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Tools For Interactive Learning And Self-Management Of Diabetes

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Tools For Interactive Learning And Self-Management Of Diabetes

Rita Capelo¹ Carla Baptista² Júlia Figueiredo²

Francisco Carrilho² Pedro Furtado¹

¹Departamento de Engenharia Informatica, ²Universidade de Coimbra

E-mail: ritacapelo2@gmail.com, cfbaptista@gmail.com,
mariajulateixeira@gmail.com, carrilhofm@gmail.com, pnf@dei.uc.pt

Abstract. Diabetes is a widespread disease and its control is dependent upon the patient. Although there is no permanent cure for diabetes, there are several available treatments which, when followed regularly, allow the patient to have a good quality of life. Patient education, especially about eating habits, is key to keep glucose levels stable both in the short and in the long term. This should include nutritional counselling, physical exercise, and the self-monitoring of glucose levels. The University of Coimbra and the Serviço de Endocrinologia, Diabetes e Metabolismo of Centro Hospitalar e Universitário de Coimbra started a collaboration to develop interactive tools for the learning and improvement of carbohydrate counting by patients. The approach presented in this paper is an interactive multimedia tool, available to patients through either the web or a smartphone. It helps them to learn how to maintain a healthy diet and how to monitor their insulin levels correctly by measuring the carbo-hidrate “equivalents” in meals. This application will create a more dynamic and interactive way of educating patients, improving solutions currently used in the Serviço de Endocrinologia, Diabetes e Metabolismo of the Centro Hospitalar e Universitário de Coimbra.

1. Introduction

Carbohydrate counting (CHC) is an established approach used by type 1 Diabetes patients to improve their glycemic control. However, CHC depends upon the patient's individual perception, and it may require a high level of subjectivity in the person's own self-assessment. Patients must learn how to recognize which foods contain CH and how to count the CH quantity in each of them. This requires a structured and continuous teaching, as well as an active participation of the patient. It is crucial to develop methods that minimize any errors the patient can make while calculating the CH amount of a specific food item or meal, since mistakes in determining these values can lead to an incorrect administration of prandial insulin.

We propose an interactive multimedia tool that offers both informative content, training, and serious games content that can help patients learn how to estimate the carbo-hydrate contents of meals. The application works by helping patients to achieve a better understanding of their disease, especially in



the counting of carbohydrate equivalents in food and meals. Thus patients can simplify the calculations they so often need to perform.

This paper is organized as follows: Section 2 contains related work; Section 3 describes the rationale behind the application that was created and its subsections describe each part of the application. Section 3.1 describes the Learning Area; Section 3.2 describes the Informational Area; Section 3.3 describes how the tools work; Section 3.4 describes the gaming area; finally, in Section 4 we discuss conclusions and future work.

2. Related Work

Some applications and resources aimed at helping diabetes patients are already available in the market. The ones which are most closely related to the subject discussed here can be found in several websites that are usually related to diabetes associations, charities, and companies that sell diabetes-related equipments and services.

The American Diabetes Association [1] provides important information for teaching patients how to control their glucose levels and how to administrate insulin. Their website provides video and text materials on the basics of diabetes, living with diabetes, and food and fitness. It includes videos and instructions on how to compose a plate (e.g. Six Easy Steps to Create Your Plate). It also provides food tips and elucidation on understanding carbohydrates.

The National Diabetes Education Program (NDEP) is a US partnership between the National Institutes of Health, the Centers for Disease Control and Prevention, and more than 200 public and private organizations [2]. This program provides free information about diabetes, using various learning resources and educational videos.

The Portal da Diabetes [3] includes information about diabetes, as well as a section of learning resources containing several brochures about different aspects of this disease. However, it does not have any interactive resources.

The mission of Learning About Diabetes, Inc. [4], is to provide easy-to-understand diabetes-care information to people with diabetes, the general public, and diabetes health care professionals. On their website we can find some learning materials about the diabetes in a quiz format. Its contents are purely static; they include both text and videos that explain what diabetes is.

There are many other organizations and companies working with diabetes which publish educational materials. For instance, MerckTM created a comprehensive program targeted at diabetes patients and healthcare professionals [5]. The program is called Journey for Control and brings together the key partners in the treatment of diabetes: Patients, Physicians, Diabetes Educators, and Health Planners. It is a comprehensive educational program designed to enlighten and empower patients by giving them the information and tools they need to make the lifestyle changes that lead to improved self-management. This website includes an explanatory guide about the disease and reference materials for its various components. OptumRx is a company specializing in the delivery, clinical management and affordability of prescription medications and consumer health products [6]. They publish materials related to educating about diabetes, such as downloadable documents and tips.

Joslin Diabetes Center [7] does present an interactive tool that allows you to drag food into a plate, like the one found in our application. It attempts to help the patient understand the nutritional values on each dish, but otherwise it does not provide the calculations that the patient must do in order to properly administer their insulin intake, and it does not include all the remaining interactive information that our application has.

The references reviewed above provide useful information for both patients and healthcare professionals. Our tool is an important addition to those mostly static or incomplete sources, as it adds interactivity and comprehensive meals and food search and visual interaction. Through it patients can experiment with plates; search for meals and types of foods in interactive ways; easily correlate what they found with carbohydrate counting, and patient must know many more features that allow them to achieve deeper insight. In particular, the gaming approach makes learning and experimenting intuitive and fun. By creating this tool, we aim to provide a set of interactive contents that the patient can interact with and through which he can assimilate knowledge, both in calculations and in the counting of "equivalents", a unit of measure frequently used in carbohydrate counting. The application contains both a learning component and interactive games that help to assimilate the relationship between food and carbohydrates and the insulin intake the patient must administer.

In addition, there are also smartphone applications designed to provide the user with information on food items, for example [8, 9, 10, 11, 12, 13]. These applications typically do not have most of the components we have created, including the gaming component, meals, equivalents, and carbon counting. Our application can also be deployed and used in smartphones.

3. Interactive Learning Experience with “Saber Contar, Saber Comer” (SCSC)

Our application is called “Saber Contar, Saber Comer” (SCSC), meaning “Know how to count, know what to eat”. Our goal when creating this interactive application was to make it easier for patients to learn and to practice their CH counting skills. There are many different issues that need to be discussed in order to achieve this. In particular, it is necessary to provide the patient with general information, learning materials, and useful tools which they can use to search for information concerning specific meals (e.g. breakfast, lunch, mid-afternoon snack, dinner) and specific foods (e.g. types of bread, vegetables, meat, milk) and, most importantly, interactive serious games which the patient can use to test their knowledge and their guessing skills. In order to represent all these important features, our application is divided into four different areas, each containing four sections:

A. Learning

A.1. Correspondence between carbohydrates and equivalents;

A.2. Food label reading.

The Learning functionality aims to teach the patient how to match carbohydrate contents of meals to equivalents. An equivalent is the unit used to make carbohydrate counting easier. Furthermore, it also intends to teach the patient how to read different types of food labels. These two aspects are the key aspects every diabetes patient must to know in order to be able to count carbohydrates, control their insulin, and to better handle their illness.

B Information

B.1. Nutritional value of food items;

B.2. Meal suggestions.

This section allows the user to search for vast amounts of information, mostly pictorial in nature. It also provides the most important facts about carbohydrate counting for various meals and types of foods. Not only does the application allow for freeform searching, it also organizes the data into

informative and logical types and categories. For instance, the patient will be able to find the contents of his breakfast (which may vary) and also to search for types of food, subtypes, and categories. This is further improved by allowing the user to enter quantities. The system will then provide the adequate CH counting, which can be learnt by the user.

C. Tools

C.1. Table of Individual data;

C.2. Insulin dosage calculator.

The calculation of insulin intake has individualized parameters, because of different sensitivity factors in each person. Our tools include customization for a specific patient, as well as a calculator of insulin intake that takes into account individual factors and the equivalents determined by the patient. This information is necessary in order for the patient to determine the adequate amount of insulin to take, or at least for the patient to learn how this is done.

D. Games

D.1. Equivalent counting

D.2. Insulin calculation

A serious game is a game that has an important practical training objective beyond just having fun. Serious games are especially appropriate for educating diabetic patients. These games are all based on imaging data. First, the user drags food and drinks into plates and glasses, respectively. Then they can raise or lower the quantities by dragging more or less items into the plate or glass or by clicking up or down. This makes the games very intuitive and easy to use by anyone, from children to old people. Its ease of use and intuitiveness make the tool quite appropriate for our purpose. We have included features for counting equivalents – the patient may compose a plate with any food he likes, all virtually, by dragging and dropping – and for insulin intake calculation, as an added feature.

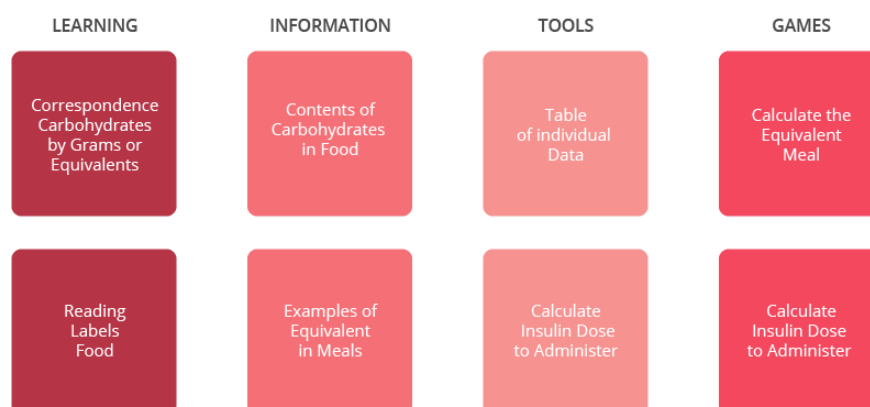


Figure 1. “Saber Contar Saber Comer” Main Menu.

Next we describe each part of the application in more detail, and provide illustrations for each. Section 3.1 describes the Learning Area, section 3.2 describes the Informational Area, section 3.3 describes how the tools work and section 3.4 describes the Gaming area.

3.1. Learning Area

The "Learning" area, shown in Figure 2, is meant to educate the patient. It includes an explanation of how carbohydrates are converted into equivalents. It also teaches patients how to read food labels, and contains three examples of labels in food items chosen by the hospital for their convenience. These are yogurt, cookies, and breakfast cereal.

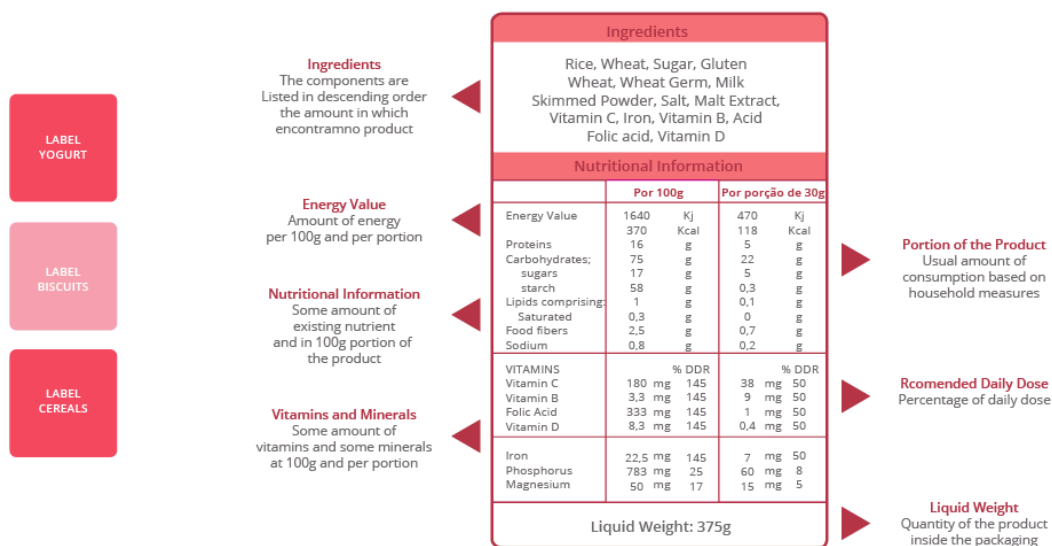


Figure 2. Food label reading

3.2. Information Area

The "Information" area is a tool that allows the user to find out how many equivalents exist in a food item. The user can choose between the following food categories: Starches, Fruits, Vegetables, Dairy, Soups, and Candy and Deserts. After selecting a category, the user sees a horizontal scroll with pictures of the more commonly eaten foods. Furthermore, on the bottom of the area they can find a search function, which can be used to find a food item that does not appear on the above list. After choosing a certain food and entering the desired quantity, the user sees the number of equivalents, calories, and its protein and carbohydrate amounts. The second section displays examples of menus for each meal of the day, in order to help the patient to follow a healthy diet.

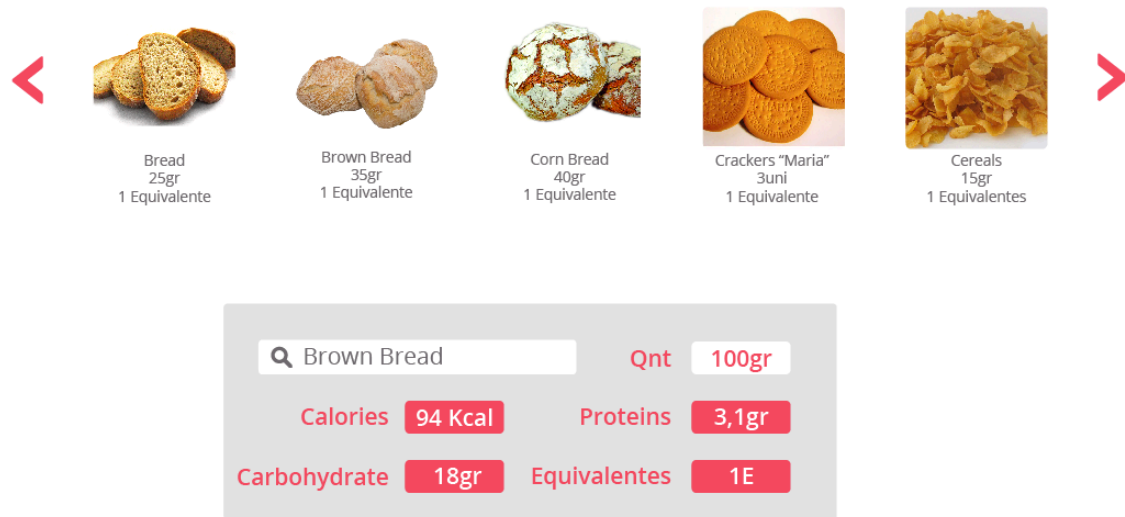


Figure 3. Nutritional value of food items



Figure 4. Meal suggestions

3.3.Tools Area

The "Tool" area includes two pages. The first one includes a table where the user can enter their personal data (as prescribed by their doctor). This is very important in order to learn the specific

insulin dosage to be administered after each meal. The second page contains a calculator tool that helps the patient to perform calculations by introducing their personal data.

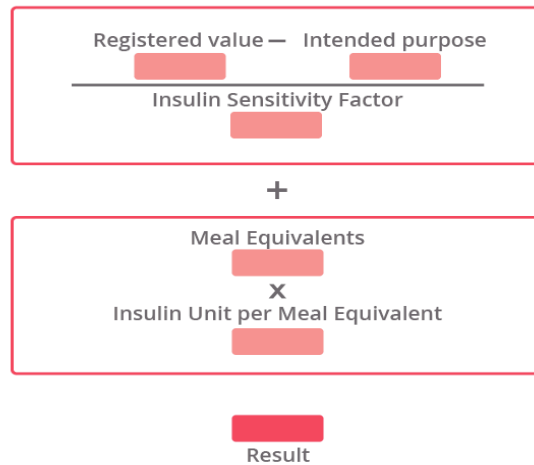


Figure 5. Insulin dose calculator

3.4. Games Area

Finally, the Gaming area includes two games which, despite their graphic similarities, have completely different goals. In the first game the user has to calculate the equivalents in a pictured food dish, based on what they have learnt in medical appointments. In the second game, the user has to calculate the insulin dosage they must administer, based on the dish pictured and their own insulin levels. These games allow users to drag food items into their plate and thus understand the amount of carbohydrates or equivalents they are seeing. Therefore, the games are an entertainment component of the application that also help patients to assimilate important information.

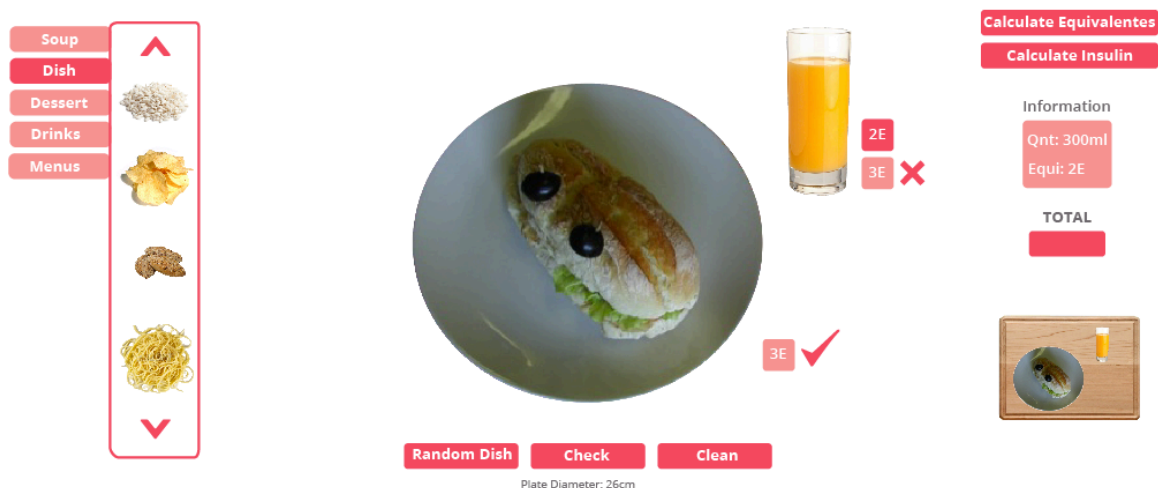


Figure 6. Interactive insulin calculator game area

4. Conclusions

In this paper we have presented a new approach aimed at teaching and training diabetes patients in carbo-hydrate counting and insulin intake planning. This interactive tool was developed in collaboration with the Servico de Diabetes e Metabolismo of CHUC Hospital. We discussed the purpose of creating this application and we explained how important it is for diabetes patients to learn how to measure their insulin intake appropriately, and why they must calculate the amounts of carbo-hydrates in meals correctly.

Currently, there are no available applications in the market that help diabetes patients to learn what to eat and how to count carbohydrates in this way. Although there are many interesting diabetes educational applications elsewhere, the interactivity that is proposed in our approach is unique and can highly benefit patients by improving their quality of life in a significant way. Unlike other approaches, this application empowers the diabetes patient by teaching him how to become independent. It both allows patients to assimilate information they have learned in their medical appointments and also teaches them how to apply this information, using the application's interactive game area.

5. References

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