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An Expert System for diseases like Diabetes Pancreas Thyroid and Parathyroid

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Abstract: This paper explains expert system which will be able to fully diagnoses and treat the diseases caused by diabetes. For example Pancreas, Thyroid and Parathyroid glands are some diseases caused by diabetes. Furthermore, the expert system will give first aids in emergency cases caused by diabetes. Since, diabetes diseases are widely spreads in the India; we chose it to be the primary target from the diabetes diseases. Our expert system is not meant to replace the human physician but using such system may be useful in cases like overcoming the problems of the shortage in human physicians and accuracy and speed in processing facts. This system can be used to help the physician in their work.

Keywords: Expert System, diabetes, Pancreas, Thyroid, Parathyroid diseases

I. INTRODUCTION

Most diseases nowadays are mainly caused by the inadequate performance of the endocrine system, regulating mood, sexual function, metabolism and growth are all depends on the functionality of the endocrine system

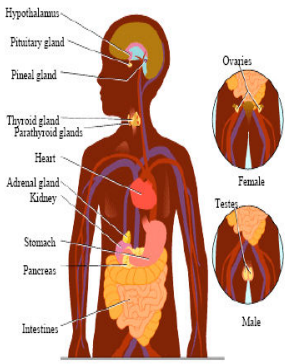

Figure 1. Endocrine System.

Generally, the endocrine system is in charge of the body processes that occur slowly, such as cell growth. Faster processes similar to breathing and body movement are managed by the nervous system. But even though the nervous system and endocrine system are distinct systems, they frequently work together to help the body function appropriately. This paper is structured as follows. In Section 2 we describe the study of diabetes diseases spread in India. In Section 3, we overview the different expert system exist for medical diagnosis. In section 4, we discuss design of expert system with advantages of our expert system. And in last section, we provide the conclusion[10].

II. RELATED WORK

Artificial Intelligence (AI) is a subfield of computer science concerned with symbolic reasoning and problem solving. Expert Systems (ES) which is a branch of AI are computer systems that apply reasoning methodologies to knowledge in a specific domain to render advice or recommendation much like a human expert. Figure 2 shows the structure of a typical expert system and its component parts. Running on an interactive computer, typically a personal computer (PC) or a work-station is a piece of software called an inference engine. Associated with the inference engine is a knowledge base, containing rules of inference and related factual information, about a particular domain. Along with the inference engine, there is need for a good interface for interaction with an expert who creates knowledge bases and with the naive end-user of the ES. This interface should offer good support for man-machine interaction, making it easy to put in rules and to edit them. The whole of the software that enables you to build and use ESs is called an expert system shell. Shells are usually quite generic. You can easily develop diverse ESs using a shell as a base. The domain-specific knowledge is in the knowledge base, which is usually created by a knowledge engineer (KE) collaborating with a domain expert.

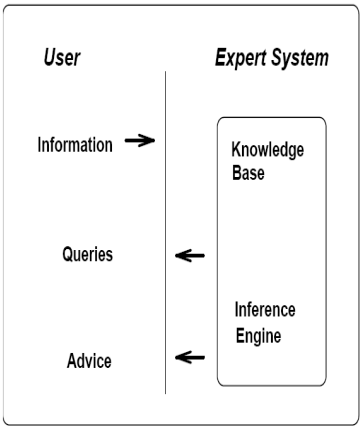

Figure 2. Structure of Expert System

In our expert system we are using the Java Expert System Shell (JESS) to perform its functions, facts and procedures. It is a rule based engine for the Java language platform which is a superset of CLIPS programming language developed by Ernest Friedman-Hill of Sandia National Lab. (Giarratano, 2002)[2][7]. It was first written in late 1995. It provides rule-based programming suitable for automating an expert system and is often referred to as an expert system shell. In recent years, intelligent agent systems have been developed also, which depend on a similar capability. This system requires having Java version 1.6.0 or 1.5.0 running on Windows XP SP2 or Windows Vista Home Premium. The following are the examples of expert system which are already design:

A. . *MYCIN*

It was the first well known medical expert system developed by Shortliffe at Stanford University (Buchanan and Shortliffe, 1984) to help doctors, not expert in antimicrobial drugs, prescribe such drugs for blood infections. The limitation of MYCIN was: its knowledge base is incomplete since, it does not cover anything like the full spectrum of infectious diseases. Running it would have required more computing power than most hospitals could afford at that time (1976). Doctors do not relish typing at the terminal and require a much better user interface than that provided one.

B. *Easy Diagnosis*

It is expert system software that provides a list and clinical description of the most likely conditions based on an analysis of your particular symptoms (Martin, 2004) [1] [3]. Easy diagnosis focuses on the most common medical complaints that account for the majority of physician visits and hospitalizations.

C. *Easy Diagnoses*

It is 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.

D. *PERFEX*

It is a medical expert system that support solving problems clinicians currently have in evaluating perfusion studies (Ezquerra *et al*., 1992). The heart of the PERFEX system is the knowledge base, containing over 250 rules. They were formulated using the expertise of clinicians and researchers at Emory University Hospital. PERFEX limitation resides in its output. It is mostly numerical.

E. *INTERNIST-I*

It is a rule-based expert system designed at the University of Pittsburgh in 1974 (Kumar et al., 2009)[5] for the diagnosis of complex problems in general internal medicine.

F. *ONCOCIN*

It is a rule-based medical expert system for oncology protocol management (Wiederhold *et al*., 2001)[4][9] developed at Stanford University. Oncocin was designed to assist physicians with the treatment of cancer patients receiving chemotherapy.

G. . *Dxplain*

It 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 (Elhanan *et al*., 1996). The DXplain provides justification for why each of these diseases might be considered, suggests what further clinical information would be useful to collect for each disease and lists what clinical manifestations, if any, would be unusual or a typical for each of the specific diseases.

H. *PUFF*

It is an expert system for the interpretation of pulmonary function tests for patients with lung disease (Aikins *et al*., 1983). PUFF was probably the first AI system to have been used in clinical practice.

Those Expert Systems suffer from limitation, bad interface or output format.

Our expert system is specialized in the diagnosis of endocrine system diseases with descriptive output and carefully designed interface

III. STUDY OF DIABETES DISEASES SPREAD IN INDIA

The rising prevalence of diabetes is evident in urban areas from large epidemiological study, such as the Chennai Urban Rural Epidemiology Study (CURES) [11] in Chennai, India. Chennai is one of the few cities in India where a series of population-based studies have been carried out, which enabled the investigators to compare the prevalence rates of diabetes. From 1989 to 1995, the prevalence of diabetes in Chennai increased by 39.8% (8.3-11.6%); between 1995 and 2000 by 16.3% (11.6-13.5%) and between 2000 and 2004, by 6% (13.5-14.3%). Thus within a span of 14 years, the prevalence of diabetes increased significantly by 72.3%. [11]. Studies have shown that Asian Indians develop diabetes at least 10-15 years earlier than Caucasian populations. [12],[13] An increase in the prevalence of type 2 diabetes at the younger age group has been noted in recent epidemiological studies. The National Urban Diabetes Survey (NUDS) in India showed that more than 50% of diabetic subjects had onset at less than 50 years of age and the prevalence of diabetes in those aged below 30 was 5.4%. [14] The CURES study reported that there appears to be a further temporal shift to the left in age at onset with the younger age groups being more affected with diabetes. [11]The younger age at onset of diabetes was also observed by Wan Nazaimoon and Suraiami among the indigenous population of Malaysia. Hence, it is increasingly becoming clear that type 2 diabetes has become prevalent even among younger age groups in Asia. This means that in developing countries, the long-term complications of diabetes can also be expected to occur in a large proportion of diabetic subjects during the most productive years of their lives, causing severe economic and social burden.

IV. DISEASES CAUSED BY DIABETES

Currently, our expert system will take number of rules which will cover: Pancreas, Thyroid and Parathyroid diseases of the endocrine system. Here, is a brief identification of each of the three diseases that our expert system can help the user with:

A. *Pancreas Diseases*

The pancreas is a pinkish-grey organ that lies behind the stomach. The organ is approximately 15 cm in length with a long, slender body connecting the head and tail segments. The endocrine pancreas is separate from the exocrine pancreas. The endocrine pancreas is made up of small clumps of cells within

the pancreas, called pancreatic islets, or the islets of Lange Hans. These account for only 1% of the pancreatic mass. It is composed of three distinct cell types each producing a different hormone. The two important hormones are:

Glucagon: Secretion of glucagon is controlled by the level of blood sugar, being released when levels are too low. This greatly increases the output of sugar from the liver and returns blood sugar levels to normal.

Insulin: Insulin is needed to convert sugar (glucose), starches and other food into energy needed for daily life. Insulin is designed to lower blood sugar levels when they become too high and is released in periods when there is a lot of sugar available, like after a meal

B. Hyperglycaemia

Diabetes Mellitus is a clinical syndrome characterized by hyperglycaemia due to absolute or relative deficiency of insulin. Lack of insulin, whether absolute or relative, affects the metabolism of carbohydrates, protein, fat, water and electrolytes. The Hyperglycaemia is introduced in terms of increasing the glucose in the blood. That means that there is no insulin to reduce the percent of the glucagose to its normal level.

C. Classification of Diabetes Mellitus

Insulin-Dependent Diabetes Mellitus (IDDM) is called the type one that means it is the first type of diabetes mellitus and this type has characteristics that different from the second one. The patients with IDDM depend on the insulin in their treatments. Death may results from the absolute deficiency of insulin, so the patients must take the insulin to stay alive. Most IDDM's patients are from children and young people. The second type of primary diabetes mellitus is the Non-Insulin-Dependent Diabetes Mellitus (NIDDM). The patients under this type have relative deficiency of insulin and they may take drugs or make diets as treatments. That does not mean that they do not take insulin but the insulin is the last choice that may be needed overtime. Most patients in this type are obese and old under excess endogenous production of hormonal antagonists to insulin topic, the probable actions of hormones countering the effect of insulin in humans.[6]

D. Diagnostic Criteria for Diabetes Mellitus

Persons presented with clinical manifestations that are normally associated with diabetes (such as polyuria, polydipsia, weight loss and blurred vision) and/or major risk factors for diabetes, should be referred to the laboratory for fasting plasma.[6]

E. Hypoglycaemia

Hypoglycaemia, defined as a blood glucose concentration of less than 2.5 mmol L-1, occurs commonly in diabetic patients treated with insulin and relatively infrequently in those taking a Sulphonylureas drug. In most instances the patient has no difficulty in recognizing the symptoms of hypoglycaemia and can take appropriate remedial action. However, in certain circumstances (e.g., during sleep) and particularly in certain type of patients (e.g., patients with long duration of IDDM) warning symptoms are not always perceived by the patient even when awake so that appropriate action is not taken and if no assistance is available, unconsciousness is the result. Severe hypoglycaemia, defined as hypoglycaemia requiring the assistance of another person for recovery, can result in serious morbidity and has recognized mortality of 2 to 4% in insulin-treated patients. The unrecognized mortality is probably significantly higher than this. Sudden death in sleep otherwise healthy young patients with IDDM has been described and has been attributed to hypoglycaemia-induced cardiac arrhythmia.

Recurrent severe hypoglycaemia is very disruptive and impinges on many aspects of the patient's life including employment, driving and sport. Risk of hypoglycaemia is the most important single factor limiting attainment of the therapeutic goal, namely normal/near normal glycaemia in patients with IDDM.[15]

F. Causes of Hypoglycaemia

The main causes of hypoglycaemia in patients taking insulin or a Sulphonylureas drug are as follows:

Missed, delayed or inadequate meal

Unexpected or unusual exercise

Alcohol

Poorly designed insulin regime, particularly that predisposing to nocturnal hypoglycaemia

Defective glucose counter-regulation/unawareness of hypoglycaemia

Gastroparesis due to autonomic neuropathy

Other endocrine disorder, e.g., Addison's disease

Malabsorption

Factitious hypoglycaemia

Other causes include the following:

GI surgery, Idiopathic, Hepatic disease, Islet cell tumor/extrapancreatic tumor, Exercise (in diabetic patients), Pregnancy, Renal Glycosuria, Ketotic hypoglycemia of childhood, Adrenal insufficiency, Hypopituitarism, Enzyme deficiency, Large tumors (e.g., mesenchymal tumors, epithelial tumors, endothelial tumors), Sepsis, Starvation and Artifact

G. Symptoms of Hypoglycaemia

The symptoms of hypoglycaemia fall into two main groups those related to acute activation of the autonomic nervous system and those secondary to glucose deprivation of the brain (neuroglycopenia). They are categorized as follows: Autonomic (Sweating, Trembling, Pounding heart, Hunger, Anxiety) Neuroglycopenic (Confusion, Drowsiness, Speech, difficulty, Inability to concentrate, Incoordination) Non-specific (Nausea, Tiredness, Headache)

H. Diabetic Ketoacidosis

Prior to the discovery of insulin more than 50% of diabetic patients died in ketoacidosis. Today this complication should account for less than 2% of deaths among diabetics. However, both the incidence and the mortality rate are still unfortunately high. Failure of patient to understand the disease and to appreciate the significance of symptoms of poor control is the most common causes. Its prevention is largely a matter of education of both patients and doctors. A significant number of new patients still present in diabetic ketoacidosis and in established diabetics a common course of events that patients may develop: intercurrent infection, lose of their appetite and either stop or drastically reduce their dose of insulin (on either their own initiative or their doctor's advice) by mistakenly belief that under these circumstances less insulin is required. Any form of stress, particularly which produced by infection, may precipitate severe ketoacidosis in even mildest case of diabetes.

I. Thyroid Disease

The thyroid is a small gland; shaped like a butterfly that rests in the middle of the lower neck (Figure.1). Its primary function is to control the body's metabolism (rate at which cells perform duties essential to living)[8]. To control metabolism, the thyroid produces hormones, T4 and T3, which tell the body's cells how much energy to use.

A properly functioning thyroid will maintain the right amount of hormones needed to keep the body's metabolism functioning at a satisfactory rate. As the hormones are used, the thyroid creates replacements. The quantity of thyroid hormones in the bloodstream is monitored and controlled by the pituitary gland. When the pituitary gland, which is located in the center of the skull below the brain, senses either a lack of thyroid hormones or a high level of thyroid hormones, it will adjust its own hormone (TSH) and send it to the thyroid to tell it what to do. When the thyroid produces and releases more hormones than one's body needs, it is called Hyperthyroidism.

J. Parathyroid Disease

Parathyroid glands are small glands of the endocrine system which are located in the neck behind the thyroid (Figure.1). There are four parathyroid glands which are normally the size and shape of a grain of rice. Occasionally, they can be as large as a pea and still be normal. Normal parathyroid glands are the color of spicy yellow mustard. Although, the thyroid and parathyroid are neighbors and both are part of the endocrine system, they are unrelated and do not have the same functions. Hyperparathyroidism is the principle disease of parathyroid glands. It occurs when one of the parathyroids develops a tumor which makes too much parathyroid hormone.

V. SYSTEM DEVELOPMENT PLAN

Communication between the user and the expert system is done through the user interface which will be implemented in English language to be easy for the regular end user. The user interface does not require much tying. When the user will choose Clinical Examination for example, a new screen will display in the format of a dialogue, the expert systems will ask a question and the user will choose the best answer from the choices provided. Finally, the expert system informs the patient/user about the initial results of consultation of the phase one checkup. The final result of consultation of phase2 is display to the user.
The Expert System will go through following phases.

1. Expert system user interface
2. General examination phase1
3. Initial results of consultation for phase 1
4. General examination phase 2
5. Results of consultation for phase 2

A. Knowledge Acquisition

Basic information about the endocrine diseases, symptoms and treatment where collected from experts (physicians), books, sites and special prepared notes by clinical physicians. Knowledge elicitation will be performed through this information.

B. Knowledge Representation

The environment of the system may affect its reliability. The use of some Expert System programming languages makes the system limited in specific features.

In our expert system, we are using Java Expert System Shell (JESS) to perform its functions, facts, rules and procedures. JESS is a rule based engine for the Java platform and it is a superset of CLIPS programming language. CLIPS (C Language integrated production System) were developed by Ernest Friedmanhill of Sandia National Labs (Giarratano, 2002) [2]. It was originally written in late 1995 and provided rule-based programming suitable for automating an expert system and is often referred to as an expert system shell. The following rule is an example of how knowledge is represented in CLIPS:

```
(defrule IDDM
(Patient (name ?first ?last)(age ?age)) (test (< ?age 30))
(BPressure Hypotension) (Symptoms (ketonuria yes)) (exists
(or (Symptoms (coma yes)) (Symptoms(CrackedLips yes))
(Symptoms(Tachycardia yes)) (Symptoms (Confusion yes)
(Symptoms (polyuria yes) (polydipsia yes) (polyphygia yes)))))
=>
(assert (Type (type IDDM)))
(printout t ?first" "?last " Has Diabetes type 1" crlf))
```

C. Requirements and Input Output Specification

This Expert System can be implemented using the Java Expert System Shell (JESS) tool to perform its functions, facts and procedures. It is a rule based engine for the Java language platform which is a superset of CLIPS programming language. S/W and H/W requirement: - JESS 7.1 Tool (Java Expert System Shell), Compatible with starting from JDK 1.4 version, Windows XP Operating System.

D. System Evaluation

In a preliminary evolution of the expert system, a few classical test cases will be used to test the expert system and the result of the system will be accurate when compared with the result of the Physicians; furthermore, some patients having diabetes diseases can try this expert system, in order to evaluate it and they will surprise by the accuracy of the diagnosis and treatment of the diabetes diseases.

VI. ACKNOWLEDGMENT

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VII. CONCLUSION

In this paper, we have presented a medical expert system for diseases caused by diabetes. Even though, our expert system is similar to some previously implemented experts systems; but we managed to overcome the limitations they had. We have concentrated on three glands: Pancreas with diabetes disease, Thyroid with hyper and hypothyroidism diseases and parathyroid with hyper and hyperparathyroidism diseases. For implementation, we are using Java Expert System Shell (JESS) to perform its functions, facts and procedures. The JESS is a rule based engine for the Java language platform which is a superset of CLIPS programming language. The system can be improved to include more glands and to add more diseases to the system. JAVA is a complicated but worthwhile method of solution and with experience, over time can provide many excellent possibilities for designs. The decision to include the JESS framework to provide knowledge-based support will prove to be a sound solution. This method of integration, coupled with the simplistic nature of cognitive execution or reasoning demonstrates that the effort required to build the EXPERT SYSTEM is proportionate to the level of support the system offers many times over

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