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Review On Glucose Monitoring Systems: A Current And Emerging Technology

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Abstract— **Diabetes is a worldwide public health problem that needs a lot of attention as it causes death and disability in the world. *A tight continuous glucose monitoring (CGM) is an important. During the last 50 years in glucose monitoring, various techniques have evolved from invasive to non invasive continuous monitoring. However there continues to be several challenges in terms of accuracy and reliability of the system. The key challenges for the development of next-generation CGM Systems for diabetic management are the decrease in the operational cost, development of prospective. Non-invasive CGM techniques for precise and specific glucose detection, significant reduction or obviation of calibration and warm up periods, improvement of signal-to-noise ratio (SNR) and sensitivity, development of closed loop CGM Systems and reducing the time taken for glucose measurement. The goal of this review paper discusses the existing modalities and future development in CGMS.***

Keywords—Non-invasive CGMS, Diabetes Mellitus, Artifical Pancreas

I. INTRODUCTION

Diabetes mellitus is one of the most common endocrine disorders with respect to carbohydrate metabolism. It is a leading cause of morbidity and mortality worldwide. Its prevalence continues to increase every day. A sedentary lifestyle combined with changes in eating habits and increasing obesity are the major factors attributing to diabetes.

Blood glucose monitoring is gaining importance as a valuable tool in the management of diabetes. A series of glucose bio-sensors are being developed to assess this condition. A biosensor can be defined as a "compact analytical device or unit incorporating a biological or biologically derived sensitive recognition element integrated or associated with a physio-chemical transducer". Fig. 1 depicts the various methods used in Glucose monitoring. Glucose biosensors may of point-of-care testing type, continuous glucose monitoring systems or non-invasive glucose monitoring systems. Non-invasive glucose analysis is an important principle used in glucose bio-sensors that occupy 85% of the bio-sensor market. Optical and trans-dermal approaches are the most common non-invasive glucose sensing techniques. The optical glucose sensors use physical properties of light to detect glucose. This approach includes polarimetry, Raman spectroscopy, infrared absorption spectroscopy, photo acoustics and optical coherence tomography. Although many non-invasive glucose sensor devices like the Gluco Watch Biographer were developed, a reliable and accurate measuring method is still not available.

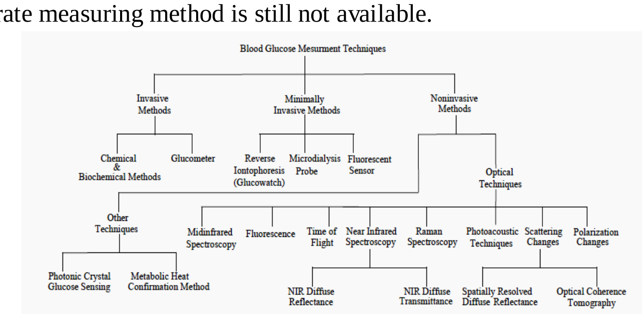

Fig. 1: Various Methods of Glucose Monitoring

This paper discusses the working principle, advantages, disadvantages and reliability of various non-invasive glucose monitoring techniques like the GlucoWatch Biographer, tattoo like sensors that can detect glucose level, contact lens tear glucose monitoring and the Silicon based Electromagnetic Non-invasive Glucose Sensors.

II. NEED FOR NON INVASIVE GLUCOSE MONITORING

Millions of people all over the globe suffer from diabetes and many of people have to test their blood sugar levels several times a day. This is very inconvenient and painful, To increase a diabetic patient's quality of life a regular monitoring of glucose level becomes inevitable. This is usually done using the finger prick glucometer. This may lead to infections and damage to finger tissue. To eliminate this painful experience, the non-invasive glucose monitoring technique was introduced. Noninvasive approaches for continuous glucose monitoring represent a promising route for obviating the challenges of implantable devices.
Some of the technologies used in non-invasive glucose monitoring are Bio impedance spectroscopy, Electromagnetic sensing, optical polarimetry, ultrasound technology, infrared spectroscopy etc. The following are some of the non-invasive techniques to detect blood glucose which are currently being used in the reality.

III. CURRENT TRENDS IN NON-INVASIVE GLUCOSE MONITORING

A. *Functional Contact Lens For Glucose Monitoring*

This system involves non-invasive wireless sensor platform for continuous glucose monitoring. Tear fluid is directly accessible on the eye and can be used as an interface between the sensor and human body. Tear fluid contains all the components of blood in nearly proportionate quantities except for the presence of RBC. There is a reflection of the body chemistry on the surface of the eye. Thus by using a contact lenses shown in fig. 2 it can give us information about what's happening inside the body without actually going into the body or collecting a blood sample.

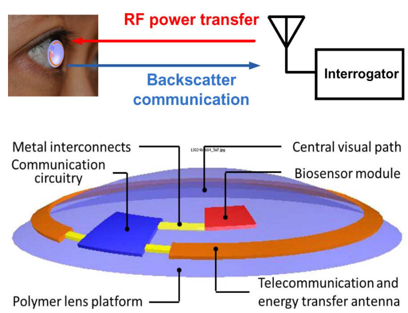

Fig. 2 : Contact Lens System for Glucose Monitoring

These lens are enabled with small radios and antennas built in, enabling them to send and receive information through radio frequency radiation. It also has a glucose sensor on the contact lens and demonstrate that it can detect glucose at levels that are found in the tear film. The fluorescence responses from the lenses can be monitored using simple excitation and emission detection devices. These elements together to develop a contact lens that constantly monitors the blood glucose level and records information that can be accessed by the patient's doctor which are ideally suited for potential use by diabetics.
These lenses are ideal for continuous non-invasive monitoring of tear glucose with a 15 minute response time and a measured shelf life in excess of 3 months. Chances of infection and irritation in eyes are high. The lenses are not cost effective as they need to be replaced every three months. A range of disposable and colourless tear sensing contact lenses, using off-the-shelf lenses embedded with new water soluble, highly fluorescent and glucose sensitive boronic acid containing fluorophores can serve dual purposes –correcting faulty vision ad checking on tear glucose.

B. *Gluocse Wristband*

The Gluco wristband is a concept medical device that offers three major functions to diabetics: non-invasive and instant glucose reading, storing previous readings history with averages and an extremely useful insulin chamber with loaded syringe catridge. This product works using "reverse iontopheresis" technology. Iontophoresis is a physical process in which ions flow diffusively in a medium driven by an applied electric field. Reverse iontophoresis is a technique by which molecules are removed from within the body for detection. The wristband uses an algorithm that analyses data collected by three sensors. These sensors monitor changes in the body through the skin as people go through their day, walking, eating, sitting and sleeping. There is a pulse sensor which measures blood flow and heart rate, plus an accelerometer which measures body movement and activity, such as the number of steps taken. The third is called a bioimpedance sensor, which can give a good measure calorie intake. The concept is that when people eat, carbohydrates are turned into glucose or sugar in their blood. Cells absorb the glucose and use it for energy, displacing liquid in the process. The bio impedance sensor measures this change using patented software to translate this into the number of calories consumed, which are shown on the band's screen.

This device collects glucose samples from the body fluids by using electric flow through the sensors. The readings are displayed in an LED and different buttons for operation are provided. These bands may cause irritation to the skin. The automatic frequent non-invasive measurements obtain with the Glucowatch Biographer provide substantially more information about glucose levels than the finger stick methods. This information can be used for improved decisions about all the aspects of diabetes management. This device may cause skin irritations. The device is not affordable for everybody.

C. Tattoo Like Sensor

This first-ever example of the flexible, easy-to-wear device could be a promising step forward in noninvasive glucose testing for patients with diabetes. Tattoo could pave the way to explore other uses of the device, such as detecting other important metabolites in the body or delivering medicines through the skin.

The Fig. 3 depicts a flexible device, which consists of carefully patterned electrodes printed on temporary tattoo paper. A very mild electrical current applied to the skin for 10 minutes forces sodium ions in the fluid between skin cells to migrate toward the tattoo's electrodes. These ions carry glucose molecules that are also found in the fluid. A sensor built into the tattoo then measures the strength of the electrical charge produced by the glucose to determine a person's overall glucose levels.

Fig. 3: Tattoo based Glucose Monitoring

This is also used in detecting other important metabolites in the body or delivering medicines through the skin. Bluetooth capabilities to send this information directly to the patient's doctor in real-time or store data in the cloud. This could be a promising step forward in non-invasive glucose testing for patients with diabetes. They are reliable for efficient diabetes management and can be extended toward non-invasive monitoring of other physiologically relevant analyses present in the interstitial fluid or to detect alcohol or illegal drug consumption.

D. Ultrasound Based Multisensor

The non-invasive method employed ultrasound, conductivity and heat capacity for blood glucose determination. Fig. 4 depicts. the NI-CGM was based on multisensors. The signals acquired were passed onto a linear mathematical model and converted to glucose values."Multisensor+model" system is able to deal with the disturbance.

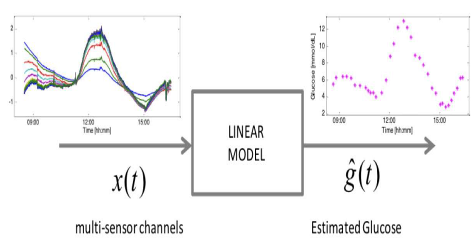

Fig. 4: Example of multi-sensor data with a mathematical mode for estimating glucose

IV. MOVING TOWARDS CLOSED LOOP MONITORING

The automation of blood glucose control has been a grand challenge, i.e., the artificial pancreas (AP). The inconvenience of early intravenous blood glucose sensing and insulin delivery motivated the development of subcutaneous continuous glucose monitor and continuous SC insulin infusion (CSII) pumps, which remain the most widely used platforms for AP development. Initially, software algorithms utilizing CGMS and CSII pumps operated with the goal of insulin. Recent clinical trials have extended this approach with process control algorithms, often augmented with compensatory manual insulin boluses, to handle more complex challenges, such as meals and exercise. The application of advanced control algorithms has led to substantial improvements in blood glucose control. The robustness of these systems has been a great challenge.

A CGMS provide a large number of glucose measurements, which are highly useful to healthcare professionals to determine the fasting and postprandial blood glucose levels for better adjustment of the insulin dose, the effect of exercise or physical activity on glucose levels and the detection of unrecognized hypo- or hyper-glycemia. The drawback is that it is invasive and requires calibration with blood glucose testing and also requires a change of the sensor after a few days.

The key challenges for the development of next-generation CGMS for diabetic management are the decrease in the operational cost, development of prospective NGM techniques for precise and specific glucose detection, significant reduction or obviation of calibration and warm up periods, improvement of signal-to-noise ratio (SNR) and sensitivity, development of wearable CGMS and reducing the time taken for glucose measurement.

V. CONCLUSIONS

In this review, the latest technologies and devices for non-invasive glucose monitoring have been described. Unfortunately, none of these technologies have produced a commercially available, clinically reliable device; therefore, much work remains to be done. It is relatively simple to measure data and find correlation with blood glucose levels under the controlled under conditions of research laboratories: the challenge is measuring these variables in normal environments. This requires understanding the physical and physiological factors that may affect blood glucose measurement.

It is important to notice that non-invasive monitoring will never be achieved without vigorous scientific and clinical evidence. At this stage, we are still far away from achieving the goal of non-invasive blood glucose monitoring, with many technical issues yet to be resolved.

REFERENCES

[1] Joseph Wang, "Glucose Biosensors : 40 years of Advances and Challenges ," in *Proc. Wiley*, 2001, paper 13, p. 983.

[2] N. S. Oliver, C. Toumazou, A. E. G. Cass and D. G. Johnston, "Review Article Glucose sensors: a review of current and emerging technology ", Journal compilation © 2009 Diabetes UK. *Diabetic Medicine,* **26,** 197–210

[3] Neesha Ramchandani1 and Rubina A Heptulla," New technologies for diabetes: a review of the present and the future," Ramchandani and Heptulla International Journal of Pediatric Endocrinology 2012, 2012:28

[4] Akesh Govada1, Ch Renumadhavi, K B Ramesh," Non-Invasive Blood Glucose Measurement", International Journal of Advanced Research in Computer and Communication Engineering ,Vol. 3, Issue 1, January 2014

[5] Yu-Te Liao, Huanfen Yao, Andrew Lingley, Babak Parviz, and Brian P. Otis, "A 3-□W CMOS Glucose Sensor for Wireless Contact-Lens Tear Glucose Monitoring", IEEE journal of solid-state circuits, vol. 47, no. 1, January 2012

[6] International Diabetes Federation. Foreword. *IDF Diabetes Atlas*. Brussels, Belgium: International Diabetes Federation; 2011. Available from: http://www.idf.org/diabetesatlas/5e/foreword. Accessed April 10, 2012.

[7] International Diabetes Federation. *Guideline for the Management of Postmeal Glucose in Diabetes*. Brussels, Belgium: International Diabetes Federation; 2011.

[8] World Health Organization. About diabetes. *Diabetes Programme*. World Health Organization; 2012. Available from: http://www.who.int/diabetes/action_online/basics/en/index.html. Accessed March 9, 2012.

[9] American Diabetes Association. Standards of medical care in diabetes – 2012. *Diabetes Care*. 2012;35(Suppl 1):S11–S63.