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Analyzing the Advantages of Digital Technologies for Managing Diabetes

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Successful advancements in technological advancements can facilitate better communication between patients and medical staff, mobile healthcare. High levels of health literacy and numeracy, self-management, and periodic interactions with physicians are necessary for managing diabetes mellitus, a disease that can be challenging to control. Mobile health applications have improved diabetes treatment and prevention, despite not being extensively used yet. Patients can acquire new routines and habits linked to managing their diabetes through the use of technology-based education. In order to provide the roadmap for the digitalization of diabetes care in the Indian context, this article gives a summary of the digital in use and suggests significant technological adaptation and governmental interventions.

Keywords: Diabetes milletus, Digital Health, Digital Technology, Insulin pens, Self-management, Treatment.

Diabetes assistance using technology Self-management is not a novel concept, but new technologies are emerging and gadgets are becoming more widely available as patients grow acclimated to them[1]. Digital health refers to the concept of continuously gathering automatic data via wearables and analysing it with smartphone and cloud-based software[2]. Devices and communication technology, medical treatments can better comprehend each patient's unique physiology and behaviour[3]. Through monitors and Internet access, devices that have sensors, transmitters, and software are increasingly able to wirelessly transfer, share, and gather data for people with diabetes and other chronic medical conditions[4]. There's also a second paradigm forming that uses telecommunication technologies to facilitate real-time, remote health service delivery[5].

Digital Health Connectivity

Diabetes instruction programs based on advanced wellbeing and made by specialists are duplicating rapidly; a few have indeed appeared research-based confirmation of their viability[6]. Are being made accessible to assist individuals with diabetes issues superior oversee their condition and move forward their clinical involvement[7]. Exact

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restorative status and self-care administration are made conceivable by these advances, encourage progressed communication between patients, specialists, and therapeutic staff[8].

Benefits of Digital Health

Digital health technology, particularly sophisticated analytics, to achieve healthcare goals. Therefore, everyone in the sector stands to gain from it, from patients to healthcare workers.

• Historically underserved populations.
• Lower the costs of healthcare for both providers and patients.
• Made strides understanding results through individualized treatment plans.
• Enhanced hospital and other healthcare facilities operational efficiency.
• Better diagnosis through the application of machine learning methods[9].

MATERIALS AND METHODS

Devices

Insulin pump

In the last fifty years, one of the biggest developments in diabetes technology has been continuous subcutaneous insulin pump therapy[10]. Retinopathy, neuropathy, nephropathy, and cardiovascular disease are among can be prevented. A number of studies have documented patients' exceptional experiences transitioning to an insulin pump[11].

Historical Evolution of Pump Technology: In the early 1960s, Arnold Kadish introduced continuous insulin delivery in the United States. This insulin delivers to the body blood glucose levels automatically[12]. Artificial pancreas consists of huge pumps linked to auto analysers for monitoring blood sugar levels and servo mechanisms that control pump operation when blood sugar levels diverge from normal ranges[13].

Regarding Kadish's creation, the Bio-Stator's intricate design, challenging size, and prolonged use were hindrances. The initial Mill Hill infuser was a compact, thick syringe pump that ran on batteries and could detect up to 159 grams[14]. The insulin delivery mechanism was dual-rate, utilizing a small button on the side of the pump to activate both a basal and an eight-fold higher prandial rate[15]. Pumps were first introduced in the late 1970s and gained widespread recognition in the medical community. Prominent pharmaceutical corporations began investing in the early 1980s[16]. The auto syringe, popularly referred to as the "Big Blue Brick," was among the first commercial insulin pumps introduced in 1978.

An insulin pump: A wearable medical gadget called an insulin pump provides fast-acting insulin under your skin continuously a narrow portable or wearable device with the pump and controls, tubing connecting the skin patch to the pump, and a skin patch with a subcutaneous injection site[17]. This second variety is a "tubeless system," and it consists only of 2 components: a wirelessly connected handheld control unit and a skin patch with the subcutaneous injection site that holds insulin and the pump[18].

Who uses Insulin pumps: Any diabetic patient who needs synthetic insulin may use an insulin pump. This incorporates Type 1&2 diabetic patients – both children and adults. Type 3c diabetic people may also use this as well. Who have gastroparesis, experience dawn phenomenon, preparing for pregnancy

Who shouldn't use an insulin pump: Issues with manual dexterity, Blindness and low vision, Issues keeping the pump attached[19].

Smart insulin pens

Syringes have not shown the and consistency in dose as insulin pens[20]. It is vital to note that while insulin type, efficacy, and safety are the most crucial factors, other aspects of insulin delivery may affect outcomes[21]. The development of innovative insulin formulations and insulin pens happens at the same time. By reducing glyceamic fluctuation in diabetic patients, using smart insulin pens (SIPs) in clinical practice can potentially improve their time[22].

What a smart insulin pen do: Calculate dosages based on doctor-prescribed settings, meal size, carbohydrate intake, and current blood glucose levels. Compatible with common diabetes data tracking platforms, smart watches, and smart phones[23].

What makes an Insulin pen SMART: Consistently records the date, time, and dosage of each injection. Makes it possible to calculate dosages more precisely by using a bolus calculator, which eases mental strain. Prevents skipping doses[24].

Insulin pen components include

Insulin Reservoir: The pen holds the insulin, which is housed in this clear plastic container. since the insulin reservoir in other pens runs exhausted, you must discard them[25].

Pen Cap: The cap is the one that protects the insulin reservoir from damage when the pen is not in use.

Rubber seal: The rubber seal is where you attach an injectable needle intended for single use[26].

Needle: Insulin pens have single-use needles, which means you only use them for one injection before discarding them away. Before administering the injection, remove the needle from the container and attach it to the pen. To find out which pen needle is right for you, speak with your healthcare provider[27].

Dosage knob: This is a knob that you turn to choose the insulin dose you require.

Dosage window: This shows how many insulin units were chosen by turning the knob.

Injection button: The insulin dose is administered by pressing the injection button after the pen needle has been injected.

Label: This label gives you the type and brand of insulin in the pen, as well as its expiration date[28].

Types on Insulin pens

If they're disposable or reusable: Some pens are disposable which means you can dispose of the entire pen after the insulin reservoir runs out or the insulin expires. Other pens are reusable. Simply change the insulin reservoir for one (a cartridge) and use the pen again[29].

The type of insulin you use: Manufactured insulins function differently depending on how long it takes for them to start functioning and remain in your body.

If they have digital components or not: Some insulin pens have an innovative app, which helps you last injected insulin and how much These may be "smart" or "connected" insulin pens. Other pens are "manual" which means there is no digital app[30].

How to utilize an insulin pen

Each time you use your pen:

• If you have more than one insulin pen, make sure to confirm the type and expiration date
• Verify that your insulin is clear and colorless and that it is not clumped.
• When handling an insulin mix pen, roll it between your palms and tilt it slightly.
• Eliminate the pen cap and wipe the top with sterile alcohol.
• Fasten the pen's needle. For each use, use a fresh needle.
• Assemble the right dosage and prime the pen first. Double-check the dosage before administering.
• Take off the cap and inject into a spotlessly clean area. Unless your doctor tells you otherwise, hold the needle at a 90-degree angle.
• To guarantee that all of the insulin is absorbed, press the button to inject the medication and wait five to ten seconds.
• Take out and properly dispose of the needle.
• Insulin pens make it possible to swiftly and simply correct errors made when measuring out too much of a dose. While some pens allow you to reset your pen to zero units and start over, others eject extra insulin via the needle so that it does not enter your skin.

Dosage with an Insulin pen

Pen use: After loading the cartridge, all that needs to be done is screw on a pen needle, prime the cartridge if needed to get rid of any air, dial the appropriate dosage, inject the needle, and press the button to release the insulin. To make sure the insulin is well mixed when using a pen that contains an insulin suspension, such as NPH or premixed insulin, give the pen a gentle shake. Pens are a convenient writing instrument for kids that may be used for both school and travel. In order to keep air out of the cartridge and stop insulin from pouring out, pen needles should be changed after every use. Pen needles come in a wide range of styles, sizes, and lengths. The tiny pen needles are extremely thin and short, which prevents insulin from spilling out. Pens need to be in position for a few seconds unlike syringes. As they transition from syringes to pens, syringe users should pay close attention to the injection site and often check their blood sugar. Pen-specific differences exist in the number of pens. Some start at 1/2 or 1 unit and allow for ½ unit dosage, while others dose in increments of 1 or 2. Pens simplify injections, but they do not differ from insulins. This means that if you inject Lantus and Humalog, for example, simultaneously, you will receive as many shots. When compared to syringes, pens offer accuracy and repeatability. Moreover, insulin users with low visual acuity can be guaranteed an accurate dose when using a pen because it requires dialing a mechanical device instead of looking at the side of a syringe[31].

How to utilize an insulin pen: Each time you use your pen: If you have more than one insulin pen, make sure to confirm the type and expiration date. Verify that your insulin is clear and colorless and that it is not clumped. When handling an insulin mix pen, roll it between your palms and tilt it slightly. Eliminate the pen cap and wipe the top with sterile alcohol[32]. Double-check the dosage before administering. Take off the cap and inject into a spotlessly clean area. Unless your doctor tells you otherwise, hold the needle at a 90-degree angle. To guarantee that all of the insulin is absorbed, press the button to inject the medication and wait five to ten seconds[33]. Insulin pens make it possible to swiftly and simply correct errors made when measuring out too much of a dose. While some pens allow you to reset your pen to zero units and start over, others eject extra insulin via the needle so that it does not enter your skin[34].

How significant are smart insulin pens as a tech development: Regarding the interoperability of connected devices, DrGriffin states: "Historically, an individual with diabetes had to manually record their insulin data often on paper or on a separate platform and could only view their glucose data in one place. Which also cuts recording time." Is also starting to notice the benefits of device connectivity in clinics. "We have someone's insulin and glucose data. On the same data, together, we can establish some tactics that will help the individual using the smart pen reach their customized goals," the speaker said. "The extensive data has enabled me to conduct more meaningful consultations that benefit people living with type 1 diabetes and their families"[35].

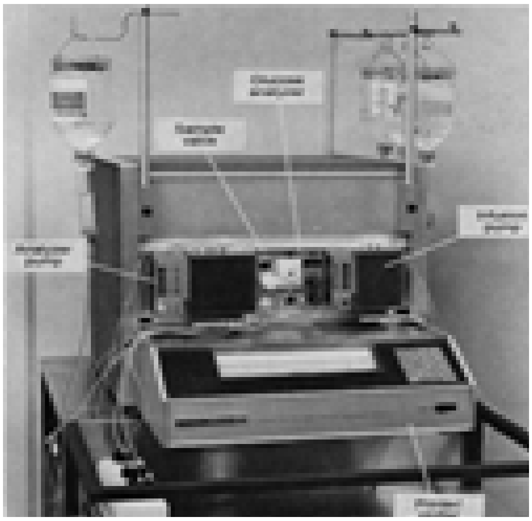

Fig. 1. Bio-stator: An insulin infusion device regulated by glucose and powered by a computer
Adapted from:https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-2710.2009.01048.x

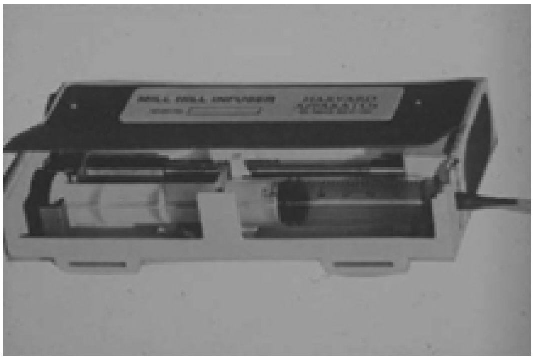

Fig. 2. The Mill Hill infuser.
Adapted from:https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-2710.2009.01048.x

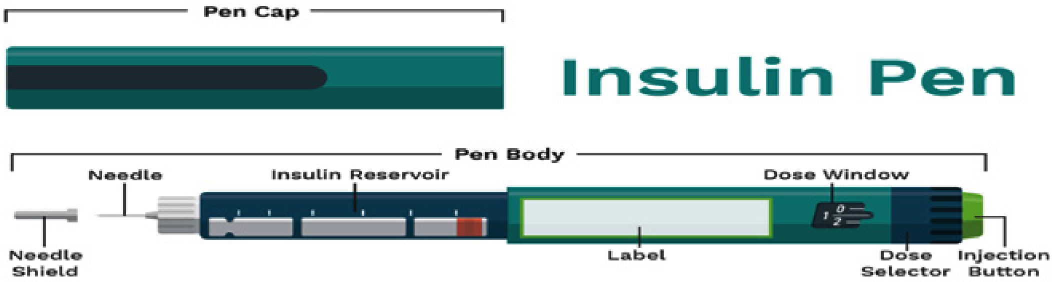

Fig. 3. Adapted from: https://images.app.goo.gl/jWyE455inqvdyYqPA

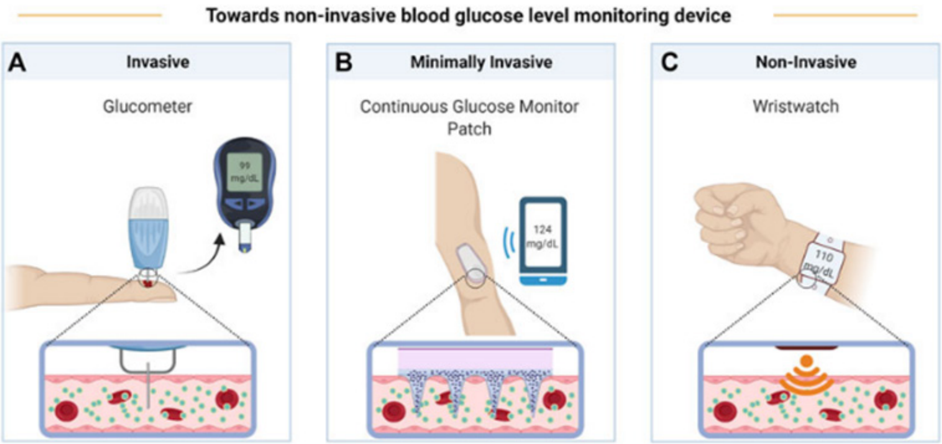

Fig. 4. Different blood monitors

Adapted from:
https://www.frontiersin.org/journals/chemistry/articles/10.3389/fchem.2022.994272/full

Blood glucose monitor

Blood glucose monitoring can pattern in food, physical activity, drugs, and diseases associated with blood glucose changes, such as diabetes mellitus. It aids in the diagnosis and treatment for certain patients with type 2 diabetes mellitus, routine blood glucose monitoring may not be necessary if they treat their condition solely with diet or oral anti diabetic medications. But when titrating oral hypoglycaemic medications including hypoglycaemia, blood glucose monitoring may be required[36].

Diagnostic tests

________Capillary Blood Glucose Test: Blood can be drawn from the palm, forearm, heel, and earlobe, among Particularly while fasting and two hours after meals. Alternative site testing yields equivalent results to finger-prick testing. A deeper lancet can be required if alternate sites are beneficial for the patient. Find out from the glucose meter's maker if testing at several locations is possible with the device[37]. Test strips and a glucose meter to pierce the skin. Test blood glucose levels. The tiny amount of blood sample that these "smart" machines require (between 0.3 and 1 mL) and their Bluetooth capabilities allow them to share data with associated smartphone applications. This information can be useful for medical professionals managing a diabetic patient's treatment plan[38].

Venous (Plasma) Blood Sample: Venipuncture is used to get a venous sample which is then processed in a laboratory of commercial caliber that has undergone the necessary complex quality control inspections[39]. This approach is the capillary blood glucose test. This is contingent on laboratory and industry-recognized criteria, though. Arduous process, potential for localized tissue injury, and inappropriate for routine specimen collection[40].

Continuous Glucose Monitoring (CGM)

Continuous interstitial fluid glucose monitoring, or flash blood glucose monitoring, entails placing a disposable, water-resistant sensor on the back of the upper arm or belly. The sensor can stay on the patient for three to fourteen days, depending on the product. The interstitial fluid glucose level trends over the preceding eight hours can be seen by scanning the sensor with a reader. CGM devices have 90-day glucose data storage capacity. Through a smartphone application, family members and caregivers can access data from the CGM device; these devices can frequently send alerts or messages, even during hypoglycaemic episodes. Furthermore, some CGMs can be used in conjunction with insulin delivery and can halt insulin delivery if the system detects or anticipates a reduction in BSL. For calibration, certain older CGM units need to be tested twice a day using finger pricks. Gadgets, on the other hand, do not need calibration.

Benefits: Research has shown that flash monitoring is more cost-effective than CBG selfmonitoring of blood glucose (SMBG) in patients with type 1 diabetes mellitus and type 2 diabetes mellitus who require intensive insulin therapy or sulfonylureas. The benefit of monitoring hypoglycaemia during sleep is that interstitial glucose levels can be taken as often as every five minutes throughout the hour.

Cons: The interstitial fluid, which the CGM measures, has glucose before the blood does. An eye on the interstitial fluid may not always be a strategy to track quickly fluctuating blood glucose levels. Due to the high cost of the sensors and machines (about $5,0000 annually), this could not be an affordable alternative for customers from less affluent backgrounds or in areas where the government or insurance does not care[41,42,43.]

Methods to control Diabetes Milletus

Regularly check your blood sugar levels: Having a glucose meter in your hand is the way to do this. Maintain a healthy cholesterol level: Diabetes raises the risk of heart disease and stroke by raising cholesterol levels and decreasing cholesterol. Eat healthily and get regular exercise[44]. When you have diabetes, the foods matter. Consume food every two to three hours, and don't wait two to five hours between meals. Exercise is equally vital [avoid exercising if your blood sugar is too high or too Lose the weight: One of the main factors influencing obesity. Obesity raises blood cholesterol levels, increasing the risk of heart disease[45].

RESULTS AND DISCUSSIONS

In the above mentioned data we have mentioned about the different types of devices which are used to diagnose the diabetes. We have known about the normal techniques which are used to check the blood glucose levels. The digital methods are more useful than normal techniques due to the easy availability. The above mentioned devices are Insilin pump, Smart insulin pens and Blood glucose monitor.

Insulin pump has many advantages compared to traditional insulin are they improve glycemic control, more flexible lifestyle, fewer injections, better for younger children. Those who use long-term pump therapy maintain significantly better blood sugar management than MDI users. Many people who switch from MDI to an insulin pump note an improvement in their quality of life. Fewer insulin injections.

Smart insulin pens found to be more potential due to their connectivity, real time evaluation and it is determined by evidence helps to improve quality of life.

Cnontinuous blood glucose monitors helps the patients to become more aware of their blood condition which affected by several factors. Also improves the cardiovascular risks and reduced cardiovascular events, overall it improves the quality life of the patients.

CONCLUSION

Many digital technologies are applied to diabetes monitoring and analysis of data. The challenge is identifying those technologies which are likely to be successful in the long-term. The new technologies listed here have great potential but ensure that they are accessible and affordable across different populations and health systems.

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Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials.

Author contributions

Galanki Vasantha : Conceptualization, Supervision, Methodology, Writing- Review & Editing; Vinjamuri Krishna Manaswini : Writing – Original Draft, Data Collection, Analysis; Sagewin Moora : Analysis and Data Collection; Guna Sekhara Venkata Satya Pavan Ganesh Kethineedi : Data Collection and Analysis.

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