

Smart Healthcare for Diabetes during COVID-19

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Abstract—The diabetic patients are at higher risk from novel coronavirus disease 2019 (COVID-19) that spreads through Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). There are around 20% to 50% of COVID-19 cases had diabetes across the different regions from the world. This article discusses recommendations and associated risk for diabetic patients to balance glycemic profile during COVID-19 outbreak. It also discusses the case study of various countries with impact of COVID-19 for diabetic patients. It presents emerging smart healthcare that can potentially safeguard against COVID-19.

I. INTRODUCTION

Diabetes is a condition where person's body is unable to balance glucose-insulin level after various prandial modes. The patients of diabetes have increased exponentially from past few years due to their unbalanced diet and unhealthy lifestyle. There are around 463 million diabetic people around the world who can be benefited by smart healthcare technologies to improve their quality of life [1], [2]. Diabetes may lead to heart disease, kidney infection, blindness and nerve damages. It has been observed that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has infected the diabetic patients largely among the others (See Figure 1). People with diabetes were also more susceptible to previous pandemic known as Middle East respiratory syndrome (MERS) and severe Acute Respiratory Syndrome (SARS) type of corona virus along with H1N1 type of severe influenza during 2009 [3]. SARS-CoV-2 has affected mainly to old-age people and persons having underneath health conditions.

The various case studies reported diabetes as the major pre-existing comorbidity among COVID-19 patients. The challenges for diabetes patient to control their the blood glucose levels after the infection due to following [4]:

- 1) The fluctuation of blood sugar affects the immunity of person which expose him against COVID-19 and unbalanced glycemic profile may lead to longer time of recovery for the patient.

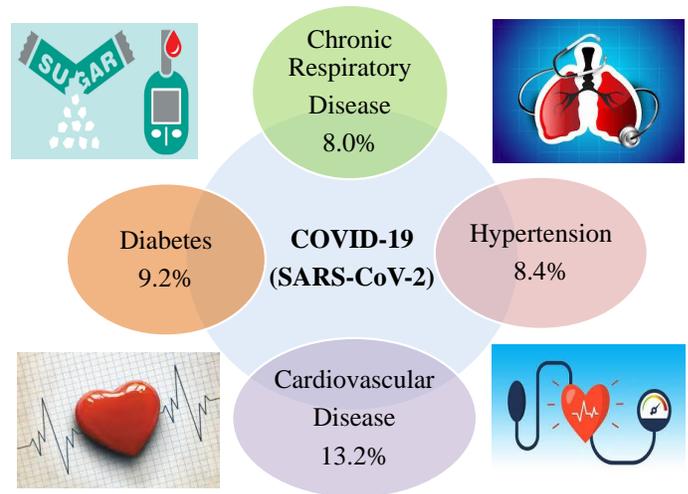


Figure 1: Comorbidities for COVID-19 Patients

- 2) The high blood glucose allows the virus to infect the human body easily.

II. DIABETES PATIENTS: WHY AT HIGH RISK

Elevated glucose level put diabetic patients at higher risk (See Figure 2). The insulin generation is difficult during infection and high fever also inhabits the control of glucose level in the blood. This would lead to severe problem known as Diabetic Ketoacidosis (DKA) where body is not generating enough insulin to burn excess amount of generated ketones in the body [5].

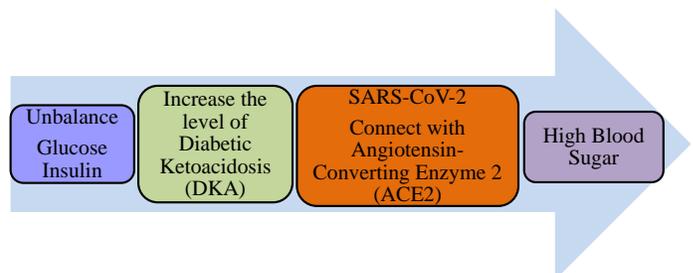


Figure 2: Unbalanced Glycemic Profile with COVID-19 infection for Diabetes Patients.

It has been observed that cellular receptor also known as Angiotensin-Converting Enzyme 2 (ACE2) binds eas-

ily with virus in comparison to earlier SARS-CoV. ACE2 lead to damage of pancreas islets to have hyperglycemia state which result in insufficient insulin secretion for blood glucose control [6]. In general, the overall immune system is affected and the body is expose fight against COVID-19. Hence, it is the necessary to continuously monitor the glucose level for diabetes person to avoid COVID-19 infection [7].

III. CHALLENGES OF DIABETIC PATIENTS DURING COVID-19

The COVID-19 outbreak has immensely affected the mental health of the person around the globe [8], [9]. This has lead to anxiety from the virus infection, concern of losing the jobs as well as the consciousness of being away from loved ones from longer time. Subsequently, the depression has built among the diabetic patients would lead to unbalanced diet [10]. Therefore, it may be beneficial to take certain self measures through remotely consulting with nutritionists, endocrinologists, physician, diabetes educators, and psychiatrists at time of COVID-19. The lock down and imposed restriction on the movement by higher authority has made difficult condition for diabetic patients to control their glycemic profile.

There are several challenges for self-management for diabetes during COVID-19 including:

- Lack of awareness of self-care device to mange the diabetes properly.
- Lack of awareness on smart healthcare technologies such as mhealth and telemedicine.
- Lack of diet plan to avoid the use of saturated fats and high carbohydrate for controlling the glycemic profile.
- Lack of access to have cost-effective solutions for medical emergency.
- Reluctant approach towards telemedicine and remote monitoring from medical fraternity because of legal barrier

IV. A BRIEF CASE STUDY AROUND THE WORLD OF DIABETIC PATIENTS IN COVID-19

India has a population of 77 million people with diabetes. Long term complication of this population due to COVID-19 can be avoided by fixing many health conditions including sugar level, blood pressure, and cholesterol level. Various study conducted in China bestowed higher risk in terms of mortality of diabetic patients as 7.3% in comparison to overall rate of 2.3% [11]. In Russia, the patients in intensive car were seen

with diabetes along with heart disease and chronic obstructive pulmonary disease [12].

Australia addressed the threat of COVID-19 pandemic with help of various products like insulin supply and medicines under National Diabetes Services Scheme (NDSS) especially for diabetic people [13].

There are over 59 millions diabetic people in European. With approximately 26 % suffered from either type-1 or type-2 diabetes in the total death in UK due to COVID-19 [14]. In Italy, the University Hospital of Padova conducted a study on hospitalised patients, wherein 8.9% were diabetic in nature. In Spain, the reports suggested the prevalence rate of diabetes cases is around 12% [15]

In USA, approximately 34.2 million people are diabetic or pre-diabetic including 14.3 millions senior citizen reported in 2018 [16]. With 32% patients in Intensive Care Unit (ICU) due to COVID-19 had diabetes whereas 24% hospitalised patients had diabetes [17]. Only 6% diabetes patients with COVID-19 infection did not seek any medical attention. However, it is not evident whether type-1 or type-2 diabetes patients are at more risk.

There are nearly 71.2% of people suffering from hyperglycemia cases of diabetes in Brazil who have been observed bigger threat from COVID-19 infection [18].

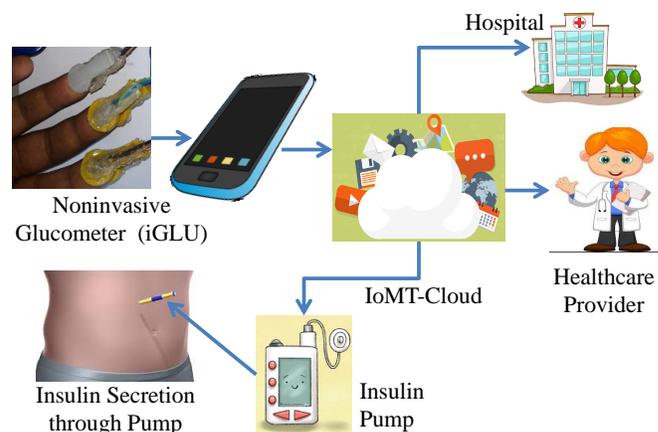


Figure 3: Intelligent Noninvasive Glucose Monitoring and its Control by iGLU [1], [2].

V. NOVEL SMART HEALTHCARE TECHNOLOGIES FOR DIABETES DURING COVID-19

A. Self Glucose Measurement through Noninvasive Device and its Automatic Control

The continuous glucose measurement is helpful for diabetic patients. It helps in controlling glycemic profile after the insulin secretion, medication and physical activity. Our intelligent noninvasive glucometer is suitable for frequent glucose level measurement (See Figure 3) [1],

[2]. Avoiding high blood glucose is key as it results in high ketone. It is important to control these ketone levels down in order to minimise the chances of infection. iGLU is integrated with Internet of Medical Things (IoMT) in a Healthcare Cyber Physical System (H-CPS) Framework. H-CPS help patients to schedule their diet plan and provide them automatic insulin injection under the observation of caretaker/diabetologist.

B. Diabetes-care through Telemedicine

Telemedicine pave a path for diabetic patients during COVID-19 as social distancing has restricted visits to doctors [19]. Also, it has affected patient’s glucose-insulin profile and hyperglycaemic components. The accessibility to telemedicine can in forms like text emails, short messaging services, chat on social media platform and by using teleconferencing. The penetration of telemedicine is expected to grow gradually with advance in digital technology. It is also useful for physician where they can connect with patients for medical diagnosis and provide them guidance to control glucose and blood pressure. This telemedicine platform serves to overcome the geographical barrier and also allows the doctor in urban tertiary to consult patient with appropriate treatment. The revolution in technology would certainly help diabetes patients during such unparalleled situation to reduce the exposure towards infection.

C. Intelligent Diet Control for Glucose Insulin Balance

Improper and unhealthy diet results in several health issues. Diabetic patients require to take care of their diet in order to maintain glycemic profile. IoMT based automatic glucose-insulin model helps in observing their diet closely and plan their food habits on daily bases. The smart log (alos known as iLog) is useful to educate user for consumption of proper food intake [10], [20]. It works on mobile application where images of foods are taken and calculates the calories and its nutrition value. It is an automatic platform for maintaining healthy life style through continuous monitoring of daily food intake at user end.

D. Wearable Safety-Aware Mobility Tracking Device

The spread of COVID-19 is due to close contact with infected person. It is necessary to use IoMT integrated device for everyone that can alert the existence of any other infected and/or came close contact with infected one within a radius of 6 to 13 feet [21]. The devices can monitor COVID-19 patient and store the information

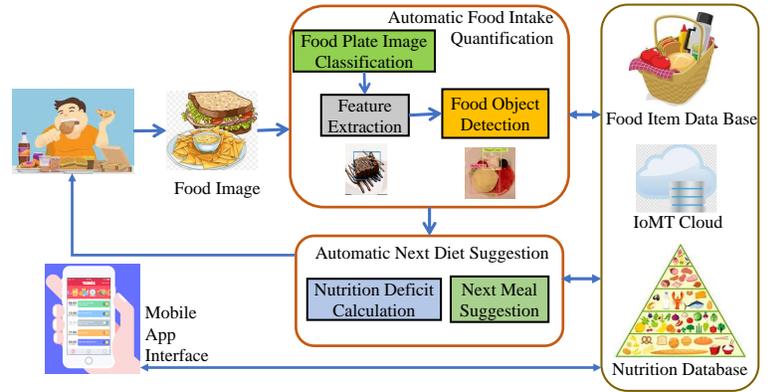


Figure 4: Diet Automatic Monitoring and Control for Blood Glucose Management [10], [20].

at cloud serve using H-CPS framework. This would be useful for diabetic patients to take care of their health during pandemic situation. Each device is able to accumulate some information like device ID, time stamp and time period of every device having contacted in last 14 days within 6 feet distance. This would trace out for diabetes people to take care of their health during this crisis time.

E. Rapid Detection of COVID-19

The detection of COVID-19 is necessary to inhabit the prevalence of virus among people who has underneath diabetes. There is a need of the solution which can provide accurate, portable and rapid solution for corona virus detection. The near infrared (NIR) spectroscopy has been applied effectively to detect hepatitis B & C and Zika virus instantly [22]. A similar optical technique can be applied for COVID-19 detection. The light of specific wavelength is used to find the presence of virus in saliva of the person. Proposed system carry emitters and detectors of specifically wavelength selected juridically along with acquisition and processing using data converters. The logged value from the system that is processed subsequently through machine learning models. The system can be integrated with IoMT based H-CPS framework to store data of patient at periodical intervals [23].

VI. CONTEMPORARY SOLUTIONS DURING COVID-19

A. Role of Industry 4.0

The COVID-19 outbreak has raised the demand in healthcare facility especially for diabetes patients (including insulin pump and glucometer) in self-care management. Industry 4.0 play a major role in essential

services related to medical management using smart manufacturing [24]. These smart solutions for diabetes patients are required in order to provide real-time point of care services using Industrial Internet of Things (IIoT). Industry 4.0 solutions would help to create a connected environment for providing useful information. This information can be used to improve health services, address necessary preventive actions and helps in the process of vaccine development without any human intervention.

B. Food Supply Chain

Internet-of-Agro-Things (IoAT) along with blockchain technology has potential for helping the suppliers to ensure safe and conform food delivery to the consumer [25], [26]. Healthy diet is must for the people suffering from chronicle disease such as diabetes to boost their immunity. The adulterated and counterfeit food consumption lead to higher chances of infection. In present scenario everyone must ensure food quality using Agriculture Cyber-Physical System (A-CPS). It is need of hour to develop a cost-effective portable solution to measure the quality of food. It is a must for diabetic people to have healthy diet during pandemic outburst as COVID-19.

C. Robotics based Technologies

Robotics can play a significant role during such pandemic outbreak. They can ensure quality of service in healthcare, teaching, entertainment and other useful communal services [27]. They can be effective in other crucial day to day services like transportation, hotels, hospital and similar places of public services where the social distancing is unavoidable. Tele robot can assist in preventive actions with auto sensing capability and other intelligent techniques. The social robot can help in housekeeping, food delivery, cleaning and other essential tasks of sustainability with safety proper measures. The usage of robotic applications has shown the exponential growth during this crisis situation and self-belief of people would help to adapt in daily life.

VII. CONCLUSION

This articles intends to create awareness for diabetes patients (may applicable to all) with contemporary technologies for smart health during COVID-19 outbreak. The literature study shows that diabetes patients are more vulnerable from SARS-CoV-2. The chances of getting infection for pre-diabetic patients are 2-3 times more than non-diabetic patients. The balance glucose-insulin

level would help of prevalence as well as morbidity rate from corona virus. The briefly discusses stress management, glucose-insulin management and diet management for diabetes patients. There is requirement of smart healthcare to tackle pandemic situation more effectively. However, there are a few substantial technologies available for healthcare, it is a requirement to have an intelligent long term plan to fight against such pandemic in future in order to minimize the impact across the globe using IoMT based H-CPS framework.

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A longer version of this work is available at [28].

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