

Health Sensors and Smart Medical Devices

Janaki Subramanyan¹, Pratibha Jolly², Deepali Manchanda³ and Nisha Sella⁴

¹Botany Miranda House University of Delhi Delhi 110 007

²Principal Miranda House University of Delhi Delhi 110 007

^{3,4}B.Sc. (Hons) Botany II Year Miranda House University of Delhi Delhi 110 007

Abstract— Health sensors are handy devices for the early detection and monitoring of diseases, quick assessment and treatment of patients, and cost-effective and improved medical care. Small changes in health parameters can be used to correlate with the development and progression, and management of diseases. The analysis of data helps in early warning for serious conditions, like those of the heart and kidney. Wearable sensors that measure electrocardiogram, oxygen saturation, heart rate, blood glucose, respiratory rate, and blood pressure are available. Similarly, an inhaler with an inbuilt asthma sensor tracks environmental conditions and helps the patient manage the ailment. Health sensors can be Bluetooth enabled and connected to an ordinary smart phone or tablet. The automatic alerts sent by the smart phones of patients to healthcare providers facilitate proper diagnosis and timely intervention. The real-time data generated by wearable sensors can be stored for retrieval and reference at a later date. Patients who are too weak to visit or to be taken to clinics, elderly people, and patients living in remote and rural areas can be provided with the necessary prescriptions. The health status of high-risk patients can be regularly monitored and immediate attention can be given in case of an emergency. The use of health sensors and smart medical devices would also help in overcoming the problem of shortage of doctors and healthcare professionals. Moreover, in the long run sensors may become cheaper than the large conventional instruments used in measuring various health parameters. Cloud computing would allow sharing of expertise of healthcare companies and healthcare workers. It is very likely that in the future sensors used in healthcare will show an upward trend in the market.

1. INTRODUCTION

Technological advancements have revolutionized both the mobile phone industry and the healthcare sector. It is certain that sensors and smart devices will play a major role in healthcare in the near future. Health sensors can be used for early detection, diagnosis, and constant monitoring of diseases. Wearable sensors measure important vital parameters, such as electrocardiogram, oxygen saturation, heart rate, respiratory rate, blood pressure, and glucose levels in the blood. Smart medical devices connected to medical professionals help to keep track important health details of patients. The automatic alerts received would enable the healthcare professionals to arrange for the necessary immediate medical attention. Health sensors can be connected to a smart phone or a tablet via Bluetooth. Hence, the smart phone or tablet can become an ideal storage unit with real-

time data on health parameters of patients. The patients can receive warning signals and suitable advice as well.

2. HEALTH SENSORS AND SMART MEDICAL DEVICES

A very commonly used sensor by diabetics to monitor blood sugar levels is the glucose meter with test strips. For patients suffering from Alzheimer's disease or dementia the GPS function of smart phones can be used to track the location of patients. The iWander app for Android devices triggers a signal to the person's family, and the patient can be found. Cube is a smart device that identifies several indoor factors, like air quality, light, temperature, humidity, noise, and pressure. Cue is a biosensor that uses the body fluids for five tests, namely inflammation, influenza, fertility, vitamin D, and testosterone. Many of the wearable health sensors used as measures of general wellness need not have the regulatory approval of the Food and Drug Administration (FDA) of the US. The fitness trackers which help in measuring heart rate, step counting, and sleep tracking do not come under the regulation of the FDA.

Some Examples of Health Sensors and Smart Medical Devices which have been Cleared by the FDA

The sensors come in the form of wristbands, wristwatches, portable devices, strapping devices, body sensors, patches, inhalers, and ingestibles. A motion-tracking wristband and a wristworn electronic diary developed by Camntech, a British company, have been cleared for use in clinical trials. These devices acquire and analyze physical activity of the body, and the data gets uploaded to a personal computer via a USB cord.

MasterCaution Device (MCD) of HealthWatch is a miniature Bluetooth enabled device that can continuously monitor up to 12-lead ECGs, posture, activity, respiration, and skin temperature. The data can be seen and analyzed by the physician in a hospital or even a remote medical service centre. Similarly, MAC 800, a portable electrocardiogram (ECG) device has been developed by GE Healthcare, based on cell phone technology. The portable ECG will be introduced into the US market.

AirStrip Sense4Baby is a wireless maternal/fetal monitoring system which is used for conducting non-stress tests by oneself. The BioHarness, manufactured by Zephyr, measures ECG, heart rate, breathing rate and skin temperature. The device trapped onto the chest transmits the data over the mobile broadband network and can be used for monitoring patients in remote areas. HealthPatch is a peel-and-stick vital signs monitor developed by Vital Connect. The device records ECG, heart rate, respiratory rate, skin temperature, body posture (detects a fall), steps, stress, and sleep staging.

DexCom's glucose monitor is a body sensor that is to be worn around the abdomen. Every five minutes the sensor measures the glucose level and sends the data to a remote handheld device within 20 feet. The remote device then transmits the data to the iPhone, which gets displayed on the Apple Watch worn by the patient. Even the tears in a person's eyes can be used to measure blood glucose levels in diabetics. Smart contact lenses have been developed by Google in association with Novartis. The data collected by the smart contact lenses is transmitted to a connected iPhone or Android app which displays the results to the patient or relevant healthcare professional.

A smart inhaler developed by Propeller Health for asthma patients gives reminders, and tells the patient how to avoid triggers and manage the disease. An activity tracking wearable developed by Global Kinetics Corporation for patients with Parkinson's disease helps the neurologist to study the changes in the patient's movements which would assist in the treatment.

The combination of the drug ABILIFY with a Proteus ingestible sensor in a single smart pill or a digital pill measures the response by the patient to the drug and helps in accurate prescriptions by doctors. The ingestible sensor communicates with the Proteus patch, an adhesive patch worn on the torso by the patient. The Proteus patch records time of ingestion of the medicine, and other physiological parameters like the heart rate, and communicates to a mobile app via Bluetooth.

3. CONCLUSIONS

The health sensors and smart medical devices are a boon to mankind. The market for these devices is showing an upward trend. The power of a medical laboratory comes into the personal smart phone. The smart phone provides an interface to link the smart medical devices to it and the repeated visits to a hospital or a diagnostic centre are minimized. Indeed, a few smart health sensors could ease our lives and improve the quality of our well being, making us manage our health and ailments smartly! The ECG and heart rate can be measured even while one is travelling using AliveCor heart monitor, an FDA-approved iPhone case. The ECG is recorded in 30 seconds by placing the phone case on the chest or the fingers.

The challenges of affordable, accessible and quality healthcare may be overcome to a fair extent with health sensors and smart medical devices. The doctors and healthcare workers will become well equipped and empowered, and the delivery of healthcare will be facilitated. The rapid strides in technology and the impact on society can be gauged from the fact that many conferences and symposia are being held all over the world on sensors and smart devices.

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