Presenting a Medical Expert System for Diagnosis and Treatment of Nephrolithiasis

Mirpouya Mirmozaffari*

Abstract—Expert systems aim to employ expert skills for non-expert person. These designs simulate intellectual and practical performance of human making the performance of expert systems close to that of an expert human. Various expert systems have been proposed in medicine, thus this area is attracting attention. Most problems in modern medicine are very complicated and there is no logic reason for accurate decision making. To this end, doctors decide arbitrarily and variably. On the other hand, large volume of medical information makes decision making more difficult while modern technologies add to volume of information and make problems more difficult. Considering these problems, there is a great challenge in medical diagnosis which requires decision-making support systems. In this paper, an expert system is presented for diagnosis and treatment of nephrolithiasis in which knowledge required for diagnosis and treatment is stored as rules in the system knowledge base. If experts are absent, diagnosis and treatment can be done reliably. Expert systems can be used as decision support by the users. However, currently, they cannot replace experts.

Index Terms—Expert systems, medical decision-making support systems, nephrolithiasis

I. INTRODUCTION

Most problems in modern medicine are very complicated and there are no compelling reasons for accurate decision-makings. Doctors usually decide arbitrarily and variably. On the other hand, volume of medical information related to a small diagnostic part is so large that fast and accurate decision-making is difficult and complex. In addition, modern technologies increase volume of this information and make the problems even more complicated. In fact, doctors have never faces such volume of information. Furthermore, people require specific decisions, because their features are different from what is mentioned in medical references and each one has its own unique requirements. Considering the mentioned problems, it can be easily understood that there is a great challenge in medical diagnosis which requires decision support systems.

Decision support systems in medicine are referred to computer software which are built to aid clinical diagnosis. These systems employ medical information and knowledge to diagnose various diseases and offer medical suggestions to the patients. In fact, they have not been designed to replace doctors but they aim to aid medical experts to diagnose diseases based on a series of empirical rules.

II. LITERATURE REVIEW

History of medical decision support systems is real history of mutual cooperation among doctors and mathematicians. As electronic computers emerged in 1950 to 1960, first medical decision support systems were innovated with different healthcare purposes. It was announced that doctors are not usually aware how to solve diagnostic problems. It was also claimed that in order to model diagnosis process, both logic rules (sets theory and Boolean algebra) and inference calculations (Bayes rules) are required. In 1961, Warner et.al designed one of the first medical decision support systems based on Bayes rules. Indeed, the first system, was a system designed by de Dombal to diagnose acute abdominal pain and it was employed in many healthcare centers. In 1965, DENDRAL was presented to describe molecular structure. In 1976, MYCIN was presented to diagnose vascular diseases. PUFF was also proposed to diagnose pulmonary diseases. XBONE was also designed to diagnose bone diseases. VM was designed to monitor patients requiring intensive care. CADCUCUEUS was also presented to diagnose internal diseases, BLUE BOX was proposed to diagnose and treat depression and expert systems for diagnosing acid material and electrolytes, anesthetic management education and diagnosing internal diseases are all among such systems [1].

Fuzzy and expert systems technologies provide a number of advantages to the science and engineering fields. Fuzzy systems store knowledge of experts in a form of rules or mathematical expressions that is easy to visualize, enter into the system, and modify. Also, membership functions and parameters are incorporated so that they allow the system to achieve a good performance [2]. Several methods have been proposed in the literature to improve the performance of fuzzy logic systems [3-5]. In [6], the fuzzy system has been used for developing a control scheme for hydropower generators in water distribution systems. This method was successfully able to control the operation of the generator for obtaining the maximum efficiency. In expert systems, logical operations are implemented in a form that is relatively easy to comprehend. In [7], the authors propose an expert system using an intelligent softbots and prepare a portfolio of IS that has the maximum alignment with the strategy plan. In [8], the author developed an expert system using the VP-Expert shell for identifying liver illnesses. Assessing other fatal disease such as heart disease plays a significant role as well. In so doing, Data Envelopment Analysis (DEA) offers a relative efficiency for each Decision Making Units (DMU) with several inputs and outputs [9]. Despite of healthcare Fuzzy

*Corresponding Author:
PhD student, Gianforte School of Computing, Montana State University, Bozeman, Montana, USA. (m.mirmozaffari@gmail.com)
DOI: http://dx.doi.org/10.24018/ejmed.2019.1.1.20
expert system and data mining play an important roles in other fields of study such as using decision tree for eco-
efficiency evaluation [10]. This paper is to presents an expert 
system for diagnosing and treating nephrolithiasis. In the 
following, the problem is described and then kidney stone is 
explained. Finally, a practical example is used to describe 
performance of a designed system. An expert medical system 
is a computer program. If they are implemented correctly, 
they help in efficient diagnosis of diseases and their 
treatment. Diagnosis and predicting side effects are 
performed after reception of patient information. This 
information is usually exchanged between patient and the 
doctor. Medical expert systems have features which 
discriminate them from other medical software. One of such 
differences is that systems mimic inferences of a doctor step-
by-step to make correct results. In most cases, a system expert 
is aware of sequential inferences. It is clear that these expert 
systems require a large number of rules and medical facts to 
offer accurate results.

This paper aim to employ a software to achieve all 
advantages of an expert system to diagnose and treat 
nephrolithiasis.

III. SPECIAL TERMS

A. Kidney

Kidneys are organs of the body which their function is 
essential for life. Most people are born with two kidneys in 
the middle of the lumbar where each one is at one side of the 
vertebral column. Kidneys are related to urine. As urine is 
produces, kidneys excrete additional water and salt. Kidneys 
are chemical masters of the body and perform various 
functions described in the following.

B. Body Liquids

Kidneys excrete and preserve body liquids. If someone 
consumed a large amount of salt in his/her diet, kidneys 
excrete additional water and salt while if kidneys 
malfunction, occlusion of additional water and salt result in 
edema of tissues and limbs like hands, feet and around eyes.

C. Excretion of Chemical Material of the Body

Kidneys preserve required chemical materials of the 
body. Potassium is one of the materials required for muscular 
actions. If kidneys do not operate correctly, amount of 
potassium becomes unbalances resulting in muscular 
weakness.

D. Excretion of Additional Material from Body

Additional material in the body is created through 
breakage of food protein and usual muscular activities. 
Kidneys excrete such material which is known as urea. 
Inefficiency of kidneys in excretion of this material results in 
uremia.

E. Hormone Secretion

Hormones are combinations secreted by glands so that 
another organ is activated to perform a specific action. These 
hormones help controlling blood pressure; if kidney 
dysfunctions, blood pressure oscillates due to defective 
secretion of these hormones.

F. Nephrolithiasis

One of the main factors resulting in kidney dysfunction is 
nephrolithiasis. Calcium and uric acid are the main types of 
kidney stones. Calcium oxalate and calcium phosphate comprise about 75% 
to 85% of all kidney stones. Since stone grows on the surface 
of carbuncles or urine collecting pipes of kidneys and create 
no symptoms. However, in many cases abdominal 
radiographies performed on the abdomen for other reasons 
are discovered. 

But what is important in prevention before treatment? 
There are many factors which cause nephrolithiasis among 
which excess consumption of animal protein, drinking 
grapefruit juice, lemon juice, salt, obesity, and sedentary life 
can be mentioned. There are other factors like genetic factors 
which cause nephrolithiasis.

Knowing the factors which result in nephrolithiasis, it can 
be treated depending on the type of stone. Fortunately, most 
stones are excreted without surgery but many of them are not 
excreted on their own and require pharmacotherapy. About 
90% of stones can be excreted through consumption of 
liquids.

Surgery is required when stones:

1. Are large or growing.
2. They are not excreted after the expected time.
3. Pain is permanent and stable.
4. Stone prevents urine excretion.
5. There exists urine infection.
6. Kidney tissue is destructed.

Finally, if it results in kidney fluctuations, kidney should 
dialyzed and if it does not get better, kidney transplant is 
the last solution.

IV. METHODOLOGY

In this paper, VP-EXPERT is used to design an expert 
system for medical decision support to diagnose diseases and 
offer treatment solutions to patients suffering from 
nephrolithiasis. Expert systems are used in medicine due to 
the following:

1. People expertise is temporary but computer expertise is 
   permanent.
2. Experts might be on their vacations which affects their 
   performance. But Computers are not affected by these 
   factors.
3. Local transmission of expertise is difficult but accessing 
   software sis easier.
4. Expertise is usually more expensive than software with the 
   same result.

And other advantages like high performance, high speed, 
reliability, flexibility, reducing dangers, stability and multiple 
expertise.

To access an expert system in order to treat 
nephrolithiasis, designing a knowledge base is necessary. 
There are three main sections in a knowledge base as follows:
In order to complete these sections, an expert nephrolithiasis program is required. Mockler diagram associated to nephrolithiasis diagnosis is shown in Fig 1.

---

**V. DESIGNING THE KNOWLEDGE BASE**

In order to design the knowledge base, first, ACTIONS section of the base and other section should be completed which are described in the following:

**A. Actions**

This section includes commands required for implementing the program. In this part, it is tried to explain the required variables to the user so that the user does not face problems while executing the programs. The program is commanded to find a specific variable to offer a treatment to the patient while execution.

**B. Rule**

This section is one of the most important sections of a knowledge base because it contains rules. As mentioned, treatment of nephrolithiasis at its first stages requires drinking liquids and exercising; then, if it is not treated, medicine should be taken along with drinking water and exercising. Final stage is to perform lithotripsy, surgery, dialysis, and kidney transplant. Facts and rules of the knowledge base are designed accordingly. Systems ask the user to diagnose disease symptoms and suggest required commands. Among disadvantages of expert systems, inability to detect validity of inputs by the user can be mentioned.

**C. Statement**

In this section, some questions are asked based on which rules and facts are investigated by the system and final result is given to the user. It can respond with respect to the options offered by the system.

---

**VI. INFERENCE MOTOR**

In systems based on rules, inference motor chooses a rule for test to see if its conditions are correct or no? These conditions might be investigated through asking the user or through facts obtained through interview. When conditions of a rule are correct, its result would be correct. So, this rule is activated and its result is added to the knowledge base. Since VP-EXPERT is used in this system and it does not require inference motor, designing the expert system would be easy. User interface of an expert system should have high exchange capacity so that information exchanged is done as conversation of a requestor and an expert. These steps are described using an example.

---

**VII. IMPLEMENTATION**

Consider a person who suddenly sees edema in his/her feet or hands, or lose his/her blood pressure balance and he/she is diagnosed with nephrolithiasis. This person aims to diagnose his/her disease and find a way to treat it using an expert system. After diagnosing the disease, system offers a treatment solution depending on condition of the patient. In order to understand how the system offers a treatment solution, program implementation is suggested.

---

**VIII. CONCLUSION**

In this paper, an expert system is presented to diagnose and treat nephrolithiasis. Primary precaution clinicians need to be attentive to the probability of nephrolithiasis and its consequences to decide upon a diagnostic method. In so doing, objectives of the expert system were defined first. Then, previous studied were reviewed and expert system environment was described. In the next step, the system of interest is analyzed. Finally, the expert system which can support medical decisions is executed. It should be noted that systems should be presented which can simulate behavior of experts which is not always possible.

---

**REFERENCES**


