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Near Infrared Blood Glucose Monitoring Systems by Using Noninvasive Technology

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Description

Diabetes mellitus is one of the world's most chronic diseases, killing 1.5 million people each year. According to the International Diabetes Federation (IDF), diabetes will cause 6.7 million deaths in 2021 alone. Diabetes affects approximately 537 million adults (1 in 10) worldwide, ranging in age from 20 to 79 years. Diabetes is not only chronic, but it is also becoming one of the most globally prevalent diseases, with a 46 percent increase in patients projected by 2045. Diabetes is on the rise at an alarming rate, particularly in low- and middle-income countries, where diabetes affects three out of every four adults.

One of the primary causes of the rise in diabetes is an increase in obesity and health illiteracy. Obesity is largely caused by unhealthy lifestyle choices, such as the consumption of unhealthy foods (junk food, soft drinks, and bakery items) and a lack of exercise. Many people are unaware of their pre-diabetic conditions because of a lack of knowledge, which eventually leads to diabetes. Diabetes is linked to a slew of other serious health problems, including cardiovascular disease, renal disease, nervous system damage, and vision impairment [1-3]. If blood glucose levels are not properly monitored and controlled, these illnesses can worsen, resulting in organ failure and, eventually, death.

Insulin is a pancreatic hormone that regulates blood glucose levels (BGL) in the human body. In diabetic patients, either the pancreas are unable to produce enough insulin hormone or the cells in the body are not responding to insulin (insulin resistance) (insulin resistance). Type 1 diabetes is characterized by insufficient insulin production and is most commonly diagnosed in children. Type 2 diabetes is defined as insulin resistance. Gestational diabetes is diabetes that develops during pregnancy. Type 2 diabetes is the most common type of diabetes in patients worldwide. Every year, there is a significant increase in the number of diabetic patients. To avoid diabetes, pre-diabetic conditions, gestational diabetes, and impaired glucose tolerance must be closely monitored. Because there is no cure for diabetes, effective diabetic management is the only way for diabetic patients to live a fulfilling life.

Effective diabetic management entails using artificial insulin, either through shots or medicine, as well as exercise, a careful diet, and frequent blood glucose monitoring [4,5]. The finger-prick method is the most common way to check BGL. It is referred to as a self-monitoring blood glucose (SMBG) monitoring device because it can be performed by the patient. It is an electrochemical method in which the finger is pricked to collect small drops of blood on a test strip, and a discrete glucose value is displayed within a few seconds. This method is the gold standard for measuring blood glucose levels in patients at home. Despite its high accuracy, many patients find it inconvenient to take measurements several times a day because finger pricking is slightly painful and the test strips are expensive and only for one use. These factors make checking BGL several times a day undesirable, particularly in low-income countries.

With only 2-3 measurements per day, it is impossible to accurately track glucose variations in blood levels throughout the day. This sparked the idea of creating devices that could help with continuous monitoring without being intrusive. Medtronic (San Jose, CA, USA) introduced the first commercial continuous glucose monitoring (CGM) device for patients' personal use in 2004. Later, Dexcon, Inc. and Abbott Diabetes Care (San Diego, CA, USA) introduced CGM, with the goal of extending the life of implanted patches while improving accuracy. Since then, the industries have been working to improve and update the accuracy, lifespan, and calibration issues of the devices. Smart features in CGM devices have also been introduced graphically, such as displaying variation in glucose levels on smartphones and sound indicators for high and low glucose levels.

Although CGM devices are now available on the international market, they face numerous challenges. They are semi-invasive or minimally invasive devices that must be implanted by a medical professional. They are costly, difficult to use, and have low accuracy when compared to the invasive method. CGM devices must improve in accuracy, cost, and technology to attract the global market and mass consumers. Many research trends in the development of optical devices for glucose monitoring have emerged over the last two decades, with the goal of being cost-effective and noninvasive. Many studies using various technologies have yielded promising results. Noninvasive glucose estimation methods studied in recent years can be classified according to their technology. They are primarily classified as electromagnetic (EM) wave sensing, transdermal, and enzymatic. EM sensing encompasses all work involving non-ionizing EM radiation, including ultraviolet (UV), infrared, microwaves, and the visible light spectrum.

Conflict of Interest

None.

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