



THE RELIABILITY OF WEARABLE SENSORS IN HEALTHCARE MONITORING

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Abstract

Wearable sensors are attracting abundant interest because of their potential to provide continuous, real-time physiological information through effective, non-invasive measurements of chemical markers. Recent developments focus on electrochemical and optical biosensors, as well as advances in non-invasive monitoring of biomarkers, including metabolites, bacteria, and hormones. A combination of composite biosensors, micro fluidic sampling and transport systems has been integrated, miniaturized and combined with flexible materials for improved portability and ease of use. Accurate and reliable real-time physiological information sensing using wearable biosensor technology will have a wide impact on our daily lives. Hence the question arises how reliable are these day to day wearable sensors ?

Key words :- Diabetes, Comparisons, Sensors

Introduction

Throughout this paper the blood glucose concentration readings are taken by three sensors : sensor 1: glucose BG-03 (non-wearable), Sensor 2: continuous glucose monitor - Abbott freestyle (wearable), Sensor 3: smart watch - Apple series 7 and are studied in depth. The key points being studied are the accuracy , pain level and the availability and costing.

Theory

The wearable sensors sensor 1: glucose BG-03 (non-wearable), Sensor 2: continuous glucose monitor - Abbott freestyle (wearable) will have inaccurate results in the long run and this may have detrimental effects on an individual.

Experiment

Difference between the readings of

Sensor 1: glucose BG-03 (non-wearable)

Sensor 2: continuous glucose monitor - Abbott freestyle (wearable) Sensor 3: smart watch - Apple series 7.

Two test subjects: female, age 52 years, and male, age 32 years were given the sensors mentioned above to utilize over the course of three weeks. Their meals were constricted to 3 meals a day as well as a purely vegetarian diet.

The apple watch was worn at all times excluding 10 pm to 8 am, for charging purposes

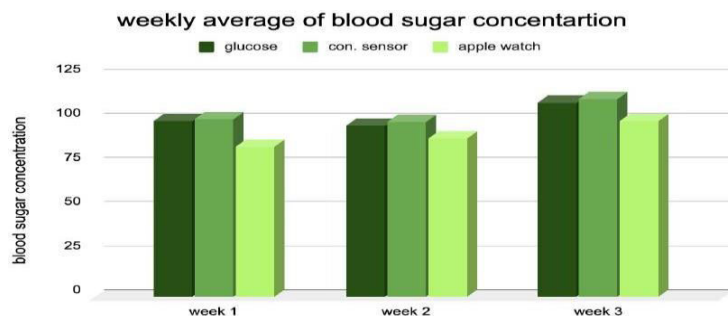
The continuous sensor was worn at all times excluding 10 pm to 8 am for charging purposes

The glucose levels in the blood were checked 3 times a day Morning 8:30 am

Afternoon 2:00 pm Late evening 9:30 pm

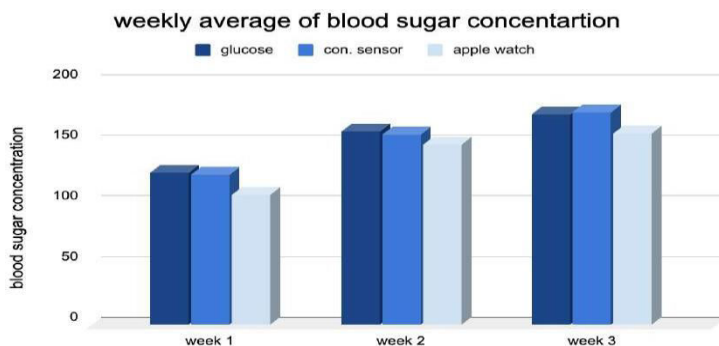
Female age - 52 :

Results



The average blood sugar concentration reading of the candidate per week was calculated and plotted on a bar chart. With reference to the preceding chart, The average concentrations of the continuous wearable sensors and the non-wearable glucose BG-03 do not significantly differ. The continuous sensors' average differs by 1 to 2 points when compared to sensor 1. The Apple Watch, on the other hand, has significantly lower readings as compared to the other two sensors used in the experiment, differing by a minimum of 9 points and a maximum of 16 points.

Male age- 48



The average blood sugar concentration reading of the candidate per week was calculated and plotted on a bar chart. With reference to the preceding chart, The average concentrations of the continuous wearable sensor and the non-wearable glucose BG-03 did not have much of a significant difference, it reached a maximum of 3 points and a minimum of 1 point. The Apple Watch readings were significantly lower as compared to the other two sensors used in the experiment, differing by a minimum of 6 points and a maximum of 17 points.

Pain levels

Sensor 1: glucose BG-03 (non-wearable)

Although highly accurate and widely used this sensor is intrusive and causes mediocre levels of pain to the user at the moment of being pricked which causes certain users to postpone the usage of this device

Sensor 2: continuous glucose monitor (wearable)



Sensor 2 is non-intrusive and pain free but can often be tagged as irritable as it has to be worn all day. Some users complain of rashes and redness caused by the adhesive but it does provide the benefit of real-time readings.

Sensor 3: apple watch series 7

This method is pain-free, non-irritable, and highly convenient as users can access their results within seconds. Because the reading can be significantly lower it is not recommended for serious diabetic patients. For an individual who is not concerned about diabetes or any other diseases this method is accurate enough and highly agreeable

Availability and costing

Sensor 1 can range from 345 - 1000 INR. It is most readily available in all countries and most popularly used in India. Sensor 2 can range from 4,600 to 6,200 INR. It is not readily available in retail stores and is mostly sold through online platforms. The technology is newer and significantly expensive hence is still not as widely used. Sensor 3: smart watches can range from 45,000 to 90,000 depending on the brand. It is most readily available in all countries although not affordable by most citizens in developing nations such as India.

Discussion

Both of the candidates, male as well as female, showed similar blood sugar concentration averages in sensor 1 and sensor 2 and notably lower blood sugar concentration levels.

The apple watch reading dip lower in candidate 1's reading as compared to candidate 2.

The difference between sensor 1 and sensor 2 reaches a high of 3 points in candidate 2 and in candidate 1 only a high of 2 points.

All the sensors before used in the experiment were first tested on a control candidate to test the accuracy of the machine. The three sensors were first given to one candidate and the readings were checked simultaneously of the same type of sensor. Only is the readings matched the sensors given to the participants of the experiment. The equipment was checked prior to the experiment for any physical faults.

Note: the readings of smart watches may differ depending on the brand all though the same software is used in all watches hence accuracy will also differ from one brand to another

Conclusion

Overall, considering the doctors of convenience, accuracy, availability and cost sensor 2 - proves to be momentarily the most reliable as is at results nearly as accurate as the and the added advantage of real time readings allowing the user to alter his or her actions in motion. It proves to be of immense aid to individuals with diabetes as it allows then to keep a track of their blood glucose level continually and hence helping in preventing major variations in blood sugar levels for such patients

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