Method	Non-invasive Blood Pressure Measurement methods
Palpatory (Riva-Rocci)	Palpable pulse when cuff pressure equals systolic pressure (SBP)
Auscaltatory	Based on sound waves generated from artery
Ultrasonic	Based on frequency difference between transmitted and reflected ultrasound wave when passed through arteries
Oscillometric (most popular and widely used)	The intra-arterial pulsation is transmitted via cuff to transducers (example: piezo-electric pressure sensor), SBP and DBP are estimated from the maximum amplitude of the pressure oscillation by using an empirical algorithm

1. The auscultatory method

Although the auscultatory method using mercury sphygmomanometer is regarded as the 'gold standard' for office blood pressure measurement, widespread implementation of the ban in use of mercury sphygmomanometers continues to diminish the role of this technique. New devices known, as "hybrid" sphygmomanometers, have been developed as replacement for mercury devices. Basically, these devices combine the features of both electronic and auscultatory devices such that the mercury column is replaced by an electronic/analog pressure gauge, similar to oscillometric devices, but the blood pressure is taken in the same manner as a mercury or aneroid device, by an observer using a stethoscope and listening for the Korotkoff sounds.

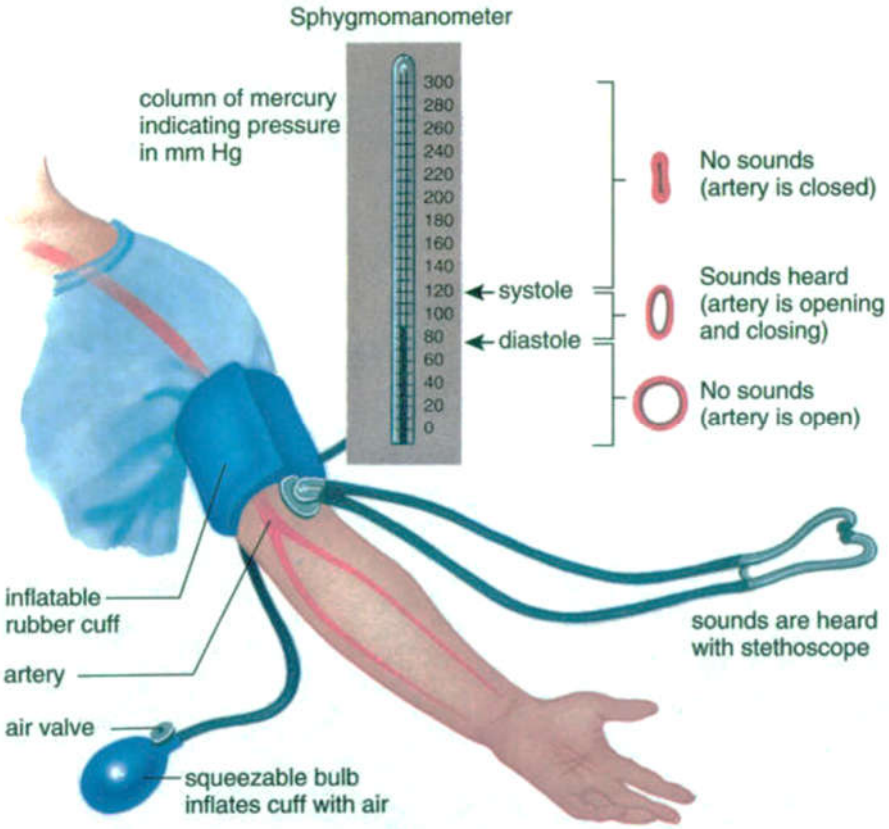
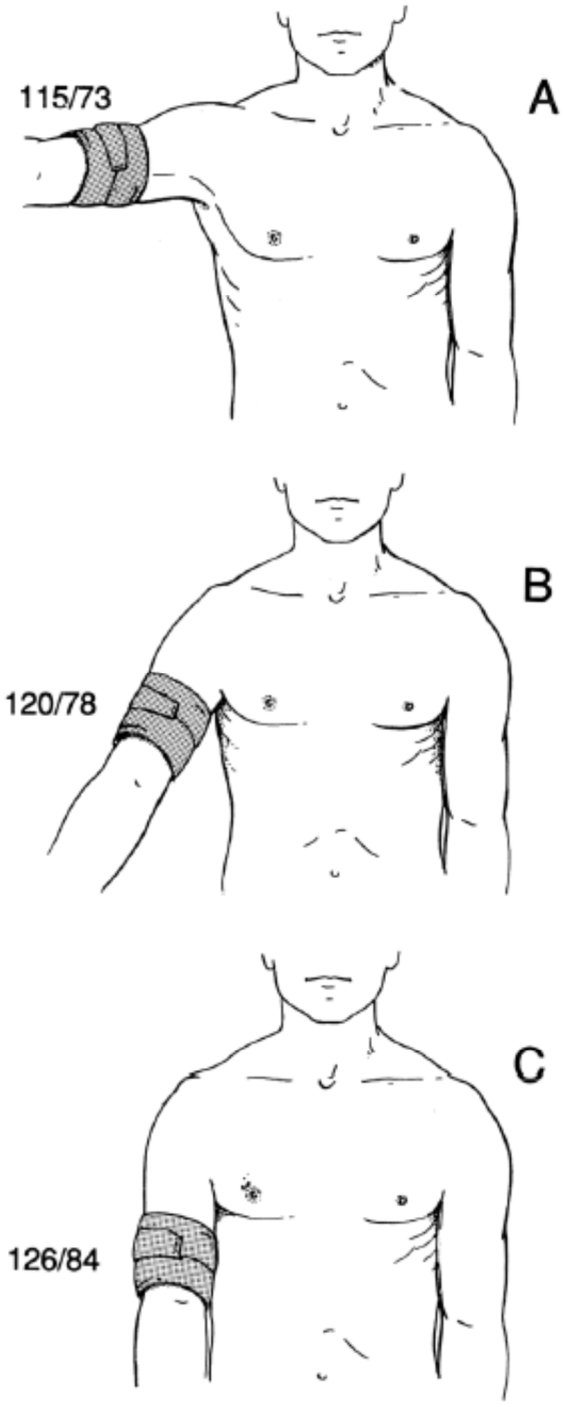
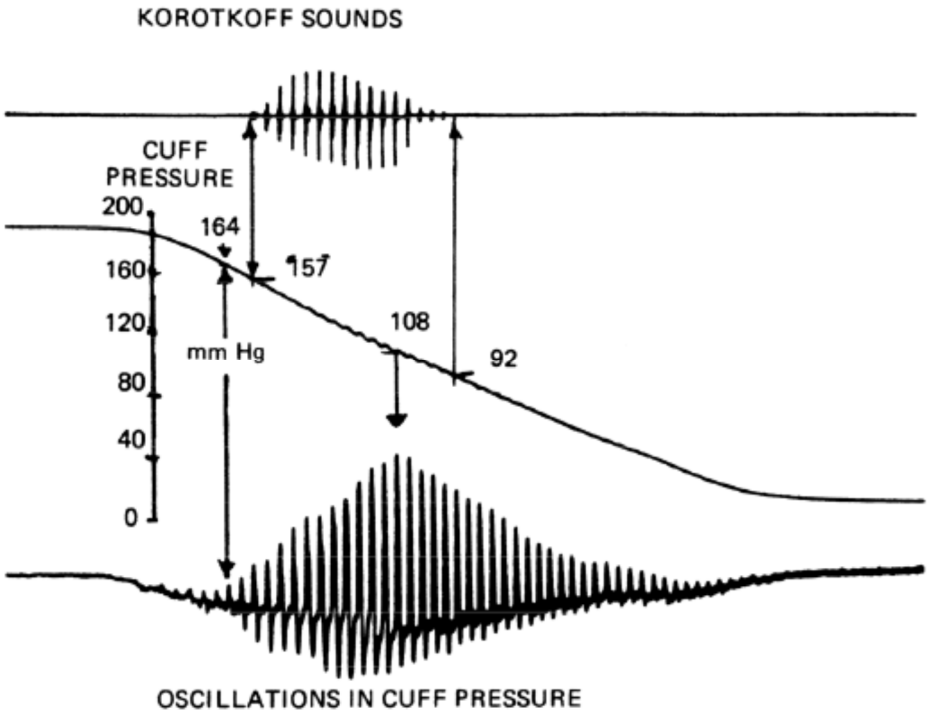


Fig. for Hybrid method

Effect of arm position on BP





2. The oscillometric technique

This was first demonstrated by Marey in 1876, and it was subsequently shown that when the oscillations of pressure in a sphygmomanometer cuff are recorded during gradual deflation, the point of maximal oscillation corresponds to the mean intra-arterial pressure.

The oscillations begin at approximately systolic pressure and continue below diastolic, so that systolic and diastolic pressure can only be estimated indirectly according to some empirically derived algorithm. This method is advantageous in that no transducer needed to be placed over the brachial artery, and it is less susceptible to external noise.

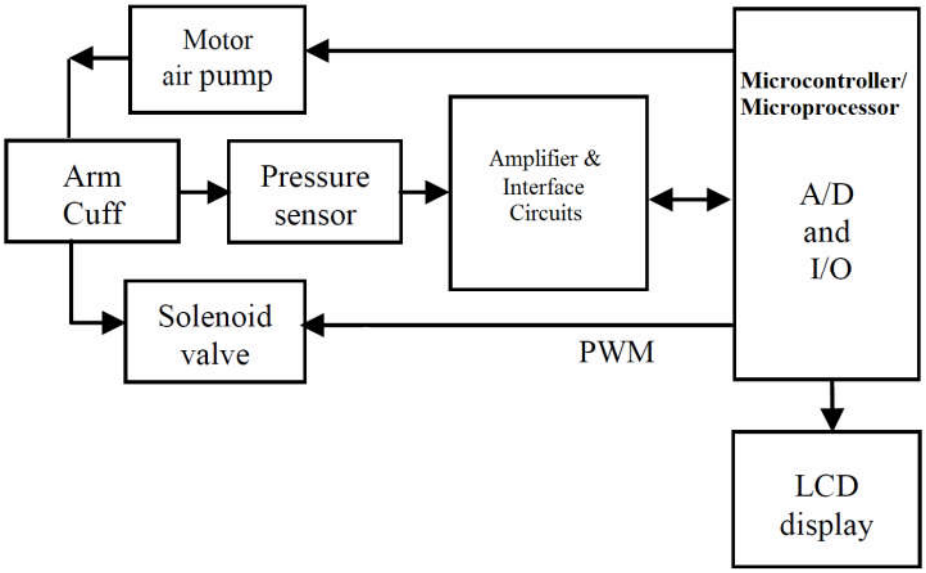
The main disadvantage is that such recorders do not work well during physical activity when there may be considerable movement artifact. The oscillometric technique has been used successfully in ambulatory blood pressure monitors and home monitors. It should be pointed out that different brands of oscillometric recorders use different algorithms, and there is no generic oscillometric technique.

Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) can be estimated from the Mean Arterial Pressure (MAP) where MAP is identified as the peak of the oscillations.

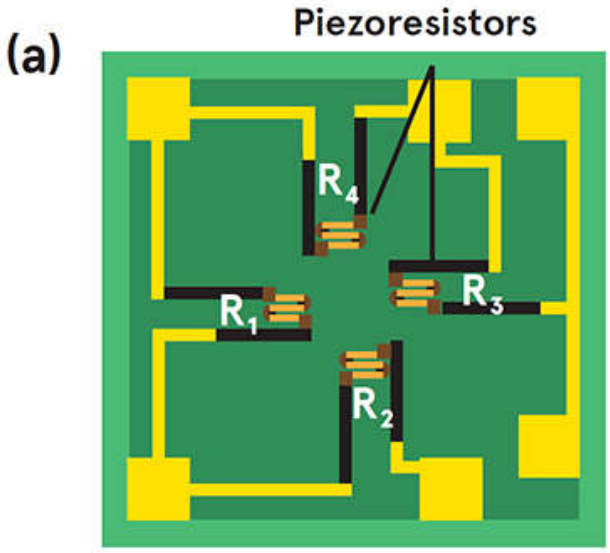
One of such empirical relation for SBP, DBP and MAP is

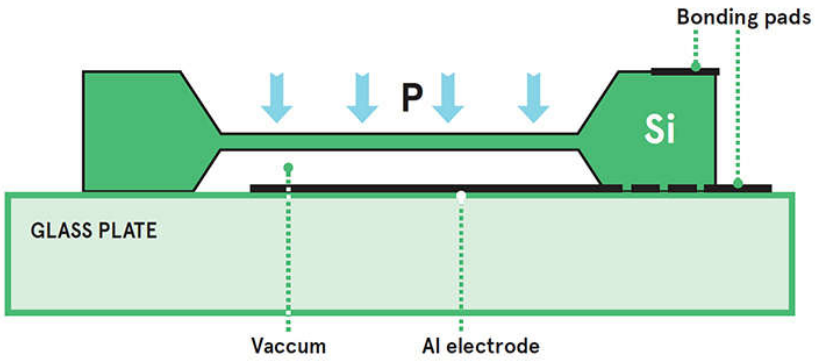
$$MAP = \tfrac{1}{3}SBP + \tfrac{2}{3}DBP$$

Or, DBP=3/2MAP-1/2SBP



The pressure sensors used here can be MEMS piezoresistive strain gauge/capacitive sensors.





(b) Capacitive sensor

3. Ultrasound techniques

Devices incorporating this technique use an ultrasound transmitter and receiver placed over the brachial artery under a sphygmomanometer cuff. As the cuff is deflated, the movement of the arterial wall at systolic pressure causes a Doppler phase shift in the reflected ultrasound, and diastolic pressure is recorded as the point at which diminution of arterial motion occurs.

In patients with very faint Korotkoff sounds (for example those with muscular atrophy) placing a Doppler probe over the brachial artery may help to detect the systolic pressure, and the same technique can be used for measuring the ankle-brachial index, in which the systolic pressures in the brachial artery and the posterior tibial artery are compared, to obtain an index of peripheral arterial disease.