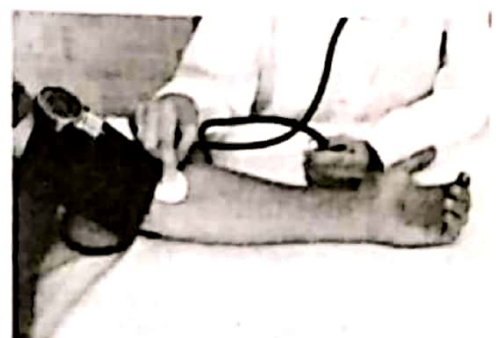
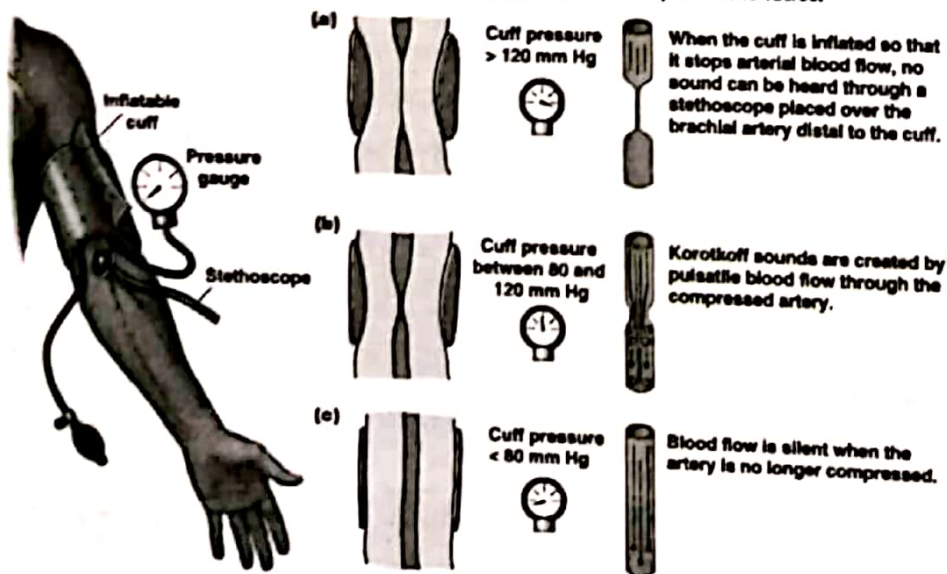
- Wrap the cuff around the upper arm with the cuff's lower edge one inch above the elbow pit
- Lightly press the stethoscope's bell over the brachial artery just below the cuff's edge. Some health care workers have difficulty using the bell in the antecubital fossa or elbow pit, so we suggest using the bell or the diaphragm to measure the blood pressure.
- Rapidly inflate the cuff to 180 mmHg. Release air from the cuff at a moderate rate (3mm/sec).
- Listen with the stethoscope and simultaneously observe the sphygmomanometer. The first knocking sound (first sound Korotkoff) is the subject's systolic pressure. When the knocking sound disappears, that is the diastolic pressure (such as 120/80).
- Record the pressure in both arms and note the difference; also record the subject's position (supine), which arm was used, and the cuff size (small, standard or large adult cuff).
- If the subject's pressure is elevated, take two additional blood pressure measurements, waiting a few minutes between measurements.
- A blood pressure of 180/120 mmhg or more requires immediate attention.

#### Precautions:

- Aneroid and digital manometers may require periodic calibration.
- Use a larger cuff on obese or heavily muscled subjects.
- Use a smaller cuff for pediatric patients.
- For pediatric patients a lower blood pressure may indicate the presence of hypertension.
- Don't place the cuff over clothing.
- Flex and support the subject's arm.
- In some patients the Korotkoff sounds disappear as the systolic pressure is bled down. After an interval, the Korotkoff sounds reappear. This interval is referred to as the "auscultatory gap." This pathophysiologic occurrence can lead to a marked under-estimation of systolic pressure if the cuff pressure is not elevated enough. It is for this reason that the rapid inflation of the blood pressure cuff to 180 mmHg was recommended above. The "auscultatory gap" is felt to be associated with carotid atherosclerosis and a decrease in arterial compliance in patients with increased blood pressure.

#### SPHYGMOMANOMETRY

Arterial blood pressure is measured with a sphygmomanometer (an inflatable cuff plus a pressure gauge) and a stethoscope. The inflation pressure shown is for a person whose blood pressure is 120/80.



## Variation of blood pressure & speed in different blood vessels

**Blood flow:** The movement of a volume of a liquid or gas over time, e.g. mL/sec.

**Blood velocity:** The distance moved by an object over time, e.g. cm/sec.

**Blood pressure:** The pressure exerted by the blood against the walls of the blood vessels, especially the arteries. It varies with the strength of the heartbeat, the elasticity of the arterial walls, the volume and viscosity of the blood, and a person's health, age, and physical condition.

Within the circulatory system, velocity can be altered by changes in blood pressure, vessel resistance, and blood viscosity. Blood vessels can vasoconstrict and vasodilate, which alters cross-sectional area. These various factors are under tight regulation to maintain sufficient blood flow to the body's organs and tissues.

- i. **Aorta:** When left ventricle contracts it pumps blood with high pressure i-e 120/80 into aorta. The average speed of blood in the aorta is 0.3 m/s and the radius of the aorta is 1 cm.
- ii. **Artery:** It decreases to less than 20 mm Hg when blood leaves arteries. In arteries speed of blood varies continuously not only from **artery to artery**, but also down along the arterial pathway, so there is no average **speed**. An average speed in the carotid arteries is 0.15 m/s
- iii. **Vein:** Blood pressure in vein is about 10-12 mm Hg and average speed is 150 mm/s.
- iv. **Venules:** It further decreased into venules. When blood finally reaches to atrium, it pressures is almost equal to zero.
- v. **Capillary:** In Capillaries BP is about 40 mm Hg. The difference between systolic and diastolic pressure is zero in capillaries.

The difference between systolic & diastolic blood pressure.

Sr. No	Vessel Name	Systolic P	Diastolic P	BP
1	Aorta	120	80	
2	Arteries	102	60	
3	Arterioles	60	45	
4	Capillaries			40
5	Venules			20
6	Veins			10
7	Vena Cave			0

## Control of Blood Pressure

Changes in blood pressure are routinely made in order to direct appropriate amount of oxygen and nutrients to specific parts of the body. For example, when exercise demands additional supplies of oxygen to skeletal muscles, blood delivery to these muscles increases, while blood delivery to the digestive organs decreases. Adjustments in blood pressure are also required when forces are applied to your body, such as when starting or stopping in an elevator. Blood pressure can be adjusted by the cardiovascular center provides a rapid, neural mechanism for the regulation of blood pressure by managing cardiac output or by adjusting blood vessel diameter which is located in the medulla oblongata of the brain by producing changes in the following variables.

- i. Cardiac output can be altered by changing stroke volume or heart rate.
- ii. Resistance to blood flow in the blood vessels is most often altered by changing the diameter of the vessels either by vasodilation or vasoconstriction.

- iii. Changes in blood viscosity i.e ability to flow.
- iv. Length of the blood vessels which increases with weight gain, can also alter resistance to blood flow.

The cardiovascular center receives information about the state of the body through the following receptors.

a. **Baroreceptors:** These are sensory neurons that monitor arterial blood pressure. Major baroreceptors are located in the carotid sinus, the aortic arch, and the right atrium.

**Types:** There are two types of baroreceptors.

**High pressure baroreceptors:** These are active at the region of circulatory system where pressure is highest i.e. aorta which monitors the blood flow to all parts through systemic circuit. High pressure atrial receptors are also found in sinuses of carotid arteries which carry and monitors blood pressure of blood supplied to brain.

**Low pressure baroreceptors:** The low pressure baroreceptor determine volume of blood & pressure at venous side & all over the body particularly where blood is held hypotension. Low pressure baroreceptors are found in the large veins, pulmonary vessels of the lungs, and in the walls of the heart itself, large systemic veins and the walls of right atrium.

b. **Chemoreceptors:** These are sensory neurons that monitor levels of CO<sub>2</sub> and O<sub>2</sub>. These neurons alert the cardiovascular center when levels of O<sub>2</sub> drop or levels of CO<sub>2</sub> rise (which result in a drop in pH). Chemoreceptors are found in carotid bodies and aortic bodies located near the carotid sinus and aortic arch.

The kidneys provide a hormonal mechanism for the regulation of blood pressure by managing blood volume. The renin-angiotensin-aldosterone system of the kidneys regulates blood volume.

## ➤ Hypertension

Blood pressure is the force exerted by the blood against the walls of the blood vessels. It depends on stroke volume or heart rate and the resistance of the blood vessels. Hypertension is a blood pressure higher than 140 over 90 mmHg. The systolic reading of 140 mmHg refers to the pressure as the heart pumps blood around the body. The diastolic reading of 90 mmHg refers to the pressure as the heart relaxes and refills with blood.

Ranges of blood pressure in mmHg.

	Systolic	Diastolic
Normal blood pressure	120	80
Prehypertension	Between 120 and 139	Between 80 and 89
Stage 1 hypertension	Between 140 and 159	Between 90 and 99
Stage 2 hypertension	160	100
Hypertensive crisis	180	110

During blood pressure checkup if the reading shows a hypertensive crisis, the person should wait 2 or 3 minutes and then repeat the test. If the reading is the same or higher, this is a medical emergency. The person should seek immediate attention at the nearest hospital.

**Causes:** Blood pressure varies throughout the day. It is lower during sleep and higher on awakening. Occasionally having high blood pressure for a short time is a normal physiological response to many situations like acute stress and intense exercise, for example, can briefly elevate blood pressure in a

healthy person. For this reason, a diagnosis of hypertension normally requires several readings that show high blood pressure over time. However, a reading of 180 over 110 mmHg or higher could be a sign of a hypertensive crisis that warrants immediate medical attention.

**Risk factors:** A number of risk factors increase the chances of having hypertension e.g. age, size & weight, sex (The lifetime risk is the same for males and females, but men are more prone to hypertension at a younger age i-e below 40 years, while rates tend to be higher rate in women at older ages i-e above 40 years), chronic kidney diseases, high cholesterol level, physical inactivity, salt-rich diet associated with processed and fatty foods, low potassium in the diet, alcohol and tobacco use, certain diseases and medications and family history of high blood pressure and poorly managed stress also contribute.

**Primary hypertension:** High blood pressure that is not caused by another condition or disease is called primary, or essential, hypertension. If it occurs as a result of another condition, it is called secondary hypertension. It can result from multiple factors, including blood plasma volume and activity of the hormones that regulate blood volume and pressure. It is also influenced by environmental factors, such as stress and lack of exercise.

**Secondary hypertension:** High blood pressure that is the complication of another problem e.g. diabetes, chronic kidney disease (CKD) is a common cause of high blood pressure, because the kidneys do not filter out fluid. This fluid overload leads to hypertension and nerve damage, a rare cancer of an adrenal gland, Cushing syndrome, which can be caused by corticosteroid hormones, congenital adrenal hyperplasia, hyperthyroidism, or overactive thyroid gland, hyperparathyroidism, which affects calcium and phosphorous levels, pregnancy, sleep apnea, obesity and common reversible causes of secondary hypertension are excessive alcohol intake.

**Symptoms:** A person with hypertension may not notice any symptoms, and it is often called the "silent killer." While undetected, it can cause damage to the cardiovascular system and internal organs, such as the kidneys. Long-term hypertension can cause complications through atherosclerosis, where the formation of plaque results in the narrowing of blood vessels. This makes hypertension worse, as the heart must pump harder to deliver blood to the body. Hypertension-related atherosclerosis can lead to heart failure and heart attacks, An aneurysm, or an abnormal bulge in the wall of an artery that can burst, causing severe bleeding and, in some cases, death, Kidney failure, Stroke & Hypertensive retinopathies in the eye, which can lead to blindness.

**Diagnosis:** Diagnosis of hypertension is made by measuring blood pressure over at least 3 clinic visits using the upper-arm cuff device called a sphygmomanometer. The doctor will take a history and perform a physical examination before diagnosing hypertension. Some additional tests may include, urine tests, kidney ultrasound imaging, blood tests & electrocardiogram (ECG) and an echocardiograph. **Treatment:** Lifestyle choices can contribute to the treatment and prevention of high blood pressure, and they can have wider benefits for the heart and overall health e.g. salt intake, more fruits & vegetables, less fats, reducing weight & finally drug treatment.

## ➤ Hypotension

Blood pressure is the force of blood pushing against the walls of the arteries as the heart pumps out blood. Hypotension is abnormally low blood pressure. Normal blood pressure in adults is about 120/80 mm Hg. Hypotension is blood pressure that is lower than 90/60 mmHg. Blood pressure also varies time to time. It lowers during sleep and rises during awakening. Human body is very sensitive to changes in blood pressure. For example, if one stand up quickly, blood pressure may drop for a short time. Body adjusts the blood

pressure to make sure enough blood and oxygen are flowing to brain, kidneys, and other vital organs. Mostly hypotension happen because body can't bring blood pressure back to normal or can't do it fast enough. Some people have low blood pressure all the time. They have no signs or symptoms, and their low blood pressure is normal for them.

**Causes & symptoms of Hypotension:** Conditions which causes hypotension include dehydration is common among patients with prolonged nausea, vomiting, diarrhea, or excessive exercise which shunts blood away from the organs to the muscles. Other causes of dehydration include exercise, sweating, fever or heat stroke. Individuals with mild dehydration may experience only thirst and dry mouth. Moderate to severe dehydration may cause lightheadedness, dizziness, or fainting upon standing. Prolonged and severe dehydration can lead to shock, kidney failure, confusion, acidosis (too much acid in the blood), coma, and even death. Moderate or severe bleeding can quickly deplete an individual's body blood, leading to hypotension. Severe inflammation of organs inside the body can cause low blood pressure. In inflammation fluid leaves the blood vessels to enter the inflamed tissues concentrating blood and reducing its volume. The fore said conditions causes these Symptoms i-e Fainting (syncope), Dizziness, A feeling of lightheadedness, Chest pain, Blurred vision, Increased thirst & Nausea

**Treatment:** Hypotension readings in healthy individuals without symptoms or organ damage need no treatment. All symptomatic patients should be evaluated by a doctor. Patients who have severe low blood pressure from their usual levels even without the development of symptoms also should be evaluated. The doctor needs to identify the cause of the low blood pressure; remedies will depend on the cause. For example, if a medication is causing the low blood pressure, the dose of medication may have to be reduced or the medication stopped. Similarly if dehydration, blood loss etc. must be recovered according to the directives of physician.

→ Cardiovascular disorders