An Expert System for Diagnosis of Ear Problems in Children

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Abstract: The study aims to apply one of the artificial intelligence technical called expert systems to develop a medical expert system for the diagnosis of ear problems in children. The expert system described in this paper is able to detect and gives a diagnosis of eleven types of ear problems as well as proper advice for treatment of ear problems in children. The knowledge of the proposed system is collected from two different sources. The first primary source is the medical knowledge of expert doctors. The second source is from specialized databases, books and electronic medical websites. Visual Basic. Net language is used as a tool for designing the proposed system. The proposed system has been tested and evaluated successfully and positive feedback was achieved. In conclusion, it hopes that, it could have contributed to the construction of a medical expert system that meets the demands of all the beneficiaries.

Keywords: Expert systems; ear problems; medical diagnosis; knowledge based system.

1. INTRODUCTION

An expert system is a system that uses human knowledge in a computer to solve problems that ordinarily require human intelligence [5][4]. An expert system also can be defined as "an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solutions [20]". However, the basic concept of an expert system is that the user supplies facts or other information into the expert system and receives expert advice or expertise in response.

The rest of this paper is organized to offer an overview of the basic background of the study which is focused on medical expert systems and describes in detail a new diagnostic system. For this purpose, section 2 includes explanation of expert systems in medical diagnosis. Section 2.1 introduces a brief explanation of background of expert systems in medical diagnosis. Section 3 includes a brief explanation of medical knowledge about the ear. Section 4 describes in detail a new diagnostic system. Section 5 result. Section 6 conclusion.

2. EXPERT SYSTEMS IN MEDICAL DIAGNOSIS

Medical diagnosis is a process that requires skilled and qualified physicians. The purpose of a medical expert system is to support the diagnostic process of physicians [11].

There are several advantages of adopting medical diagnosis system using an expert system. The major advantages are: they give the prescription as the doctor. Also, they are always available, which means, they can be used anytime and anywhere. Furthermore, they can work as a human expert (when hospitals are facing the problem of general expert they can work as a human expert). Another advantage is that it reduces cost that is because the cost of providing expertise per user is greatly lowered. On the other hand, there are some disadvantages of

Adapting them such as they cannot examine a patient instead. Another disadvantage with expert systems is that their expertise are limited to the knowledge domain that the system knows about, typical expert systems cannot generalize their knowledge by using an analogy to reason about new situations the way people can [2].

There are several types of problems that can be solved using expert systems in different diverse areas, and they include science, engineering, business, and medical [17][24]. However, medical diagnosis was one of the first knowledge areas to which an expert system technology was applied [2]. There are several diverse areas in the medical field where expert system used successfully such as diagnostic processes, patient monitoring, treatment of illness, determination of drug dose [17], laboratory analysis, and teaching of medical students. However, in remote areas where doctors are not available when required, less qualified health care person may have to do the job. A medical diagnostic expert system will be an invaluable tool in such situations [20].

2.1 Background/ literature review

More recently, there are several expert systems available and used in the medical field, some of them are small, but nevertheless make positive contributions to health care [24]. The most successful examples of medical expert systems are:

One of the most famous expert systems in medical is the EMYCIN. It is an expert system shell with a backward reasoning inference engine; it was developed by Feigenbaum, Buchanan and Ted Shortliffe at Stanford in 1980. This domain-independent framework was used to build diagnostic rule-based expert systems, a system designed to interpret pulmonary function tests for patients with lung disease[17][27].

CADUCEUS was a medical expert system first begun in the 1970s and finished in the mid-1980s by Harry People

at the University of Pittsburgh. The motivation to develop it was intent to improve on MYCIN, and it took a long time to build the knowledge base. CADUCEUS eventually could diagnose up to one thousand different diseases [13].

MEDICO is a rule-base system which gives the advice to ophthalmologists about the management of chorioretinal diseases. It contains general clinical knowledge and a large database of facts about previous patients and events [11][13].

PUFF is backward reasoning and rule base system developed at Stanford University. It was probably the first artificial intelligence system to have been used in clinical practice and it was developed for the interpretation of pulmonary function tests for patients with lung disease [11][13].

ONCOCIN is a rule-based medical expert system developed at Stanford University for oncology protocol management. It was designed to assist physicians in the treatment of cancer patients receiving chemotherapy [13][27].

AAPHelp: de Dombal's system is an early attempt to implement automated reasoning under uncertainty. It developed at Leeds University in 1972, was designed to support the diagnosis of acute abdominal pain and, based on analysis, the need for surgery [12].

ESMDA is a knowledge management expert system for diagnosis as well as for proper advice for treatment for six diseases Cold, Flu, Cough, Fever, Ear and Eye problems [21].

Based on the above literature, there is a lack to develop an expert system for diagnosis of ear problems. Thus, the primary goal of this research is to develop an expert system for diagnosis of ear problems in children (ESDEPC). The scope of this expert system is the following ear problems: Otitis Externa (Swimmer's Ear), Acute Otitis Media, Chronic Otitis Media, Inner Ear Infections, Ruptured Eardrum, Ear Barotrauma, Trauma, Ear Foreign Body, Dental Related Ear Pain, Glue Ear, and Earaches from Throat infections and Colds. This system could assist doctors and health professionals to determine the proper diagnosis to patient.

3. MEDICAL KNOWLEDGE ABOUT THE EAR

The ear is divided into three main parts: the outer ear, the middle ear, and the inner ear. Hearing and balance is the main function of the ear. Ear problems are mainly due to the ear infection that can be in the middle, inner or outer ear. It can occur in single ear or both. The pain can be mild, moderate or severe, depending on the infection [23]. Ear infections are most common in children; children get them more often than adults. Five out of six children will have at least one ear infection by their third birthday. 40% of children have had more than 3 episodes before the age of 6 years. The study estimated that over 24.5 million episodes of otitis media occur per year in the United States and $3 to $5 billion per year are the associated medical [6]. It is important to treat an ear infection correctly since this ailment can contribute to temporary hearing loss or

other problems. Below is a brief explanation of ear problems in children that the proposed expert system was covered:

Otitis Externa, sometimes this infection is called swimmer's ear. The symptoms are almost always in one ear only. Symptoms can be a gradual build-up of pain and itchiness when you pull on your ear or earlobe; the outer ear may be noticeably red and swollen [1].

Another more common ear pain in children is Acute Otitis Media. It usually follows a viral upper respiratory tract infection, such as a cold or flu. Common symptoms of acute otitis media are fever, pain, and irritability. Other symptoms can include difficulty sleeping, tugging on the ear and loss of or decreased hearing [8].

Chronic Otitis Media refers to a long-lasting ear infection. This is often caused by a hole in the eardrum. Common symptoms of it include, ear pain, fever, drainage of pus/ blood from the ear, hearing loss and lack of balance [16].

Inner Ear Infections are known as labyrinthitis, a major symptom of inner ear infection is dizziness or vertigo, which can lead to nausea and vomiting. Children may also experience a lack of balance and involuntary eye movement due to the effect on the nerves [7].

Ruptured Eardrum means there is a small hole in your eardrum, or tympanic membrane. In rare cases, the condition can cause permanent hearing loss. Pain is the main symptom of eardrum rupture. In addition, fluids that are watery, bloody, or filled with pus may drain from the affected ear, temporary hearing loss and a ringing or buzzing in the ears [3].

Ear Barotrauma, also called airplane ear, which is caused by changes in altitude and air pressure. There are many causes of ear barotrauma; it includes scuba diving, after an airplane flight, and driving through mountains. It is common in children; the study reflects that the signs of ear barotrauma are present in 10% of adults and 22% of children after an airplane flight. The common symptoms include ear pain, stuffiness of the ears and decreased hearing. Trauma, the patient has fever, redness and swelling of the outer ear and the surrounding skin. The most common injury is laceration of the auricle [25].

Ear Foreign Body: Foreign objects in the ear canal are a relatively common problem, especially in toddlers. A study by Svider et al indicated that children aged between 2-8 years being the most frequent patients. Pain is the most common symptom [22][26].

Dental related ear pain: Ear and tooth pain that occurs at the same time on the same side. It is usually felt in just one ear and is felt very deeply. It may travel down the neck, to the temple, or to the back of the head. Some of the symptoms may include: a pain in the ears, ear pressure or sense of fullness, ringing in the ears, dizziness, and excessive ear wax [28].

Glue ear; it occurs when the middle ear is filled with fluid instead of air. It is very common among children, one in five children around the age of two will be affected by it, and about 8 in every 10 children will have had glue ear at least once by the time they are 10 years old. The main symptom associated with glue ear is dulled hearing. Other

symptoms of it include: ear pain, hearing loss, irritability, and problems sleeping [19].

Earaches from Throat Infections and Colds: typically, a sore throat comes first and it is followed by an earache. The symptoms may include difficulty sleeping, fever, feeling difficulty while swallowing, and swollen glands and lymph nodes [14].

4. THE PROPOSED DIAGNOSTIC SYSTEM

The expert system developed in this work consists of three components: knowledge base, the inference engine and the user interface. It is designed to provide a suitable diagnosis of ear problems in children. For this, the proposed system performs many functions to conclude the suitable diagnosis. The structure of the expert system is shown in Fig. 1 and explained in detail below.
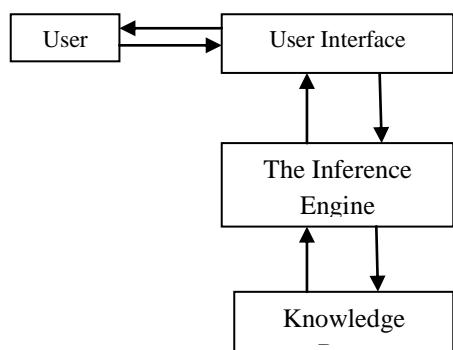

Fig. 1. ESDEPC system architecture.

4.1. The knowledge base

Knowledge is the most important ingredient in any expert system. The knowledge base is formed by means of a declarative representation of the expertise or information gathered from different sources. The knowledge base can be used as the mind of the expert system as all the necessary facts for constructing the rules are contained in the knowledge base [18]. The medical expert system uses knowledge about the diseases and facts about the patients to suggest the diagnosis. Thus, the medical knowledge of specialized doctor is essential and required for the development of an expert system. The background knowledge in this work is collected in two main sources. The first primary source is the medical knowledge of the expert doctors ear, nurses and also the patients, and it is recorded through the creation of personal interview with them. The second source is from relevant medical books/documents and electronic medical websites.
The information collected in this work was analyzed and classified according to their characteristic of the symptoms of each disease. It was back to doctors and experts to confirm them, enabling the system to diagnose the type of extreme precision and aiding in the description of the treatment required. Then turned into rules for easy programming into the computer.

4.2. The inference engine

The inference engine is the portion of the system architecture that direct the system to choose the appropriate rule based on the information produced by the user [10]. The background information of ear problems is analyzed and classified according to the main symptom that distinguishes each problem. The proposed system ESDEPC is a rule-based medical expert system. Knowledge is represented in the form of rules, using a rule base approach IF, IF THEN ELSE. The proposed system ESDEPC works in two major mechanisms for the confirmation of the disease and to determine which rules are selected to be fired. The first mechanism is forward reasoning, and it means getting a result based on the known facts (such as symptoms). The second mechanism, which is the backward reasoning and it, involves getting information about the already known ear problem in order to aid treatment.

The system starts asking the user for his/her symptoms, and the user answers with a simple YES or NO. The system searches the inference rules, if the system is able to find the ear problem, it will provide the name of that particular problem with detailed information. Otherwise, if the system is not capable of identifying the disease on the basis of symptom such as there is a similarity in symptoms, the system will ask some symptoms to the user. After giving the feedback by the user the system examines knowledge in a sequence until it finds one that matches a desired goal. When found, it can conclude, and the system informs the user with proper diagnosis. Example 1 shows one of the production rules implemented in this system to determine one of the ear problems.

Example 1
RULE 7
IF
Does your child have a fever? NO
Does your child have thick pus-filled or bloody drainage from the ear canal that started after a sharp, sudden pain? NO
Is your child's ear swollen, and does it itch or hurt when he/she pulls on her/his ear or earlobe? NO
Does your child's jaw joint when he/she chew or open her/his mouth, or does your child feel tenderness in her/his jaw? NO
Does your child has cold or flu symptoms, and does your child's hear fluid in her/his ear, and feel pressure or stuffiness that cannot be cleared by coughing, yawning or swallowing? NO
Does your child has tooth pain on the same side as the ear pain when he/she bites down? NO
Did your child's ear pain start during an airplane flight or right after he/she traveled on an airplane? YES
THEN
Most probably your child has the Middle Ear Barotraumas.

Fig. 2 shows the diagnosis of previous rule as appears in the ESDEPC system.

Diagnosis screen
- - - -- - - -
Diagnosis:
The Middle Ear Barotraumas, also called Airplane Ear

Treatment:
Decongestants Nis Nasal drop
Advance:
If you experience the symptoms of barotraumas during a flight, there are several things you can do:
1- Chew gum or suck on hard candy.
2- yawning
3- using breathing exercises
4- taking antihistamines or decongestants
If you have mild ear pain or hearing difficulty that continues after flying, a medical exam is required to rule out an ear infection. You should consult your doctor for verification.
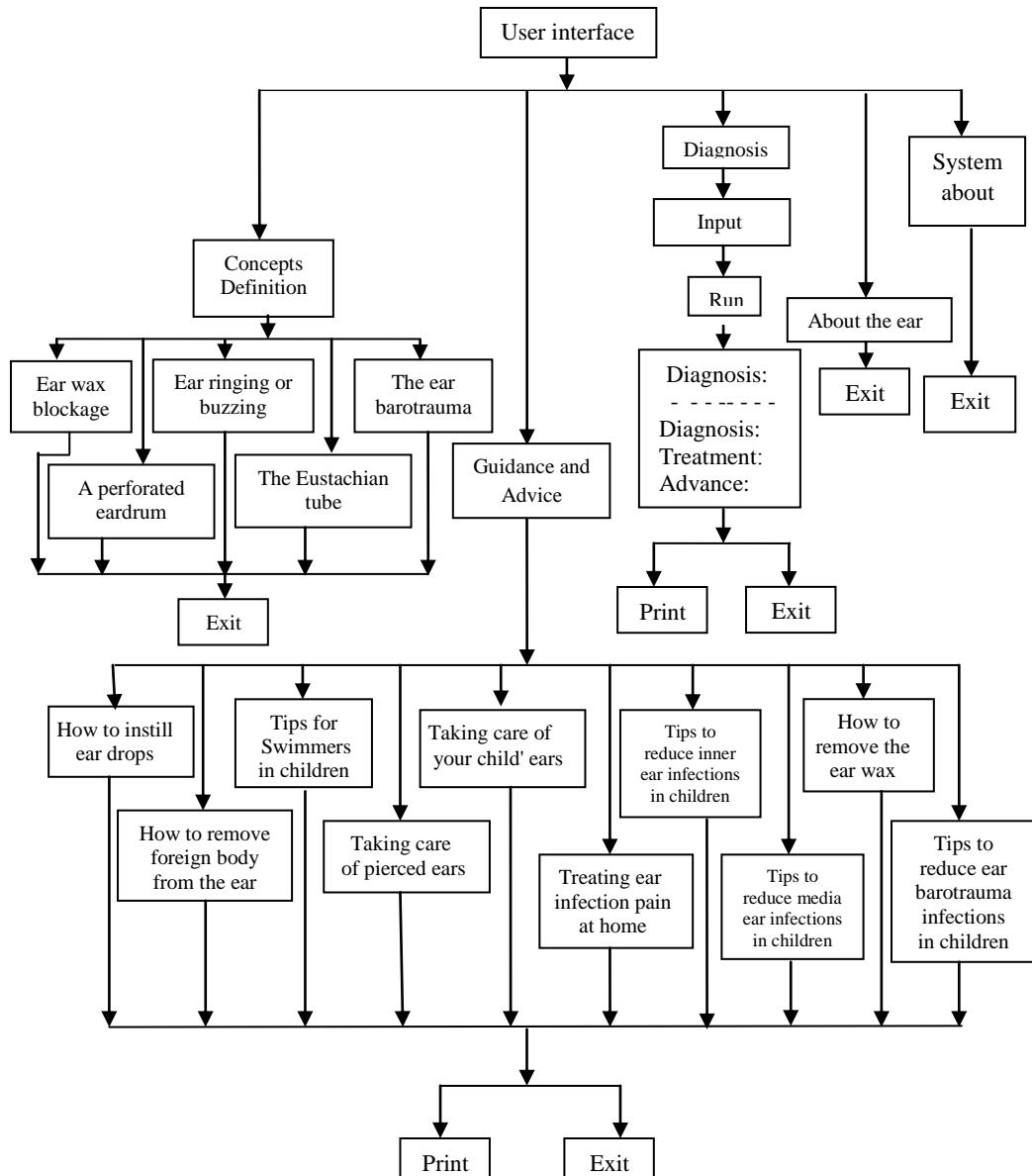Thank you for using our services

Fig. 2. Diagnosis screen of ESDEPC system.

4.3. The user interface

The user interface means the communication between the user and the system. The user interface is one of the essential components of an expert system; the acceptability of an expert system depends to a great extent on the quality of the user interface [10][15]. For this purpose, ESDEPC is carefully designed using Visual Basic. Net language. The user interface in this system includes five screens as shown in Fig. 3 and as described below:

(1) Diagnosis screen: This is the main screen where all major research work is focused. The system starts asking the patient for his/her symptoms, if the system is able to find ear problem then, it provides the name that particular problem on the basis of available cumulative information. Finally, user can look at the results, print a report of the findings, or go back to the diagnosis screen again.

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(2) Ear care advice screen: The main purpose of this screen is to provide expert advice about health care of ear if the person seeks advice from the system. In addition, some good habits for taking care of the ear are introduced in this screen.

(3)   Concepts screen: this screen gives an explanation for some medical concepts of the ear.

(4)   Screen of about the ear: this screen gives a full description about the ear.

(5)   Screen of system about: help and detail information about the correct use the system can be found in this screen.

5.   RESULT

The proposed system ESDEPC has been developed and tested successfully. An initial evaluation of the expert system was done by doctors and patients. A number of doctors and patients tested the system and gave us a positive feedback when the results obtained by proposed system are similar to that produced by the doctor.

6.   CONCLUSION

The article presented an expert system for diagnosing ear problems in children ESDEPC. This system was tested successfully and a better and faster diagnosis was achieved. The representation of the knowledge in a database provides an opportunity for other research for ear problems to be carried out in the future. As future work we will constitute the expert system to cover all ear problems in the children and adults as well.

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