

## MEASUREMENT OF BLOOD PRESSURE

Blood pressure is considered a good indicator of the status of cardiovascular system. Blood pressure measurements has been saved many persons from death by providing a warning of hypertension in time to take treatment. There are two pressures they are systolic pressure and diastolic pressure.

Systolic pressure:

Maximum pressure reached during cardiac ejection is called systolic pressure.

Diastolic pressure:

Minimum pressure occurring at the end of a ventricular relaxation is termed as diastolic pressure.

The normal values in the basic circulatory system are

Arterial System – 30 to 300 mmHg

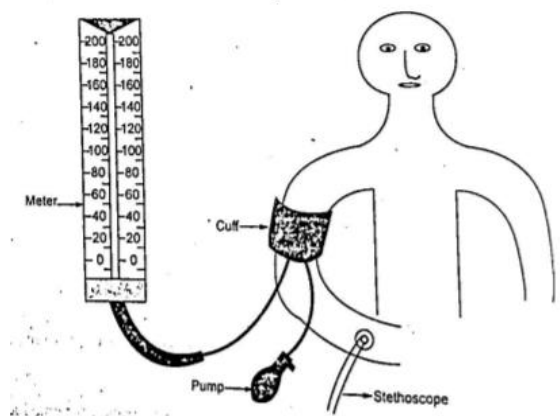
Venous System – 5 to 15 mmHg

Pulmonary System – 6 to 25 mmHg

Blood pressure is usually measured by two methods. They are Direct method and Indirect method.

### In-Direct Method or Non-Invasive Method:

Blood pressure measured by indirect method using a sphygmomanometer and a stethoscope. The sphygmomanometer consists of an expandable pressure cuff and a mercury or aneroid manometer to measure the pressure in the cuff.



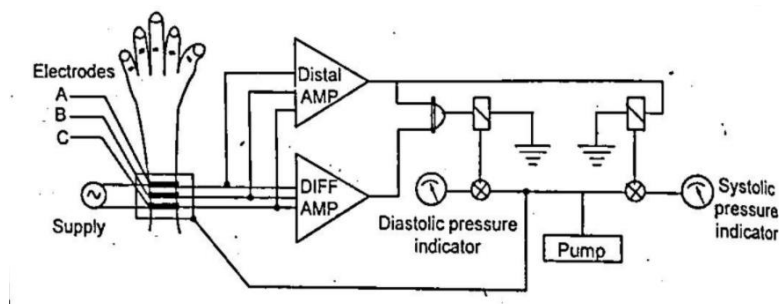
**Fig: Sphygmomanometer**

Principle:

- When the cuff is placed on the upper arm and expanded arterial blood can flow but only when the arterial pressure exceeds the pressure in the cuff.
- The sounds generated by this disturbance can be heard through a stethoscope placed over the downstream of artery from the cuff. Then the sound is known as Korotkoff sounds.
- If the pressure exceeds above systolic pressure no sound can be heard through the stethoscope.
- If the pressure gradually reduced as soon as cuff pressure falls below systolic pressure, a small amount of blood rush the cuff and Korotkoff sounds being too heard through stethoscope.
- The pressure in the cuff continues to drop and block the vessel during any part of the cycle then Korotkoff sound disappears, and the value is recorded as diastolic pressure. It is usually 80 mmHg.
- Familiar method of locating the systolic and diastolic pressure values by listening the Korotkoff sounds is called Auscultatory method of sphygmomanometry.
- An alternative method that the physician can identifies the blood flow and feeling the pulse is called palpatory method.

Rheographic Method:

In this method a set of three electrodes were attached to the cuff are placed in contact with skin. A high frequency current source operating at 100 KHz is connected to the electrode A and C.



**Fig: Rheographic method of indirect measurement**

The impedance between any two electrodes is pressure before pressurizing the cuffs and modulated in accordance with blood flow pulsations in the artery. Therefore, arterial

pulses can be detected by the demodulation and amplification of this modulation. The same principle what we have seen in before takes place here too the only difference is diastolic pressure and systolic pressure are shown by the indicators.

**Direct Method or Invasive Method:**

A direct method of pressure measurement is used when the highest degree of absolute accuracy, dynamic response and continuous monitoring is required. This method is also used to measure the pressure in deep regions inaccessible by indirect mean. Direct measurement of blood pressure is usually obtained by any one of the three methods.

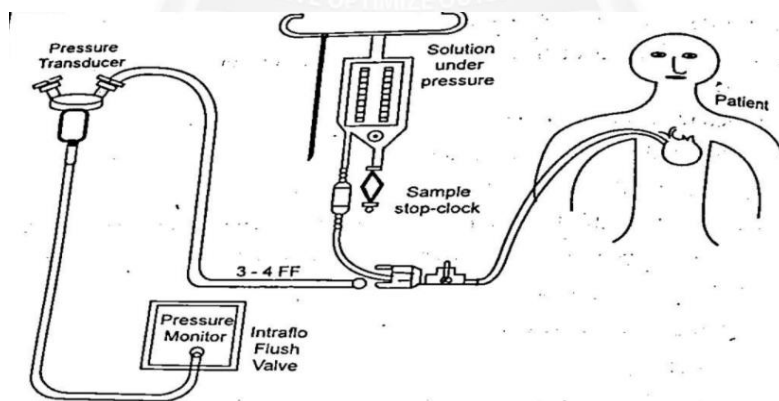
- Percutaneous insertion
- Catheterization
- Implantation of a transducer in a vessel or in the heart

Catheter tip probe:

In this type, the sensor is mounted on the tip of the probe and pressure applied on it are converted to the proportional electrical signal.

Fluid-Filled catheter type:

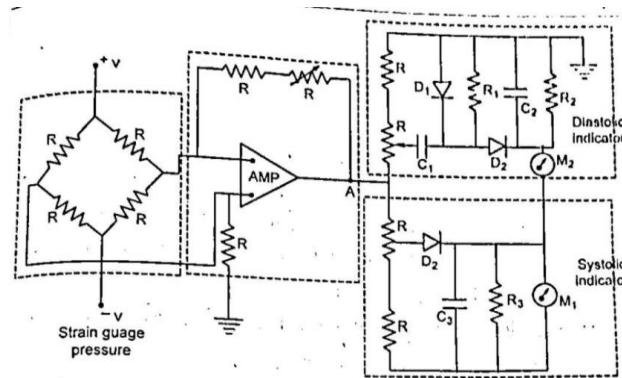
In this type, transmitted pressure applied on its fluid filled columns to an external transducer. This transducer converts the applied pressure to electrical signals. Then the electrical signals are amplified and displayed or recorded. The following diagram shows the typical set up of a pressure measurement system by direct method.



**Fig: Pressure measuring system by direct method**

Before inserting the catheters into the blood vessel, the fluid-filled should be thoroughly flushed. In practice a steady flow of sterile saline is passed through the catheter

to prevent blood clotting. As air bubbles dampen the frequency response of the system, it should be ensured that the system is free from them.



**Fig: Transducer measurement of systolic and diastolic blood pressure**

A simplified circuit diagram commonly used for processing electrical signals received from the pressure transducers for measurements of arterial pressure.

Working:

The transducer is excited with a 5V DC excitation. The electrical signals corresponding to the arterial pressure are amplified in an operational amplifier or a carrier amplifier. Modern preamplifier for processing pressure signal is the isolated type.

The input stage is a differential circuit, which amplifies pressure change and it sensed from the patient connected circuit. Gain of the amplifier can be adjusted depending upon the sensitivity of the transducer. There are two types of meters with indicator available to measure diastolic pressure and systolic pressure.

Case i:

- For the measurement of systolic pressure, a conventional peak reading type voltmeter is used.
- When a positive pulse from amplifier is separated at A, diode  $D_3$  conducts and the capacitor  $C_3$  is charging upto peak value of input signal, corresponding to systolic value.
- Capacitor  $C_3$  and Resistor  $R_3$  is used to set time constant  $RC$  to get steady state output in the indicating meter.

Case ii:

- Diastolic pressure value is derived in an indirect way.

- A clamping circuit consisting of  $C_1$  and  $D_1$  is used to develop a voltage equal to peak-to-peak value of the pulse pressure.
- The voltage appears across  $R_1$  then diode  $D_2$  conducts and capacitor charges to peak value of the pulse signal.
- Then the diastolic pressure is indicated by a second meter  $M_2$ . It shows the difference between peak systolic and peak-to-peak pulse pressure signal.

Some of the specific direct measurement techniques with important aspects are,

1. Liquid-column methods
2. Measurement at the site
3. Floatation catheter
4. Percutaneous transducers
5. Implantable transducers

