SMARTPHONE BASED INSULIN RECOMMENDATION FOR TYPE1 DIABETES

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Abstract- Type 1 diabetes mellitus(T1DM) is a chronic condition in which the pancreas produces little or no insulin. The patients suffering from type 1 diabetes requires constant pre-meal insulin dosage. The common method that is adopted to suggest insulin dosage is done only based on blood glucose level. But there exists many other factors that affect the insulin dosage such as carbohydrate intake and dosage level such as low dose, moderate dose and high dose based on physical condition of the patients suffering from T1DM. Moreover such patients have to change their long standing eating pattern.

This project focuses on creating a smart phone based insulin calculator which incorporates the factors such as the blood glucose level, time of the day, carbohydrate content of the meal and the dosage types to calculate the insulin dosage. This helps the T1DM patients to easily calculate their insulin dosage using the android application installed on their smart phone. They need not change their long standing food patterns as they can adjust their insulin dosage based on the carbohydrate intake of meal.

Keywords – Diabetes Mellitus, Blood glucose, Insulin dosage.

I. INTRODUCTION

Diabetes mellitus type 1 (also known as type 1 diabetes) is a form of diabetes mellitus in which not enough insulin is produced. The lack of insulin results in high blood sugar levels. The classical symptoms are frequent urination, increased thirst, increased hunger, and weight loss. Additional symptoms may include blurry vision,feeling tired, and poor healing. Symptoms typically develop over a short period of time. The cause of type 1 diabetes is unknown. It however is believed to involve a combination of genetic and environmental factors. Risk factors include having a family member with the condition. The underlying mechanism involves an autoimmune destruction of the insulin-producing beta cells in the pancreas. Diabetes is diagnosed by testing the level of sugar or A1C in the blood. Type 1 diabetes may be distinguished from type 2 by autoantibody testing. There is no way to prevent type 1 diabetes. Treatment with insulin is typically required for survival. Insulin therapy is usually given by injection just under the skin but can also be delivered by an insulin pump. A diabetic diet and exercise are an important part of management. Untreated, diabetes can cause many complications. Complications of relatively rapid onset include diabetic ketoacidosis and nonketotic hyperosmolar coma. Long-term complications include heart disease, stroke, kidney failure, foot ulcers and damage to the eyes. Furthermore, complications may arise from low blood sugar caused by excessive insulin treatment. Type 1 diabetes makes up an estimated 5–10% of all diabetes cases. The number of people affected globally is unknown, although it is estimated that about 80,000 children develop the disease each year. Within the United States the number of people affected is estimated at one to three million. Rates of disease vary widely with approximately 1 new case per 100,000 per year in East Asia and Latin America and around 30 new cases per 100,000 per year in Scandinavia and Kuwait. It typically begins in children and young adults.

II RELATED WORKS

The Current Status of Bolus Calculator Decision-Support Software

David C. Klonoff, M.D., FACP

The purpose of self-monitoring of blood glucose is to take action based on the results of the tests. The three actions that must be taken by insulin-using diabetes patients in response to blood glucose self-testing are, first, to record the blood glucose level, second, to calculate an appropriate dose of insulin, and, third, to administer the dose of insulin. A low-technology solution exists for each of these three actions. In addition, a commonly used high-technology solution exists for the first and third of these three actions (recording the blood glucose level and administering the insulin dose), but no high-technology product is currently approved by the Food and Drug Administration (FDA) for calculating an insulin. The currently unavailable high-technology approach to glucose-directed insulin dosing is approved software for calculating a bolus dose of insulin. If proper safety systems can be designed specifically for blood glucose monitors, then it is likely that bolus-dosing software will gradually become more widely adopted in many countries. A blood glucose monitor with pattern recognition software (the LifeScan OneTouch Verio IQ) has been approved by the FDA. This system provides alerts to the user about patterns but does not provide bolus-dosing recommendations. If a software product that stores, sorts, and analyzes blood glucose data makes no specific treatment recommendations, then the patient can receive some assistance from software without the product having to be as tightly regulated as a formal bolus calculator. This approach is a type of "decision-support light," which provides less advice than frank decision-support software but is less stringently regulated. Some patients are particularly likely to benefit from bolus calculating software. If a patient has difficulty estimating the carbohydrate content of foods or the weight of foods, then decision-support software can be helpful by basing mealtime bolus doses on general descriptions of meals by patients coupled with stored databases of food compositions and carbohydrate contents of various-sized portions. Not only patients, but even diabetes educators can have trouble estimating the carbohydrate contents of foods. Many patients with diabetes have been shown to have difficulty understanding and using numbers. These patients have a great deal of difficulty calculating mealtime bolus doses and even more trouble combining correction boluses with mealtime boluses.

A Bolus Calculator Is an Effective Means of Controlling Postprandial Glycemiain Patients on Insulin Pump Therapy, *T.M.Gross, D. Kayne, A.King, C. Rother, and S. Juth*

Postprandial hyperglycemia is a modifiable risk factor in diabetes management. Until recently, only two techniques were available to guide patients through self-adjusting pre-meal insulin bolus doses. Patients on intensive therapy regimens were required either to perform complex mental calculations based on current and target blood glucose, CIR, total CHO (g) in the meal, and ISF; or to administer a predetermined bolus insulin dose and follow a rigid calorie- and CHO controlled diet. Compliance with either technique involves behaviour modification that has been difficult to achieve and maintain in patients with diabetes. It is generally easier to adjust an insulin dose than to change long-standing eating often difficult for adults to estimate correct bolus doses, and may be especially difficult for children who often have ISF and CIR that result in doses of a fraction of an insulin unit. A bolus calculator aids patients in accurately adjusting pre-meal insulin boluses, and provides them with added flexibility in their meal times, food choices, and physical activity, allowing them to focus on other aspects of the diabetes management regimen. Bolus calculator technology using a personal digital assistant (PDA) may make pre-meal bolus calculations more convenient and more accurate, and may help to improve patient adherence to the diabetes management regimen. The user is only required to perform a pre-meal fingerstick and estimate the total CHO (g) in the meal.

Benefits of bolus calculator in pre- and post prandial glycaemic control and meal flexibility using continuous subcutaneous insulin infusion (CII), ***B. Shashaj, E. Busetto and N. Sulli***

Achieving good glycaemic control while conserving quality of life and flexibility of lifestyle is the main objective of insulin intensive treatment of Type 1 diabetic paediatric patients. Indeed, a rational insulin therapy should ensure flexibility in the quantity, quality and choice of foods without jeopardizing postprandial glycaemic control. In childhood, the reduction of postprandial fluctuations in glycaemia levels is very important, in that such oscillations give rise to high glycated haemoglobin and consequently favour the onset and progression of the chronic complications of the disease. In current basal–bolus schemes, and especially when therapy utilizes an insulin pump, there is a need to control postprandial glycaemic oscillations, whilst maintaining dietary flexibility. Empirical methods of calculating the preprandial bolus currently in use have proved to be imprecise and impractical, leading the patient to adopt a rigid dietary regimen. This means that the pre-prandial bolus must be carefully calculated on the basis of the prevailing glucose level and the carbohydrate content of the meal. The Bolus Wizard, a bolus calculator incorporated into the insulin pump, estimates the dose of insulin to be administered at the meal on the basis of the following parameters: current blood glucose, grams of carbohydrate in the meal, carbohydrate to-insulin ratio (CIR), insulin sensitivity factors (ISF), target blood glucose and quantity of insulin previously administered, thereby making calculation easier and more precise.

Bolus calculator improves long-term metabolic control and reduces glucose variability in pump-treated patients with Type 1 diabetes, ***G. Lepore, A. R. Dodesini, I. Nosari, C. Scaranna, A. Corsi, and R. Trevisan***

Study designated to improve or evaluate long term efficacy of bolus calculator in improving metabolic control. Prospective observation on experience in bolus calculator usage. Use of therapy management software may safely help the achievement of better long term metabolic control and decreased diurnal variability in type 1 diabetic patients without using frequency of hypoglycaemia. Evaluation of one year efficacy of bolus calculator on long term glycaemic control.ISF calculated using the ration 1700/daily insulin dose and subsequently modified based on blood glucose level. HbA1c , BMI, insulin requirement and severe hypoglycaemia were evaluated every three months the year before and after the use of calculator. Post-prandial glucose levels and some measures of glucose variability were lower during the use of bolus calculator. It reduces fear of hypoglycaemia.

Use of an Automated Bolus Calculator Reduces Fear of Hypoglycemia and Improves Confidence in Dosage Accuracy in Patients with Type 1 Diabetes Mellitus Treated with Multiple Daily Insulin Injections
Katharine Barnard, C.Psychol, Christopher Parkin, Amanda Young and Mansoor Ashraf

Large controlled clinical trials have shown that intensive management of glycemia and other risk factors associated with diabetes can significantly decrease the development and/or progression of microvascular and macrovascular complications. Despite advances in developing new medications, insulin delivery systems, and glucose monitoring technology, a significant percentage of patients with diabetes remain well above their glycemic goals. Intensive self-management of diabetes is complex and time-consuming, and creates a significant psychosocial burden on patients and their families. Adding to the burden of self-management is the underlying, debilitating fear of hypoglycemia, which can result in poor adherence to insulin regimens and subsequent poor metabolic control. Compounding the problem are the challenges that arise when clinicians escalate patients to multiple daily injection (MDI) therapy to provide better glycemic control. Calculation of an insulin dose is a complex process in which numerous factors, such as pre-prandial glucose level, grams of carbohydrate (CHO), insulin sensitivity, insulin-to-CHO ratio (I:CHO), and active insulin on board should be taken into account. Because manual calculation of insulin boluses is complex and time consuming, patients may rely on empirical estimates, which may result in hypoglycemia.

III.EXISTING SYSTEM

Most of the existing work focus on calculating the insulin dosage only based on blood glucose level. Some systems focus on the physical activity level. Commercially available bolus calculators lack the ability to automatically adapt over time and require frequent revisions.

We present the system architecture and initial usability results of ABC4D, which provides personalized and adaptive insulin recommendations. ABC4D implements an *in silico* validated algorithm based on CBR, which differentiates between various scenarios and adapts bolus calculator parameters according to changes in the diet and life style of the patient by analyzing the postprandial glucose excursion. They show promising initial results of the presented system in a pilot study assessing usability and acceptability, which are key factors for the adoption of decision support systems for insulin dosing.

IV. PROPOSED SYSTEM

At present, the majority of people with Type 1 diabetes mellitus (T1DM) control their blood glucose levels by drawing blood from the fingertips and measuring glucose concentration with a blood glucose meter (i.e., self-monitoring of blood glucose), and by administering insulin through multiple daily injections or continuous subcutaneous insulin infusion pumps. Insulin boluses are usually calculated by estimating the insulin required to cover the ingested carbohydrates and by adding the insulin needed to correct elevated pre-meal glucose levels to target (i.e., correction bolus). Existing technologies used in diabetes management, such as insulin pumps and some blood glucose meters, incorporate bolus calculators that help users to simplify these calculations and potentially improve glycaemic control. The proposed bolus advisory system implements a *in silico* validated advanced insulin bolus calculator based on case based reasoning (CBR), which provides personalized insulin recommendations and automatically adapts its parameters over time. CBR is an artificial intelligence technique that solves newly encountered problems by applying the solutions learned from solving similar problems encountered in the past.

A. ADAPTING INSULIN THERAPHY FOR CBR

Adapting Insulin Therapy with CBR:
The CBR algorithm can be described in four steps
1) *Retrieve* cases from the case base and select the one that is most similar to the current situation (i.e., meal scenario) using a selected similarity metric.
2) *Reuse* the solution of a successfully retrieved case. If necessary, the solution can be further adjusted to the current scenario.

3) *Revise* the glycaemic outcome (e.g., postprandial hypoglycaemia or glucose area under curve) of the applied solution, if the user accepted the bolus advice. In case the outcome is unsatisfactory, adaptation of the solution of the retrieved case may be required.

4) *Retain* the adapted case in the case base or create a new case

B. SMARTPHONE BASED PATIENT PLATFORM

The patient platform provides the users with the graphical user interface to get the recommendation of the insulin dosage. The patient platform is an android application. It allows manual input of glucose and variables affecting blood glucose levels such as the time of meal, carbohydrate content of meal and the physical nature of the patient. The patient platform provides real time insulin bolus recommendations.

C. CLINICAL REVISION PLATFORM

The clinical revision platform is constructed for the sole purpose of safety in the insulin recommendation to the patients. It can access the database and check for the insulin dosage level recommended for the blood glucose levels. The clinician can make changes to the insulin sliding scale to ensure safety and check for the carbohydrate chart values also.

D. CALCULATION OF CIR

Every person responds differently to insulin. This means that any two people with diabetes can have quite different carb-to-insulin ratios. For some adults, one unit of fast-acting insulin can usually cover 15 grams of carbohydrate. However, for a very young child, as little as 1/10 unit of fast-acting insulin might cover 15 grams of carbohydrate. Healthcare professionals typically estimate a starting carb-to-insulin.

V. IMPLEMENTATION

The patient platform is implemented by using the Android studio. The patient platform implemented provides the means of the user interface. Options such as the blood glucose level, time of the day, carbohydrate content of the meal and the dosage type of the patient is provided. The user can enter his/her blood glucose level using the mobile keyboard. The type of the day includes a drop down list citing the breakfast, lunch and dinner. The patient can select it according to their time of meal. The patients can enter the amount of carbohydrate intake in grams. Option is also added to know the carbohydrate content of the food. Moreover the insulin dosage will vary according to the physical nature of the patients. Dosage can be classified as low dosage, high dosage and moderate dosage.

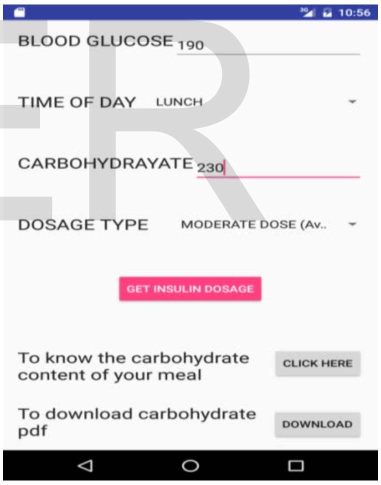

Figure 5.1

Figure 5.2

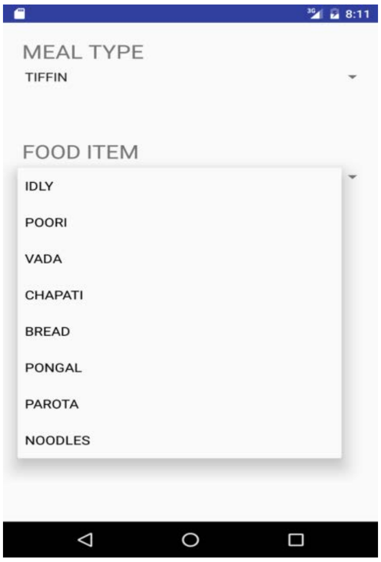

Figure 5.3

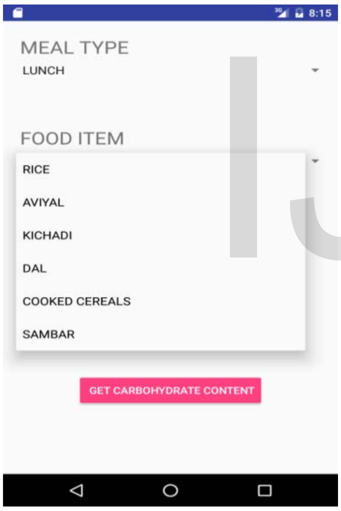

Figure 5.4

VI. CONCLUSION

In this project, the recommendation of insulin dosage to type-1 diabetic patients is provided by calculating the blood glucose level, carbohydrate intake of meal and the physical condition of patients. This helps the patients to take up regular insulin dosage without changing their food patterns. Moreover the safety parameters such as the clinical revision platform helps to have a continuous and safety adaptations of the insulin dosage by the patients. Usability and acceptability are the main features of the recommended insulin calculator which can be easily accessed with the help of a smart phone

VII. REFERENCES

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