Expert System for Diagnosis and Management of Kidney Diseases

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Abstract *- Kidney disease (KD) represents a major public health problem in developed and developing countries. Attempts at dealing with renal diseases have been worrisome. This study describes an Expert System for Diagnosis and Management of Kidney Diseases. The structure of the system, its components and their functions are described. The system has about 76 rules. It can detect various types of Renal Diseases. The system has been tested and gave promising results. Symptoms and risk factors associated with renal failure are taken as the basis of this study. The building tool for the system is CLIPS expert system version 6.3.*

Keywords: *Expert System, Kidney, Renal, Diagnosis, Clips*

1.0 INTRODUCTION

Kidney disease (KD) is a long term condition caused by damage to both kidneys. There is no single cause and the damage is usually irreversible and can lead to ill health. In some cases dialysis or transplantation may become necessary. It is only relatively recently that the epidemiology of KD has been studied in detail findings shows that KD more common than previously thought. The average prevalence has been reported at 11% in USA and Europe (excluding those on dialysis or with a functioning transplant). Kidney disease is seen more frequently in older people and therefore is likely to increase in the population as a majority of people with KD are at higher risk of cardiovascular disease and hence the need for early test and diagnosis so that appropriate preventative measures can be taken. In the early stages of KD people may be unaware that they have any illness and a blood or urine test may be the only source of discover of KD. Establishing which conditions predispose to KD identifies those who should have the necessary blood or urine tests. Early detection of KD can establish if kidney disease is likely to be progressive allowing appropriate treatment to slow progression.

Kidney disease (KD) represents a major public health problem in developed and developing countries. It is estimated that approximately 5% of the adult U.S. population is affected by KD, which is defined as serum creatinine concentrations greater than 1.2 to 1.5mg/dl. The European Kidney Health Alliance (EKHA) reports that approximately 10% of European citizens are affected by some degree of KD. KD patients are at increased risk of cardiovascular disease (CVD), which includes coronary heart disease (HD), cerebrovascular disease, peripheral vascular disease and other heart failure related diseases [1]. Renal or Kidney Failure is a world-wide health problem. Statistics reveal that about 14 people per 1000 population suffer from renal failure in India, and with the incidence of Diabetes and Hypertension, the two most common causes of renal failure [2], while the situation in developing nations are pathetic. In view of the foregoing, the need for an expert system for diagnosis and management of kidney diseases becomes imperative. The aim of this study is to design and implement an expert system for diagnosis and management of renal diseases, which should:

a. know and identify the various causes of renal or kidney failure.
b. enhance early diagnosis and treatment of kidney diseases.
c. serve as a temporary assistance to those who are in need of instant help when expert consultant is not readily available due to time and distance.

This paper is organized as follows; Section 2: Related Literatures. Section 3: Description of the developed System. Section 4: Analysis. Section 5: Conclusion and Recommendation. Section 6: Future work.

2.0 RELATED LITERATURE

Expert System is described as a branch of artificial intelligence, which studies the field of developing and implementing computer programs that can act and work on the lines of human brain which can acquire knowledge and develop intelligence of its own to act accordingly in situations that may be entirely or partially new to it. It is a kind of intelligent computer program, that uses a knowledge base and inference engine to solve the problems solved only by experts, we can infer from this definition that expertise can be transferred from a

human to a computer and then stored in the computer in a suitable form that users can call upon the computer for specific advice as needed. Then the system can make inferences and arrive at a specific conclusion to give advices and explains, if necessary, the logic behind the advice [3].

ES provide powerful and flexible means for obtaining solutions to a variety of problems that often cannot be dealt with by other, more traditional and orthodox methods [4]. The terms expert system and knowledge-based system (KBS) are often used synonymously, the four main components of KBS are: a knowledge base, an inference engine, a knowledge engineering tool, and a specific user interface. Some of KBS important applications include the following: medical treatment, engineering failure analysis, decision support, knowledge representation, climate forecasting, decision making and learning, and chemical process controlling [5].

Expert system can be developed for many kinds of applications involving diagnosis, prediction, consultation, information retrieval control, planning, interpretation and instruction [6].

An expert system to assist in the operation of competence management in educational institution was presented in [7]. The knowledge based consists of a rule-based expert system for the competence management and subsequent performance assessment. It is generally recognized that an expert system can cope with many of the common problems relative with the operation and control of the competence management process.

The design of an expert system for decision support system for transport demand management: object oriented approach using Kappa Pc 2.4 expert system shells was described [8]. As traffic grows around the world, congestion becomes more widespread and occurs significantly longer during weekdays. As such congestion and traffic-related pollution are increasingly becoming major issues in towns and cities world-wide. In view of the fact that supply strategies alone could not solve urban congestion, many cities around the globe have adopted Transport Demand Management (TDM) strategies as part and partial of their congestion mitigation plan..

Expert System Approach for Soil Structure Interaction and Land Use was developed in [9]. The application of expert systems has emerged as a cost efficient tool in civil engineering over the past decades The aim of this research is to investigate the effects of Soil Structure Interaction SSI on structural response using structural and ground motion data from 58 sites with neural network NN approaches. Five models are analyzed in this research.

A web-based expert system for diagnosis and management of kidney disease was presented in [10]. Along with the explosive increase of information services using World Wide Web (WWW), the practical application of web-based expert system has shown tremendous growth. One of the most important branches of Artificial Intelligence is the expert systems. Expert systems are application oriented. An expert system is a computer application that solves complicated problems that would otherwise require extensive human expertise

The aim of the study is to design and implement a web based expert system for diagnosis and management of kidney diseases. For the development of expert system, free e2gLite expert system building tool (shell) implemented as a Java applet was applied which is equipped with an inference mechanism and a knowledge base, and the web interface was developed with the use of HTML. The system asks questions of the user to elicit the information needed in order to recommend or give final result based on the user input and uses IF-THEN rules to represent knowledge. The system has been tested with domain dataset, and results given by the system have been validated with domain experts [10].

An expert system for diagnosing poultry diseases was presented in [11], which could also be used both by the farmer and the experts to train their students. This Poultry constitute by far the largest group of livestock which are estimated to number about 14000 million, they mainly consisting of chickens, ducks and turkeys throughout the developing world, many living in rural areas keep small flocks of scavenging poultry. These birds are usually chickens and have an important role to play in poverty alleviation and food security. The flocks are small but important – providing meat and eggs for family consumption, for sale to provide additional income, or for social obligations. Rural poultry also provide manure and are active in control. But for long time, poultry diseases have been one of the main problems to influent our poultry industry development; have become the bottleneck limiting the development of our poultry industry. Knowledge elicitation is the process of collecting data from consultations with domain experts which are the most important individuals in an expert's system design process. In this work, knowledge is acquired by consulting experts in poultry farming. This involves constant interaction with the expert and extraction of relevant information including the signs, symptoms, diseases, pests, economic importance and control measures [11].

In the study, knowledge based system for poultry disease diagnosis has been designed and presented.

The usefulness of an expert system in diagnosing poultry disease is really required in the field of poultry and all other aspect of life. The study will actually assist poultry farmers and as well enhance foreign exchange earnings for the country of adoption. Furthermore, adding feature system besides diagnoses of pest and disease could make expert system complete and more powerful [11].

3.0 DESCRIPTION OF THE DEVELOPED SYSTEM

Expert System for Renal Failure Diagnosis is a rule based medical system for the diagnosis of renal failures using CLIPS as the programming language. Forward chaining inference mechanism (This method involves checking the condition part of a rule to determine whether it is true or false. If the condition is true, then the action part of the rule is also true. This procedure continues until a solution is found or a dead end is reached. Forward chaining is commonly referred to as data-driven reasoning) are employed for the development of this expert system. Features of CLIPS are presented in [12] and [13].

This is a menu based interactive system where systems communicate with user in common understandable language. The system consists of multiple options to Diagnosis, Management, viewing various symptoms and terms and overview information about renal diseases. As the system uses plane English Language to interact with user no special knowledge required for individual to use. In the Diagnosis option, based on the individual's answer the system concludes the level of renal diseases impact in the person.

The system gives some details of each symptoms to the user during the diagnosis process thus helps the user to learn by doing. Normally the doctor won't get time to explain the reasoning to each patient, but the expert system gives the explanation about the cause of the disease. So the user will get knowledge about the symptoms ~~so~~ and with this they can control the disease themselves. The renal symptoms are categorized into risk from individual's life style, risk from family history, classic symptoms, complicated symptoms and other symptoms. The symptoms are stored in facts list. Different rules exist for different symptoms. The system consists of 76 rules. It provides a simple, interactive, text oriented, command prompt, menu based interface. It stores all the rules as a batch file. So the series of rules can automatically read or run directly from the batch file. So the series of rules can automatically read or run directly from a batch file as a result of a batch command. That is whenever the user click the batch file icon, the CLIPS file with rules will start automatically. The expert system is not a substitute for physician; expert system will provide a generic conclusion based on user input. The application identifies the renal risk in individual and recommends treatment but cannot perform dialysis or renal transplanting. The Structure of Kidney failure diagnostic System is presented in Figure 1.

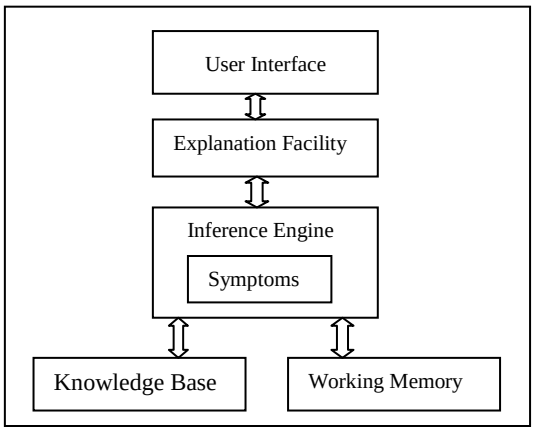

Fig. 1: Structure of Kidney failure diagnostic System

Knowledge acquisition; Basic information about the renal diseases, risk factors, symptoms and treatment were collected from Kidney Consultants (experts) and patients in Ladoke Akintola Teaching Hospital, Osogbo, Nigeria. Information was also collected from Books, websites and journals.

Data Collection; Medical field data collection was done through direct interview with patients, their past history, their physical examination records, laboratory test results etc. For the purpose of this system various journals, textbooks and different symptoms and treatment are gathered from Human Expert (Renal Consultants) in the field. Table 1 shows some of the collected symptoms.

Tool selection; The expert system developed using CLIPS languages version 6.3 in windows platform. CLIPS are a specially designed tool for expert systems. CLIPS expert system may be executed in three ways: interactively using a simple, text oriented, command prompt interface; interactively using a window/menu/mouse interface on certain machines, or as embedded expert system in which the user provides a main program and control execution of the expert system.

TABLE 1: SOME SELECTED SYMPTOMS OF RENAL DISEASES

Classic Symptoms	
Urine Microscopy Unremarkable	(yes/no)
The Urine Contain Tubular Cells and Casts, or Granular and Red Cell Cast	(yes/no)
The Disease Contain Red White Cells, granular and Tubular Cast	(yes/no)
The Specific Gravity of the Urine above 1015	(yes/no)
The Urine Sodium Less than 20mEq/liter	(yes/no)
The Urine Sodium Greater than 40mEq/liter	(yes/no)
Progressive Rise in the Serum Urea and Crea	(yes/no)
Hyperkalaemia,with Characteristic ECG changes	(yes/no)
Are there Metabolic Acidosis	(yes/no)
Are there hyponatraemia (from salt and water overload)	(yes/no)
Fatigue, Lethargy, decreased mental acuity	(yes/no)
Bruising and epistaxis, bleeding gums, Heamatemesis and melaena	(yes/no)
Anaemia which is usually normocytic and normochromic	(yes/no)
Muscle Cramps	(yes/no)
Hypertension which together with anaemia	(yes/no)
Hyperventilation, because of metabolic acidosis	(yes/no)
Elevated Serum Creatinine and urea	(yes/no)
Normocytic, normochromic anaemia	(yes/no)
Metabolic acidosis	(yes/no)
Normal or Reduced Serum Sodium	(yes/no)
Fixed Urine Volume	(yes/no)
Left venticular hypertrophy on the ECG and echocardiography	(yes/no)
Small Kidneys on Plain X-ray of the abdomen and on abdominal Ultrasound	(yes/no)
The Fractional Excretion of Sodium less than 1% and Renal Failure Index Less Than 1	(yes/no)

Knowledge representation; The collected knowledge was converted into CLIPS knowledge base syntax. That is; facts and rules. Currently the expert system consists of 76 rules. There is a brief description of the cause of each symptom. So the expert system can assist the user by giving information about the symptom or the cause of the renal disease.

4.0 ANALYSIS

In the system, the rules involve personal life style, family back ground, normal kidney symptoms and other complications. Among these 67 rules are kidney symptoms, 4 rules representing main menu, 1 rule for viewing symptoms and terms, and 1 rule for general overview of information about kidney diseases.

The last 3 rules are diagnosis rules. It is decided that system will be using a score based approach to identify whether the individual has kidney problem or not. Depending on the importance of the rules, the weight of the score will be varying. The score levels to conclude the chance for different level of kidney problems are decided after discussion with medical expert. The system can give reasoning for the symptoms like what is the cause of the symptoms and gives possible treatment. Examples of rules used in the design are presented in Table 2.

TABLE 2: RULES FOR THE SYSTEM

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If selection is "RENAL DISEASES DIAGNOSIS"
        (THEN start diagnose)
        (Suggest either Acute or chronic renal failure)
        (Display possible treatment)
       (if (eq ?option 1)
THEN
    Start diagnose (Acute or Chronic Failure with treatment)
Rule 1:   If selection is 2 "RENAL INFORMATION"
        (View Information about renal failure)
      Then (if (eq ?option 2)
THEN
     View General Overview about Renal Failure
Rule2: If selection is 3 "VIEW SYMPTOMS AND TERMS"
        (VIEW VARIOUS SYMPTOMS, MEDICAL
        TERMS & MEANING)
        (if (eq ?option 3)
THEN
    View Terms and Symptoms about Renal Failure
Rule 3: If selection is 0 then the program terminate
        (to exit the program)
THEN
GO TO MAIN MENU
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The initial rule to be executed should be main menu that display below screen. As illustrated in Figure 2

Fig. 2: Menu of an Expert System for Kidney Diagnosis

A. Validation of User Choice

If selection is 1, then renal diseases will be diagnosed.
If the user choice is 1 the system will start diagnosing based on the user input, the system will ask some question based on the possible symptoms which the user supplies answer based on (yes/no) as shown in Table 2. Then after the diagnosis, the system indicates either the patient is suffering of Acute or Chronic renal diseases and gives possible treatment. If the system is unable to diagnose based on the input supply by the user it will prompt for Human Expert to Dialysis or Kidney Transplant. As shown in Figure 3.

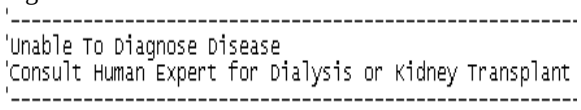

Fig. 3: Unable to Diagnose

B. System Implementation

This system is implementable in places like Teaching Hospitals, Universities clinics and other institutional clinics or medical centres. The environment requires DOS/Windows environment and installation of CLIPS Win.exe version 6.3. So people can freely check their renal diseases risk and also learn what are the different symptoms and their causes.

C. System Evaluation and Testing

To evaluate this system, a few classical test cases were made and the result of the system was accurate when compared with the result of the Human Expert. During the test phase of system it never gave wrong diagnosis according to the rules used. The system indicated that a full expert system has been developed and can be extremely useful in providing consistent Kidney failure detection.

5.0 CONCLUSION AND RECOMMENDATION

The develop system is a medical expert system for diagnosing kidney diseases. The system is a generic tool for renal failure and can be used by all type of people because the symptoms of different types of renal failure are almost similar. It is a rule based systems that supports forward chaining inference. Using this system user can enter the symptoms, the system will find out how much severe and give suggestions for leading a healthy living. It provides a very fast and accurate diagnosis and if they have high chance of having kidney failure, it gives recommendation to meet a physician or Human Expert in the field. It acts guide and gives an overall knowledge about the kidney diseases. Also it helps people to understand about the complications if they want. Although this system gives recommendations, the researchers also wish to advice and recommend to people as preventive measures for KD that: People should avoid self-medication which is not prescribed by satisfied medical doctor/physician. People should cultivate the habit of doing excise and taking at least three litres of water are recommended to be taking every day. Visit your physician for regular medical check –up.

6.0 FUTURE WORK

This expert system can be considered as the base of future work. It can be extended by other researchers; it has a very good knowledge about renal diseases. The system can still be upgraded by adding more to the knowledge base consequent on advancement in technology. It can be made accessible to more people as a web based application. Moreover, it can integrate with language like Java using JESS, a rule engine that is the superset of CLIPS languages.

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