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REVIEW: NIR SPECTROSCOPY FOR NON-INVASIVE BLOOD GLUCOSE MONITORING

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ABSTRACT

Diabetes is becoming a serious and alarming illness. Regular monitoring of blood glucose is important to avoid complication of diabetes. *In recent medical practice, the concentration of glucose in blood is measured using an invasive techniques which generally involves puncturing finger. Continuous blood glucose monitoring with Invasive method is inconvenient and dangerous.* Non-invasive method is a pain free technology which helps patient's regular blood glucose monitoring. This review firstly describe current status of diabetes, secondly describe Non-invasive blood glucose monitoring, thirdly describes NIR spectroscopy for Non-invasive blood glucose monitoring

Keywords: Diabetes Mellitus, Blood Glucose, Non-invasive, NIR Spectroscopy.

I. INTRODUCTION

Diabetes Mellitus (DM) more commonly referred to as “Diabetes” is group of metabolic disorder becoming a serious and alarming illness. In 2017, there was around 451 million people had diabetes worldwide, the number is expected to increase 693 million by 2045. It was observed that almost half of all people i.e. 49.7% living with diabetes are undiagnosed and in 2017, approximately 5 million death occurred worldwide because of diabetes[1]. The acceptable range of glucose concentration is from 70 mg/dL to110 mg/dL. But soon after eating, glucose concentration of a person may rise to a level up to 140 mg/dL[2]. Diabetes can lead to very serious and severe complications including heart failure, blindness, obesity, kidney disease and nerve disease. There are three main types of Diabetes.

- 1) Type- I Diabetes
- 2) Type- II Diabetes
- 3) Gestational Diabetes.

In Type I body does not produce insulin. People usually had type I diabetes before their 40th year, often in early adulthood or teenage years. Type II occurs in childhood or occurs later in life perhaps after 40 years of age. The pancreas does not produce sufficient insulin or cells do not respond to insulin properly. Hence, requires insulin doses to maintain life. In addition healthy eating & exercise needed. Gestational Diabetes affects females during pregnancy. The majority of gestational diabetes patients can control their diabetes with exercise and diet [2, 9]. Currently, Blood glucose can only be monitored through the use of invasive techniques. This method involve finger puncturing, which is painful. There is a risk of infection and bruising with all of the invasive techniques. Non-invasive method is excellent alternative to existing invasive method [4,9]. Non-invasive glucose monitoring refers to the measurement of blood glucose levels without drawing blood, puncturing the skin, or causing pain or trauma. Advancing technology improves diagnostic techniques and needed equipments. There are many technologies to measure blood glucose. Near infrared spectroscopy has become a promising technology among others for blood glucose monitoring [5].

II. METHEOD AND MATERIAL

NIR Spectroscopy

Spectroscopy is the branch of science concerned with the investigation and measurement of spectra produced when matter interacts with or emits electromagnetic radiation. Spectroscopic techniques are used to determine the presence or concentration of a substance by measuring how it interacts with light. This spectrum contains information about the optical properties and structure of the medium being measured. Near Infrared spectroscopy is a well established and constantly developing analytical technique which allows for the rapid, high-throughput, non-destructive analysis of a wide range of sample types [6]. It allows blood glucose measurement in tissues by variations of light intensity, based on transmittance and reflectance. The light focused on the body is partially absorbed and scattered, due to its interaction with the chemical components within the tissue [2]. In NIR spectroscopy, the absorption spectrum range of glucose is from 700 to 2500nm. Molecular formula for glucose molecule is C₆H₁₂O₆. There is bonds C-H, O-H and C=O which causes absorption of NIR light in blood or other human bodily fluid. Glucose concentration could be estimated by variations of light intensity both transmitted through a glucose containing tissue and reflected by the tissue itself [11]. NIR spectra are made up of broad bands corresponding to overlapping peaks: the overtones (ie, first, second, third, and combination overtones), formed by molecular vibrations [5].

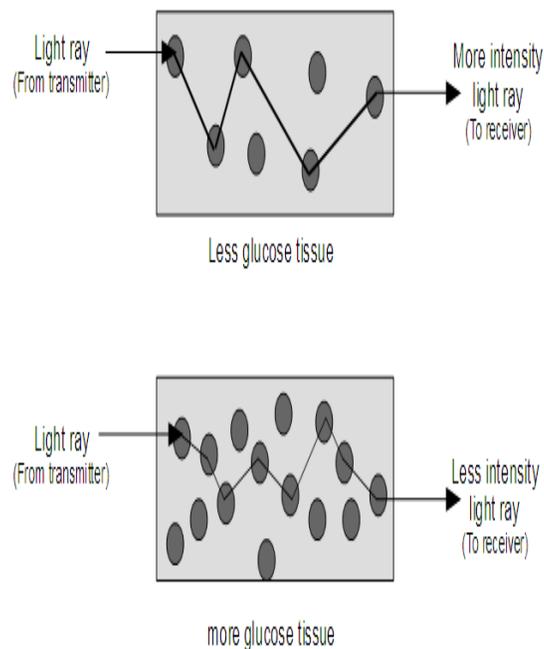


Figure 1 Schematic description of affect of glucose on light path [10].

III. NIR SPECTROSCOPY USED FOR NON- INVASIVE BLOOD GLUCOSE MONITORING

Akesh Govada, *et al*[2] in 2014 have reported about the problems and side effects of invasive method such as risk of infection, costly and discomfort for the patients and gives the innovative idea about the continuous monitoring blood glucose by developing non-invasive blood sugar measurement technique. Here NIR spectroscopy is used to develop a Non-invasive blood glucose concentration monitoring system. NIR has greater penetration depths and less background interference due to water absorption.

Jui-Lin Lai, *et al*[3] in 2016 proposed the non-invasive bio-sensor to sensing the blood glucose using NIR LED of 960 nm. It base on the absorbance rate of the NIR LED emitted into the finger. The NIR source element is suitable to detect the absorbance energy from the skin tissue corresponding to the concentration of the blood glucose.

Jyoti Yadav, *et al*[4] in 2014 described the need to develop a non-invasive monitoring system which can measure blood glucose continuously without finger puncturing. The present work is focused on development of non-invasive blood glucose measurement sensor system using Near-infrared (NIR) technique. Here NIR LED at 940nm wavelength is used. NIR is widely used optical technique because of its high penetration in skin. It can be applied on various body parts such as finger, palm, arm, forearm, earlobe etc.

Chi-Fuk So *et al*[5] in 2012 have reported about the main technologies currently being explored for non-invasive glucose monitoring. In their report the principle of each technology is mentioned with its advantages and limitations. As per report relatively low cost and the high sensitivity of the photoconductive detectors is the main advantage of NIR spectroscopy. NIR spectroscopy has become a promising technology, among others for blood glucose monitoring.

T. R. Jaya Chandra Lekha, *et al* [6] in 2015 have reported that diabetes and its complications have been a heavy burden on the society. The continuous blood glucose measurement and monitoring requires to control of blood glucose levels. The existing method is invasive for blood glucose measurement which requires extraction of blood through a lancing device. This method is painful, potentiality dangerous and expensive to operate. Non invasive glucose measurement eliminates the painful pricking, expensive, risk of infection and damage to finger tissue. Optical methods have been developed as the most powerful technique for non-invasive glucose measurement. The NIR spectroscopy method is one of the most promising optical approaches. NIR spectroscopy is simple, quick, non-destructive technique for non-invasive blood glucose measurement.

Rolamjaya Hotmartuaa, *et al* [7] in 2015 have reported that invasive method is costly and uncomfortable. The development of non-invasive blood glucose detector is desired to replace the existing Invasive method. NIR spectroscopy is used to detect blood glucose noninvasively. Glucose has specific absorbance spectrum in NIR range, 850nm – 2500nm. LED is utilized as incoherent infrared source to irradiate body surface in wavelength 1550 nm. Penetrated light is then detected by InGaAs photodiode, sensitive for wavelength 850 – 1700 nm. Photodiode's current is converted into voltage using trans-impedance amplifier circuit. In order to minimize high frequency noise, low pass filter is applied consecutively. Earlobe is chosen as the measurement sites, since it is thin. This paper shows NIR spectroscopy has potential as a window to look at the concentration of blood sugar in vitro.

IV. RESULT AND DISCUSSION

Regular blood glucose monitoring is very important to avoid diabetes complications. From the study using Invasive method, regular blood glucose monitoring is not possible. It is the necessity of time to use Non-Invasive methodology. This paper overview Non-Invasive blood glucose monitoring using NIR spectroscopy. The NIR spectroscopy is one of the most promising optical method.

V. CONCLUSION

NIR spectroscopy is very useful in Non- Invasive blood glucose monitoring. It is safe, simple and painless technique. Non-Invasive blood glucose monitoring system is needs to improve for continuous monitoring in healthcare centres and Homes, hence diabetic patient will monitor their blood sugar regularly.

VI. ACKNOWLEDGEMENTS

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