A study on Expert Systems for Diabetic Diagnosis and Treatment

IBRAHIM M.AHMED, ABEER M.MAHMOUD, MOSTAFA AREF, ABDEL-BADEEH M.SALEM
Computer Science Department,
Faculty of Computer and Information Sciences,
Ain Shams University, Cairo, Egypt
ibrahim1630@gmail.com, drabeerm3@yahoo.com
abmsalem@yahoo.com, and aref_99@yahoo.com,

Abstract: - The research in diabetic systems is important to both medical industry and diabetes patients because these systems can be used to improve the quality of healthcare in many ways. These systems are helpful to doctors and treatment of patient with all kinds of conditions. This paper presents study of the intelligent systems in diabetes to support and give advices to clinical management and patients. It aims to; (1) determine the current state of research in the area, (2) to help derive the key features and problems with the existing systems and (3) using these key features as a guide in developing a new tool for diagnose and treat of diabetes type 2.

Key-Words: - expert systems, diabetic diagnoses, intelligence techniques, healthcare.

1 Introduction

The intelligent systems used in diabetic are important within the medical industry because they allow doctors and nurses to quickly gather information and process it in various ways in order to assist with making diagnosis and treatment decisions. These systems could help in diverse areas from the storing and retrieval of medical records, storing and retrieval of key substances in medicines, examination of real-time data gathered from monitors, analysis of patient history for the purposes of diagnosis, analysis of family history (for cardiac conditions for example), and in many other areas [1].

This paper presents a comparative study of recent research on the use of intelligent systems in diabetic within clinical management and clinical research. This paper present a survey of the current research in intelligent systems in diabetes to support and give advices to clinical management and patients, in order to, (1) determine the current state of research in the area, (2) to help derive the key features and problems with the existing systems, (3) using these key features as a guide in developing a new tool for diagnose and treat of diabetes type 2.

The information gathered in this comparative study with the analysis and discussion will help in identifying potential issues for developing intelligent systems for diabetic type 2, in addition to developing a knowledge based system for diabetes diet. The rest of the paper is organized as flow: section 2 discusses our research motivation. The expert systems is briefly presented in section 3. Section 4 presents the medical knowledge needed for understanding diabetic. A literature review in section 5. Section 6 discusses the comparative study. Conclusion is in section7.

2 Medical knowledge

2.1 Motivation

In the domain of medical treatment by controlling patient food (healthy diet) there are numerous variables that affect the decision process of selecting interesting food list from the patient point of view and efficient list in treatment from the doctor's point of view. These numerous variables causing the differences in the opinions of the practitioners. Also, there are many uncertain risk factors resulted from eating certain types of food with certain amount especially for example, diabetes and blood pressure patients. Furthermore sometimes it is really hard for experts to reach a good tasty and efficient in treatment, meal planning for such patient. Therefore, an accurate tool will be of a great help for an expert to consider all these risk factors and show certain results. Our research is motivated by the need of such an important and efficient tool. Therefore a survey on intelligent systems developed for diabetic has been our first step towards building such tool.

2.2 Diabetes Mellitus

The Diabetes Mellitus is a disease that causes blood glucose level rise in human body. The normal blood glucose level lies between (70-100) mg/100 ml during fasting and approximately 140 mg/100 ml otherwise. For a diabetic person, the blood glucose is around 126 mg/100 ml during fasting and 200 mg/100 ml otherwise. The most common symptoms observed in diabetic patients are: polyuria, weight loss, excessive thirst, continuous hunger, blurring and changes in vision, and fatigue. The Diabetes Mellitus can create many complications [2]: (1) Heart disease, (2) Stroke, (3)

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Kidney disease, (4) Blindness, (5) Nerve damage, (6) Leg and foot amputations, (7) Death.

There are three diabetes types, (1) Type 1 diabetes or insulin-dependent diabetes mellitus (IDDM), an autoimmune disease in where no insulin is produced and it must be treated by insulin injections, treatment also includes regular exercise and development of a meal plan.

(2) Type 2 diabetes, or non-insulin-dependent diabetes mellitus (NIDDM), in which tissues do not respond to insulin, is linked to heredity and obesity and may be controlled by diet; it accounts for 90 of all cases, many of which go undiagnosed for years.

(3) Gestational diabetes, during pregnancy – usually around the 24th week – many women develop gestational diabetes. A diagnosis of gestational diabetes doesn't mean that you had diabetes before you conceived, or that you will have diabetes after giving birth, but it's important to follow your doctor's advice regarding blood glucose (blood sugar) levels while you're planning your pregnancy, so you and your baby both remain healthy [4].

2.3 Spread of Diabetes Mellitus

Diabetes Mellitus is spreading at an alarming rate around the world. According to a study by the World Health Organization (WHO), it was estimated in year 2000 the diabetes prevalence around the world was 171 million, and the number is expected to double in year 2030, to 366 million, WHO (World Health Organization) provided on their website the shocking numbers of Diabetes Mellitus affecting this region Figure.1.

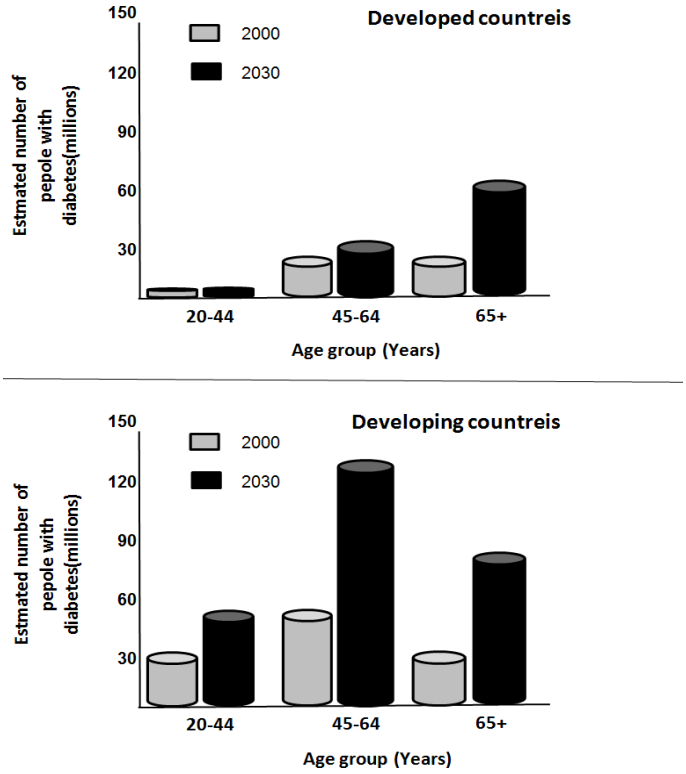

Figure.1 Projected diabetes prevalence increase (2000–2030) in developed (top) and developing (bottom) countries.

3 Expert Systems approach in diabetes

3.1 Expert Systems

An expert system is a computer program that provides expert advice (decisions, recommendations or solutions) as if a real person had been consulted. They can retain the knowledge and experience of anyone in an organization (including people who are retiring), per-process in information to increase an expert's productivity, or allow someone with less training to perform functions at a higher level. Rule based expert system includes both conventional techniques, such as data base management system (DBMS), and artificial intelligence (AI) techniques, such as knowledge based systems (KBSs) [2]. Figure 2 shows the general architecture of expert systems. the system compose of three main software components, (1) knowledge base (2) interface engine and (3) user interface. The first class is a set of production rules or conditions and each production rule represents knowledge about a field. The main sources of expert system knowledge are the experts themselves texts, books, journals, articles and database. The second class, inference engine makes inferences by deciding which rules are satisfied by facts, prioritizes the satisfied rules, and executes the rule with highest priority. Finally, the third class, user interface, is the mechanism by which the user and expert system communicate [3]. Figure1 shows a block diagram of the expert system structure.

A large number of expert systems are utilized in day to day operation throughout almost all the areas. Each of these systems attempts solving part or whole of a significant problem to reduce the essential need for human experts and facilitates the effort of new graduates in a certain domain. Examples of these domains are law, engineering, airspace, military, medicine, chemistry, sectors and banking

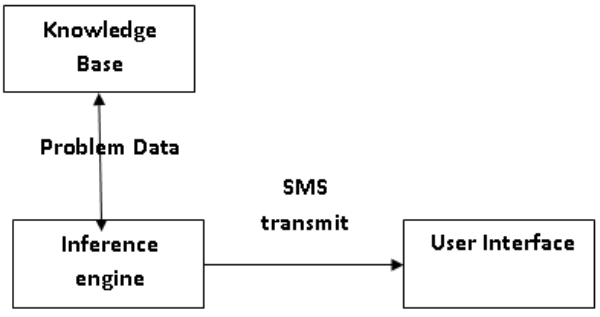

Figure.2 Expert system block diagram

3.2 Related Work

M.Garcia et. al (2001) [5] introduced an intelligent system to help diabetes people to monitor and to control the blood glucose level. The system named ESDIABETES. In the first phase of the ESDIABETES

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they presented a small prototype in CLIPS 6.0, where in final phase their system was implemented in WxCLIPS due to its friendly user interface than CLIPS 6.0. Actually the system start by asking questions and the system answers. This procedure will continue until ESDIABETES has enough information to give a recommendation to maintain the glucose level in the blood within acceptable values. This tool proves advantageous for testing and training purpose, thus it can be used by medical trainees to study about diabetes.

J.Cantais1 et. al (2005) [6] introduced building an environment for Health, and Knowledge Services Support. They create a dynamic knowledge environment that focus in managing heterogeneous knowledge from different sources. Also they proposed a Food Ontology which organizes foods in 13 main categories. They used hierarchical structure for designing the ontology. They suggest the size of the portion that allowed safely for diabetic type1.

P. M. Beulah et. al (2007) [7] introduced the ability to access diabetic expert system from any part of the world. They collect, organize, and distribute relevant knowledge and service information to the individuals. The project was designed and programmed via the dot net framework. The system allows the availability to detect and give early diagnosis of three types of diabetes namely type 1, 2, gestational diabetes for both adult and children.

M.Wiley et. al (2011) [8] presented diabetes management tool that monitors and controls blood glucose (BG) levels in order to avoid serious diabetic complications. They mentioned the difficult task for physicians, to manual large volumes of blood glucose data to tailor therapy of each patient. Also they describe three emerging applications that employ AI to ease this task. Actually, their system enables: (a) automatic problems detection in BG control (b) offering solutions to the detected problems (c) remembering the effective and/or ineffective solutions for individual patients type1 diabetes (T1D).furthermore their system might be embedded in insulin pumps or smart phones to provide low-risk advice to patients in real time. Finally, they used support vector regression (SVR) model for building the system.

W.Szajnar and G.Setlak(2011)[9] proposed a concept of building an intelligence system of support diabetes diagnostics, where they implemented start-of-art method based on artificial intelligence for constructing a tool to model and analyze knowledge acquired from various sources. The initial target of their system was to function as a medical expert diagnosing diabetes and replacing the doctor in the first phase of illness. Diagnostics the sequence of dealing with their system were as flow: (1) getting patient information and symptoms (2) competing basic medical examination in details (3) based on previous information the system find out whether the patient has diabetes and decides whether it is type1 or type2. The systems used decision tree as a model for classification.

S. Kumar and B. Bhimrao (2012)[10] developed a natural therapy system for healing diabetic, they aim to help people's health and wellness, which don't cost the earth. Their main goal was to integrate all the natural treatment information of diabetes in one place using ESTA (Expert System Shell for Text Animation) as knowledge based system. ESTA has all facilities to write the rules that will make up a knowledge base. Further, ESTA has an inference engine which can use the rules in the knowledge base to determine which advice is to be given to the user. Their system begins with Consultation asking the users to select the disease (Diabetes) for which they want different type of natural treatment solution then describes the diabetes diseases and their symptoms. After that describes the Natural Care (Herbal /Proper Nutrition) treatment solution of diabetes disease.

3.3 A Comparative Study

The motive for the construction of this comparison framework was to determine key functional requirements for later development of the intelligent systems used in diabetic, research applied within the medical domain.
Based on the related work introduced in section 4, the comparison from work used from our perspective is presented in this subsection.
The frame work includes the flowing features

- What kind of decision the system support, either a diagnostic or treatment or both.
- The language of coding.
- The artificial intelligence technique the system is based on.
- What kind of user interface the system provides. It is either a request/response where each request results is a response which can lead to another request; or an interactive UI where the human can clarify and enhance his requests at any time and the computer can ask for clarification if required.
- What kind of platform the application support. It is either pc, smart phones or even a medical devices.
- Whether the system support data distribution or not.
- Whether, there are some clinical trials performed by the system and the availability of results.

Table 1 and table 2 list a summary of these features.

Table 1: Comparative features for type 1 diabetes

Authors	System task	Implementation language /shell	ML technique	Integration with clinical management	UI / Application	Reported clinical trials	System main target
M.Garcia et. al [5] 2001	Diagnosis/ Treatment	CLIPS 6.0 and WxCLIPS	Not Specified	No	Request/ Response / Pc	No	Monitor and to control the blood glucose level.
J.Cantais1 et.al [6] 2005	Treatment	OWL-DL	Not Specified	No	Request /Response / Pc,mobile, medical devices	Yes	Create novel healthcare delivery models
M.Wiley et. al [8] 2011	Diagnosis	Not Specified	support vector regression (SVR)	No	Interactive / Pc, insulin pumps or smart phone	No	Monitor and control their blood glucose levels

Table 2: Comparative features for type 2 diabetes

Authors	System task	Implementation language /shell	ML technique	Integration with clinical management	UI / Application	Reported clinical trials	System main target
P. M. Beulah et.al [7] 2007	Diagnosis	Not Specified	Not Specified	Yes	Request /Response / Pc	No	Detect and give early diagnosis of three types of diabetes for both adult and children
W.Szajnar & Setlak [9] 2011	Diagnosis /analyze	Not Specified	decision tree	No	Interactive / Pc	No	Model and analyze knowledge acquired from various sources
S.Kumar & B. Bhimrao [10] 2012	Treatment	Expert System Shell for Text Animation	Not Specified	No	Interactive / Pc	Yes	Integrate all the natural treatment information of diabetes in one place

From table 1 and table 2, it can seen that all the reported research papers are focus on the diagnosis of diabetics. Also, few extended their work to treatment but only for type 1. Actually, most of the systems are used as prototype, a few support distributed data. Most of the systems can run on only a pc, but few may support running on smart phones or even a medical devices. Three of the system descriptions include the language of coding which were ESTA OWL-DL, CLIPS 6.0 AND Wx CLIPS. Three systems use a request/response interface, where the other systems use interactive real classification UI.

4 Conclusion

The research in diabetic systems is important for both medical industry and diabetes patients. An efficient tool for diagnosing and treatment diabetes is urgently needed for helping both specialist doctors and patients. Our research was motivated by the need of such an efficient tool, therefore a survey on intelligent system developed for diabetic has been presented in this paper as a first step towards building such tool. The paper discussed systems for both diagnosing and treatment but mostly for diabetic type 1. Although 90% of diabetic patients have type 2, only diagnosing systems were reported for this type 2, but no paper for treatment was reached by our survey.

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