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Recognition and utility of wearable and portable health monitoring devices in society - A Review

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Abstract:

With the advancement of technology, physical activity of human beings has reduced enormously that lead to higher population living a sedentary lifestyle. The same advancement of technology became a key in provision of data respected to health through wearable and portable health monitoring devices. Health monitoring devices are soundly helping people to monitor status of health in a better way. It is also helpful at clinical level in providing more efficient data to practitioners, clinicians and consultants for the diagnostics, research as well as in consideration to the treatment protocols. People are being aware of the use devices like digital thermometers, wearable smart bands, pulse oxy-meter as well as mobile applications that support provide reading like heart rate, respiratory rate, intake and consumption of calories, perspiration, sleep activity, step count etc. This article is constructed to take a review of health monitoring devices that can be used on daily basis and can be personalized to be kept at home.

Key words: health monitoring parameters, lifestyle, wearable devices.

Introduction:

A complete health is termed as wellness in physical, mental and social status of individual along with a total absence of even a feeling of illness. Health is a fundamental right of people also a intense necessity for a good life. With a greater sense of awareness, the demand for improvised healthcare went on increasing globally. Certain factors can be taken responsible for the same like poor healthcare related services, greater differences and distance between rural and urban regions, poor availability of staff and equipments in the critical situations etc. Therefore it has been necessary to monitor one's health by external devices or applications at the nearest possible, for which home can be the nearest place. The requirement for self health monitoring and preventive medicine is increasing. Along with the time, wearable technology went on evolving from a magnifying lens to Virtual reality (VR). In health care sector, use of spectacles in correction of focal errors, discovery of sound amplifiers for the impaired auditory functions set a base for the popularity of such advancements in technology. Along with modifications in the healthcare devices, following devices are being frequently used in day to day practice in monitoring health.

1. Thermometers:

Raised body temperature is one of body's first reactions to any kind of biological intruders in the body. Thermometer is the device used to count/measure the temperature. It is commonly observed in illnesses

like viral infections. Other conditions that can alter body temperature are exercise, psychological state, trauma or injuries, atmospheric changes as well as medications & certain drugs.

As per respective purpose, body temperature is taken from mouth (oral), skin (axilla), anus (rectum) and ears (tympanic). With advancement in technology, two methods have been developed for temperature measurement. One is direct contact and other is contactless measurement. The sensors assembled in direct contact type of devices senses the average temperature from the skin. Whereas non-contact devices work by measuring or sensing thermal radiations emitted by or reflected from part of body that is well exposed. Infrared radiation (IR) thermometers are non contact temperature assessing devices that now a days been mostly used in malls. Theatres, shops or similar public places. It is also utilised by clinicians for tympanic and skin temperature measurements. Other wearable devices like reusable devices lined with an adhesive plaster, temperature sensing tattoos and disposable sensors are also utilised for contact-less readings[1]. Devices that provide a mean difference of ±0.5^{o} Celsius as well as meet limit of agreement of ±1.0 ^{o} C are considered to be clinically efficient [2].

The devices like digital thermometers, IR thermometers, the classical mercury thermometers and even automated devices viz. smart bands, mobile apps are handy appliances, thus these can be carried along anywhere. These appliances can track the body temperature as well as keep a record of the same. In some conditions like internal infections, specific kinds of pyrexia like dengue, malaria etc. maintained record of temperature variation may lead to better management of the condition by the medical practitioner. The data produced through such apps will definitely be helpful for the clinical personal in case of medical emergencies that may occur.

These devices neither need any separate accommodation nor do they need special efforts to use. Still in terms of accuracy, mercury thermometers are best reliable devices as electronic interference may alter true readings due to instrumental defects or human errors. Electronic devices need external battery support whereas mercury devices being made of glass, demands careful handling. Thus as far as household utilization of thermometers is concerned, mercury thermometers can be considered as trustworthy until thoroughly refined digital devices can be recognized.

2. Pulse Oxi-meter:

The purpose of pulse oximetry is to check the oxygen saturation (SPO_2) in the blood. Being portable and easy to use device, pulse oxi-meteres have been widely used even in the general population, especially since the COVID19 outbreak. There are conditions that alter the blood oxygen saturation viz. respiratory system disorders like chronic obstructive pulmonary disease, asthma, pneumonia, lung cancer, blood disorders like anemia, leukemia, cardiac conditions like heart failures etc which needs prompt monitoring. Commonly pulse oxi-meteres display oxygen saturation level along with heart rate.

A Pulse oximeter can deploy two types of waveforms of light. Thus only values of haemoglobin (Hb) & Oxygen saturation can be read by such appliances. Furthermore, factors such as decreased blood corpuscle count, containment of Carboxyhemoglobin, Methemoglobin in the blood, residual stains of ink or nail paints on skin or nails, presence of bright light around the finger may alter the results. Other factors like anomalies like pigmentation, abrasions or scars on the skin may also lead to faulty assessment by the device. A low perfusion state may also intervene in data generation and thus limiting the usefulness of device in diagnostic measures[3-4]. Abnormal values generated through instrumental faults or human errors raises probability of mis-diagnosis which may ultimately lead to biased management of disease. As oxygen saturation relates to

cardiovascular or respiratory disorder, the biased values may induce psychological anxiety to the patient as well. Thus Layman's responsibility should always be limited to recording the data and informing to authorised practitioners before undertaking self-judgements.

3. Sphygmomanometer (SM)

A generalized human nature always makes humans to be keen about values that can be generated through one's body. It can be lab blood tests or checking one's own body weight at hospitals or clinics. Blood pressure is one such similar parameter that can be obtained externally through a device commonly called as Blood pressure (BP) apparatus. A layman to medical system may or may not understand what blood pressure is but may understand elevated or deprived values of it. Just like human body thermometers, BP monitoring has always been a part of attraction in the public as it doesn't need any needle pricks (as of lab blood tests) nor it requires any specific accommodation.

Blood pressure is one of the vital parameter which significantly indicates well being of the body. Continuous alterations or fluctuation in the blood pressure may mean active cardiovascular disorder or it may indicate necessity of differentiation of underlying illness. This would lead to undergo further investigations necessary for final diagnosis of patient. There are three types of BP apparatus available and used widely viz. the classic mercury SM, aneroid SM and digital SM[5].

Out of the three types, the mercury column BP apparatus is being used from a long time in clinical practices. Aneroid type of instrument is a slight modification of the classic one as mercury column is replaced by air pressure gauge. The portable digital instrument assesses blood pressure digitally through sensors. There are many researches carried out to recognize and compare accuracy of these three types. Some of these claimed to have no major difference between systolic and diastolic blood pressure measured through these devices[6]. Some studies found digital instruments de-meritorious over other types in concerns of standards of accuracy[7].

Regarding the benefits of sphygmomanometers, the digital BP apparatus wins the race in terms of ease of use. When layman is considered to take BP readings, assessment of BP through mercury and aneroid apparatus needs a stethoscope and quite an experience to pick up exact values. A digital device doesn't need other accessory devices. Moreover these devices display the values as well as can keep a record of previous readings, making it convenient and easy to utilize.

4. Electrocardiogram (ECG/EKG):

Electrocardiogram termed as ECG or EKG in medical terms is used to scrutinize the electrical activity of the heart. Cardiovascular deformities can display its characteristics in two ways i.e. electrical network issues such as arrhythmia and myocardial diseases caused either by hampered blood circulation or underlying infections. In either case the electrical impulse carried through the purkinje's fibers in heart may get affected resulting in abnormality in the conduction. These abnormalities can be assessed through ECG.

Since the invention of these devices, ECG machines were neither portable nor easy to be used. The earliest invented devices required special attention to reset back to normal temperature. Moreover, these devices were heavy and used to occupy lot of space as well. Gradual innovations ran through almost a century succeeded in compressing the device structurally. Thus advancement of technology resulted in portable devices we are familiar with today[8].

Technological advancement is stepping the utility ahead with innovation of wearable ECG devices. Though understanding ecg takes a lot of experience the technical devices can be helpful at least in generating electro cardio graph from a wearable device like a smart bands or wrist watches. An analytical research concluded as wearable devices can track cardiac activity to some extent but cannot be reliable source as far as ecg is concerned. These devices can detect abnormalities in the cardiac activity like elevation or irregularity. The conventional devices denote ECG via 12 leads out of which 4 leads are placed peripherally. Wearable devices available today may act like a peripheral lead.[9]

On the other hand portable or wearable small sized monitors are also available that work in collaboration with small leads placed on the chest. These monitors can be connected with mobile phones via cellular Wi-Fi network or accessibilities like Bluetooth. These devices can provide information in real time as well as can store the collected data to be utilized later[10].

5. Glucometer

Sedentary lifestyle and stress are one of the problems rewarded by advancement of technology. As a result, many people are suffering from fluctuating blood pressure, elevated lipid levels, devastated blood sugar levels as well as other discomforting disorders. Though it is easier to rule out the causes of these changes, a competent and competition oriented world doesn't allow everyone to sustain and manage a healthy lifestyle. Therefore, in conditions like diabetes mellitus, many people choose lifelong allopathic medication along with a regular blood sugar level monitoring. Earlier, blood sugar could only be counted at pathology labs to which technological advancements provided a solution with an innovation of household blood sugar detecting device called glucometer. It is a simple setup that even elderly people can handle. Moreover, this device provides results instantly. These devices functions with the help of enzymatic reactions and sensors. Glucose oxidase, glucose dehydrogenase, and hexokinase are the enzymes used in the reactions for blood sugar detection. Even these substances have specific advantages along with distinctive perimeters [11].

Though these devices are handy and have multiple merits, queries still arise about the accuracy and reliability concerned. Higher blood sugar levels leads to gradual deterioration of health in many biological aspects whereas lowered level may prove fatal if not attended urgently. Practices such as improper operating techniques, changing environmental exposure, patient physiologic and medication effects may alter the results[11].

Summary:

Social media is popular source of information in the society these days. Moreover search engines like google, bing etc are easily available to everyone in the mobile devices which can provide any required information at any point of time. These platforms provide vital information regarding the advancements in the technology and its use. Moreover the commercial companies provide attractive endorsements on the televisions, internet and other media to lure people of all potentials. Such a way, these have impacted in creating a drastic change in the society concerning health of individuals. People belonging to newer generation are leaning more and more towards maintenance of health as compared to previous ones. Along with the access and personalization of mobile phones, reduced internet access tariffs, people are getting more and more used to with mobile apps and devices like digital thermometers, glucometers, portable digital BP apparatus. Many of these devices can store the generated data and thus a proper record may prove helpful to the clinicians or healthcare providers in a proper diagnosis and management. Though these devices are handy and easy to use, accuracy, human errors and faulty devices may lead to inaccurate readings. Parameters like ecg, blood glucose level are sensitive factors and thus faulty alterations in these readings can prove fatal in

many cases. Innovation is good way of improvisation of human life still reliability on equipments should always be limited.

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