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Biosensors for Real-time Monitoring of Blood Pressure

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Hypertension and Blood Pressure

Abnormally high blood pressure is termed as hypertension. Hypertension is the significant risk factor for worldwide mortality and is therefore a major public health concern worldwide. Hypertension is the major risk factor for myocardial infarction as well as other cardiovascular diseases. Therefore for prevention of such diseases, monitoring of the blood pressure for timely management is very crucial. Under hypertension condition the blood flows through the blood vessels in a fluctuating manner surpassing the normal range. Elevated blood pressure has no obvious systems and therefore it needs to be diagnosed and prevented before advancing to more severe state that can have clinical compilations. Oscillometric or asuscultatory cufs are standard methods for measurement of blood pressure. However, these methods are not available to the people who are in initial stage of prehypertension. Therefore, a more frequent determination of blood pressure provides the actual and precise estimate of hypertension so that preventive measures could be undertaken to maintain the blood pressure [1]. A non-invasive approach is more suitable for continuous monitoring and to undertake better control measures. One such method is the measurement of the pulse transit time. It works on the principle of time that is taken for a pulse to propagate from proximal point to distal point in the arterial tree. Systolic blood pressure can be calculated as the sum of diastolic blood pressure with pulse pressure and mean blood pressure and the mean of pulse pressure [2].

Conventional BP Monitors and Limitations

The conventional pulse wave system, optical, pressure and electrocardiogram sensors are larger in size and pose difficulty in portability and inaccurate reading during mobile mode and hence their widespread applications are limited. The conventional method for estimation of blood pressure is the sphygmomanometer with an inflatable cuff. However, this required medical assistance for performing an auscultation technique [3].

Modern Non-invasive BP monitors

Some of the novel non-invasive blood pressure and pulse pressure estimation are based on the pulse transit time and pre-ejection period. In addition to the pulse transit time, pulse wave analysis has also been developed. Another most common method is the use of electrocardiogram and photo-plethesmography for derivation of pulse arrival time. These parameters are estimated using electrocardiogram, seismocardiogram and photoplethythysmogram. Such measures are based on the ratio of stroke volume and pulse transit time. These methods are robust in wide range of hemodynamics conditions and stroke volume.

Wearable interactive health monitoring systems have several advantages including comfort, convenience, security and continuous monitoring. These devices that work on the principles of biosensors help in the early diagnosis, real-time monitoring, treatment effect evaluation, monitoring of heart rate, wrist pulse, motion, intraocular pressure including blood pressure and other physiological signals. The wireless systems that are used include the blue tooth, near field communication devices and resonance antenna systems. Some biosensors use multimodal systems for continuous monitoring such as photo-plethysmography and impedance plethysmography signals concomitantly to read the signals from the wrist. Here the pulse transit time was found to correlate highly with blood pressure of systolic and diastolic nature [4].

There are several factors that determine the efficiency of the blood pressure biosensors. The volume of the blood ejected by the heart into the arteries, the elasticity and the stiffness of the arterial walls, the rate of blood flow affect the blood pressure. Systolic pressure is the pressure exerted when the blood is ejected out of the heart whereas the diastolic pressure represents the resting state of the heart between the two consecutive heart beats. Normal systolic blood pressure is 110–115 mmHg and diastolic blood pressure is 70–75 mmHg, and these ranges are considered to be normal in a healthy individual. A different signal associated with the arterial pressure varies continuously during the cardiac cycle and these can be measured as electrocardiograph, ballistocardiograph, or phonocardiograph signals. The elasticity and the stiffness of the arteries determine the blood pressure and the direction of blood travel either from the heart or towards the heart, either upward or downward also determines the blood pressure [5].

Material science and their functionalities play an important role for obtaining the expected clinical performance for the biosensors. These materials need to be developed for generation of pressure sensors for clinical application. These biosensors can be linked to the telemedicine and digital medical records and this will help the patient to assess the health status, help the physicians in prescription and modification of medication and help in faster recovery. This is particularly useful for monitoring patients in home quarantine. A small investment in these biosensors can prevent great financial burdens in future.

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