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Review

Diabetes Mellitus: Prevalence, Knowledge and Future Consideration for The Development of Technological Innovation

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Abstract- A significant metabolic illness known as diabetes mellitus is characterized by a lack of insulin or the pancreas failure to produce enough insulin. The blood glucose levels rise as a result of this condition in the human body. Nowadays management of diabetes is very easy by using various technologies such as biosensors. These types of devices are mainly used in the medical field for the advancement in cure and management of disease or disorder accurately. The main aim of advanced diabetes technology is to treat or control diabetes properly by using continuous glucose monitoring devices (CGM), insulin pens, insulin pumps, smartwatches, and some mobile applications. Above mention devices continuously give information to patients by Bluetooth in the patient's smartphone or smartwatch and according to data patients have control blood glucose levels and manage diabetes mellitus. While these technologies have demonstrated improvement in health outcomes. For achieving rational control over elevated blood glucose levels, frequent monitoring with invasive blood glucose monitoring techniques is mandatory for diabetic patients. We can easily manage blood glucose levels by using various diabetes technologies. The development of noninvasive glucose biosensor methods will be painless and reduce the complexity of invasive techniques. The main challenge of the biosensor is to recognize biological signals and these signals are transduced into electrical signals after being detected by specified detectors which are made up of semiconductors.

Keywords- Biosensors; Diabetes mellitus; Glucose monitoring devices; Insulin pump technology; Telehealth

1. DIABETES AND TECHNOLOGY

1.1. Current scenario of diabetes mellitus

Outperformed 101 million, seeing a critical increment from 70 million of every 2019. Also, roughly 136 million Indians are classified as prediabetic, while around 315 million people experience the ill effects of hypertension [1]. In spite of India being known as the "capital of diabetes," a few states with lower human improvement rankings have a diabetes-to-prediabetes proportion of short of what one [2]. The quantity of people determined to have diabetes mellitus in India is around 74 million. Looking forward, the India ceaseless glucose observing business sector is anticipated to encounter a Build Yearly Development Rate of 11.95% during the estimated time of 2023 to 2028 [3]. This projected development will bring about the market size expanding from USD 291 million. India is home to the world's second largest adult diabetes population and every sixth person with diabetes in the world [4].

1.2. Overview of currently used smart technology in diabetes mellitus

Currently, for the diagnosis of diabetes, there are many devices come to the market such as various types of biosensors which are currently change the life of diabetic patients by using various systems such as continuous glucose monitoring devices, intelligent insulin pumps, insulin pens, medicated patches, smartwatches which are directly attached with skin and they give information continuously about glucose level in blood and also give another diabetes-related information in Bluetooth devices [5]. By using such technology, we can revolutionize the medical field, and we can easily manage diabetes mellitus and in the future may be chances to cure diabetes mellitus accurately. Intensive insulin therapy is the standard treatment (or "gold standard") for type 1 diabetes patients [6]. Extensive randomized studies conducted across multiple centers have shown the beneficial impact of aggressive glycemic control on microvascular outcomes. However, there is still ongoing debate about the influence of different glucose-lowering drugs on macrovascular results and cardiovascular safety [7]. Over time, advancements in insulin formulations, such as rapid-acting and long-acting insulin analogs that closely mimic natural insulin production, have significantly improved the adaptability and efficacy of type 1 diabetes treatment [8].

1.3. Worldwide continuous glucose monitoring devices market trends

In the Asia-Pacific area, India has recently seen the second-highest incidence of diabetes cases. Younger people are now more likely to develop diabetes as a result, which has increased the demand for (CGM) devices and raised the adoption rates for these devices. The market for CGM devices is thus anticipated to expand significantly. The promotion of devices is expected to be a key focus for major market participants including Abbott, Dexcom Inc., Medtronic Pump, and Eversens Diabetic [9]. Because of improvements in diabetes devices, an increasing

number of people worldwide are developing diabetes, there is an increasing demand for quick diagnostics, and diabetes is still developing, it is predicted that the diabetic care market will dominate throughout the forecasted period [10].

The Diabetes Care Devices Industry is divided into regions and products. The market is divided into insulin delivery devices and blood glucose monitoring devices, depending on the product. Testing strips, self-monitoring blood glucose meters, lancets, and continuous glucose monitoring devices make up the blood glucose monitoring devices market category [11]. Insulin syringes, insulin pens, insulin pumps, and insulin jet injectors are the several types of insulin delivery systems [12]. The United States, Canada, and Mexico make up North America, followed by Germany, France, Italy, the United Kingdom, Spain, and the rest of Europe, then Asia-Pacific (China, Japan, Australia, India, South Korea, and the rest of Asia-Pacific), and finally LAMEA (Brazil, South Africa, Saudi Arabia, and the rest of LAMEA (Latin America, middle east & Africa)) [13].

1.3.1. Healthcare Executive Analysis of the Glucose Devices Market in India

The India Diabetic Devices Market is now valued at $413 million and is anticipated to grow to $899 million by 2030, at a CAGR of 10.20%. The outstanding $10.75 billion allocated for medical costs in India's budget proposal for 2023 represents a $0.28 billion (or 2.71%) increase over the $10.47 billion allocated in FY23 [14]. Initially, $10.42 billion, the estimated budget for the Indian Ministry of Health for 2022–2023 was eventually lowered to $9.57 billion at the same time. This year, investments are expected to be worth $10.78 billion [15]. The amount of money allocated to healthcare in India fell from 2.2% to 1.97% this year. These devices are becoming more widely available and cheaply priced in India, which is expected to drive market growth [16]. The importance of proactive medical care is growing in India, and this encompasses the administration and control of chronic diseases like diabetes. As a result, it's expected that demand for diabetes devices will increase, particularly among people who are at an elevated risk of developing the illness [17].

1.3.2. Analysis of the insulin delivery pump market in Indian

In order to establish correct blood sugar management and lessen the consequences of hypoglycemia, insulin is administered via an insulin pump. The insulin delivery quantity may be precisely controlled by the user using a computer chip, a rechargeable pump, and a pump storage that resembles an insulin cartridge [18]. The insulin is administered using a flexible lance (or syringe) at the end of a thin tube of plastic (an infusion set) that is connected to the pump. The inflation gadgets, infusions set, and reservoir markets for insulin infusion pumps are divided into submarkets in India. For the aforementioned segments, the report provides both the price and capacity [19,20].

1.3.3. From 2021 to 2026, wearable biosensors will see the greatest CAGR in the biosensors market

Because they have the potential to alter traditional healthcare diagnosis and ongoing surveillance of health paradigms, wearable biosensors have garnered a lot of attention. In order to shift from centralized hospital-based health care to at-home personal medicine and decrease healthcare costs and diagnosis times, wearable biosensor apps are being developed [21]. We now observe that biosensors that are worn are causing a surge of innovation to sweep through society. They might offer a new degree of accessibility to a patient's current health state due to their comfort and improved utilization. This availability of real-time data allows for improved clinical judgment, which improves health outcomes and maximizes the effectiveness of health systems [22].

1.3.4. High-growth prospects exist in the market for wearable biosensor technology

There are more and more prospects for wearable biosensors to continuously monitor the vital indicators of patients, preterm newborns, kids, athletes, and those in distant locations far from healthcare and medical facilities. Biosensors that are wearable and networked enable remote monitoring so that patients might avoid hospitalization or depart sooner [23,24]. Wearable biosensors can reduce the workload for medical staff while opening away hospital resources for more nimble treatment by enabling e-health (monitoring and sending health information from outside the hospital). Vital sign monitoring might be made easier and more convenient by using smart textiles with embedded sensors. Biosensor patches that make use of conformal, printed electronics can let doctors collect data on a patient for extended periods of time [25].

1.3.5. Market limitation for diabetes equipment

The cost of diabetes equipment like insulin pumps and glucose monitoring systems may be considered to be too expensive by many people with diabetes, particularly those who live in rural regions or have lower incomes. This could limit the adoption and usage of these technologies [24]. Despite improvements in diabetes awareness and instruction, there is still a substantial knowledge and comprehension gap with regard to the condition, its underlying factors, and efficient management techniques. As a result, there may be a decrease in the demand for diabetic devices, which will make it harder for manufacturers to properly promote their products [26,27].

1.3.6. From 2021 to 2026, the biological sensors market will expand at the fastest rate across all types of home diagnostic applications

During the anticipated period, consumer demand for home diagnostic applications is anticipated to expand at the fastest rate. The market expansion may be ascribed to rising healthcare industry advances and the rapid use of innovative diagnostic techniques. The

epidemic of the coronavirus has increased the need for personal diagnostics. As a result, producers in the home diagnostics industry are increasing their capacity [28,29].

1.3.7. Healthcare Regulation and Policy Environment

The National Scheme for the Prevention and Management of Cancer, Diabetes, Cardiac illnesses, and Stroke (NPCDCS) was established by the Indian government in 2010 to prevent and manage illnesses that are not transmissible in India, including diabetes. The program supports the creation and execution of diabetes prevention and treatment strategies across the nation [12]. The Indian government issued the Indian Medical Device Rules (MDR) 2017 as a set of rules to regulate medical devices, including diabetic devices [30,31]. According to the regulations, manufacturers must follow particular labeling and reporting standards and receive certification from reliable organizations. For a variety of necessary medications and medical supplies, including insulin, the Indian government has established price limitations [32].

2. BIOSENSORS

2.1. Working patterns of biosensors devices

Molecular biosensor is a seeing device that measures specific molecules known as biomarkers molecular reorganization is used for the detection of biomarkers working in conjunction with the reader the biosense operates by detecting the sample taken from the interstitial fluid and is worn either inside or on the body for nonstop monitoring with glucose being the most common biosensing device used by diabetic patients [33,34]. The process being with molecular recognition, followed by the signal creator, reader instrument, and disposable detector device [35]. Biomarkers bind to recognition patch and they can be either an antibody or an enzyme. This result in a signal generation inside a disposable seeing device and the signal can be optic, electronic, and glamorous. The signal is also restated and the disposable sensor devices also display this into data and information as user-friendly and easy to understand [36]. Our bio-sensing devices have a wide range of capabilities that can be applied to different aspects depending on the user's specific requirements. In recent years we've developed biosensors used in the analysis of food similar to garlic, ginger, and styronese [37]. We have a point-of-care exhalation technology that detects analytes in the breath, more prevalently a device that aids in COVID-19 detection another operation is nitrate seeing in soil using our nitrates rods used conjunction with the user's smartphones for non-stop monitoring. A biosensor is a tool that analyzes a sample of the body, such as a drop of blood, or it may be worn internally or externally to continually monitor particular parameters. The glucose detector, which tracks glucose levels in the blood or skin, is one of the most well-known biosensors [38]. Since it provides real-time data for patients and doctors, it is incredibly helpful for those with diabetes. It facilitates treatment optimization, reduces needless hospital stays, and enables improved management of medical and health disorders [39,40].

2.2. Features of biosensors

Two distinguishing features of biosensors are: 1) Biological building blocks, such as DNA, cells, and enzymes. 2) Electronics, transducers, amplifiers, etc. are examples of physical components. The analyte is recognized by the biological component, which then reacts with it to bring about a physical change that the transducer may pick up [41]. As long as the biological material is appropriately adsorbed on the transducer in practice, the resultant biosensors can be employed again over an extended period of time. The term "analyte" refers to a substance whose concentration has to be determined. Glucose, urea, a drug, or a pesticide are a few examples. A material of interest that has to be located is referred to as an analyte [42]. Glucose is described as an "analyte" in a biosensor designed to detect it. Nowadays the healthcare sector is very progressive in the diagnosis of diseases based on biosensors [43,44].

The biosensors market's integrated device category is expected to have the maximum market share during the anticipated timeframe. The market for biosensors has a bigger market share for embedded devices than other types [45,46]. Numerous applications, including point of care, home diagnostics, food and beverage, research lab, monitoring the environment, and biodefense, make extensive use of these devices. Internet of thinking which has had a significant impact on linked healthcare applications. Real-time alerting, tracking, and monitoring made possible by IoT allow for hands-on treatments, enhanced accuracy, timely clinician intervention, and better overall patient care [47].

2.3. Types of analytes in biosensors

Contrary to the common belief that blood is the sole bodily fluid used in biosensors, various other fluids such as saliva, sweat, urine, tears, and breath are also utilized. These fluids offer the potential to identify a wide range of biomarkers beyond what blood can do. Let's explore a few examples saliva-based biosensors are employed to detect blood components like glucose [39,48]. Gradually, invasive blood-based biosensors for glucose detection are being replaced by saliva-based ones. Saliva-based biosensors can also measure levels of lactate, cortisol, and other substances. Sweat-based biosensors have the capability to measure chemical quantities of glucose, lactate, ascorbic acid, and uric acid, providing valuable insights into a person's health status [49,50].

2.3.1. Bioreceptor

A molecule with the capacity to uniquely identify an analyte is referred to as a bio-receptor as per Figure 1. Bio receptors include things like enzymes and macromolecules. When a bioreceptor interacts with the analyte, bio-recognition involves the production of signals, such as light, heat, pH changes, charge fluctuations, or mass shifts [35,51].

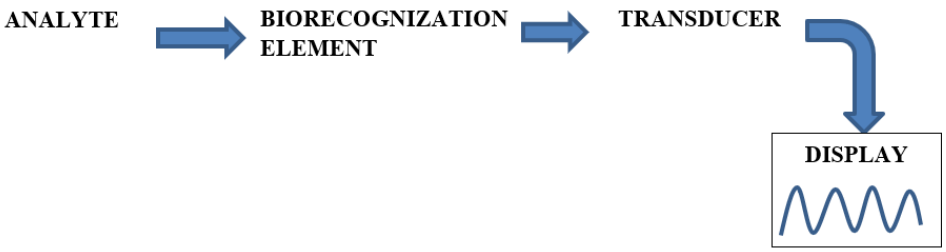

Figure 1. Working mechanism of bio receptor

2.3.2. Transducer

A transducer is a component of a biosensor which are responsible for the conversion of one energy form to another energy e.g. windmills are useful for wind power to electrical power similar principles are used in transducers which are useful conversion of bio-reorganization events to quantifiable events [52,53].

2.3.3. Electronic display

They function as a component of a biosensor and are helpful for showing countable signals as graphical patterns. The greatest examples of current electronic displays used for this purpose include pulse oximeters, thermometers, and glucometer displays [39,54]. Here, signal processing and display signal preparation for a biosensor take place. Its complex electrical circuitry performs signal conditioning functions including amplification and digital signal conversion. The display device for the biosensor then quantizes the signals. A user interpretation system is employed, such as a direct printer or a computer's liquid crystal display, to generate numbers or curves that the user can comprehend [50,55].

2.3.4. Consideration of biosensor design

Selecting a biological receptor: The biological receptor utilized affects a biosensor's sensitivity and selectivity to the target analyte. Choosing a good immobilization technique: Any biological molecule has to be attached to a transducer's surface in order to function consistently as a biological receptor and this procedure is also known as immobilization [56,57].

2.4. Types of biosensors

There are mainly four types of biosensors - electrochemical, piezoelectric, thermometric, and optical. Electrochemical biosensor: This type of biosensor consists of a bioelectrode, which is typically used to measure changes in electron, ion charge, and conductivity. In general, this type of biosensor generates electrons through an enzymatic catalytic reaction. This type of biosensor mainly consists of three electrodes, a reference electrode, and a working electrode [58]. Types of electrochemical biosensors: Amperometric biosensor, potentiometric biosensor,

and conductometric biosensors. In an amperometric biosensor, the current is directly proportional to the substrate concentration**.** Other types of biosensors include optical biosensors, silica biosensors, biosensors based on nanomaterials, genetically encoded biosensors, and microbial biosensors [59].

2.4.1. Electrochemical biosensor

The first discovery of biosensors was electrochemical biosensors which are useful for regular monitoring of blood glucose in diabetic patients. generally, glucose biosensors contains enzymes such as glucose oxidase and their substrate-producing hydrogen peroxidase which is detected by an electrode [60]. Recently prepared electrochemical biosensor consists of a metal surface and carbon electrode which are made from carbon molecules and several biomaterials are used to generate output over the surface of electrodes or catalytic reactions occur [61].

2.4.2. Optical biosensor

The working pattern of optical biosensors is also dependent on a change in a particular wavelength of light. Optical biosensor is also used in biomedicine and the environment need advancement in these biosensors to be simple and ultrasensitive by incorporation of dot nanoparticle of gold, silica, and quartz, glass & carbon-based material with micro-fibrillation provide a new tool [35]. Highly sensitive cytochrome p 450 enzyme biosensors were developed by using technology. Similarly, fiber optic chemical biosensor is used in biomedicine, de novo drug design, and biosensor devices. Currently, hydrogels are used as entrapment material for sensing element immobilization [62,63].

2.4.3. Silica biosensor

Silica is generally found in the crust of the earth and this metal is very ununiform in nature so they are recently used in biosensors. Silica is responsible for various catalytic and chemical reactions with safe and non-toxic in nature. The nanomaterial is also used for chemotherapy, biosensing devices, and bioimaging. Silicon nanoparticles have many advantages and some future challenges and issues such as large-scale development, biocompatibility, and low-cost production after being marketed [64].

2.4.4. Genetically encoded biosensor

This biosensor is very useful in the study of various cellular processes like biological processes and molecular pathways in cells [65,66]. Fluorescence generates imaging of fixed cells by using tagged antibodies. So genetically encoded biosensors work as secondary messengers. small molecules binding to analytes and biological proteins. These sensors are also responsible for the conversion of physical and chemical signals to light as shown in Figure 2 [67].

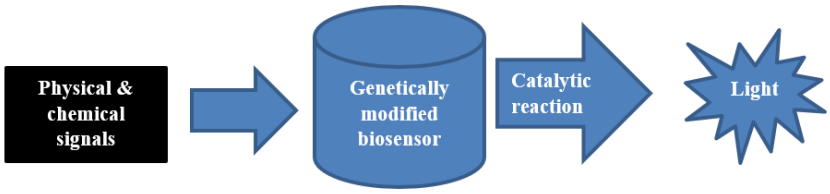

Figure 2. Genetically encoded biosensor

2.5. Future of biosensors

The newest sensor is very accurate and comfortable and an improved reagent to test with even smaller sample volume and more accurate results. The former is important to the patients who prick their finger several times daily because a smaller sample volume necessarily means finger punctures that are less severe, more accurate, and especially more robust, the system is always at the top of our priority list as we try to provide the customer with useful information [68,69]. Into the future biosensors will occupy a major role and efficient way to control diabetes mellitus. Bright future of biosensors because they are also used in drug delivery systems in recent times similar to implants drug delivery systems [70]. We concentrate on aptamer-based biosensor development, with a focus on aptamer pair screening. Aptamers are modern bioreceptors that may selectively attach to target molecules and take the role of conventional antibodies [71]. They are composed of DNA or RNA nucleic acids. Single-aptamer biosensors frequently have issues with repeatability and signal production, which reduces their stability. The majority of commercial biosensors utilize a pair of receptors-aptamers or antibodies to address this [72]. The goal of our study is to create an aptamer pair (aptamer1-target-aptamer2) that can attach to the same target in two separate binding sites at the same time, forming a "sandwich" shape. In order to do this, we created a proprietary aptamer development process dubbed "Graphene-oxide SELEX (GO-SELEX)" [73]. We have successfully produced multiple pairs of aptamers for diverse targets, including protein biomarkers and viruses, using the GO-SELEX technique [74]. Advancements in biosensor technology, diabetics may now more readily check their blood glucose levels. One bio-wearable that totally substitutes blood tests is the PK vitality K' Track Glucose tracker. Instead, this tracker "tastes" the skin with small needles to analyze the chemical composition of the interstitial fluid, a fluid that rapidly absorbs glucose from the blood. This straightforward tracker eliminates the need to carry several test kits without interfering with their daily routines [75].

2.5.1. Smart device apps

Some applications are just able to provide data. This information might relate to physical activity, eating, blood sugar levels, medication dose, and timing (including insulin), as well as additional medical information like heartbeat frequency, blood pressure, and a variety of other details. Other programs keep the information, allow for interactive usage, adapt to the

preferences and profiles of the users, and employ suggestions [76]. There are also other applications related to calorie and carbohydrate consumption. Some aid patients in accessing food databases, providing nutritional data, displaying the carbohydrate content, and assisting with calorie and carbohydrate counts. Additionally, suggestions can be made about the fat, salt, vitamin, and fiber levels of foods [77]. Some apps can communicate with algorithms used to determine medicine doses, such as insulin dosage adaptation. The majority of smart device apps now enable users to recognize and measure physical activity. Additionally, certain programs allow patients to track the frequency, kind, and duration of their physical activity [77]. In order to improve patients' motivation, empowerment, and adherence to therapy, a number of doctors also created applications for smart devices. They are able to teach patients and increase adherence to medicine, insulin administration, and self-control of blood glucose levels.

2.5.2. Wearable gadgets and biosensor miniaturization

Health trackers and smartwatches are examples of popular consumer gadgets that make use of wearable technology. Wearable technology is now being used in a variety of contexts, from medical care, consumer products, professional athletics, and powerful textiles, thanks to recent developments in the Internet of Things (IoT) and artificial intelligence (AI) [78,79].

2.5.2.1. Specifications of Wearables devices

Tools were often identified as having more than one device measurement, and we disclosed these together with the values used for the principal-related studies. We observed that several researchers have. As their top principal device metrics, blood glucose is followed by climate, rhythm, and galvanic skin reaction [80]. The majority of research revealed an opportunity-driven strategy (i.e., one where participant involvement is not necessary) when employing WDs to collect data, whereas the others employed a participative methodology. Different sensors were used for sensing technology, utilized, either as sensors that are worn or built-in to the WD, frequently recorded as more than a single sensor per unit [81]. As biosensors get smaller and more portable, wearable gadgets that can continuously monitor various physiological signs start to appear. These devices are useful for self-monitoring and preventative healthcare since they can link to smartphones or other devices to offer real-time health information [29,82]. In wearable devices key component is a wearable sensor. The future of wearable biosensors faces difficulty in the integration of sensors for the detection of diverse biomarkers, which calls for ongoing technological advancements in sensing devices. Electrochemical-based biosensors stand out among other types of biosensors because they are simple to build, more sensitive, responsive, and have a low power need [83,84].

2.5.2.2. What functions do wearable devices have?

Smartwatches, activity trackers like the Fitbit Charge, VR headsets, smart jewelry, web-enabled eyewear, and Bluetooth headsets are just a few examples of the wide range of usable digital wearable technology [85].

2.5.3. Internet of Things Integration (IOT)

This integration would enable without seam data sharing and remote monitoring of patients, making easier for the management of patients, making it easier for a healthy lifestyle [86].

2.5.4. Application in personalized medicine

Biosensors play an important role in medicine by providing real-time data on an individual health status. This information leads to more effective and targeted therapy. Biosensors play an important part in medical science advancement very growing in them [87,88]. Some of the applications that are related to biosensors include cancer detection and monitoring, heart disease monitoring, and diabetes mellitus control [43,89]. Given the prevalence of the disease, the high mortality rate, and the high incidence of recurrence following therapy, the identification and management of cancer are of tremendous interest. In the field of medicine, biosensors are used to track the growth of cancer, identify microorganisms, and measure glucose levels in the blood of diabetic patients [55].

2.5.5. Environmental monitor

Biosensors can be used to analyze experimental pollutants, toxins, and hazardous substances 90.

2.5.6. Real-time Data Analysis

Advancements in data analytics and artificial intelligence will enable real-time analysis of biosensor data. This will allow for immediate responses to environmental changes or pollution incidents, helping to help or alleviate adverse impacts [39,91].

2.5.7. Environmental DNA (eDNA) sensing

eDNA is an inheritable material released by organisms into their terrain. Biosensors able to detect eDNA can give precious information about the presence and cornucopia of colorful species in submarine ecosystems, abetting in biodiversity monitoring and conservation sweats [92,93].

2.5.8. Environmental Health Monitoring

Biosensors could be applied to cover the health of ecosystems and assess the overall environmental quality. By continuously tracking environmental parameters, biosensors can help identify trends and implicit pitfalls to ecosystems and wildlife [94]. So, there are numerous devices are coming under this order of wearable technology devices similar as nonstop glucose

monitoring systems & automated insulin pumps are illustration of these technologies, which can make blood sugar management simpler and more accessible [95].

Biosensors are not only useful in diabetes but also for numerous diseases with diabetes like cancer treatment, congestive heart failure and hypertension, etc. We're also changing the future by using advanced technology and in recent times there are numerous researches working on biosensors to make veritably small, effective easy to handle, and low-cost [96]. We can manage diabetes using smart mobile because in recent times mobile health is a growing field that has been influenced in various areas including self-management of different types of chronic disease such as cancer, diabetes mellitus, etc. The main aim of m-health devices is to improve quality of health and quality of life (defined by US FDA) [97]. These devices also give colorful services like short communication service, text messaging, smartphone application, and wearable technology and they also include telemedicine and health information technology. Smartphone technology is veritably effectively to diabetes management as it can give frequent contact with patients and timely dissemination of health information [98]. There are numerous mobile apps are connected with wearable devices and this mobile app also rendering by wearable devices companies which are manufacturing of wearable devices.

3. GLUCOSE MONITORING DEVICES

3.1. Continuous glucose monitoring system (CGM)

CGM is an advanced way for people who are suffering from diabetes mellitus to check their sugar level in real time over a period of time by using continuous glucose monitoring devices. Up to 60 minutes ahead, the Smart CGM predicts future high and low sensor glucose occurrences and gives you access to extra algorithms and insights that might alert you to clinically important glucose patterns [41]. People with type one diabetes are advised to utilize the continuous glucose monitoring (CGM) solutions from Medtronic. Ages 2 and above may use the guardian Sensor 3 as a component of the guardian tm Connect and minimized 640G systems [99]. Use of the sensor is recommended for the arm and abdomen. When used with the MiniMed 670G system, the GuardianTM Sensor 3 can be utilized by type 1 diabetics aged 7 and older [100]. Only the abdomen is intended for use with the sensor. For type 1 diabetics aged 7 and older, EnliteTM Sensors are recommended for use with GuardianTM Connect, ParadigmTM VEO systems. The sensor is intended for usage on the upper buttock, buttock, and abdomen [101,102].

For those with diabetes, glucose monitoring is made easy by freestyle liber ease of use, accessibility, and user-friendly design. Continuous glucose monitoring has ushered in a new paradigm of monitoring for those with Type 1 and Type 2 diabetes. Young babies above the age of four, women with gestational diabetes (during pregnancy), and people with Type 2 diabetes who want to keep their diabetes under control may all use CGM devices [103].

Innovative and affordable technological solutions may become a staple of efficient illness treatment at home at a time when our healthcare system is under pressure and resources are scarce [104]. These devices also provided serious medical and lifestyle benefits. In the current scenario effect of food and exercise on your blood glucose levels and make condition of hyperglycemia in patients are potentially dangerous consequences. Blood glucose monitoring gives only one reading at a time. CGM is an option for blood rearrangement and reducing A1C [105,106]. CGM is very beneficial for children and adult patients and also controls glucose during night fluctuation. It is also a lifesaving tool for people who are suffering from diabetes mellitus.

3.1.1. Continuous glucose monitoring Vs blood glucose monitoring devices

Earlier blood glucose monitoring was used but in recent times there has been a demand for continuous blood glucose devices because blood glucose monitoring is more complicated and painful than CGM. Blood glucose monitoring is measuring the glucose level in capillary blood vessels and continuous glucose monitor measures the glucose between the cells in your tissue. They are useful in both types of diabetes type 1 and type 2 [107]. Time in range is an addition to HbA1c, the present industry-recognized gold standard for measuring glucose management. HbA1c has been utilized by individuals with diabetes and medical professionals for more than three decades as a diagnostic index and a tool for managing diabetes [41]. TIR has been linked to a lower chance of developing microvascular and macrovascular problems from diabetes, much like HbA1c. The average blood sugar levels a person had over the preceding two to three months are measured by HbA1c, although daily changes are not taken into account [108]. In addition to giving a more comprehensive picture of glucose levels than TBR and TAR, TIR also has the ability to show patterns of hypo- and hyperglycemia across the day and night. Time in range can provide a personalized and unique account of a patient's glucose levels when combined with HbA1c, assisting people with diabetes in understanding their daily changes and the factors that contribute to them as well as assisting healthcare professionals in making better diabetes management decisions [109,110]. Diabetes gadgets play a significant role in the treatment of diabetes in India. Blood Glucose Monitors (BGMs) are devices that test blood glucose levels. They are used by diabetics to monitor their blood glucose levels all day long. By regularly monitoring blood glucose levels, BGMs assist diabetics in self-managing their condition. Users have the ability to access real-time data using devices, which continuously measure blood sugar levels throughout the day [111]. CGM systems can be beneficial for diabetics who must closely monitor their blood glucose levels, particularly type 1 diabetic who require insulin therapy. Through a catheter implanted beneath the skin, tiny devices known as insulin pumps continuously provide insulin [112].

3.1.2. Glucose Monitoring in Flash

3.1.2.1. The Flash Libre

Another CGM-type system is the libre flash. Because it is factory-calibrated, it offers continual interstitial measurement of glucose without the requirement for blood sugar calibration. Despite being calibrated, continuous information is only accessible for 8 hours backward from the user prompt. The device employs a reader to scan over the glucose sensor that is implanted into the skin above the triceps [113]. To display the most recent eight hours' worth of glucose measurements, 15-minute reading intervals are used. The sensor was manufactured. Each sensor is calibrated and may be worn for up to 14 days [114,115].

3.1.2.2. Guidelines for using flash glucose monitoring from professionals

The FreeStyle Libre might be used to replace routine blood glucose monitoring in T2D patients receiving insulin therapy, according to a 2017 Med tech innovation briefing by NICE. However, it was noted that patients receiving fixed dosages of insulin could not gain as much from the gadget [116]. It was also mentioned that the FreeStyle Libre may be especially helpful for persons with T2D who frequently experience hypoglycemia, reflecting findings from clinical trials [116].

3.1.2.3. Libre Pro

Using a Freestyle, A specialized CGM system called the Libre Plus Rapid Glucose Monitoring Device is suggested to record glucose levels, patterns, and excursions either above or below the target range, simplifying medication modifications in diabetics who are eighteen years of age and older. The technology is designed for use by medical specialists [113]. No alarms are sent, and neither patients nor a third party, not even a healthcare expert, are allowed to access the data in real-time [117].

3.1.2.4. Dexcom

Dexcom pump for insulin with dexcom RT-CGM system compatibility. Additionally, Dexcom is attempting to collaborate with Omni Pod [19]. It contains an always-on hypoglycemia safety alarm that notifies the patient when blood sugar levels rise to 55 mg/dL. When the levels of glucose decrease drastically or climb beyond user-selected limits and when the glucose is quickly increasing or decreasing, customizable notifications with a variety of tones can warn the user [118]. Work with the dexcom RT-CGM system dexcom Share program that transmits real-time glucose levels up to 5 caregivers can use the cloud to store values. Real-time glucose readings may be viewed on some Apple or Android devices using a connected Dexcom phone application. It is suitable for use by both parents and children aged two and over [119,120].

3.1.3. Benefits of continuous glucose monitoring device

With the use of CGM, you can make connections between different glucose measurements to obtain an improved understanding of your blood sugar levels: You can monitor your blood sugar levels day or night. Recognize how your blood levels of sugar change when you don't

typically check them, as at night when you're sleeping. To observe visual patterns of the information you provide over time, use the offered program [121]. Remotely communicate your data to the diabetic team. Gain an understanding of the effects that elements of your daily life, such as food, exercise, stress, drugs, hormones, and sickness. You may anticipate a wide range of health and convenience benefits from using a CGM system, regardless of whether you treat your diabetes with several daily injections or an insulin pump. more information than is possible with just a meter [122,123]. A CGM offers real-time, constantly changing data on the pace and movement (trending upward or lower) of the levels of glucose in contrast to a single measurement from your blood glucose meter increased control of blood sugar. According to him, the product originated from the USA, and the firm had not experienced any supply problems as a result of the epidemic in recent months [124]. According to him, the most recent product will be sold over-the-counter, online, and in pharmacies. India has had access to Abbott's FS Libre Pro since 2015. However, this was less expensive just about 2,600. In this instance, the reader follows the physician. Consumers will pay 5,500 for the reader upfront, and maybe another 5,000 every three months for the sensor [109,125]. The sensor provides 14 days of continuous measurements and three months' worth of analytics, charting blood glucose levels against things like food and activity [50].

3.1.4. Feature of smart technology

If a person's blood sugar drops below the predetermined values, an alert sounds; if they don't reply, the insulin is stopped. A large dosage estimator that calculates dosages automatically and alerts a user if they are placed too closely together, preemptive warnings, waterproof defense, a color display with a programmable brightness, choices for customized skins, every 2 to 3 days, people ought to exchange the tubing [110].

3.1.5. Obstacles to the Use of Intelligent Insulin Pens

The development of a realistic economic analysis requires that each new smart pen, like all new medical technologies, show unique better clinical results, patient feedback quality of life. The recently developed programmable insulin pen technology will need to pass both health economics assessments and human aspects usability engineering tests in order to become widely used [126,127]. Many novel diabetes solutions, such as pumps that deliver insulin, continuous glucose measurements, and mobile applications for insulin dosage, have been broadly adopted more slowly than their creators anticipated [127,128].

4. INSULIN PUMP

To control their blood sugar levels, all people with diabetes with type 1 and numerous individuals with type 2 must take insulin. Currently, there are two ways to inject it: using a pump that releases insulin or a tiny needle and pen [129]. A pump that delivers insulin is a little electronic gadget. Through a little tube that is inserted beneath your skin, it distributes insulin.

These developments are being driven by ongoing worries about the short-term hazards of diabetic ketoacidosis, extreme hyperglycemia, and potentially deadly hypoglycemia [130]. Concerns concerning the long-term danger of consequences from hyperglycemia and diabetic unpredictability linked to modern insulin delivery techniques are also present. Early glycemic management is crucial since early hyperglycemic stressors may lead to long-term vascular problems, as suggested by research on the significance of metabolic recall [131-133].

4.1. Science behind insulin pump technology

The insulin is released by the device in a manner that is very similar to what your body would do naturally: You set up the pump to administer bolus and basal dosages. You can design a higher bolus to cover your extra food's carbohydrates if you consume more than usual. Additionally, a bolus helps lower elevated blood sugar levels at other times [134,135]. Insulin can be delivered via pumps for insulin, which are computerized devices, in incredibly small, precise amounts. Based on their unique insulin-to-carbohydrate (IC) ratios and insulin-responsiveness factors, the patient may design the device to provide basal insulin every hour as well as boluses for food consumption throughout the day [136]. The number of units-to-bolus for meals and snacks is calculated using the IC ratio, which stands for the number of grams of glycogen covered by a single dosage of insulin. Insulin pumps are useful for deciding on correction dosages for individuals with high BG since they represent the reduction in blood sugar (measured in milligrams/deciliter) brought on by one unit of insulin [137,138].

4.2. Advantages of insulin pump technology

4.2.1. Progression of diabetes mellitus control

There is strong evidence that continuous subcutaneous insulin infusion treatment outperforms MDI in terms of results for patients. Less frequent hypoglycemia, enhanced awareness of hypoglycemia, lower HbA1c numbers, and decreased glucose fluctuation are just a few of these better results.10-17 Pickup and Sutton conducted a meta-analysis and discovered a 2.9-fold decrease in severe hypoglycemia occurrences in each of the pediatric and adult groups [139]. Studies have shown reductions in HbA1c in adults, pediatric, and adolescents with diabetes. Evidence suggests that starting the continuous subcutaneous insulin infusion procedure in a person with a greater than average baseline hemoglobin A value will result in the largest HbA1c benefit [140]. In comparison to MDI treatment, continuous subcutaneous insulin infusion produced average HbA1c readings that were 0.65% lower when the patient's baseline HbA1c was 10%. However, there was no blood sugar level reduction effect of continuous subcutaneous insulin infusion over MDI treatment if the baseline HbA1c was 6.5% [141,142]. In a 4-month experiment, patients who received continuous subcutaneous insulin infusion therapy, as opposed to MDI, had an average HbA1c reduction of 0.35%, while in

another research, the average HbA1c decreased by 0.9% after 3 months of continuous subcutaneous insulin infusion therapy, and by 0.7% after 6 months [143,144].

4.2.2. Precise bolus dosing

Patients must input the present blood glucose and the number of grams of carbs they want to take for accurate bolus dosage. The individual receiving treatment must take responsibility for providing the bolus dosage after the pump suggests it. They also consist of bolus calculator, they describe bolus amount on display [145]. Patients frequently have the following misperception concerning CSII treatment. Patients can administer manual boluses that can be predetermined ahead to each bolus for commonly used quantities to make the bolus procedure simpler if they are not counting carbs or checking their blood sugar before each meal (usually not advised) [146]. Before beginning medication, patients should be informed about the bolus dosage capabilities of insulin pumps.

4.2.3. Improved Standard of Life

Patients taking CSII report better quality of life than those taking MDI. These findings are backed up by a ton of research. Less low blood sugar, fewer injections, more freedom and adaptability with diets and daily changes, simpler problem-solving, and better convenience than MDI are all reported by patients [147]. Another study that used the DCCT questionnaire demonstrated how CSII treatment led to patient-reported increases in daily convenience. Additionally, there is proof that patients using CSII as opposed to MDI see benefits in family cohesion [148]. Additionally, patients have the option to cover up their insulin pumps using clothes. CSII therapy resulted in statistically substantially greater satisfaction rates and decreased hypoglycemia concern in T1DM patients compared to MDI, according to self-reported surveys on treatment satisfaction for diabetes and fear of hypoglycemia [149].

4.3. Types of insulin pump

4.3.1. Smart Insulin Pens

The availability of second-generation "smart pens" with a recall function date from 2007. Due to their capacity to store several doses, these devices can keep track of every present, time, and dose of previous administrations. These gadgets contain Bluetooth and USB features for efficient data handling and monitoring [126]. The Huma Pen LUXURA, a refillable pen for those who need an insulin dosage of 0.50 to 30 units, and the Huma Pen MEMOIR, the initial digital diabetes pens with recollection in the world, were both released by Eli Lilly in 2007 [144,146,150]. Because of its straightforward ability to store half-increment units a research study found that Novo Pen Echo provided pediatric patients with a higher degree of satisfaction than NovoPen. Due to its greater appeal than NovoPen Junior, NovoPen Echo eventually

superseded it in 2013. NovoPen 5, a replacement for NovoPen 4 that features a basic memory function for use with the 3-ml Penfill cartridge, was released in 2012 [151,152].

The first insulin smart pen with FDA approval went on sale on December 2014 [76,153]. This gadget has the ability to wirelessly and Bluetooth-transmit each insulin dose's quantity and time to a specific mobile application. This related smartphone app also monitors insulin in-transit, suggests dose, and generates reports for medical experts. Other comparable smart pens with these features are probably going to get FDA clearance shortly [76]. The majority of insulin users and professionals will only begin to have access to crucial clinical data on insulin administration with the development of smart pens, which will help to more effectively individualize diabetes management [154,155].

4.3.2. The Future of Smart Pens

In order to facilitate insulin therapy with ongoing Internet access, clinicians will soon be working within a "Digital Diabetes Ecosystem" consisting of internet access of Medicine (connected physiological and behavioral sensors embedded within various medical devices that are utilized by an individual) and the new smart pens [156]. We anticipate that real-time continuous plasma insulin data11 and insulin dosage data when paired with machine learning and artificial intelligence to enable dose calculations, may eventually be able to identify and avoid adverse outcomes like hypoglycemia [138,157]. When an intervention has a better chance of succeeding, these predictions will be possible much earlier. Therefore, we anticipate that "smart" insulin pumps will take the place of "dumb" insulin pens, which are devoid of sensors, transmitting devices, and the capacity to connect to other diabetic data collection systems [158,159]. The first consensus standard for network-connected diabetic device cybersecurity, known as DTSec, already lays out security standards and a procedure for determining compliance with them [160].

4.3.3. Obstacles to effective insulin use

There are now three significant obstacles to using insulin well, hence the introduction of intelligent syringes is likely to be advantageous. Insulin omission and insufficient adherence Missed insulin doses can happen for a variety of reasons, such as simple forgetfulness, embarrassment, the intricacy of the dose, financial burden, and purposeful omission for weight management [161,162]. Having access to insulin data will provide physicians the chance to have better-educated conversations with insulin users, and the smart pen app may be able to give patients straightforward reminders when doses are missed [163,164].

4.3.4. Risk

Compared to other drug classes, insulin has been linked to higher prescription mistakes, especially in hospitals. It will be possible to minimize in-hospital insulin dosing errors7 and promote safer insulin use by automatically accessing information on the time and dose of

insulin delivery [165,166]. You must transfer to a new location each time you replace your cannula or patch pump, which should be done every two to three days. Because you might develop lipohypertrophy, in which your body creates hard lumps that prevent insulin from functioning correctly, this is really essential [167-169]. Additionally, switching websites can prevent rashes and irritation that develop from using the same website for an extended period of time. There are 1000 insulin pump users in India [170,171].

4.3.5. Tethered insulin pump

Tethered pump can vary in color, screen size, and other aspects. Some even include added functions like Bluetooth remotes. Another tiny tube that joins to your cannula tethers a tethered pump to your body. The pump by itself, which may be worn on a belt, in a pocket, or in an elastic band, often has all the controls on it. If you don't want it to be visible, you are able to wear it underneath your clothing [172].

4.3.6. CGMs built into insulin pumps

A continuous glucose meter and pumps can now communicate directly thanks to new pump technology. This cutting-edge feature enables certain systems to instantly cease the release of insulin in response to low glucose readings, which is crucial for those who experience hypoglycemia overnight [173]. The Medtronic Mini Med 640G [174,175] and the Medtronic Mini Med Paradigm Veo [176] are two pumps with integrated technologies.

4.3.7. Closed-loop techniques

Closed-loop systems, an artificial pancreas, employ a smartphone app that continually alters your insulin dose on your insulin pump in response to data from an implanted glucose monitor [177]. An Android-based closed-loop system called CamAPS FX is used [178,179]. Research has demonstrated that closed-loop insulin administration results in improved diabetes management, lower HbA1c readings, and less hypo and hyper [180].

4.3.8. Insulin pump implantation (IIP)

The most recent insulin pump technology is found in implanted insulin pumps. The peritoneal cavity of the abdomen is where the pump is implanted. Unless there is a condition that necessitates removal of the pump, the pump remains inside the body forever. Insulin is delivered into the peritoneal cavity via the implanted insulin pump [181]. The insulin is quickly taken into the bloodstream since this location is well-supplied by blood vessels. Even though there aren't many IIP users, those who had pumps implanted speak highly of their experiences. Pump installation and refilling are currently only done in Montpellier, which restricts their use. However, usage is probably going to expand more broadly in the future [182,183].

4.3.9. Cost of insulin pump

A costly and life-saving medical gadget is insulin pumps. We attempted to determine if insulin pump pricing in India is affordable in order to give insulin pump consumers accurate information. We discovered that an automated insulin pump can be very cost-effective for some individuals who need large amounts of insulin often after completing a thorough analysis [174,185]. The efficacy of the pump for insulin pricing in India and its cost-efficiency are crucial issues that are brought up by this. Over time, these gadgets have become more expensive in India. The number of persons utilizing insulin pumps has also increased in tandem with this rise in price. Insulin pumps were used by more persons in 2013 than in 2012 [186,187].

4.4. Recommendations for advance research

We provide the following suggestions to direct this project's future research. Outcome data must be recorded in a consistent and methodical manner in order to improve our comprehension of the possible dangers and advantages of CSII treatment. The possibility of improved glucose management is just one of several potential considerations that need to be taken into account when beginning pump therapy, accurate insulin delivery system is now available [188,189]. For instance, those who select CSII therapy frequently need to reevaluate their previous approaches to managing their diabetes, which may involve learning new skills, checking urine ketones and blood glucose levels more frequently, and raising awareness of insulin-to-carbohydrate ratios [190,191]. All of these actions may potentially increase the demands placed on patients' ability to care for themselves. Future research is required to properly explore how CSII treatment affects patients' and their families' psychological well-being [192]. Targeting anxiety appears to be a crucial psychosocial element to include in such evaluations because a large body of evidence suggests that diabetes enhances one's risk for depression [193].

The treatment of diabetes is adjustable with insulin pump therapy. It allows basal insulin to be adjusted to daily demands and circadian rhythms, provides more accurate therapy for meals and exercise, and, when used in conjunction with continuous glucose surveillance, permits the administration of glucose responsive insulin [192,194]. Treatment optimization is made possible by the capacity to retrieve and send data for analysis. Modern pumps are easier to use and provide a better user experience. Studies show that pump treatment is effective in enhancing glycemic control and decreasing the incidence of hypoglycemia without escalating episodes of diabetic ketoacidosis [195]. They raise quality of life as well. Recent research indicates that pump treatment may help to lessen diabetes-related microvascular and macrovascular problems [193]. The creation of also-called "artificial pancreas," an entirely automated, external, closed-loop device for delivering insulin, has advanced steadily over the years [196]. With less hyperglycemia and hypoglycemia and a longer period in the target range than open-loop control, closed-loop glucose control using continuous blood glucose monitors

(CGMs), insulin pumps, and pump-controlling programs has demonstrated advantages to open-loop control in experimental settings [197].

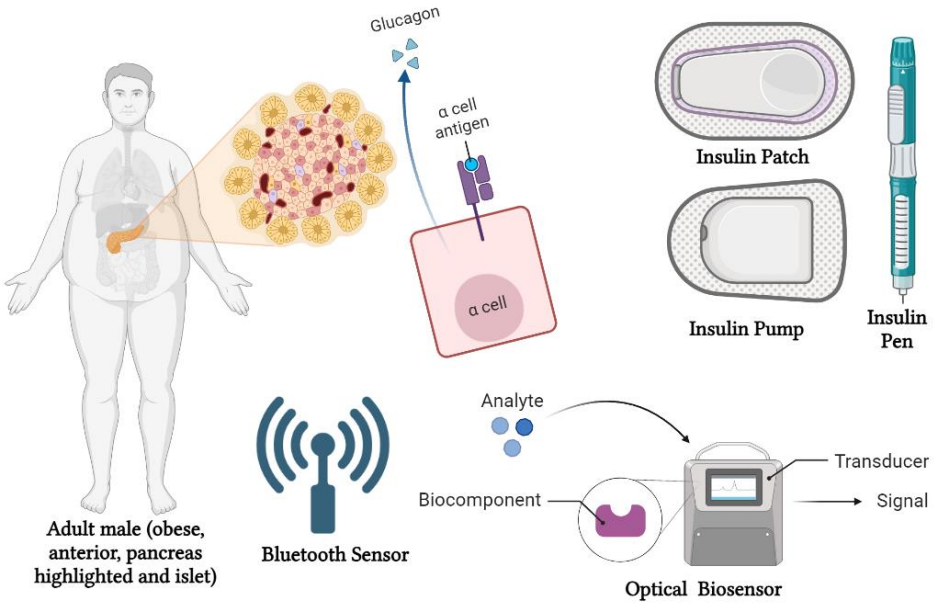

Figure 3. Novel treatment and diagnosis equipment for diabetes mellites

4.5. Telehealth

Due to the COVID-19 epidemic, telehealth has lately been more readily accessible to inpatient and outpatient clinicians, when before centers for health & medicare. Only outpatient services are permitted for telehealth coverage [198]. suppliers in remote areas. nearly all endocrinologists spatial concentration in cities, with as much as considering that thirty-six percent of children and sixteen percent of adults lack access to within a 20-mile radius, an endocrinologist [199]. Consequently, there is a critical requirement for telehealth to eliminate care inequalities across classes of socioeconomic status, rural/urban, and race/ethnicity. Telehealth can perhaps ease patients' attendance at medical appointments who must work and are denied time off, and who have restricted mobility or transit options [200,201]. For purposes of education (tele-education), consulting (teleconsultation), and monitoring (telemonitoring), telehealth is a general word for electronic, telephonic audio, video, or text contact between a patient and their provider [202].

Any intervention that instructs, transports, or educates patients remotely is referred to as tele-education. Tele-education comprises a wide range of services, such as on-demand prerecorded movies or PowerPoint presentations, video conferences with certified diabetic care and education professionals, and more [203]. Through teleconsultation, a patient or a physician can speak with another provider without physically meeting them. Data can be transmitted through telemonitoring to a doctor [204]. Telehealth can be further classified as synchronous, which comprises both speech and image interaction during the visit, or asynchronous, which

involves online interactions without face-to-face contact. Numerous meta-analyses have been conducted to examine the effect of telemedicine on outcomes for people with diabetes [205].

A meta-analysis of 55 research on people with T1D or T2D from throughout the world found that 22 studies indicated larger improvements in HbA1c among those who got telemedicine treatment compared to those who received standard care, while 33 studies found no differences between the two groups [206,207]. Individuals with T2D around the age of 40 who participated in studies with positive outcomes often had an intervention for no more than six months. E-consults may be the best method of getting in touch with specialists for people who don't have access to endocrinologists [208]. A doctor who provides primary care (PCP) and an endocrinologist can speak with each other in person via an e-consult to discuss managing diabetes [209]. In one research comparing e-consult to standard care, providers were randomly assigned to the e-consult arm or the care-as-usual arm. They discovered no differences between the two groups HbA1c changes at one year. Several causes were identified for the lack of improvement in the e-consult arm at a 6-month follow-up. Based on an examination of the information from electronic medical records and a qualitative interview [210]. Due to the fact that few telemedicine researches successfully recruit racially and ethnically diverse samples, inequities in telehealth are understudied [23,24]. Meta-analysis of telehealth therapies revealed that tele-monitoring studies had median improvements in only 23% of the population is from a minority [211].

Moreover, recent research with respectable under represented population ratios. Some people might not be appropriate for situations in the actual world [212]. Considering that they frequently offered freebies or financial incentives gadgets such as strips for tests, and others to increase involvement an illustration of this kind of study is the randomized NHB and T2D participants who panic to a weekly phone call against a 3-month period of remote weight, blood sugar, and blood pressure [213]. Despite the fact that these studies highlight the beneficial effects of different telehealth models in marginalized groups, COVID-19 data revealed that only around half of all Federally Qualified Health Centers used telehealth during the first year of the COVID-19 pandemic [205]. The number of providers that give these services to underprivileged clients as well as the best way to spread these practices in actual care paradigms are raised by this [214]. Meta-analysis of telehealth therapies, video communication between the educator and patient was necessary for telemedicine to be effective, as measured by an improvement in HbA1c initiatives that made use of less labor-intensive interventions, such automatic phone calls or text messages [215]. There are several obstacles in the way of underprivileged communities utilizing telehealth technologies. Broadband internet connection is not universally accessible [216].

The 24 million Americans, the majority of whom reside in rural regions or on tribal territory, don't have access to high-speed Internet, which restricts their capacity to take part in telehealth [217]. In comparison with White patients with diabetes and/or hypertension, Black

and Hispanic patients have been demonstrated having a lower level of broadband usage and usage [218]. Especially younger, educated individuals, to aid in reducing the price that low-income households must pay may be useful for internet service [219]. These initiatives also provide cheaper or free linked gadgets, such a laptop or tablet. Future developments in this area include "smart pens" with built-in calculators to accurately advise patients on the insulin dosage, memory features to show the quantity and time of injections, as well as automated Bluetooth communication to create computer-generated reports [220,221].

5. CONCLUSION

Diabetes mellitus is a chronic disorder, they are characterized by a deficiency of insulin and increasing glucose levels in the blood because pancreas is unable to produce insulin in sufficient amounts due to the destruction of beta cells of Langerhans of islets which are located in pancreas. Mainly two types of diabetes mellitus insulin dependent diabetes and non-insulin dependent diabetes mellitus. So, it’s a major metabolic disorder of the present time. Nowadays many technologies have been developed for the management of diabetes type 1 and type 2, continuous glucose monitor devices, insulin pumps and pens, and smartwatch technology which give continuous information to a patient. Nowadays scientists are developing many technologies for the proper diagnosis of diabetes which will be beneficial in the future. In recent times diabetes is a serious medical condition that affects millions of people all over the world.

For the management of diabetes various biosensors are very useful such as digital glucometers, continuous glucose monitoring devices, and another device like insulin pumps which work as artificial pancreas and release sufficient insulin in the body for control blood glucose levels. Various microchip is inserted under the skin and this microchip is directly connected to your smartwatch and smartphone which are given all body-related data, this system is specially designed for diabetic patients they consist of various features if a diabetic patient glucose increases or decreases that time alert system of device is activated and they inform to patient. There are many advantages of these microchips but some drawbacks of biosensors like they are very expensive, sometimes inflammation on the attachment site of the skin, replace every 14 days, but with drawbacks many advantages of biosensors like they give immediate and accurate information to patients. They also give information about HbA1C test and glucose levels in body. They also use the internet of thinking to transfer data immediately to patients. Biosensors are useful in various places like analysis of the environment, checking purity of water, air purity, and also useful in the study of cancer molecules. And in the current scenario some biosensors aid in the detection of viruses like COVID-19. CGM technology will likely improve metabolic control and quality of life in people with diabetes.

Declarations of interest

The authors declare no conflict of interest in this reported work.

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