

Modeling an Expert System for Diagnosis of Gestational Diabetes Mellitus Based On Risk Factors

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Abstract: Expert systems are recent product of artificial intelligence. It is a set of programs that manipulate encoded knowledge to solve problems in a specialized domain. Diabetes is a chronic illness that requires continuous medical care in patient self management education to prevent acute complications. Gestational diabetes mellitus (GDM) is a type of Diabetes present in around 3-4% of all pregnancies. This paper proposes a methodology to identify the GDM in pregnant women. Researchers contributed their work in diagnosing the diabetes mellitus. Our proposed work focuses on modeling an expert system to diagnose GDM using Feed forward Neural Network architecture.

Keywords: Expert systems, Diabetes, Diagnosis, GDM, OGTT, and Feed forward Neural Network.

I. Introduction

An expert system solves problems by simulating the human reasoning process and applying specific knowledge and interfaces. Expert systems also use human knowledge to solve problems that normally would require human intelligence.

These expert systems represent the expertise knowledge as data or rules within the computer. These rules and data can be called upon when needed to solve problems. Books and manual guides have a tremendous amount of knowledge but a human has to read and interpret the knowledge for it to be used. A computer program designed to model the problem solving ability of a human expert.

Expert systems and Artificial intelligence encompasses such diverse activities as game playing, automated reasoning, natural language, automatic programming, machine learning, robotics and vision, software tools, modeling human performance and expert systems for complex decisions. Complex Medical decisions are central in each phase and our system help to solve this field of expert system.

There are many medical diagnostic expert systems in the literature: like MYCIN, Easy Diagnosis, PERFEX, INTERNIST-I, ONCOCIN, DXplain, and PUFF. MYCIN was the first well known medical expert system developed by Shortliffe at Stanford University to help doctors, not expert in antimicrobial drugs, prescribe such drugs for blood infections. EasyDiagnosis is expert system software that provides a list and clinical description of the most likely conditions based on an analysis of your particular symptoms. EasyDiagnoses focuses on the most common medical complaints that account for the majority of physician visits and hospitalizations. It has a poorly designed user-interface, the user is required to answer a large number of questions without any notion that gives him the feeling that his data is accepted and will be diagnosed. PERFEX is a medical expert system that support solving problems clinicians currently have in evaluating perfusion studies. The heart of the PERFEX system is the knowledge-base, containing over 250 rules. DXplain is a decision support system which uses a set of clinical findings (signs, symptoms, laboratory data) to produce a ranked list of diagnoses which might explain (or be associated with) the clinical manifestations. PUFF is an expert system for the interpretation of pulmonary function tests for patients with lung disease. PUFF was probably the first AI system to have been used in clinical practice.

The proposed work uses architecture of ANN, a supervised multilayer forward network with back propagation learning algorithm has been used. As far as awareness is concerned, many patients have self question like whether I am having diabetes mellitus or hypertension. But how frequent the patient will go and check blood sugar is a question. This would be beneficial for these patients.

The rest of the paper is organized as follows. Section 2 is about Gestational diabetes mellitus. Section 3 describes the review on literature survey. Section 4 represents about the proposed framework of GDM and explains the procedure for GDM diagnosis expert systems. Section 5 summarizes the conclusion and future work.

II. Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM) is characterized by carbohydrate intolerance of varying severity with onset or first recognition during pregnancy. Women with a history of GDM are at increased risk of future diabetes, predominantly type-2 diabetes, as are their children. The extent of this risk depends on diagnostic

criteria used to identify GDM. Studies conducted in different populations and with different methodologies, consistently reported an increase in GDM in all race ethnicity

Gestational Diabetes Mellitus (GDM) is defined as any abnormal carbohydrate that begins or is first recognized during pregnancy. It does not exclude the possibility that unidentified glucose intolerance have preceded the pregnant state.

Gestational diabetes mellitus (GDM) is defined by abnormal glucose tolerance during pregnancy; the glucose tolerance test is normal before, and which will usually be normal, after pregnancy. It can be associated with significant morbidity and mortality in the fetus and newborn

Although uncontrolled hyperglycemia in all types of diabetes increases potential maternal and fetal risks, it is necessary to distinguish among types, because each type generates different challenges during gestation and distinct developmental outcomes for the fetus.

The clinical importance of GDM lies in the fact that it is associated with significant maternal and fetal morbidity.

The overall prevalence of hyperglycemia during pregnancy may be as high as 13%;0.1% of pregnant women per year have type 1 diabetes mellitus (T1DM),2% to 3% have type 2 diabetes (T2DM), and up to 12% have gestational diabetes mellitus (GDM).

GDM has been found to be more prevalent in urban areas than in rural areas. The sample size was determined based on the overall prevalence of GDM in Indian population (13.9%) and with 90% statistical power, a total of 1,463 consecutive pregnant women were recruited into the study between April 2009 and February 2010.

The pathological factors of GDM are placental secretion of hormones that causes an insulin resistance state, impairment of the compensatory increase in first phase insulin secretion, presence of islet cell auto-antibodies and deterioration of beta cell function.

There is no worldwide agreement on the best way to screen for GDM. Globally screening at 24-28 weeks of Gestation with 50-g Oral Glucose Challenge Test has been recommended. Women with 1-Hour glucose level > 140 mg/dl are referred for diagnostic Oral Glucose Tolerance Test (OGTT).

III. Literature Survey

Artificial Intelligence (AI) has overlap with almost all fields for broad applications like medicine, banking, biology, defense, civil engineering and aerospace etc. A lot of research has been done using Artificial Neural Networks (ANN) in diagnosing diabetes mellitus. The basic architecture of ANN used for accomplishing the classification task is a supervised multilayer feed forward network with back propagation learning algorithm.

Siti Farhanah Bt Jaffar and Dannawaty Mohd Ali [7] proposed a method for diagnosing diabetes. The diagnosis is accomplished using back propagation neural network algorithm. The inputs to the system are plasma glucose concentration, blood pressure, triceps skin fold, serum insulin, Body Mass Index (BMI), diabetes pedigree function number of times a person was pregnant and age. The biggest challenge was the missing values in the data set.

Artificial Neural Networks (ANN) is a mathematical model widely used for classification and diagnosis in various thirst areas like effective decision making in medical field, signal processing and so on[5]. Nahla H.Barakat, et.al, utilized support vector machines [9]. A five layer fuzzy ontology has been developed in fuzzy expert system by Chang-Shing Lee, et.al, for diabetes decision support application and Classification of Type 1 Diabetes using neural networks was successful in [10].

Neural networks have been used to develop classification models for medical diagnosis purposes. The advantages of using neural network approaches in diagnosis are their generalization ability in addressing both the nonlinear and fuzzy nature of the patients' data. Neural networks have been applied in building diagnosis models for various diseases and they have the capability to transform the nonlinear or fuzzy patients' data into simplified black-box structures.

Artificial neural network ensemble is a powerful learning technique that could significantly improve the generalization ability of neural learning systems, but its comprehensibility is even worse than that of a single artificial neural network, which may hinder the wide acceptance of this technique in medicine.

IV. Back Propagation Neural Network (Methodology)

Back propagation is a neural network learning algorithm. The feedback forward network structure is most important ANN structure. Design of a feed forward net for any specific application involves many issues, most of which require problem dependent solutions. The overall computational approach comprising of two parts: feed forward implementation of learned mapping and training of 3 layer network. [5]Actual algorithm for a 3-layer network (only one hidden layer) as follows:

Initialize the weights in the network (often randomly)

Do

For each example e in the training set(Symptoms)
 O = neural-net-output (network, e); forward pass
 T = Diagnosed output for e
 Calculate error ($T - O$) at the output units
 Compute δ_{wh} for all weights from hidden layer to output layer; backward pass
 Compute δ_{wi} for all weights from input layer to hidden layer; backward pass continued
 Update the weights in the network

As the algorithm's name implies, the errors propagate backwards from the output nodes to the inner nodes.

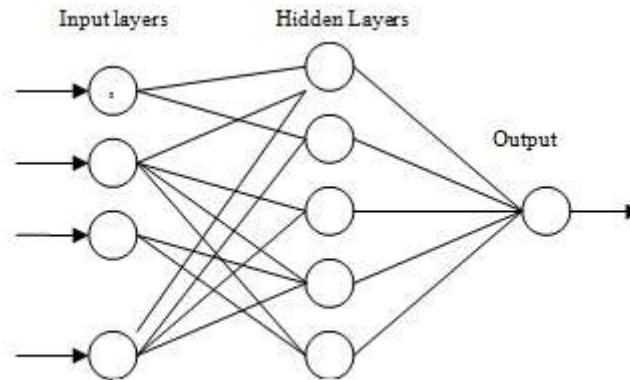


Fig 1. Feedforward Network Architecture

V. Procedure For Gdm Diagnosis Expert System

The proposed model diagnoses the GDM patient in two phase's i.e. Analysis phase and Evaluation phase

5.1: Gathering Details form Patient:

In analysis phase we gather patient information. The inputs designed for the system are age, family history, gender, personal habits, complications, physical examinations, past history and finally test measurements. The gathered information can be analyzed, normalized and stored in database.

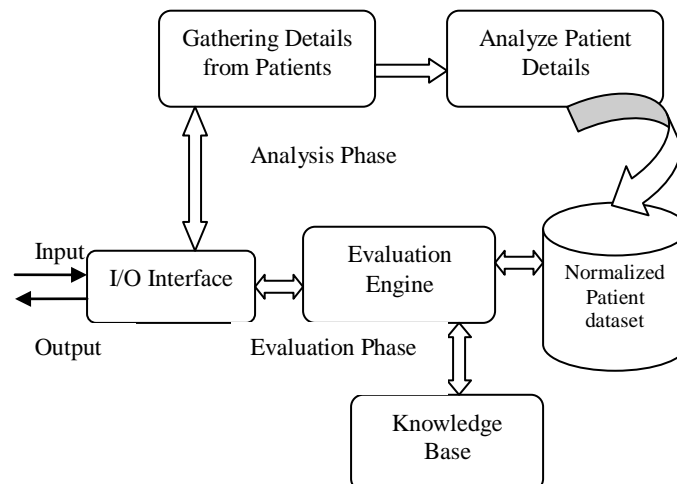


Fig 2. Framework of GDM Expert System

4.2: Evaluation Engine:

In Evaluation phase, Evaluation Engine places major role. It accepts the user input queries and responses to the questions through the I/O Interface and use the dynamic information together with the static knowledge stored in the knowledge base. Knowledge in the knowledge base is used derive conclusions about the current case or situation as presented by user inputs. Diagnosis is based on the fuzzy rules framed and implemented using back propagation neural network algorithm. In the proposed diagnostic system the knowledge is presented by object oriented representation for reusability.

The Evaluation Engine diagnoses the GDM Patient by the following Screening process proposed by ADA (American Diabetic Association) Method [3]:

- Perform a 75-g OGTT, with OGTT, with plasma Glucose measurement fasting and at 1 and 2h at 24-28 weeks of gestation in women not previously diagnosed with overt diabetes.
- The OGTT should be performed in the morning after an overnight fast of at least 8h. The diagnosis of GDM is made when any of the following plasma glucose values are exceeded:

- * Fasting ≥ 92 mg/dl (5.1 mmol/l)
- * 1h ≥ 180 mg/dl (10.0 mmol/l)
- * 2h ≥ 153 mg/dl (8.5 mmol/l)

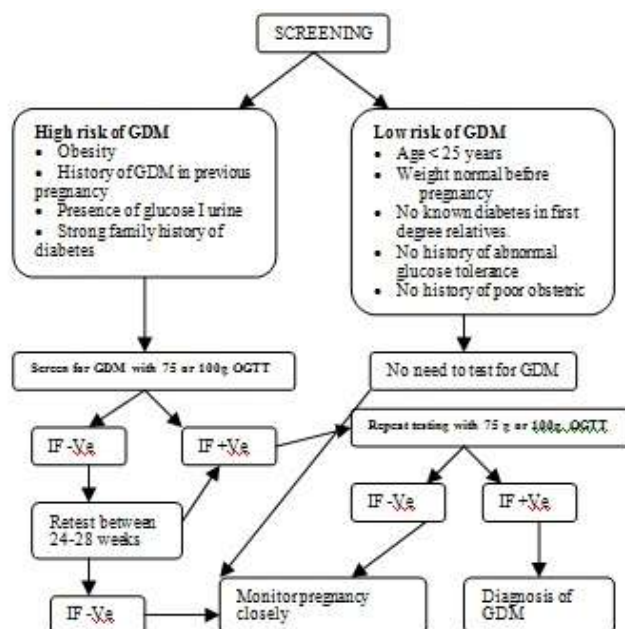


Fig 3. Screening of GDM

VI. Conclusion

Women with GDM may go on to have Type II diabetes in later life. They must be considered as having high risk for the development of diabetes and must undergo annual testing. In our proposed system the patient can perform self examination without concerning the doctor. It will identify the GDM by considering different facts/symptoms as input and evaluate/process them in the evaluation engine for diagnosis using Back propagation algorithm.

References

- [1] [1].K.Rajeswari,V.Vathianathan,D.Gurumoorthy “Modeling Effective Diagnosis of Risk Complications in Type 2 Diabetes – A Predictive model for Indian Situation” a paper published in European journal of Scientific Research ISSN 1450-216X Vol.54 No.1 (2011), pp.147-158
- [2] [2]. Prof.Sumathy,Prof.Mythili,Dr.Praveen Kumar,Jishnujit TM,K.Ranjith Kumar “ Diagnosis of Diabetes Mellitus based on Risk Factors” a paper published in IJCA,Vol.10,No-4,Nov 2010.
- [3] [3].Dr.Vijay Viswanathan,Dr.M.Parthiban “Gestational Diabetes & Devices in DM”
- [4] [4] Sreedevi E,Vijaya Lakshmi K, Chaitanya Krishna E, and Padmavathamma M. “Modelling effective diagnosis of risk complications in gestational diabetes mellitus: an e-diabetic expert system for pregnant women” published SPIE Proc. SPIE 8334, 833437 (2012)
- [5] [5] Robert J.Saschalkaff “Artificial Neural Networks”
- [6] [6] Dan.W.Patterson “Introduction to Artificial Intelligence & Expert Systems”
- [7] [7] Siti Farhanah Bt Jaafar and Dannawaty Mohd Ali, “Diabetes mellitus forecast using artificial neural networks”, Asian conference of paramedical research proceedings, 5-7, September, 2005, Kuala Lumpur, MALAYSIA
- [8] [8]Chang-Shing Lee, Mei-Hui Wang, “A fuzzy expert system for diabetes decision support application”, IEEE transactions on systems, man and cybernetics 2010.
- [9] [9] Nahla H. Barakat, Andrew P. Bradley, and Mohamed Nabil H. Barakat, “Intelligible support vector machines for diagnosis of diabetes mellitus”, IEEE transaction on
- [10] information technology in Biomedicine, Vol. 14, No. 4, July 2010
- [11] [10]Kit Yan Chan, et. al, ‘ Classification of Hypoglycemic Episodes for Type 1 Diabetes Mellitus based on Neural Networks’, 978-1-4244-8126-2/10/\$26.00 ©2010 IEEE.