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Use of Technology in the Management and Treatment of Prediabetes, A New Era: A Case Report Series

Chhavi Goyal Mehra[1], Annie Mattilda Raymond[1*], Ankitha Sequeira[1] and Shefali Mehra[2]

[1]Ragus Healthcare Pvt, ltd., Bangalore, Karnataka, India

[2]Miller School of Medicine, Miami, Florida, United States of America

ABSTRACT

Introduction: The escalating prevalence of prediabetes has positioned it as a silent precursor to a looming public health crisis, particularly as it paves the way for type 2 diabetes mellitus (T2DM). This case series report explores the transformative role of technology, specifically the Sugar Fit's Diabetes Reversal and Management Program (SDRMP), in the treatment and management of prediabetic patients.

Methods: The case series follows the progress of two patients aged 31-44 with prediabetes utilizing the SDRMP to prevent the progression to diabetes. The interventions for both patients involved continuous glucose monitoring, personalized nutrition plans, fitness strategies, and behavioral modifications. The patients also engaged in regular communication with their life coaches through the Sugar Fit application, ensuring ongoing support and adherence to the program.

Results: The results revealed significant improvements in glycemic control, lipid profiles, and overall well-being. The first patient, a 44-year-old male, demonstrated a successful return to normal glycemic control in 177 days through a comprehensive approach involving dietary changes, exercise, and lifestyle modifications. The second patient, a 31-year-old male, achieved normal glycemic control in a comparable timeframe, showcasing the effectiveness of the SDRMP.

Discussion and Conclusion: These cases demonstrate that patients were able to adhere to the goals of care, preventing the progression of prediabetes to diabetes and improving insulin resistance. The study also underscores the potential impact of technology on public health outcomes, bridging the gap between traditional interventions and the evolving needs of a tech-savvy population. The synergy between healthcare expertise and technological innovation not only arrests the progression of prediabetes but also contributes to a broader societal shift towards metabolic well-being, paving the way for a healthier future. Future monitoring is essential to ensure the maintenance of lifestyle modifications and continued success in preventing diabetes.

***Corresponding author**
Annie Mattilda Raymond, Ragus Healthcare Pvt, ltd., Bangalore, Karnataka, India.

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Introduction

In the ever-evolving landscape of healthcare, the escalating prevalence of prediabetes has emerged as a silent precursor to a looming public health crisis that is type 2 diabetes mellitus (T2DM) [1]. According to recent estimates, a substantial portion of the global population is grappling with prediabetes, highlighting the urgency to address this condition as a paramount public health concern [2]. Additionally, Southeast Asia is predicted to have one of the greatest increases, from 2010 to 2030, in the number of adults with Impaired Glucose Tolerance (IGT) [3]. Prediabetes, defined by elevated blood glucose levels with the presence of insulin resistance and beta-cell dysfunction that are not yet diagnostic of diabetes, serves as a harbinger of impending metabolic challenges [2,4]. As a precursor to type 2 diabetes, prediabetes demands our attention due to its alarming prevalence and the potential for devastating consequences if left unchecked.

The progression from prediabetes to diabetes is not inevitable, and intervening during the prediabetic phase offers a unique opportunity to alter the trajectory of metabolic health for these patients. This can often be highly beneficial for patients, considering the myriad of complications associated with diabetes, including cardiovascular disease, neuropathy, and renal dysfunction [5]. In fact, studies have demonstrated patients with conditions such as prediabetes and metabolic syndrome may have an increased risk for cryptogenic sensory peripheral neuropathy (CSPN) [6,7]. Furthermore, prediabetes has been linked with increased risk of developing nephropathy, chronic kidney disease (CKD), diabetic retinopathy, and possible macrovascular disease [8-10]. Acknowledging the gravity of the situation, it becomes imperative to explore innovative avenues that can empower individuals to take charge of their health and prevent the progression from prediabetes to the more formidable realm of diabetes.

Yet, medical communities tend to differ when it comes to consensus for exact definitions for this condition. This makes streamlining treatment and managing the patients with prediabetes according to set guidelines more difficult for clinicians [11]. Navigating the intricate web of lifestyle choices, genetic predispositions, and environmental factors, the critical intersection of technology and healthcare presents a promising frontier in the battle against prediabetes [12]. Traditional approaches to prediabetes management have centered around lifestyle modifications, such as dietary changes and increased physical activity [13,14]. While these interventions have demonstrated efficacy and form the cornerstone of treating prediabetes, the evolving landscape of healthcare technology introduces novel tools that hold the potential to revolutionize the way clinicians might approach prediabetes. These technological advancements extend beyond conventional interventions, offering a personalized and dynamic approach to treatment. For example, SugarFit's Diabetes Reversal and Management Program (SDRMP) is a tailored intervention initiative utilizing technology-enabled medical oversight and guidance from dedicated physicians along with expertise from diabetes and nutrition Coaches. The program offers personalized nutrition plans, progressive fitness strategies, and behavioral modifications, aiming for a comprehensive approach to managing T2DM.

These cases delve into the burgeoning realm of technology-driven interventions such as the SDRMP and its pivotal role in the treatment for patients with prediabetes. This case series follows the progress of two patients aged from 31-44-year-old with prediabetes utilizing technology through virtual care in the form of programs such as the SDRMP in order to prevent progression to diabetes and be able to return to regular glycemic processing.

Case Series

44-year-old male with prediabetes returning to normal glycemic control in 177 days. This patient established care in August 2022 with initial labs demonstrating a HgA1C of 5.9%, fasting glucose of 97.63mg/dL, total cholesterol of 228 mg/dL, total triglycerides of 295 mg/dL, and a serum LDL of 165.1 mg/dL. On initial consultation, the patient's primary complaint was having polyuria and feeling increasingly tired post-lunch. The patient endorsed walking as his primary form of exercise. The patient's medications included Fenofibrate + Rosuvastatin (Roseday) 10mg at night daily. After consultation with a life-coach, the patient's diet was analyzed and revealed high intake of carbohydrates with every meal with an inadequate protein content, in addition to a decreased water intake. The patient's family history was significant for the patient's father having a diagnosis of T2DM. The patient's physical exam was notable for having a normal Body Mass Index (BMI) of 22.83 kg/m^2.

In order to establish baseline glucose levels, continuous glucose levels were monitored for a time period of 15 days which revealed events of hypoglycemia (from 60-80 mg/dL) in the afternoon post-lunch and between 12.00 AM to 5.00 AM. Based on initial consultation, the patient was encouraged to follow a diet plan aimed at increasing protein intake and decreasing carbohydrate content of food consumed in addition to increasing walking exercise with a goal of 10,000 steps daily along with muscle toning exercises. The patient was encouraged to avoid spicy, oily, and excessively sugary foods as well as increase hydration intake to a goal of 3 liters per day. Follow up labs were ordered for three months.

The patient maintained continuous communication with their life coach via the SugarFit application, utilizing both calls and messages. Over the course of the program, the patient engaged in 15 video calls, 32 audio calls, and exchanged 507 text messages with their coach, ensuring consistent support and guidance. Conversations regarding diet changes and questions regarding diet as well as adjustments were all included. Personal surveys and reminders were displayed on the application regarding whether goals were being met or not to which the patient's responses were recorded. Regarding fitness, the patient had over 244 goals to complete out of which the patient was able to complete 227 (94%). With regards to nutrition interventions the patient was supposed to complete 744 different kinds of interventions and was able to complete 672 in (91%). In addition to fitness and lifestyle recommendations, specific emphasis was placed on reduction of daily stressors in the patient's life in order to promote better well-being. Out of the 239 interventions made to improve mindfulness in the patient, for example meditation or cutting down screen usage two hours prior to bedtime, the patient was able to complete 223 of these in (94%). Thus, out of a total of 1227 interventions, the patient was able to adhere to 1122 interventions having an overall 91.4% adherence rate to the program.

With completion of the program in February of 2023, the patient's HbA1C reduced from 5.9% to 5.5%. Additionally, the patient's average blood glucose went down by 111.15 mg/dL from 122.63 mg/dL, the patient's total cholesterol decreased to 189 milligrams per deciliter from 228 g/dL, serum triglycerides decreased to 235 mg/dL from 295 mg/dL, serum LDL went down to 126.6 mg/dL from mg/dL, while the patient's serum HDL increased to 42.9 mg/dL from 39.2 mg/dL. The patient's BMI remained stable, as he successfully maintained his weight throughout the program.

2 31-year-old male with prediabetes achieving normal glycemic control in 78 days. A 31-year-old patient was diagnosed with prediabetes in March of 2023 on routine health testing in an outside facility. Labs conducted then demonstrated that the patient had a HbA1C of 5.90%, fasting blood glucose of 80.2 mg/dL, total cholesterol of 186 mg/dL, serum triglycerides of 111 mg/dL, serum HDL of 38 mg/dL, and serum LDL of 127.1 mg/dL. Of note, the patient reported having an elevated serum uric acid level of 12.3 mg/dL. The patient was able to establish care with the current facility and clinicians in April of 2023.

On initial consultation, the patient endorsed wanting to change lifestyle to prevent progression of disease to diabetes. The patient mentioned using intermittent fasting as a way of losing weight in the past. On further history, the patient had no family history of type 2 diabetes. With regards to medications, the patient took many multivitamins such as collagen, vitamin C, biotin, glutathione, N-acetyl cysteine, and omega-3 supplements. On objective measures, the patient's weight was 89 kg with a BMI of 26.87 kg/m^2. The patient was given a goal to work out three times a week for 60 minutes in total, with specific focus on muscle building exercises as opposed to more cardio focused workouts. Moreover, the patient was asked to include a variety of foods in his diet such as fresh fruits and vegetables that would be able to provide the nutrients he would need as opposed to taking extra supplements. Given that the patient had switched to a vegan diet following the pandemic, he was given extensive education and counseling regarding plant-based protein sources and methods on how to incorporate such protein sources into his regular diet.

After completing the program and having interaction with coaches for over 2 months, labs for the patient in June of 2023 demonstrated that the patient's HgA1C had decreased to 5.60%. In addition to this, the patient's total cholesterol decreased to 182 mg/dL, serum HDL decreased to 36.9 mg/dL, and serum LDL decreased to 121 mg/dL. In addition to this, the patient's uric acid also decreased to 7.5 mg/dL. Most remarkably, upon completion of the program, the patient was offered an opportunity to continuously monitor his glucose levels. The patient was amenable and underwent tracking of glucose levels for 15 days by a continuous glucose monitor (CGM). CGM demonstrated, on average, a HgA1C level of 4.8%

with the patient's sugar levels being within the target range for 99% of the entire 15 days.

Discussion

In recent years, mobile applications and wearable devices have gained prominence as powerful tools for facilitating lifestyle modifications and fostering behavior change. These technologies have the capacity to seamlessly integrate into individuals' daily lives, providing real-time feedback, personalized coaching, and data-driven insights [15]. The inherent advantages of accessibility and convenience make technology an attractive ally in the quest to engage and empower individuals in the management of their prediabetic condition.

As seen in these two cases, the patients were able to stay consistent with the goals of care provided by clinicians and thus prevent progression of their condition to diabetes and even allow their bodies to decrease insulin resistance and restore pancreatic beta cell functioning and have normal glycemic processing. With prediabetes being associated with increased mortality (7.36 persons per 10,000 individuals) and cardiovascular event rates (8.75 persons per 10,000), these patients have been able to successfully implement changes that would prevent such events from occurring [16,17]. Future monitoring is required to ensure that patients are able to maintain lifestyle modifications.

By harnessing the capabilities of these innovative tools, healthcare professionals can bridge the gap between traditional interventions and the evolving needs of a tech-savvy population.

The connection between type 2 diabetes and technology has been thoroughly explored; for example, a study conducted by Wu et al. determined that mobile phone applications were able to successfully help patients achieve appropriate lifestyle modifications in order to improve type 2 diabetes outcomes. The study does touch upon how evidence is inconclusive when it comes to the implementation of technology and, in particular, mobile phone applications for other subtypes of diabetes [18]. Our case review is unique and serves to highlight that with appropriate interventions, outlining of goals of care, using reminders to ensure maximal adherence to the program, and the ability for patients to readily connect with providers, prediabetic patients greatly benefit from mobile applications and technological interventions such as the SDRMP which successfully help patients with lifestyle modification.

Despite the difference in opinion and when it comes to the technical specifics regarding diagnosis and the definition of prediabetes in general, almost all medical communities agree that lifestyle modification forms the foundation for prediabetes management. This can be seen in a study by Galaviz et al. whose meta-analysis demonstrated that amongst 27 studies testing lifestyle modification interventions and 25 studies testing for medical intervention for prediabetic patients, lifestyle modification provided the strongest evidence in terms of effectiveness for managing the disease [19,20]. Both patients were able to achieve reversal of their prediabetes with lifestyle modifications alone.

In conclusion, it is essential to underscore the potential impact of these interventions on public health outcomes. The synergy between healthcare expertise and technological innovation holds the promise of not only arresting the progression of prediabetes but also instilling lasting changes that transcend the individual level, contributing to a broader societal shift towards metabolic well-being.

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