

## REVIEW ON BLOOD PRESSURE VARIABILITY AND ITS SIGNIFICANCE

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### ABSTRACT:

Blood pressure (BP) is the pressure or resistance that exists in the walls of the blood vessels and heart. A circadian rhythm of pumping of the heart that results in repetitive pressure is called Blood pressure. Systolic Blood pressure is the maximum pressure in one heartbeat and Diastolic Blood Pressure is the minimum pressure in two heartbeats in the cardiac cycle. Many physiological factors which affect blood pressure in a normal individual are called Blood Pressure variability. This article aimed to overview the blood pressure variability and its significance. We concluded that the blood pressure can vary according to the position of the patient, the arm which is used for taking blood pressure should be considered for routine clinical practice.

**Keywords:** Blood pressure, Variability, Systolic, Diastolic, Baroreceptors, innovative technique.

### INTRODUCTION:

Blood pressure is a non-unique and uncertain pressure of circulating blood against the walls of blood vessels (arteries)(1,2). There is a circadian rhythm of pumping of the heart that results in repetitive pressure known as Blood Pressure. When the term 'Blood Pressure' is used without a qualification it is known as the pressure in the large arteries(3). Blood pressure is usually expressed in terms of "maximum pressure in one heartbeat" (systolic) over "minimum pressure in two heartbeats" (diastolic) in the cardiac cycle(4).

During evaluating the patients' health condition Blood pressure is considered as one of the important vital signs along with the respiratory rate, heart rate, oxygen saturation, and body temperature(5,6). In the early days, Blood pressure was measured non-invasively using auscultation with either an aneroid gauge or using a mercury tube sphygmomanometer(7). Still in clinics auscultation is considered as a gold standard method of finding blood pressure and also its variability.

Blood pressure having a constant low pressure is called hypotension, blood pressure that shows constant high pressure is known as hypertension, and the blood pressure having a normal pressure of consistency is known as normotension. Both hypotension and hypertension have many causes and may be due to a sudden onset or of long duration(8). Long-term hypertension is more commonly considered long-term hypotension. Long-term hypertension is a cause of many risk factors like stroke, heart failure, and kidney failure. But nowadays several other factors are affecting blood pressure rather than hypertension and hypotension(9,10). In adults and children, there has been a massive change in the regularity of daily routine and change in the food habits which cause obesity conclusively results in higher blood pressure also a risk factor of having heart failure or cardiac failure.

### WHAT IS BP VARIABILITY?

Generally, Blood Pressure variability is known as when there is a change in the measured blood pressure from time to time. There are two types of BP variability (I) long term and (ii) short term.

Long-term BP variability is defined as the oscillation of the blood pressure over a long time as months to years, in individuals with definite cardiovascular risk factors.

Short-term BP variability is defined as the oscillation of blood pressure within 24 hours. The fluctuation of blood pressure in a time range from minutes to hours mainly reflects the influence of central and autonomic modulation(11,12).

### METHODS OF BLOOD PRESSURE ESTIMATION:

Clinically the constant location for the blood pressure measurement is the brachial artery, it's very common to measure the pressure at the wrist of an individual using a finger grip. But the most important thing to remember is that systolic and

diastolic pressure varies substantially in different parts of the arterial tree with systolic pressure increases more in the distal arteries and decreasing in diastolic arteries.

#### **AUSCULTATORY METHOD:**

In the auscultatory method, it is done using the mercury sphygmomanometer is commonly considered as the gold standard method of estimating the blood pressure value. But later this method started to decrease and diminish due to the ban of sphygmomanometer because of mercury pollution that is constantly increasing. Also there is a decrease in the mercury resources in the environment. As a result of this condition an aneroid manometer is used which was not sufficiently giving a proper reading. Later, a new device known as hybrid sphygmomanometers has been developed and used in clinical conditions(13).

#### **OSCILLOMETRIC TECHNIQUE:**

This method was first discovered and demonstrated by Marey in 1876, it was constantly shown that when there are oscillations of pressure seen in a sphygmomanometer cuff are recorded during gradual deflation, the point of maximal oscillation with respect to the mean intra-arterial pressure. The oscillation starts at systolic pressure (approx.) and continues down to the diastolic pressure and because of that, both systolic and diastolic pressure can be estimated indirectly according to the derived non-conditional algorithm. This method was considered more comfortable during resting as they can adjust or remove the cuff and place it wherever it is necessarily needed, but there are slight complications like they are not that predictable during physical movement until it is a monitored movement. The oscillometer technique has been used successfully in ambulatory blood pressure monitors and home monitors. It should be pointed out that different brands of oscillometer recorders use different algorithms, and there is no generic oscillometer technique(14).

#### **ULTRASOUND TECHNIQUES:**

In this technique an ultrasound transmitter and a receiver are placed under the flat sphygmomanometer cuff over the brachial artery. Considerably the cuff is deflated and due to its significance property, the movement of the arterial wall at the systolic pressure causes a doppler effect in the resulting ultrasound graph and diastolic pressure is considered as the point at which the diminution of arterial motion occurs(15).

#### **FINGER CUFF METHOD OF PENAZ:**

This method was first discovered and demonstrated by Penaz, and this method especially works on the principle known as “unloaded arterial wall”. In this arterial pulsation of a finger is detected by the photoplethysmograph under a pressure cuff. This method gives a more approximate estimation of the changes in the systolic and diastolic pressure when compared to brachial artery pressure it is due to the inflated strap can be there for 2 hours(16).

#### **TYPES OF BLOOD PRESSURE:**

In general, there are mainly two types of blood pressure

1. Systolic blood pressure
2. Diastolic blood pressure

Systolic blood pressure is a pressure that refers to the inside of the heart when it is pumping. Diastolic blood pressure is a pressure that refers to the inside of the heart when it is resting between two consecutive beats.

#### **FACTORS AFFECTING BLOOD PRESSURE:**

Being overweight or Obese:

Due to excessive weight, there is an excessive amount of oxygen supply needed for the blood and nutrient supply for the tissues. When a larger amount of oxygen is deployed then there will be more pressure on the arterial walls which leads to increased blood pressure.

Too much salt in diet(sodium):

Excessive amounts of sodium in the body can retain fluid content and can activate more of the sodium channel in the renal and also results in the arteries of the body constricting and sometimes result in renal failure and also hypertension (increased blood pressure)(17).

Extra potassium in diet:

Mainly potassium is used to balance sodium in the body, and excessive potassium may result in relaxing the arterial walls more than needed, resulting in hypotension (low blood pressure).

No physical activities:

Regular exercise increases blood pressure through all arteries of the body, which promotes the release of hormones, vasodilators, and cytokines, which cause smooth muscle relaxation and blood vessel dilation, lowering blood pressure. Lack of physical activity also increases the risk of hypertension (18).

**Alcohol:**

Alcoholism causes hypertension and this is due to activating the adrenergic nervous system which leads to constriction of blood vessels and increases in more blood flow and these occur simultaneously(19).

**Stress:**

High levels of stress can always lead to temporary but a drastic increase in blood pressure which results in hypertension. But by eating, alcohol, and smoking we try to reduce the stress. It will always result in causing several problems related to high blood pressure, so it is always safe to use meditation to control stress.

**Non-steroidal anti-inflammatory drugs (NSAIDs):**

NSAIDs like Ibuprofen can cause marked worsening of existing hypertension through renal damage, impaired venous return, and impaired cardiovascular perfusion. Other drugs in this family are naproxen, sulindac, diclofenac, piroxicam, indomethacin, Mobic, Lodine, and celecoxib. (20).

**Chronic conditions:**

Certain chronic conditions, including diabetes, kidney disease, and sleep apnoea, also may increase your risk of high blood pressure(21).

**Diet low in vitamin D:**

It is well known that having a low vitamin D diet can always result in high blood pressure. If there is no sufficient vitamin D it will destroy an enzyme that is secreted in the body resulting in hypertension(5).

**REGULATION OF BLOOD PRESSURE:**

**Baroreceptor reflex:**

When there is an acute change in the blood pressure the body responds to it through the baroreceptor that is located within the blood vessels. Baroreceptors(Figure 1) are a form of mechanoreceptors that can be activated by stretching the wall of blood vessels(22,23). This sensory information is received in the central nervous system and used to constrain the peripheral vascular resistance and cardiac output(24). There are two types of baroreceptors (i) High-pressure baroreceptor and (ii) Low-pressure baroreceptor(25).

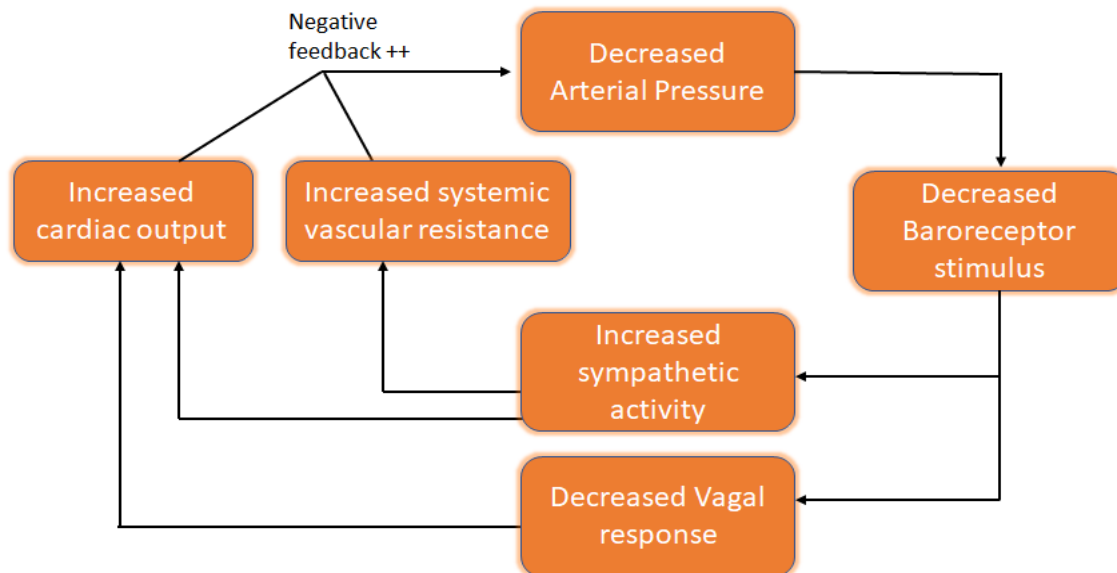


Figure 1: Baroreceptor response in regulation of Blood Pressure.

In a high-pressure baroreceptor, the carotid baroreceptor will respond to both increase and decrease in the blood pressure and sends the afferent signal via the 9th cranial nerves(26). The aortic arch baroreceptor only responds to an increase in blood pressure and sends its signal to the 10th cranial nerve(27).

In a low-pressure baroreceptor, they are located within the low-pressure venous system. antidiuretic hormone, renin, and aldosterone secretion due to low-pressure baroreceptor action induced low-frequency action potentials to lead to a downstream effect to regulate arterial pressure(28).

Antidiuretic hormone:

Antidiuretic hormone (ADH) is also known as vasopressin. It is a hormone synthesized in the magnocellular neurosecretory cells within the paraventricular and supraoptic nucleus in the hypothalamus (29). Its synthesis is resulting from low and high-pressure baroreceptors stimulation and osmoreceptor stimulation in the hypothalamus. It also results from the action of Angiotensin II in renin-angiotensin system activation (30).

Renin angiotensin aldosterone mechanism:

When there is an increased Blood pressure, the juxtaglomerular apparatus will release renin in the kidney and the renin will produce angiotensin and it will get converted into angiotensin I using the enzyme angiotensinase and similarly it will get converted into angiotensin II using the same enzyme, it will result in increase absorption of sodium and water in renal which eventually results in a decrease of blood pressure to normal level (31,32).

#### **DISEASES RELATED TO BLOOD PRESSURE:**

Due to increased blood pressure:

1. Essential Hypertension: It is a condition in which the pressure on the arterial wall is considerably more than required (28).
2. Cardiovascular disease: It is a condition where the arterial walls are diseased and there are blood clots in the walls of blood vessels (33), (34).
3. Mental disorder: A wide range of probability of affecting the mood, thinking, and normal functions of the brain (35).

Due to decreased blood pressure:

1. Dehydration: When extreme loss of body fluid due to sweating, inadequate intake, and illness results in decreased blood pressure (36).
2. Orthostatic hypotension: It is also known as postural hypotension where an individual's blood pressure is decreased to an extent. (37).
3. Sepsis: A life-threatening complication of infection that leads to decreased blood pressure in the body. (38).
4. Addison's disease: A disorder in which the adrenal glands don't produce enough hormones. (39).

#### **BLOOD PRESSURE VARIABILITY:**

(i) Position:

1. Diastolic pressure variability: When the blood pressure is taken in the sitting position diastolic blood pressure will be 5mmHg higher than the supine position (40).
2. Systolic blood pressure variability: Systolic pressure can be 8 mmHg higher when the arms are at the heart level than when a patient is in the supine position rather than sitting (12).
3. Supporting the arms and back: When a patient supports their arm while taking the blood pressure, it may show an increase in both diastolic and systolic Blood pressures. The diastolic blood pressure will be increasing by 6mmHg if the patient is not supporting his back. A rise in systolic pressure by 2-8 mmHg is seen when the patient is in crossed leg position (41).

(ii) Age (42):

1. Children tend to have normal Blood pressure conditions rather than adults.
2. Adults have a higher blood pressure than normal
3. Old people tend to have low blood pressure among all the age group
4. Pregnant women always have high blood pressure and it will increase during pregnancy.

(iii) Arm position:

Arm position plays a dramatic role in value errors as well. While taking the blood pressure reading, a higher blood pressure value can be noticed if the arm is below the level of heart and a lower blood pressure value will be seen if the arm is above the level of the heart. A 2mmHg blood pressure variation is seen for every inch the arm is above or below the level of the heart (43). Our team has extensive knowledge and research experience that has translate into high quality publications ((44-53)), ((54-63)).

#### **CONCLUSION:**

In this article, we overviewed the different physiological factors that cause Blood Pressure variability in detail and highlighted the pathological factors affecting blood pressure. We conclude that the factors causing blood pressure variability and the definite variation levels of blood pressure should be instructed and followed in routine clinical practice.

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No conflicts of interest in the present study.

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