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An Expert System for Pneumococcal Prognosis

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***Abstract*— Threats and viruses are particularly alarming for children with low immunization levels. Pneumococcal disease is the world's most important cause of child death and has claimed many lives. Since awareness of the dangers of Pneumococcal viruses among parents is low in Malaysia, preventive measures such as vaccine intake cannot be done comprehensively. Hence, in order to communicate information about Pneumococcal disease, a pneumococcal disease diagnosis system for children is developed. This system employs expert system method and apply forward chaining technique for its reasoning. Knowledge base of the system is stored in the database for data management. This alternative system allows access to information as well as early diagnosis of early symptoms can be detected. This system is expected to benefit users in terms of knowledge sharing, and self-checking on their body condition, especially parents, to prevent any possible diseases that may infect children's.**

***Keywords*—threats, viruses, pneumococcal prognosis, expert system.**

I. INTRODUCTION

Public awareness of pneumococcal disease is still low in some of the community groups. A group of members in this community do not have specific knowledge on the precautionary method, disease impact, and appropriate treatment of the disease. For residents in the rural area, the dissemination of information may not be well received although the ministries and bodies responsible have provided various relevant information. [1] - [4]. As a result, parents do not recognize and do not realize their child has it in the early stages of infection until it gets worse. In Malaysia, Pneumococcal disease is one of the main causes of preventable death among children <5 years [5]. In recent year, diseases of the respiratory system were the primary cause of hospitalizations of infectious-cause among the Ministry of Health (MoH) hospitals in Malaysia [3]. It is alarming because the disease can be controlled and avoided if detected early.

It is very costly to treat pneumococcal infections in critical stage which require high cost of intensive treatment from specialized doctor as well as cost of drugs [7] - [9]. Hence, follow-up treatment is necessary to provide full recovery for patients [10]. Therefore, patients who are burdened with treatment costs will choose an alternative method or do not receive intensive treatment. While information and knowledge on illness from the Ministry of Health and public health officials are disseminated among the community through campaigns and electronic media [11]. However, the understanding of the public society is difficult to be comprehensively achieved because of the different society levels. Healthcare professionals such as doctor need to play their role in promoting pneumococcal disease information while carry out regular task. Though, expert (doctor) knowledge can be distributed in different way apart from public speech, such as poster, social media, electronic commercial and leaflet. Without massive effort from healthcare professional by sharing and delivering this knowledge to community about of pneumococcal disease cannot be thorough [1].

In this project, an expert system method is optimized to design the knowledge base of pneumococcal disease and develop an expert system for diagnosing symptoms and pneumococcal disease among children. Implementation of expert system in this diagnosis system is based on forward chaining method. This system is able to identify the symptoms that lead to pneumococcal disease and determine the type of pneumococcal disease in children. This system contains a knowledge base which stores information about pneumococcal disease, decision rule, and prevention methods for information sharing. Hence this system is useful to assist parents to obtain information and to detect the early stages of the Pneumococcal Disease.

In this study, 3 types of common pneumococcal disease; *Pneumonia*, *Otitis Media* and *Meningitis* are selected. There are five main modules provides in this expert system which are the main module, diagnosis, treatment, administrator and report modules. This expert system offers to the user an opportunity to make a self-diagnose and get information

from medical expert. User also be able to communicate with experts for any inquiry about pneumococcal disease. Additionally, the knowledge base reside in the system is utmost important because it stores the expert knowledge to be used by system to generate the result based on user's input. Knowledge base should be validated by the expert to ensure the correctness of the information. This module should be handled carefully to assure its rightness.

This paper contains five sections. Section I describes background information of the study. Section II presents the methodology to complete the project. Expert System component is explained in Section III. While, Section IV presents the results and conclusion is provided in Section V.

II. METHODOLOGY

Knowledge engineering model [12] is employed to assist the development of pneumococcal expert system in this project. The model contains specific processes that coincided with the development of expert systems. Knowledge engineering method focused on how intelligence in humans is used in a program or computer system [13]. Table I summarizes the work schedule and results of each phase involved according to plan based on the knowledge engineering model.

TABLE I
PROJECT DEVELOPMENT WORKFLOW

Phase	Activity	Result
Problem Statement	Examining the problems and needs of users. Identify the module to be developed in expert systems and Pneumococcal category that will selected as the scope.	• Background Studies • Problem • Objective • Scope Details • Human Expertise
Analysis	Made an analysis of the process used to diagnose pneumococcal and conducting interviews with experts for gaining information.	• Symptom • Rules • Fact
Design and Development System Prototype	Specified database design, input design, product design and the design of the user interface. The content structure of knowledge, methods of inference control strategies have been prepared. Implementation of database.	• Data flow diagram • Entity relationship diagram • Database • Knowledge base • Inference engine • Requirements specification
Complete System Development	Develop a comprehensive system by developing user interface with specific software to facilitate the users. Conduct a system testing.	• A system • Testing report

III. EXPERT SYSTEM DESIGN

An important component in the development of expert system are network inference and set of rules. The two components allow reasoning and diagnosis. Fig. 1 illustrates the main component of Pneumococcal Disease Diagnosis system. This system involves users (public) and experts (medical expert) to communicate through system interfaces. Meanwhile, experts use this expert system to disseminate information to public users. Expert knowledge is stored and managed in the system database. While, expert system engine perform diagnosis based on the fact and rules.

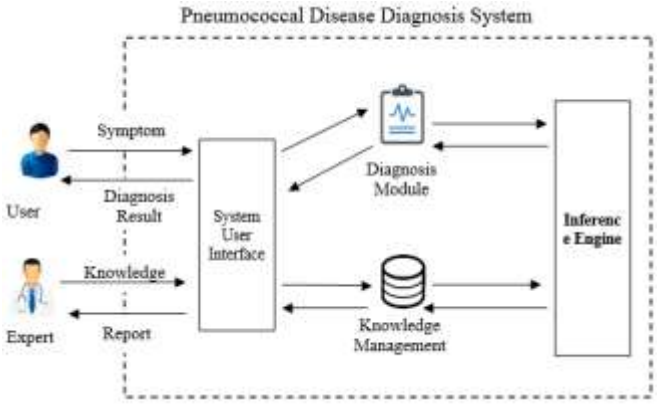

Fig. 1 Pneumococcal Disease Diagnosis System

A. Inference Network

Fig.2 shows the inference network of this expert system, which summarize all symptoms that have been categorized and grouped by Pneumococcal disease category. The information in the inference network is acquired from domain expert by knowledge engineer [14] – [15]. Inference network illustrates all connecting fact to form rule.

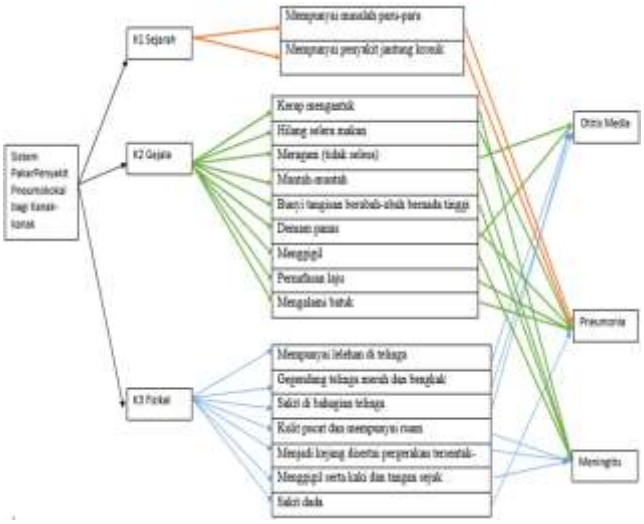

Fig. 2 Inference network for Pneumococcal disease

Inference network consist of rules and will be coded into computer through programming and follows `if…then` structure.

B. Rules

A set of rules have been coded using computer programming through `if…then` structure based on the information in the developed inference network. Fig 3 lists part of rules based on the information in the inference network.

```
Rule 1
        IF Hot fever
        AND Have a melt in the ear
        AND Red ear swollen and swollen
        AND Pain in the ear
        AND flu in the long run
```

```
        AND Less aroused at slow sound
        OR Sleep is always distracted
        OR Always cry at night during sleep
        THEN Otitis media

Rule 2
        IF Hot fever
        AND The skin is pale and has a rash
        AND Be a seizure with jerky movements.
        AND Vomiting or diarrhea
        AND The sound of crying varies high
        pitched
        AND outrageous headaches
        AND Less level of self-awareness
        AND Shivering as well as cold legs and
        hands
        OR Do not like being controlled
        OR Lack of appetite
        THEN Meningitis

Rule 3
        IF Hot fever
        OR Have a lung problem
        OR Have chronic heart disease
        AND LOST appetite
        AND Cough with or without sputum
        AND chest pain
        AND Rapid breathing
        AND BLOOD Lips
        THEN Pneumonia
```

Fig. 3 Rules

Inference engine developed in this expert system uses this set of rules to generate diagnosis result based on data input from user. A forward chaining inference process [16] is used in this study as reasoning approach. This approach automatically matches facts against patterns to determine which rules are matched. Forward chaining [17] starts with the available data and uses inference rules to extract more data until a goal is reached. Once a rule is found, the engine can infer a conclusion. This iterative process will continue until a goal is achieved.

Apart from that, the administrator module also was developed to accommodate the required amendment of the system engine and knowledge base. In this module, a new set of diagnosis question can be developed. This module is intended to assist the experts and for the system administrator to amend the rules whenever changes is required.

IV. Result and Discussion

This system is developed using Adobe Dreamweaver CS6, Xampp, and Adobe Photoshop CS6 software. The server-side database plays an important role in the development of this expert system. It was used to store all information needed for disease diagnosis. Most of the data and images were initially collected from the patients, Internet and specialist doctors in which all the information was placed in SQL Server by the system developers.

Fig. 4 shows the diagnosis page of the system. User can enter the required information such as name, age and gender before diagnosis process is started. This information is required to identify diagnosis session.

Fig. 4 Diagnosis Module

While Fig 5. (a) – (c) illustrates the diagnosis process. The user interface displays a set of questions based on the categories and options for answer. User may go through all questions and select the answer wisely. Questions are representing the symptoms of disease and answer shows the occurrence of the symptom.

The diagnosis session through question-answer mode via system user interface is resembling real diagnosis from doctor and patient. This is the idea of bringing expert system in the computer-based simulation. It gives people a chance to diagnose their health condition at their own convenient, before performing actual clinical tests.

Fig. 5 Diagnosis Session (a)

Fig. 5 Diagnosis Session (b)

Fig. 5 Diagnosis Session (c)

Fig. 6 shows result from a diagnosis session. The result contains an information about disease type, suggested treatment, complication and main symptoms.

Fig. 6 Diagnosis Result

This system also provides `administration` page. One of the modules in the administration page is `management module`. This module allows administrator to manage the disease, symptom and rule information in a system database.

Fig. 7 Disease Management

To conduct `disease management`, users should choose the disease management menu and the system will directly display disease management page as in Fig. 7.

Adding new disease list procedure is outlined as follows:

1 The administrator should set the name of the disease.
2 Enter the treatment. If the treatment list exceeds one, click the plus button.
3 Add complication information. If the list of complications exceeds one, click the add button.
4 For disease picture settings, click on the browse button to select a picture.
5 Save the information.

Fig. 8 Symptom Management Module: List

On the other hand, `symptom management` module is divided into two parts, which are updating and adding new symptoms. On the update page, there is a list of different symptoms and descriptions according to id and symptom. This page allows administrator to update or remove symptom, where necessary. Fig. 8 and Fig. 9 displays the pages for symptom management.

Fig. 9 Symptom Management: Update

To generate rule on new symptoms, administrators need to make sure they are registered in symptom management database. The steps for managing the rules are as follows:

1 Press the edit button on the list of diseases.
2 Details about symptoms by categories, rules, treatments and complications will be displayed.
3 To delete the symptoms, select desired checkbox, and press the delete button.

Fig. 10 Rule Management

While, to add new rule, the steps should be taken as follows:

1. Press the ‘add’ button.
2. Select the category and symptoms. Symptom list is based on the choice of symptom category.
3. Select the rule operators according to the suitability of the rules. Press the ‘save’ button. Fig. 10 and Fig. 11 display the page for rule management.

Fig. 11 Rule Management: Add new

Some of the advantages identified in this Pneumococcal Disease System include providing diagnostic function for the three categories of Pneumococcal disease that are specific to the children. This system supports self-examination by parents towards child health. The results of the diagnosis are generating diseases that include Meningitis, Pneumonia, and Otitis Media. These three diseases are among the most common illnesses in children in Malaysia.

This expert system also works to enable users to submit some questions to experts to obtain additional information and answers to the questions posed will be responded directly and sent to the user's email address. The interface on the system also offers additional information navigation on each question in the diagnostic module. Also included is confirmation of error messages for each input entered by the user.

From the administrator's point of view, the advantages of this expert system are that administrators can update and add information changes are necessary. The management of this knowledge base includes the update of the category of symptoms, the type of treatment, and the complications encountered. In addition, administrators also can use the report module function to generate a diagnosis decision report according to the desired month in the form of a graph.

20 users were selected to test this system. A questionnaire was distributed to users who tested this expert system as a means of obtaining feedback on each component of the expert system from the user's perspective. Meanwhile, experts who are tested as respondents are doctors of children from the Hospital.

V. Conclusions

This paper describes the development of an expert system for pneumococcal disease. The main technical requirement for an expert system development has been described. This system is aimed to help the public to identify the type of pneumococcal disease based on the symptoms given so that early detection can be made. This system offers useful reference for people suffering from pneumococcal disease. From this study, several advantages have sought. Expert system method allows natural and human-like reasoning while producing the result. Optimizing the use of Internet to disseminate the knowledge is clearly no doubt and efficient. Finally, it is hoped that the system can help communities, especially public to obtain more information about the disease and conduct self-checking, while assisting the physicians to share their knowledge to prevent the disease.

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