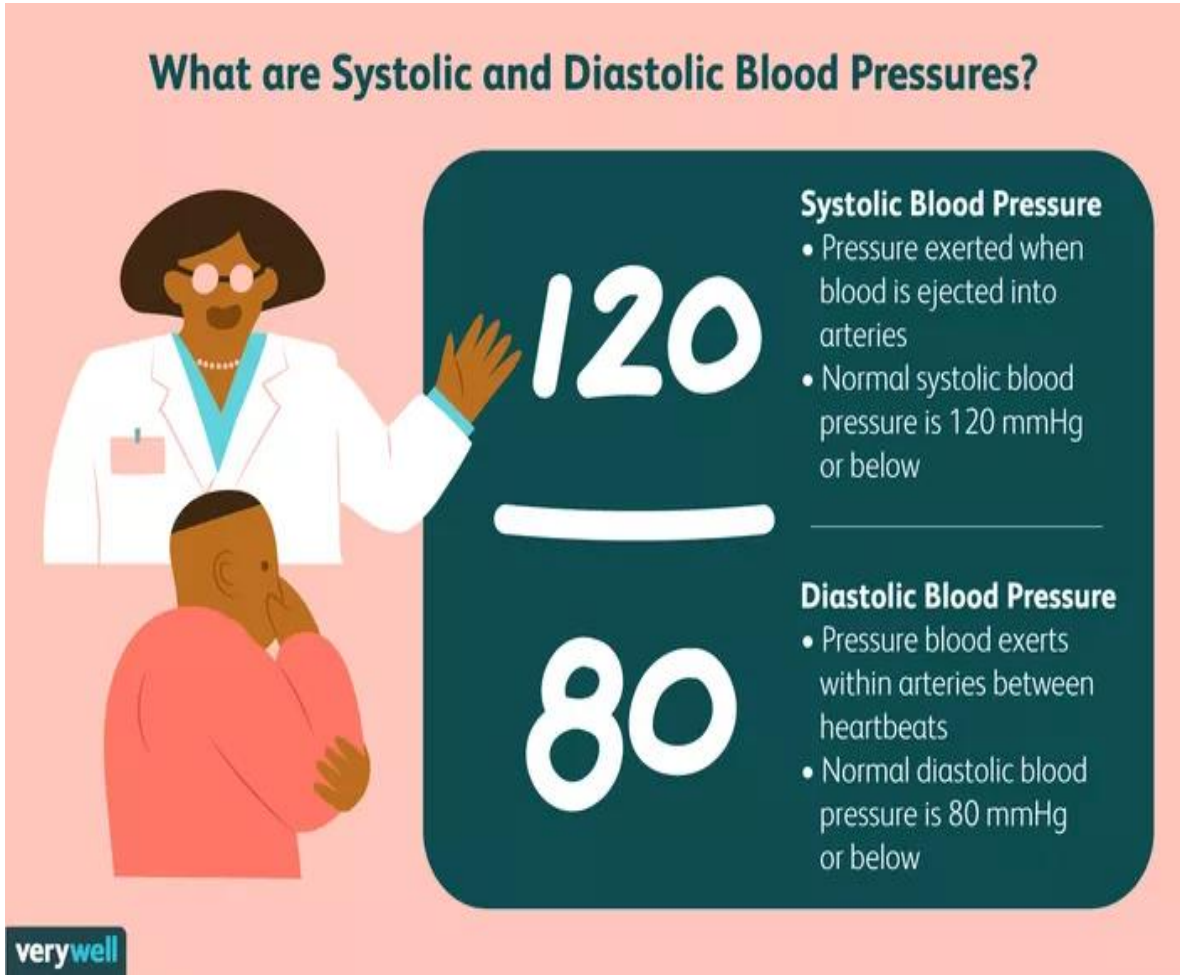
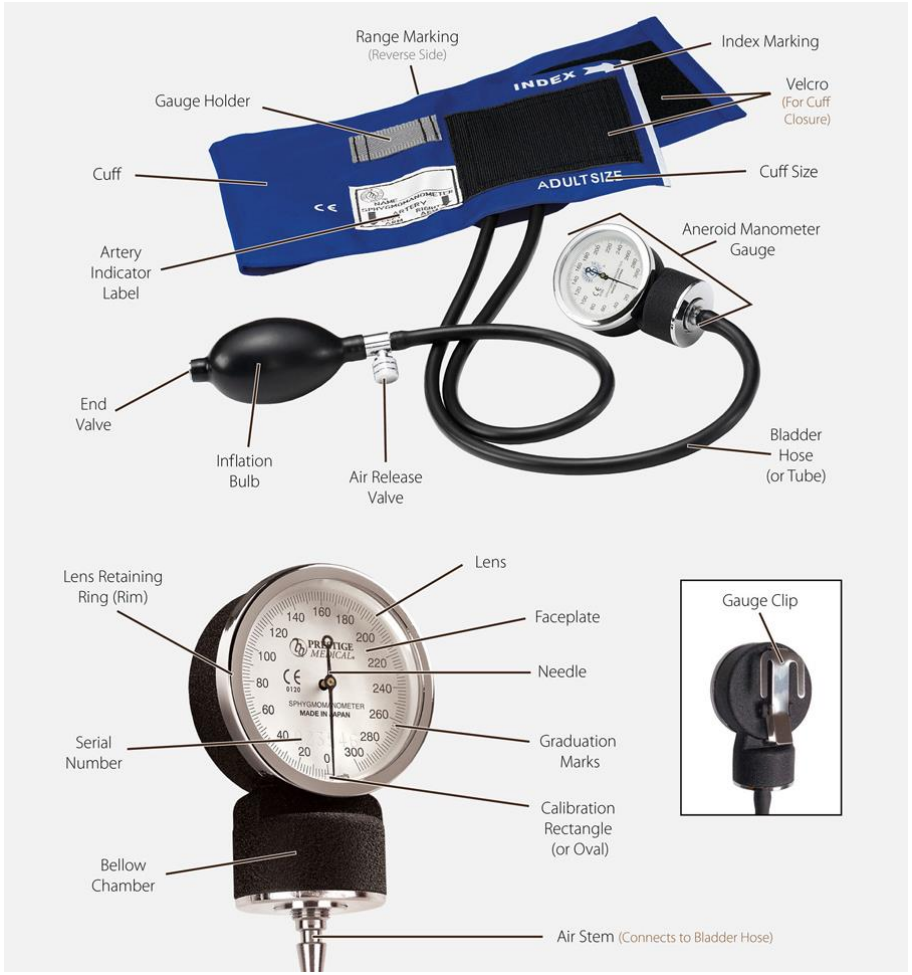
BLOOD PRESSURE

- Blood pressure is the pressure exerted by circulating blood against the walls of blood vessels.
- Types of blood pressure
  - Systolic blood pressure : refers to the maximum arterial pressure during contraction of heart
  - Diastolic blood pressure : refers to the lowest pressure within the arterial blood stream due to expansion of heart

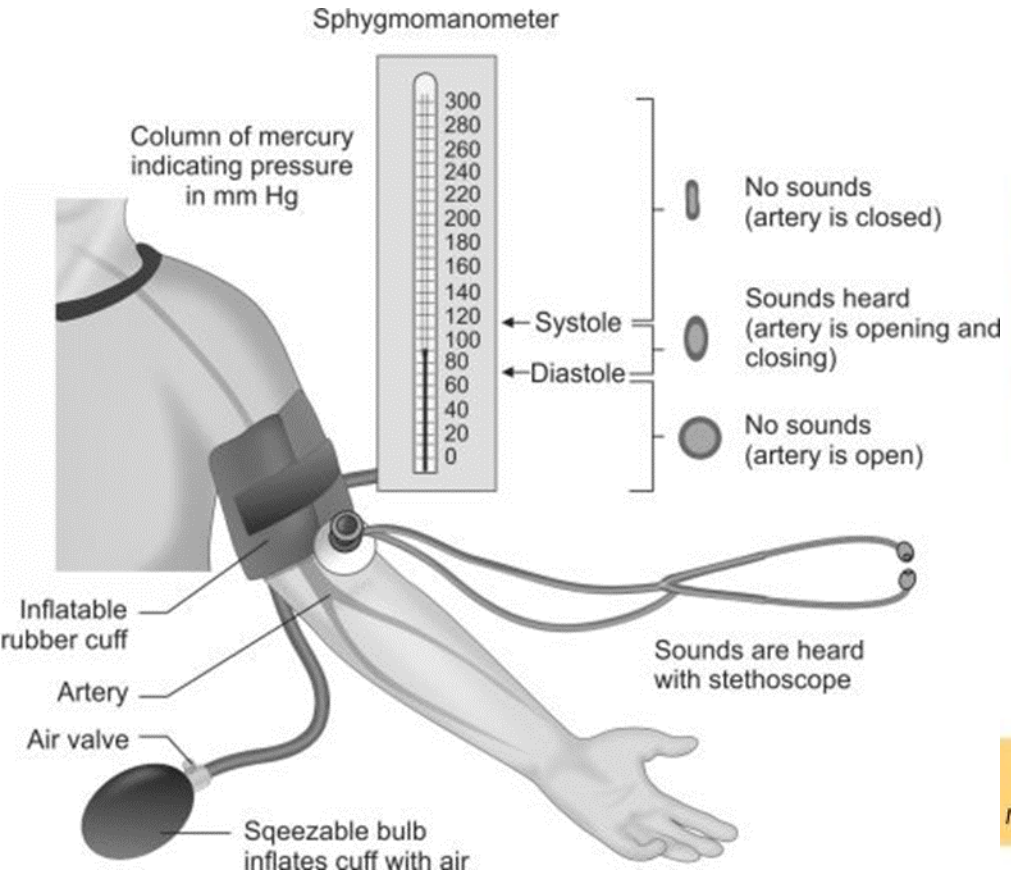


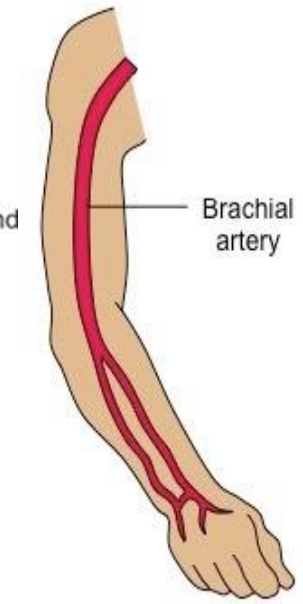
Measurement of blood pressure

- Indirect method
  - Auscultatory method
  - Osillometricmethod
- Direct method

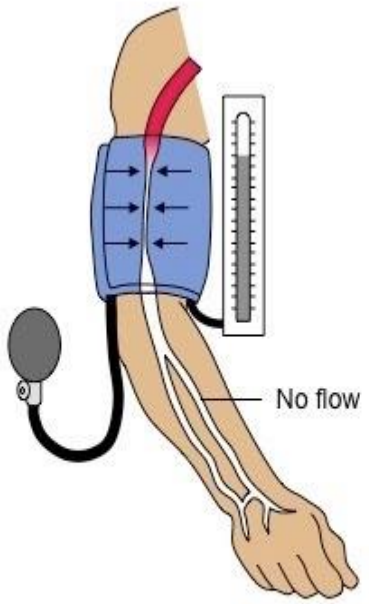


Principle of Blood pressure measurement

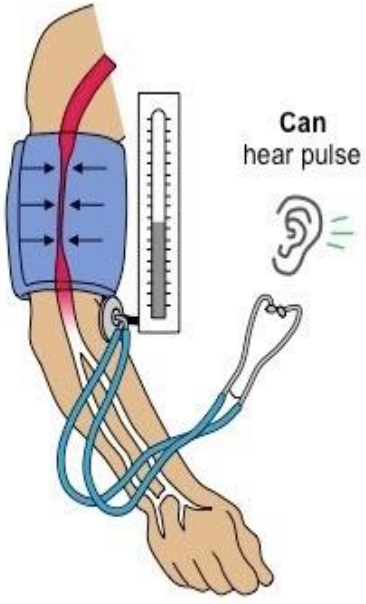




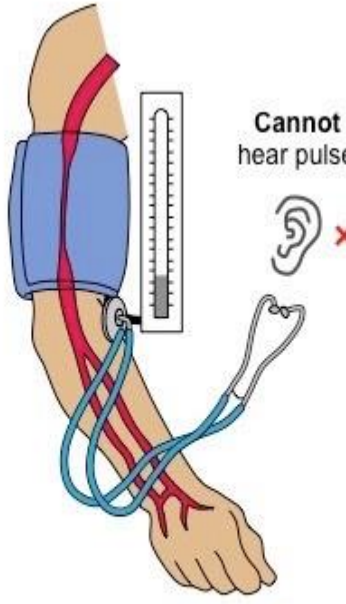
Normal Blood Flow
no occlusion of blood flow



Blood Occlusion
cuff pressure blocks blood flow

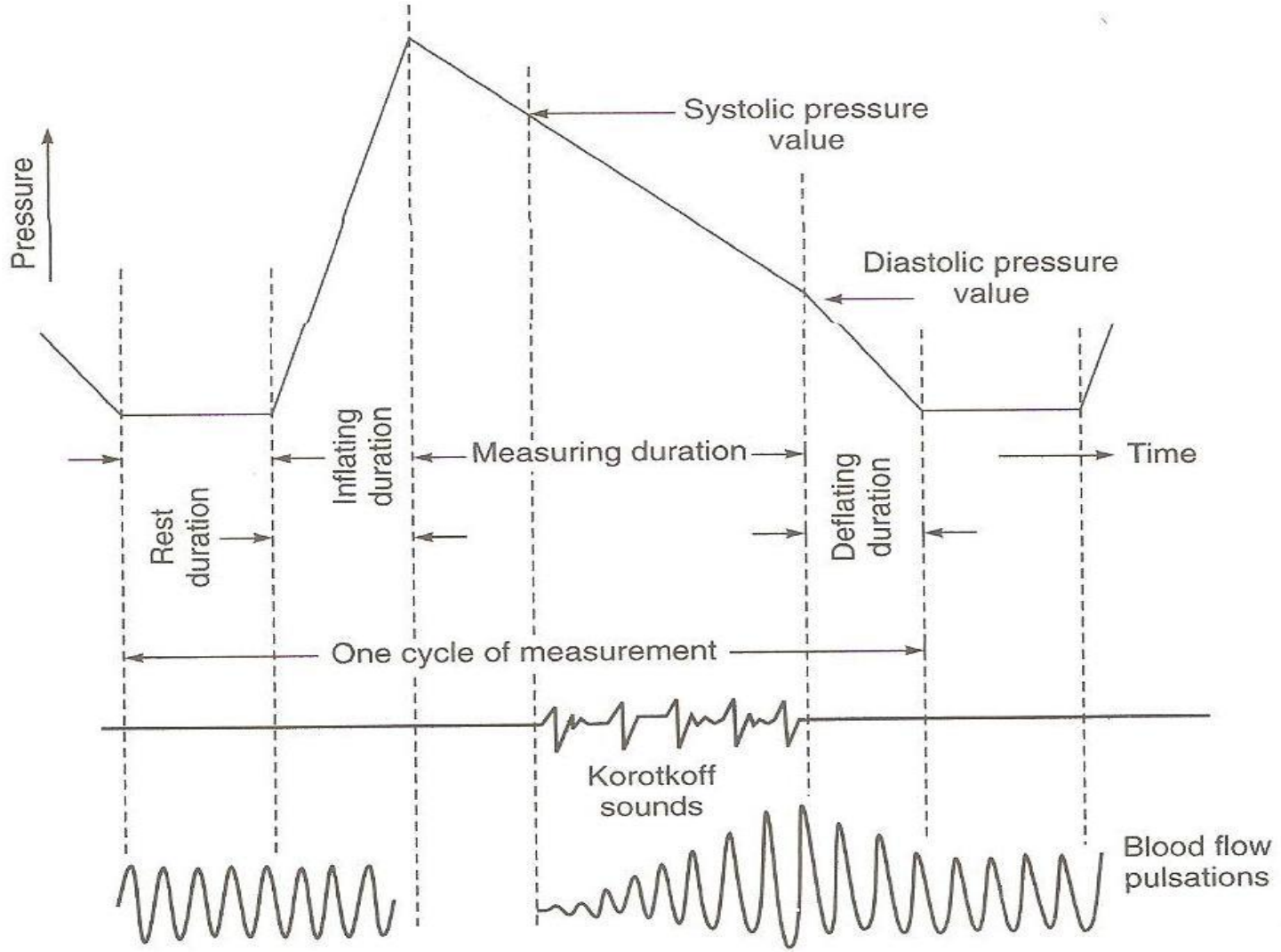


Systolic Pressure
systolic pressure > cuff pressure



Diastolic Pressure
diastolic pressure > cuff pressure

- **Korotkoff** are the sounds that medical personnel listen for when they are taking blood pressure using a non-invasive procedure



➤ Fig. 6.26 *Principle of blood pressure measurement based on Korotkoff sounds*

- The pressure cuff on the upper arm is first inflated to a pressure well above the systolic pressure.

- At this point no sound can be heard through the stethoscope, which is placed over the brachial artery, for that artery has been collapsed by the pressure of the cuff.

- The pressure in the cuff is then gradually reduced.

- When the systolic peaks are higher than the occlusive pressure, the blood spurts under that cuff and causes a palpable pulse in the wrist ***(Riva-Rocci Method)***

- Audible sounds (***Korotkoff*** (named after Dr. Nikolai Korotkoff) ***sounds)*** generated by the flow of blood and vibrations of the vessel under the cuff are heard through the stethoscope.

- The pressure of the cuff that is indicated on the manometer when the ***first Korotkoff sound*** is heard is recorded as the ***systolic blood pressure.***

- As the pressure in the cuff is continues to drop, the Korotkoff sounds continue until the cuff pressure is no longer sufficient to occlude the vessel during any part of the cycle. Below this pressure the ***Korotkoff sounds disappear***, marking the value of the ***diastolic pressure.***

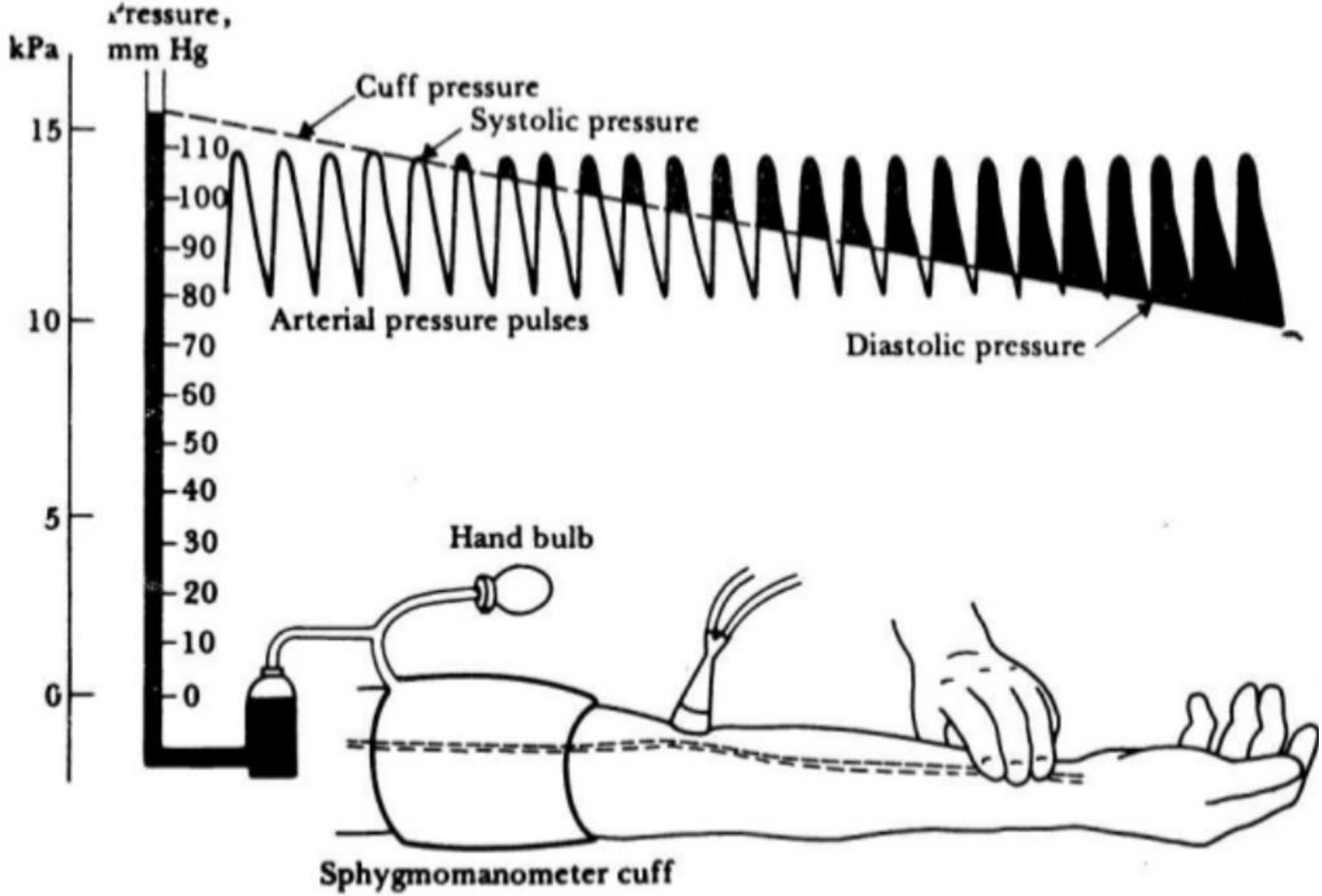
Auscultatory method

- Auscultatory (based on the Korotkoff sounds) technique is simpler and cannot be used in noisy environments.

➢The *auscultatory* method (from the Latin word for *listening*) uses a stethoscope and a sphygmomanometer. This comprises an inflatable cuff placed around the upper arm at roughly the same vertical height as the heart, attached to mercury or aneroid manometer .

➢The mercury manometer measures the height of a column of mercury, giving an absolute result without need for calibration, and consequently not subject to the errors and drift of calibration which affect other methods.

➢The use of mercury manometers is often required in clinical trials and for the clinical measurement of hypertension in high risk patients, such as pregnant women.


ressure,
kPa
mm Hg
Cuff pressure
Systolic pressure
15
110
100
90
80
10
Arterial pressure pulses
Diastolic pressure
70
60
50
40
5
Hand bulb
30
20
10
0
0
Sphygmomanometer cuff

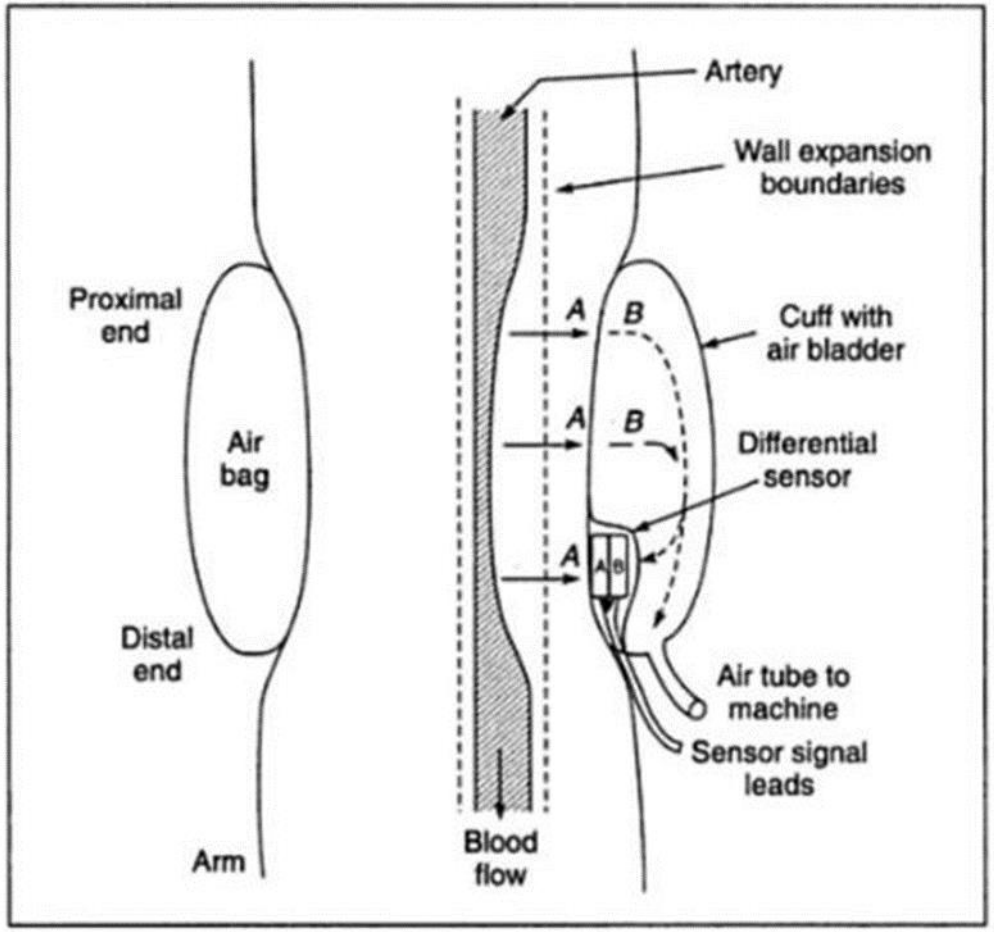
- A cuff of appropriate size is fitted smoothly ,then inflated manually by repeatedly squeezing a rubber bulb until the artery is completely occluded. Listening with the stethoscope to the brachial artery at the elbow, the examiner slowly releases the pressure in the cuff.
- When blood just starts to flow in the artery, the turbulent flow creates a "whooshing" or pounding (first Korotkoff sound). The pressure at which this sound is first heard is the systolic BP.
- The cuff pressure is further released until no sound can be heard (fifth Korotkoff sound), at the diastolic arterial pressure.
- The auscultatory method has been predominant since the beginning of BP measurements but in other cases it's being replaced by other noninvasive techniques.

Auscultatory method aneroid sphygmomanometer with stethoscope

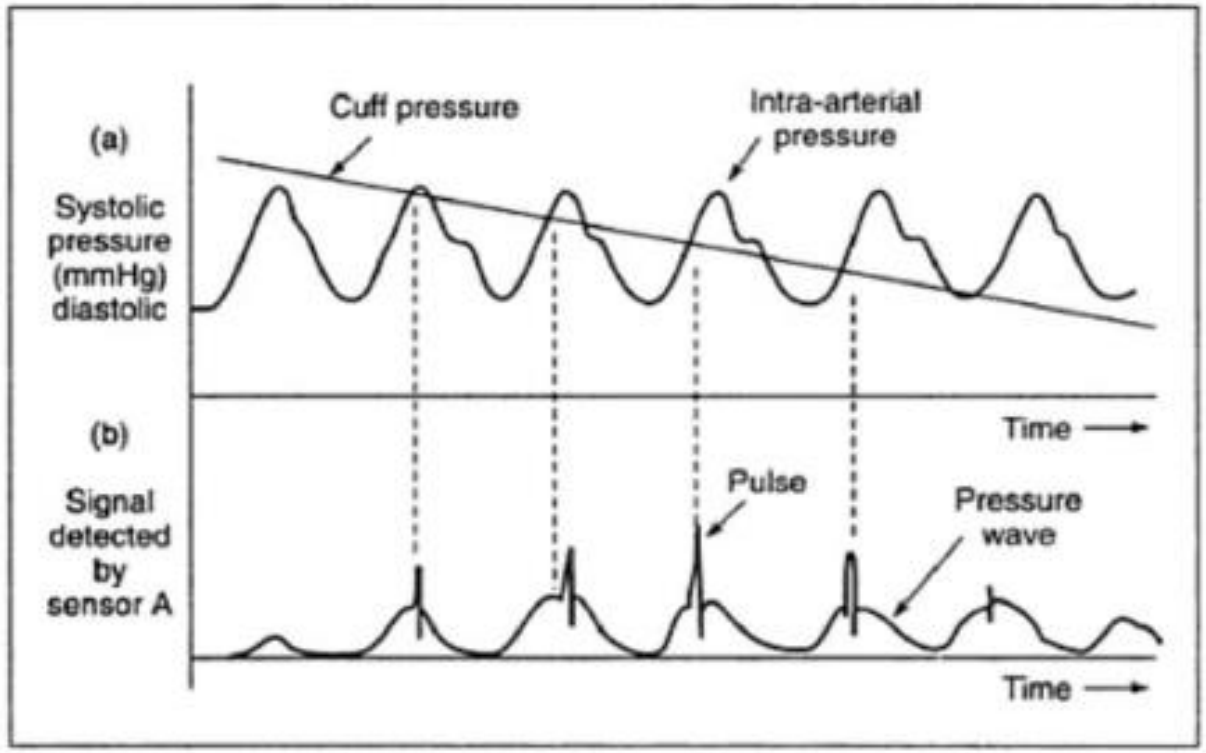
MERCURY MANOMETER

Differential Ausculatory method

- It is a Non invasive method for accurately measuring blood pressure by using special cuff mounted sensor consist of pair of pressure sensing elements, isolates the signal created each time the artery is forced open.

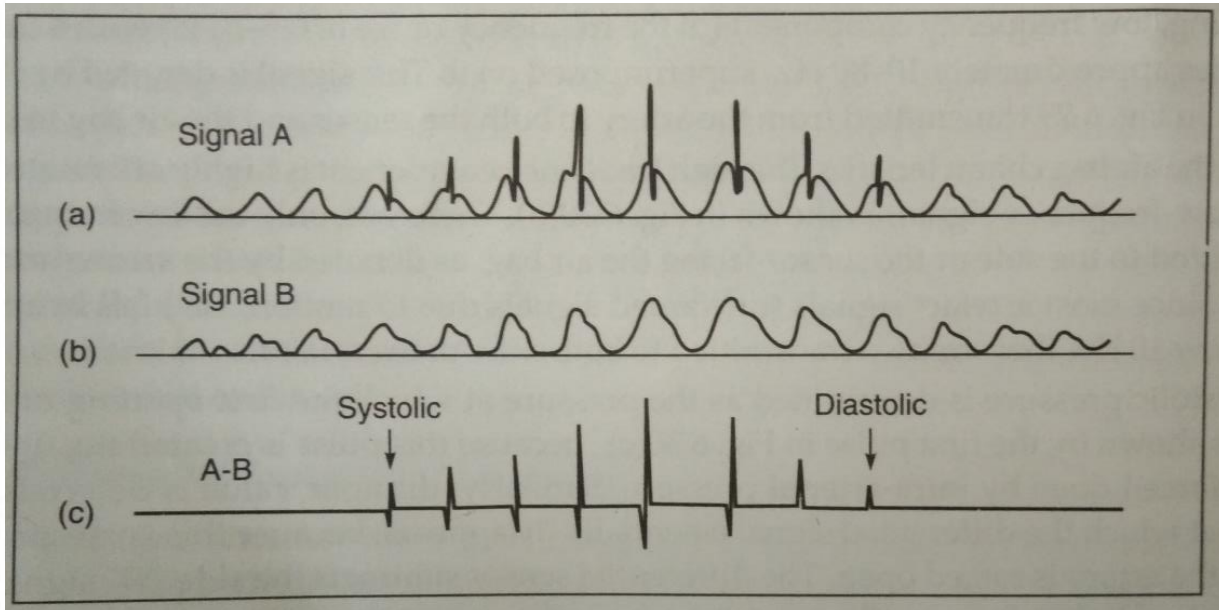


➤ **Fig. 6.29** *Cut-away view showing signal detection*



5.28 (a) *Diagram showing the relationship between cuff pressure and intra-arterial pressure*

(b) *Signal created by the relative pressure changes*



6.30 (a) *Signal generated by artery as air is bled from cuff*

(b) *Signal 'A' after filtering by air bag (equivalent of oscillometric signal created by expansion of arterial walls; frequencies are in 0.5 – 5 Hz range)*

(c) *Differential signal due to opening and closing of artery (frequency range 10-80 Hz)*

OSCILLOMETRIC METHOD

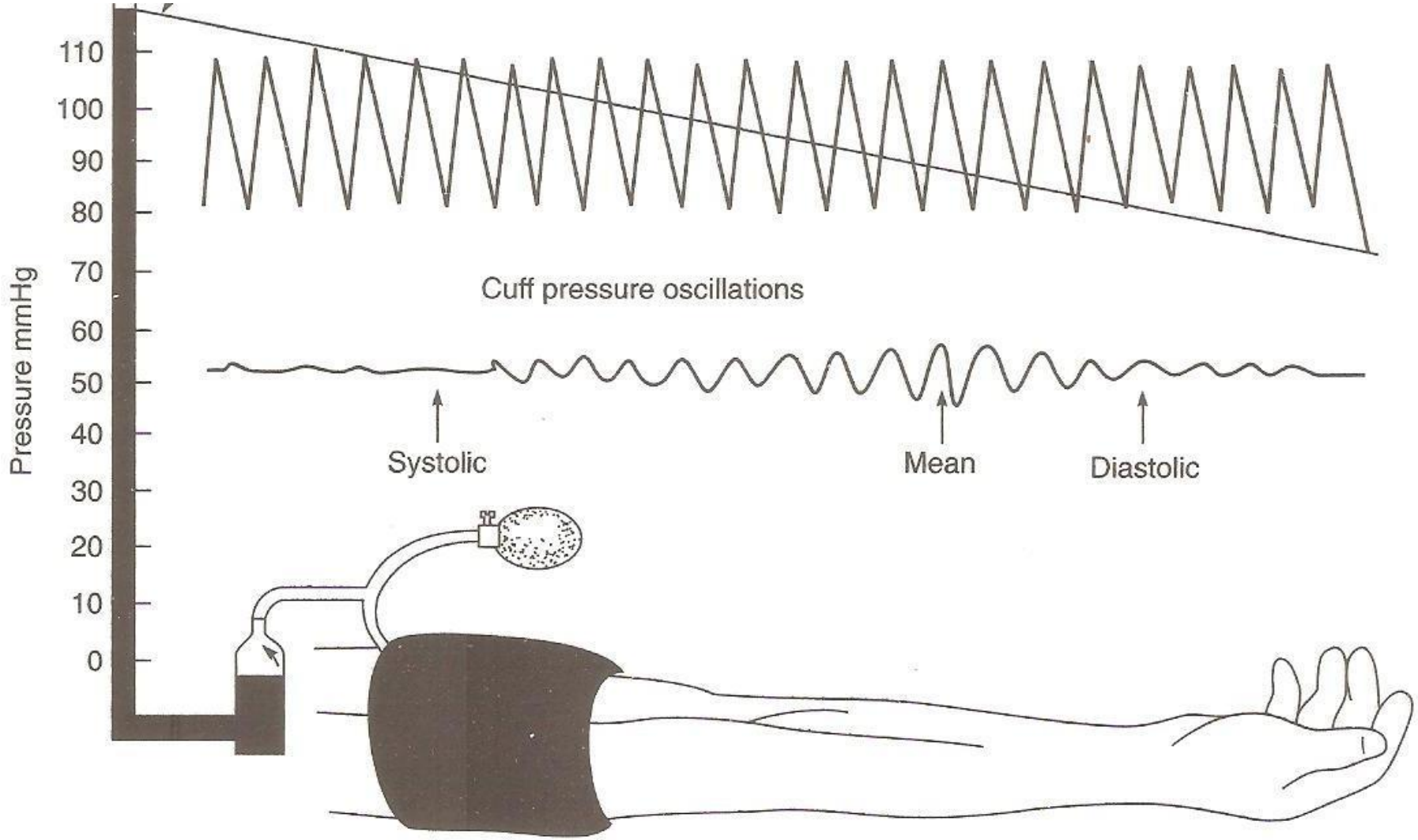
- Automated method of non invasive BP measurement
- It has some distinct advantages over the auscultatory method
- Sound is not used during measurement
- This technique does not require a microphone or transducer in the cuff.

- Disadvantage of oscillometric method as well as auscultatory method is that the excessive movement or vibration can cause inaccurate readings

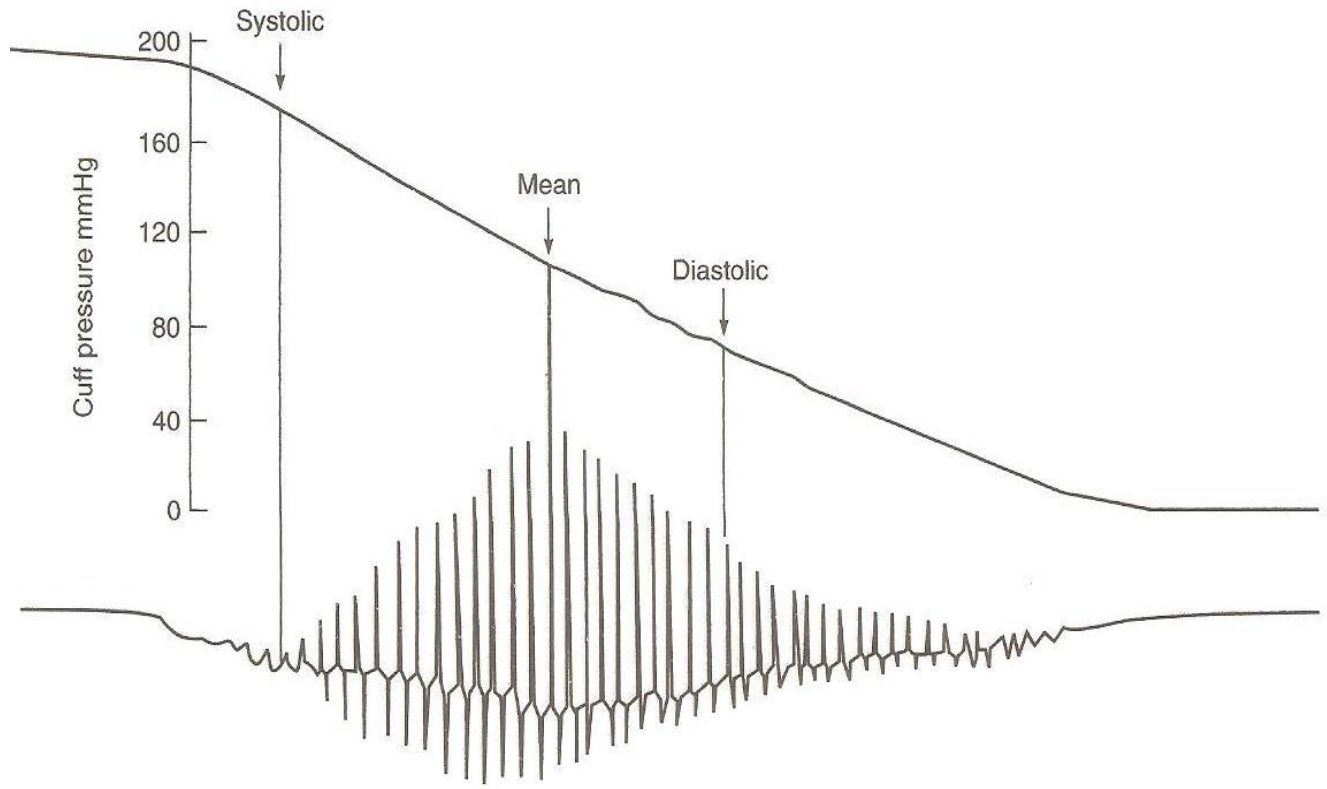
PRINCIPLE

- "occluding cuff deflates from a level above the systolic pressure,the artery walls begin to vibrate as the blood flows through the partially occluded artery and these vibrations will be sensed in the transducer system monitoring cuff pressure"

OSCILLOMETRIC METHOD



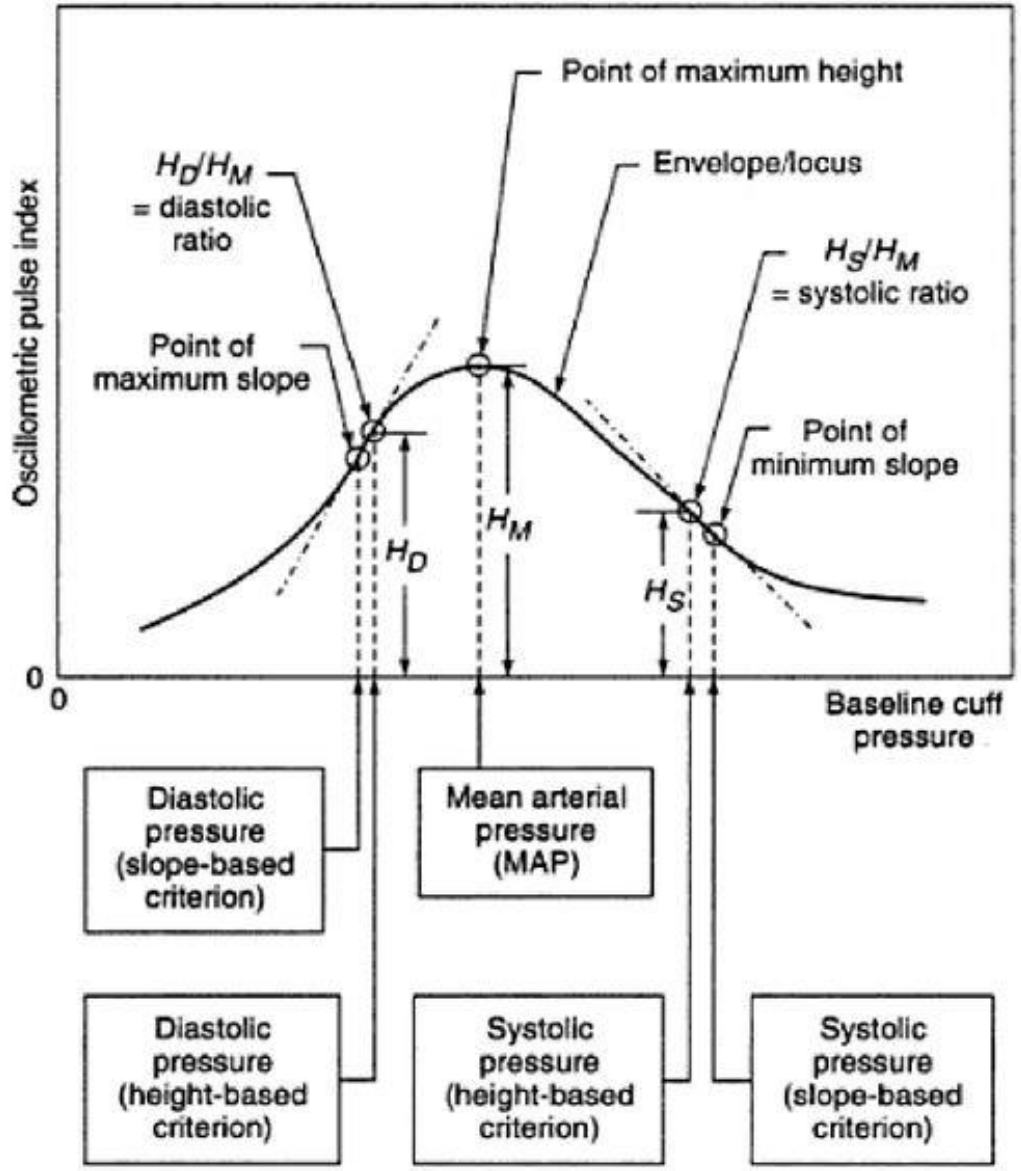
(a) Oscillometric method



➤ Fig. 6.31 *Illusration of oscillometric method of blood pressure measurement*

- The cuff pressure at the point of maximum oscillations usually corresponds to the mean arterial pressure.
- The point above the mean pressure at which the oscillations begin to rapidly decease in amplitude correlates with the diastolic pressure.

Oscillometric measurement:



➤ **Fig. 6.32** *Criteria for oscillometric blood pressure determination*

ULTRASOUND METHOD

- A transcutaneous (through the skin) Doppler sensor is applied here. T he motion of blood-vessel walls in various states of occlusion is measured. The vessel opens and closes with each heartbeat when DP < P < SP .
- The frequency difference between transmitted (8 MHz) and received signal is 40-500 Hz and it is proportional to velocities of the wall motion and the blood. As the cuff pressure is increased, the time between opening and closing decreases until they coincide.

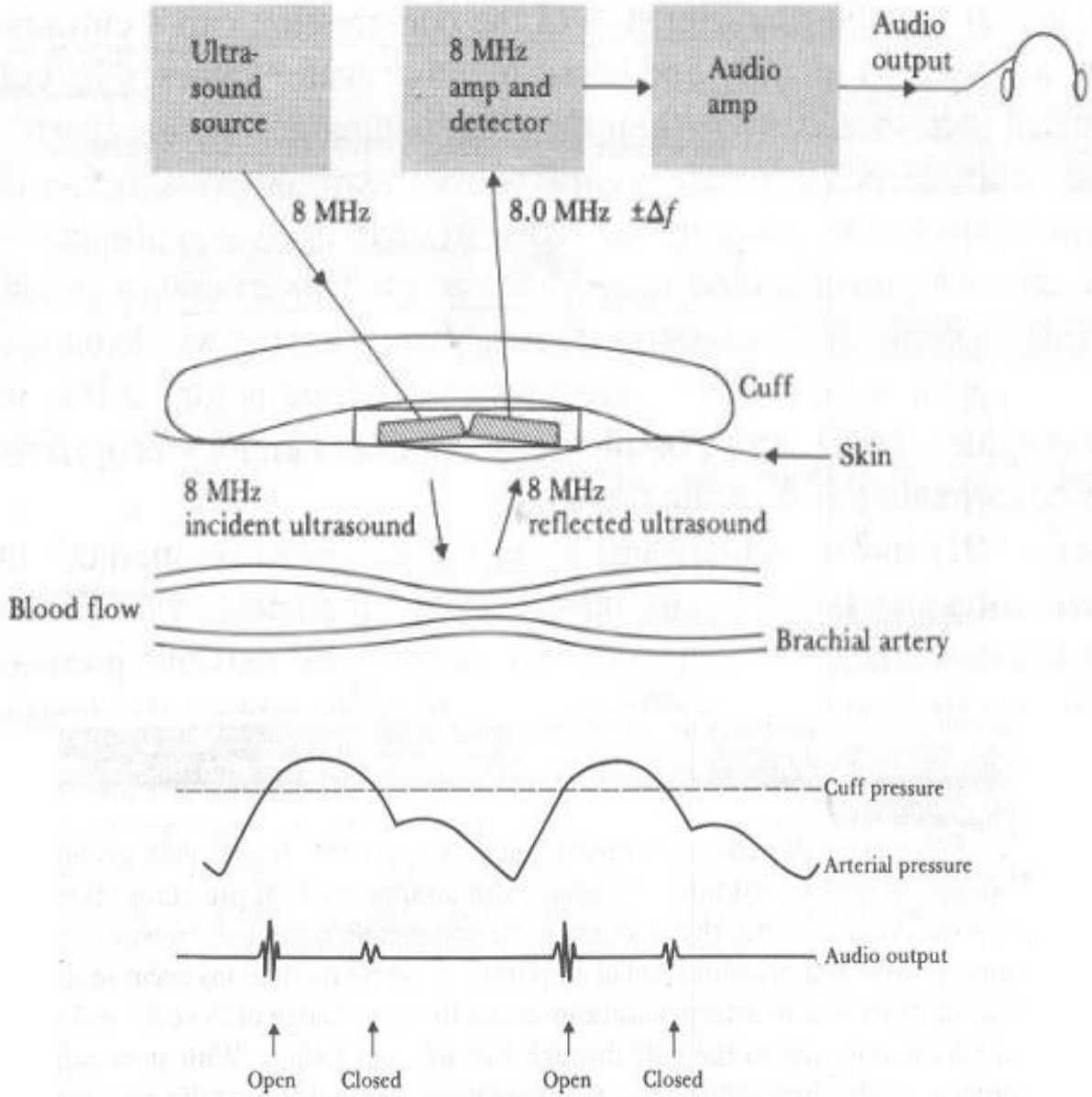
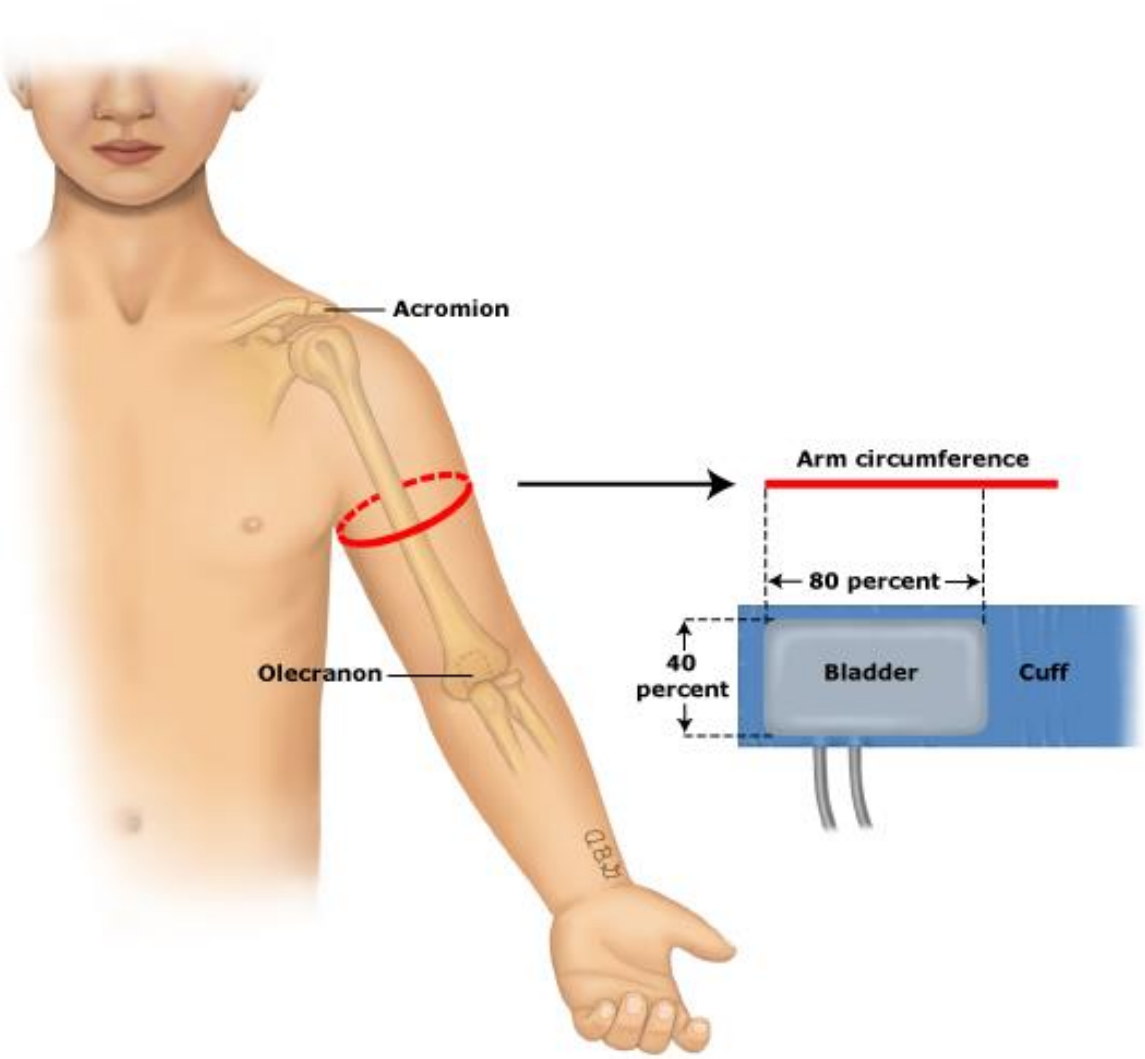


Figure 2.30 Ultrasonic Method

CUFF SIZING

- **The width of the bladder of the blood pressure cuff should be approximately 40% of the circumference of the upper arm midway between the olecranon and the acromion**. The length of the bladder of the cuff should encircle 80 to 100% of the circumference of the upper arm at the same position.



Recommended Cuff Sizes for Accurate Measurement of Blood Pressure

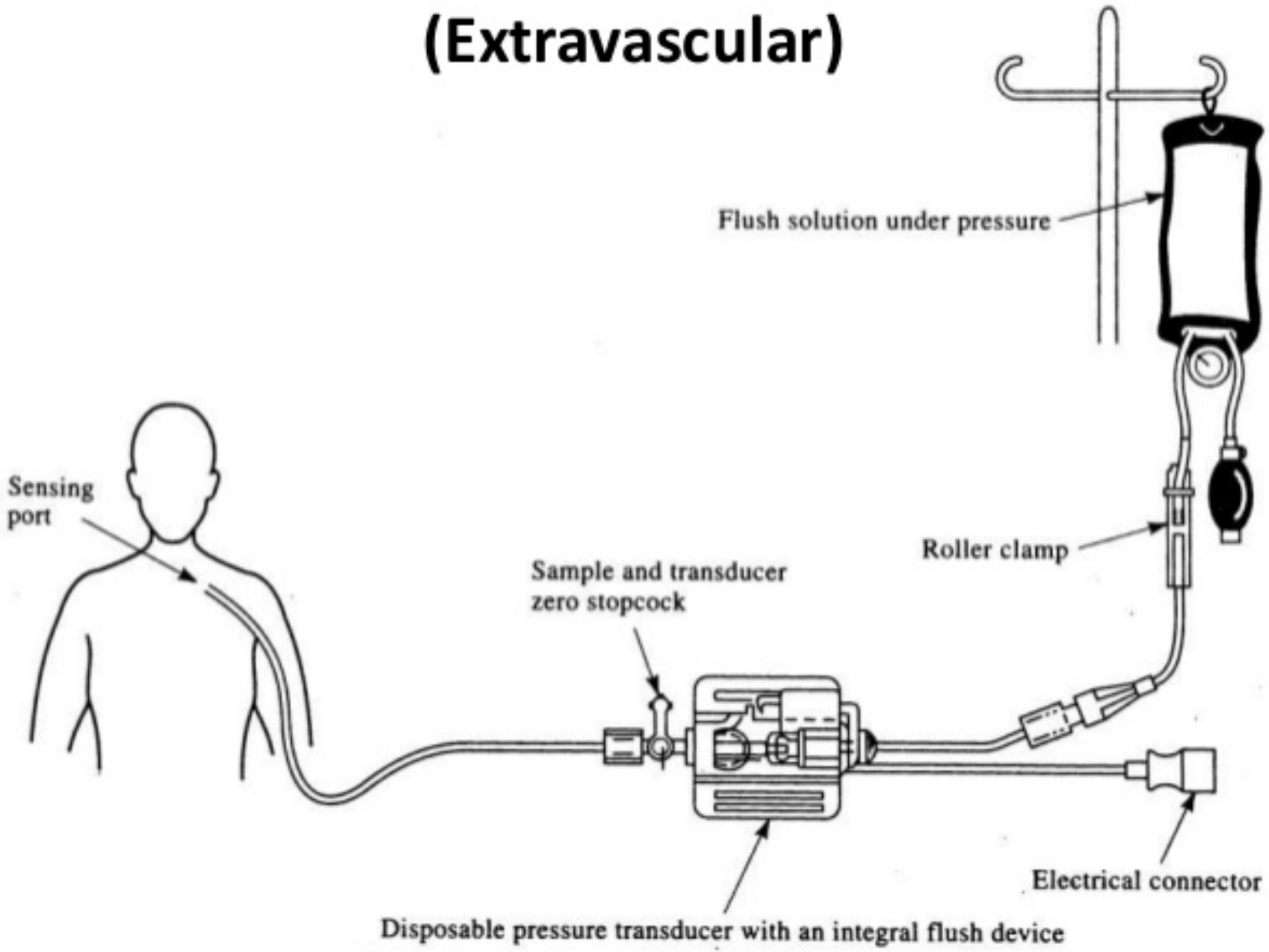
Patient	*Recommended cuff size*
Adults (by arm circumference)	
22 to 26 cm	12 × 22 cm (small adult)
27 to 34 cm	16 × 30 cm (adult)
35 to 44 cm	16 × 36 cm (large adult)
45 to 52 cm	16 × 42 cm (adult thigh)
Children (by age)*	
Newborns and premature infants	4 × 8 cm
Infants	6 × 12 cm
Older children	9 × 18 cm

- **Direct (invasive)**
  1. **Extravascular Method**
     - The vascular pressure is coupled to an external sensor element via a liquid filled catheter.

[**Catheter** – is a long tube introduced into the heart or a major vessel by way of a superficial vein or artery.]

  2. **Intravascular**
     - A sensor is placed into the tip of a catheter that is placed in the vascular system.

Direct Measurement (Extravascular)



Direct Measurement

Extra Vascular

- The extra vascular sensor system is made up of a catheter.
- The catheter is connected to a three way stopcock and then to a pressure sensor
- It is filled with a saline-heparin solution.
- It must be flushed with solution every few minutes to prevent blood clotting at the tip.

Direct Measurement

Extra Vascular *contd…*

- Physician inserts the catheter
  - Either by means of a *surgical cut-down*, which exposes the artery or vein.
  - or by means of *percutaneous insertion* which involves the use of a special needle or guide-wire technique.
- Blood pressure is transmitted via the catheter column to the sensor and finally to the diaphragm which is deflected.
- The displacement of the diaphragm is sensed electronically.

Direct Measurement

Extra Vascular *contd…*

- **Disadvantages**
  - The frequency response of the catheter-sensor system is limited by the hydraulic properties of the system.
  - Creates time delay in detection of pressures when a pressure pulse is transmitted.

Direct Measurement

Intravascular

- The sensor is placed at the tip of the catheter.

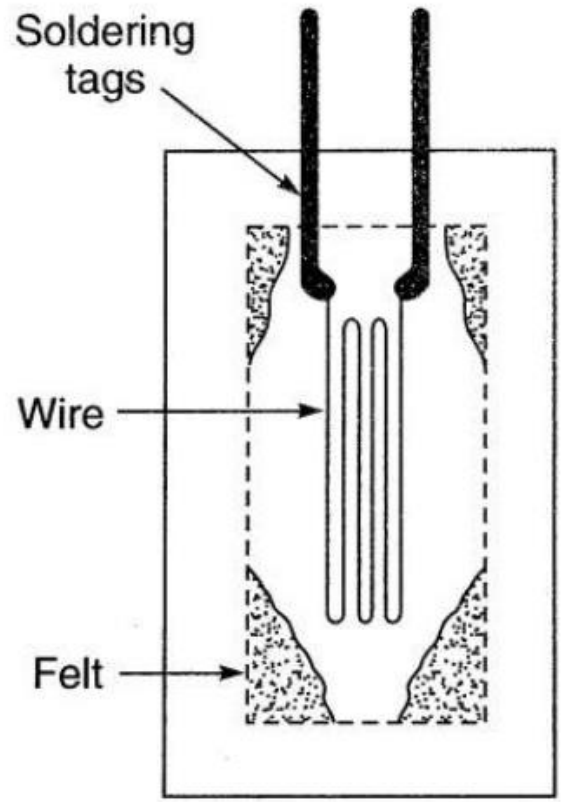
- Enables the physician to obtain a high frequency response in detection of pressures at the tip of the catheter.

- Types of sensors
  1. Strain-gage systems
     - bonded onto a flexible diaphragm at the catheter tip.

  2. Fibre-optic device
     - Measures the displacement of the diaphragm optically by varying reflection of light from the back of the deflecting diaphragm.

Bonded Strain Gage pressure transducer

- Consists of strain-sensitive gages which are firmly bonded with an adhesive to the membrane or diaphragm whose movement is to be recorded.
- Made by taking a length of a very thin wire or foil which is formed into a grid pattern and bonded to a backing material.
- Is then attached to the diaphragm.
- Deflection of the diaphragm causes corresponding strain in the wire gage.
- Causes a corresponding change in the resistance which is proportional to the pressure.



Fiber optic type pressure transducer

- Measures the displacement of the diaphragm optically by the varying reflection of light from the back of the deflecting diaphragm.

- Inherently safer electrically