CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter presents the background of this project, problem statement, objectives, and scope of study.

1.1. Background

Infants are susceptible to disease. The immune systems in the infant's body have not been built properly. Therefore, infant health is important to all parents in all over the world.

Most parents seem to know instinctively when their child is sick; the child may not be as lively as he usually is; he may refuse food; he may become clingy. However, the parent is not always able to diagnose exactly what is wrong, nor is he or she necessarily able to recognize whether the child's symptoms are serious or not, or even potentially serious [3].

Therefore, there should be an expert system which able to replicate the expert's decision making abilities. In other hand, allowing parents to utilize that tool to get the same quality decision and result as the expert does.

Beginning in the mid 1960s, a new type of system, called an expert system, began to be developed to support management in the decision making process [15]. An expert system is a computer program that captures the logic of an expert in regard to a well-defined problem or task. Through a series of questions to the user, it evaluates his or her response and makes recommendations as to how the problem can be solved or the task carried out [14].

An Expert System to diagnose the infant illness, called ES-4i, is developed to ease the non-expert user, targeted for the parent, to preliminary diagnose potential common illnesses of infant.

Furthermore, infant health is a precious thing for all parents in all over the world. However, infants are susceptible to disease. Most childhood illnesses are minor and others are easily

preventable; inoculations are effective against most infectious diseases [3]. In an infant seemingly minor illnesses can cause complications: a cold that develops into a throat infection, for instance, may cause breathing difficulties [3]. Therefore, rapid and accurate handling will greatly help to reduce the risk of diseases that certainly is not desirable.

1.2 Problem Statements

I. Parent doesn't have capability to perform preliminary diagnostic test when their infant is sick.

For instance, study said that there are many times when parents cannot tell why their baby is crying [24]. It make parent unable to react properly when that situation arise. When it happens and become worst, parent usually get panic and does not know what to do.

It is natural for the parent to worry when their infant gets sick. Therefore, parent has to know basic knowledge in some common infant illnesses, for instance, fever. When their infant gets fever, it means that there is an infection in infant bodies. Based on studies, fever is the body's natural response to infection [26]. It is a good sign for the parent, because when infant body's temperature is rising, it is actually means that the body's immune system is trying to fight the infection.

Moreover, Infants are susceptible to disease. During the first months and years of life, children's organs are developing rapidly, making them more prone to functional damage. For example, the nervous system continues to develop throughout childhood and therefore is especially vulnerable to environmental factors [25].

In addition, there are a number of illnesses with similar symptoms among each disease. For instance, runny nose is one of the symptoms in Colds, Syncytial Virus (RSV) and Food Allergies. A part of that, Cough also one of the symptoms in Colds, RSV and fever.

Furthermore, another factor which should make parent worry is sudden infant death syndrome (SIDS). In Malaysia; one study mention that 2% of 143 post-mortems done in children 12 years and below resulted in a SIDS diagnosis [13]. It

happens to an apparently healthy infant which dies without any symptoms in the beginning. In short, without knowing symptoms, as a warning sign, parent definitely needs to worry.

II. *Huge information and take long time to find the answer through the internet. Hence, the need of an expert system is crucial, which allows parent to easily find or get the information on preliminary diagnoses the common infant illnesses.*

Because of above reasons, parent requires a tool which can ultimately help them to reduce those worries. Parent need an expert system which able to provide the nearest possibility illnesses by matching the symptoms that suffered by their infants.

III. *Current available expert system has not focus on diagnosing common infant illnesses.*

There are several medical expert systems already available in the internet, for instance MYCIN, NATEX, INTERNIST, PUFF, Iliad, and 5GL.

MYCIN is an expert system which focuses to help doctors, not expert in antimicrobial drugs, prescribe such drugs for blood infections [19]. Next, is "NATEX", an expert system which is intended to support a neonatologist's diagnostic decision making at the first stage of neonatal nursing with the total number of diagnosed conditions in a baby is 63 [23]. Other than that, INTERNIST has main function to diagnose clinical diseases and it focused on blood-borne infectious bacteria - to focus on more comprehensive issues than a narrow field like blood poisoning

In short, those expert systems are not focused on diagnosing common infant illnesses.

1.3 Objectives

All the data collections are obtained from interviewing with the expert and also surveying the parent as net user for this project. A part of that some books and journals are used as main references in developing this projects. The design of this project will suits with user needs, in which user will interact with the system through user interface. In addition, the aims of developing this project are as followed:

1. To develop the expert systems which can preliminary diagnose the common infant illnesses.
2. To provide non-expert, especially parent, to get the general knowledge of the common infant illnesses as the experts has.
3. To help the experts themselves in taking further action based on the information given from the parents who has preliminary diagnosed using the system.

1.4 Scope of Study

The studies which are carried out in this project are discussed as follows:

1. The development of this expert system is limited to provide on common infant illnesses only (which are Colds, Diarrhea, Fever, Constipation, Ear Infections, Food Allergies, Gastroesophageal Reflux (GER), and Respiratory Syncytial Virus (RSV)).

2. This expert system is targeted or used for parent.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter focuses on retrieving the information from many resources which will support the knowledge in developing this project. It will consist of artificial intelligent, expert system and its benefit and challenges, list of comment infant illnesses with the explanation for each illnesses and followed by the symptoms, at the end of this chapter will focuses on the sample of the expert system which related with this project.

2.1 Artificial Intelligent (AI)

Artificial Intelligent refer to the science that provides computers with the ability to solve problems not easily solved through algorithmic models [1]. In short, AI is a branch of computer science, which has the goal to make the computer as if it was human.

There are two main factors that are required to make an AI application. The first one is Knowledge Base which consists of the facts, theories, and relationships among each other. The second one is Inference Engine which able to provide conclusions based on experience.

Furthermore, like most other science, artificial intelligence consists of several sub-disciplines. Principally it still uses problem-solving approach, but each focused on specific application areas. For instance, expert system focused on solving a particular problem by retrieving data and knowledge from the experts.

2.1.1 Expert System

Expert system is an artificial intelligence computer program designed to substitute human expert in a specific domain [2]. Figure 2.1 presents how expert system works;

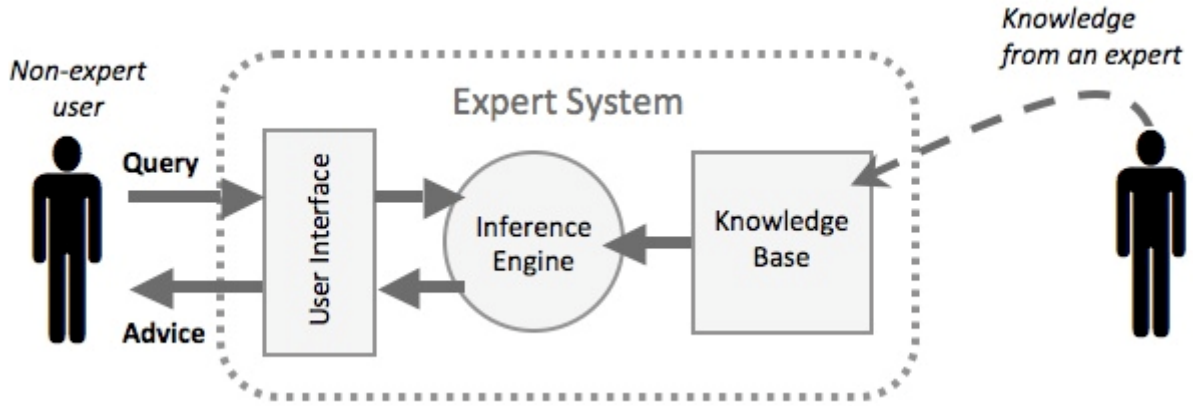

Figure 2.1 How expert systems works [20]

Expert system is also a computer system that could match or mimic the ability of an expert. A good expert system designed to solve a particular problem by mimicking the knowledge and work of the experts. With this system, ordinary people will be able to solve quite complex problems that actually can only be solved with the help of experts. In addition, the system will also help the experts themselves to work with them as an experienced assistant.

2.1.1.1 Expert System Components

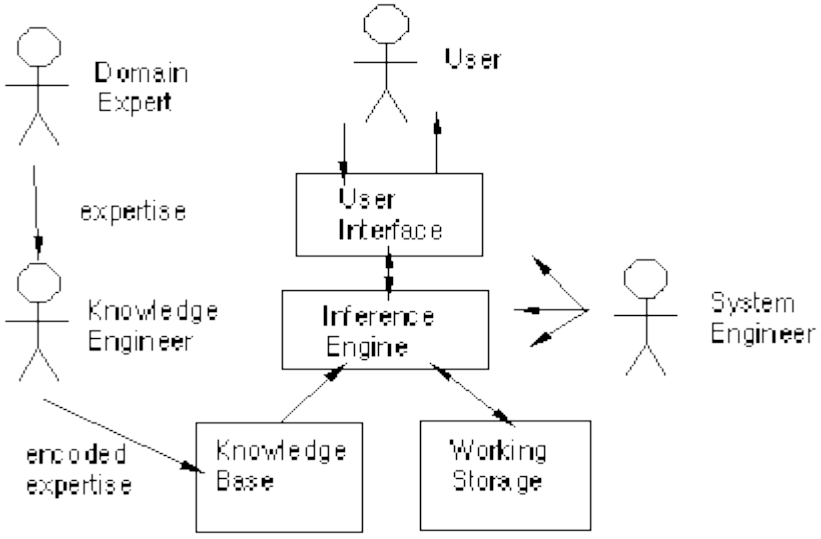

Figure 2.2 Expert System Components and Human Interfaces [16]

Expert systems have a number of major system components and interface with individuals in various roles [16]. These are illustrated in Figure 1.1. The major components are:

- Knowledge base - a declarative representation of the expertise, often in IF THEN rules;
- Working storage - the data which is specific to a problem being solved;
- Inference engine - the code at the core of the system which derives recommendations from the knowledge base and problem-specific data in working storage;
- User interface - the code that controls the dialog between the user and the system.

2.1.1.2 Expert System Benefits & Challenges

Generally, the benefits & challenges of expert system are represented in the table below:

Benefits	Challenges
• Provides consistent answers for repetitive decisions, processes & tasks	• Lacks common sense needed in some decision making
• Holds and maintains significant levels of information	• Cannot make creative responses as human expert would in unusual circumstances
• Encourages organizations to clarify the logic of their decision-making	• Domain experts not always able to explain their logic and reasoning
• Never "forgets" to ask a question, as a human might	• Errors may occur in the knowledge base, and lead to wrong decisions
• Can be used by the user more frequently & work round the clock	• Cannot adapt to changing environments, unless knowledge base is changed

***Table 2.1**. Benefits & Challenges of Expert System [17]*

Furthermore, for non-expert, the reward is saving time and money to see the expert with having the same quality decision or result as the expert. For expert itself, the reward is a less secure position with corporation, because their decision-making abilities in their area of expertise essentially have been extracted, distilled, and made one of the corporation's permanent assets.

2.2 Common Infant Illnesses

Common illnesses that commonly strike the infant are described in Table 2.2

***Table 2.2**. Common Infant Illnesses*

No	Illnesses	Explanations	Symptoms
1	Colds	Colds are caused by viral infections that cause the membranes of the nose and respiratory passages to swell and pour out mucus [4]	• Runny nose, • Nasal congestion, • Have a low-grade fever (100 degrees F or less), • Coughing & Sneezing, • Difficulty sleeping, • Irritability • Decreased appetite, • Trouble breathing, • Lips or nails turn blue [5].
2	Constipation	The Passage of infrequent hard stools with difficulty in defecation. [6]	• Hard pebble-Like stools, • Pain in the lower abbdoment, • Blood on nappy or underpants [3].
3	Diarrhoea	An increase in the frequency, fluidity, and volume of faeces [7].	• Earache, • Dysuria, • Coryza [7]. • High fever, • Bloody diarrhea, • Increasing abdominal pain, • Vomiting, • Dehydrated or losing weight, • Infant's bowel movements become much more frequent and watery all of a sudden [4].

4	Ear Infections	Ear infections are often a result of accumulation of fluid in the middle ear that results in growth of germs. It may also be caused by viruses or due to cold [8].	• Cranky, • Wake up during the night, • Unwilling to lie flat, • Cry during feeding [4].
5	Fever	A rise in internal body temperature to levels that are considered to be above normal [9].	• Temperature of >100.4 F • Change in aleretness & activity, • Noisy Respirations, • Ear pain, • Cough, • Lethargy, • Rash, • Vomiting, • Diarrhea, • Cheats Paint, • Dysuria [10].
6	Food Allergies	An Adverse raction to a particular food or food constituent that is not psychologically based [6].	• Itching or changes in skin within a few minutes to an hour of eating [11]. • Excess gas/wind, • Nausea, • Vomiting, • Possible blood in stools, • Runny nose, • Watery or red eyes, • Wheezing [12].
7	Gastroesophageal Reflux (GER)	GER happens, because the circular band of muscle that acts, as a valve between the esophagus and the stomach is still immature in babies [8].	• Frequent spitting up or vomiting • Movements such as throwing the legs up, • Arching the back, • Frequent wet burps, • Throaty gagging noises [4].
8	Respiratory Syncytial Virus (RSV)	RSV, which stands for respiratory syncytial virus, is a common virus of early infancy that can be very serious. It is the major cause of hospitalization for	• Infant touches something contaminated, or just touched, kissed with the infected person. • Cold, • Runny nose,

		respiratory illness in children under one year of age [4].	• Low fever, • Cough, • Wheezing [4].

2.3 Related Project

A Medical Expert System is computer software that generates diagnosis and management guidelines given the patients symptoms, signs and investigation results. It is intended to be an aid to physicians rather than replace them and their clinical judgment [18].

Table 2.3 shows others expert system which are related with this project.

Related Work	
Expert System	Function
NATEX	Diagnose major syndromes of neonatal diseases (Kurakina Tiu, 1999)
INTERNIST (CADUCEUS)	Diagnose clinical diseases and it focused on blood-borne infectious bacteria (Wolfram, D (1995).)
PUFF	Diagnose lung disease and pulmonary problem (Janice S, 2002)
Iliad	Diagnose the indications for surgery for three surgical operations—cholecystectomy (Bouhaddou O, 1993)
5GL	Further information button built-in the system. As references while doctor are diagnosing (MDES, 2012)

***Table 2.3**. Related Work*

2.3.1 MYCIN

[19] MYCIN was the first well known medical expert system developed by Shortliffe at Stanford University to help doctors, not expert in antimicrobial drugs, prescribe such drugs for blood infections. MYCIN has three sub-systems:

1. Consultation system
2. Explanation System
3. Rule Acquisition system.

In the consultation part, the system will provide some questions in which a user has to enter the required data into the system. After all the questions are answered, the system will responds by using its inference engine to carry out the reasoning involved in deriving an answer to the questions posed by the user [19].

Furthermore, in the explanation system, the system will provide user with the conclusion of nearest possibility illnesses by matching a path between the inputted data from the user and known data in the system. It does this by manipulating its record of the rules it invoked, the goal it was trying to achieve, the information it was trying to discover [21]. Lastly, in the rule acquisition system, the rule and the data in the system can be added and edited with the new premise or rules by the expert itself.

2.3.2 NATEX

The aim of developing "NATEX" expert system is employed to diagnose major syndromes of neonatal diseases. The system intended to support a neonatologist's diagnostic decision making at the first stage of neonatal nursing. [23]

In term of knowledge base, there are 33 syndromes of neonatal diseases and 63 diagnoses condition is applied in a baby. A part of that, it covers all major syndromes assessing the vital systems of the neonatal body and their occurring processes. Therefore, there are 700 syndromes to support a diagnostic decision. In addition, hierarchical semantic threshold network is used in designing this system and to run this system, it required MS DOS 3.0 and higher.

2.3.3 INTERNIST (CADUCEUS)

INTERNIST-I was designed between 1972 and 1973 to provide computer assisted diagnosis in general internal medicine by attempting to model the reasoning of clinicians [34]. This expert system is developed by Pittsburgh and has main function to diagnose clinical diseases and it focused on blood-borne infectious bacteria - to focus on more comprehensive issues than a narrow field like blood poisoning [27]

[34] INTERNIST-I was an expert system designed in the early 1970's to diagnose multiple diseases in internal medicine by modelling the behaviour of clinicians. Its form and operation are described, and evaluations of the system are surveyed. The major result of the project was its knowledge base which has been used in successor systems for medical education and clinical use.

There are 1000 different diseases that can be. The results are the set of solutions based on diagnose. While CADUCEUS worked using an inference engine similar to MYCIN's, it made a number of changes (like incorporating abductive reasoning) to deal with the additional complexity of internal disease- there can be a number of simultaneous diseases, and data is generally flawed and scarce.

2.3.4 PUFF

[35] PUFF is an expert system for interpretation of pulmonary Function Data. This system is developed by Stanford to diagnose lung disease and pulmonary problem. Reporting for attending physicians is the result of this system.

[35] PUFF was built using EMYCIN, a generalization of an arlier medical system named MYCIN. The task chosen for PUFF is described briefly, and the rationale for the appropriateness of this choice is presented. PUFF was initially developed on the SUMEX computer, a large research machine at Stanford University, and was later rewritten in a production version to run on the hospital's own minicomputer.

[35] PUFF interprets measurements from respiratory tests administered to patients in the pulmonary (lung) function laboratory at Pacific Medical Center in San Francisco. The laboratory includes equipment designed to measure the volume of the lungs, the ability of the patient to move air into·and out of the lungs, and the ability of the lungs to get oxygen into the blood and carbon dioxide out. I The pulmonary physiologist interprets these measurements in order to determine the presence and severity of lung disease in the patient.

2.3.5 Iliad

Iliad is another example of expert system which was developed to diagnose the indications for surgery for three surgical operations--cholecystectomy, cataract extraction, and knee arthroscopy [31]. It suggests relevant diagnoses, give advice regarding cost-effective workup strategies, and explain relationships of findings to diseases [32].

This expert system uses Bayesian reasoning to come out with the probability of the illnesses. A part of that, the system is used as a teaching tool for medical students. Furthermore, it being used by medical students to make and compare the diagnosis between their knowledge and the computer. The results indicate that students made fewer diagnostic errors and more conclusively confirmed their diagnostic hypotheses when they were tested in their trained domain. We conclude that expert systems such as Iliad can effectively teach diagnostic skills by supplementing trainees' actual case experience with computerized simulations [33]. At the end the goal is to help or access students' knowledge in diagnosing the possibility of illnesses.

In term of knowledge base, this system has 1500 diagnoses in this domain. A part of that, it developed initially for the Apple Mac; a version for the PC-AT running windows has also been released [32].

Those above information shows that this expert system is more focus on neonatal disease with huge scopes of syndromes inside the knowledge base. Therefore, the system might be very accurate in term of diagnosing the possibility of the diseases. A part of that, the system is very useful for helping medical students in assessing their knowledge in that particular disease. However, this system will be useful for the internal user only, doctor and medical student.

2.3.6 5GL

[36] 5GL is medical expert system for Windows, matching symptoms and signs using artificial intelligence techniques.

There are two function can be used in this system. The first one is used health professionals, which they can use as references while they are diagnosing.

Another function is further information button built-in the system. For instance there is a click button on a medical term and also explanation and conversations which can be used by non expert user. For example, in particular to do with babies and children's health issues, there will be a question like “say your child is irritable and refuses to eat?” and followed by another question like “Do you take him to a doctor?” Those are the types of approaches to meet the user needs. Hence the ordinary person is likely to find the software informative and useful [35].

[35] In regards to the Brain and Mind database which is separate to the main database, the accuracy of what are known as IRC algorithms in differentiating from aneurysms, migraine, tumors, or a disease process such as Multiple Sclerosis, approached 99% in this system as a sample of studies. Compare to the typical diagnosis accuracy of medical experts in this area which overall, depending on the condition, is perhaps at best around 50%. Indeed, as some of the case studies included show, in some cases a child with brain symptoms was so misdiagnosed that the final correct diagnosis was made just days before death would have taken place. The area of correctly diagnosing brain conditions is perhaps the least reliable area of medicine.)

As a conclusion, even though MYCIN, NATEX, INTERNIST, PUFF, Iliad, and 5GL has been developed, there has been lacking in term of addressing or focusing on diagnosing common infant illnesses. Therefore, it is very crucial to have and develop an expert system which focused on preliminary diagnosing the common infant illness.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter focuses on Expert system development life cycle (ESDLC). As ESDLC is adopted in developing this project, the life cycle is started with identifying and analyzing the problem from the user. After that locating system specification which consist of software and hardware. That stage is needed to access the problems which have found earlier. Next stage is developing selected tools. Knowledge base is very important to complete that stage. There are three main components in knowledge base which are knowledge acquisition, knowledge representation, and computer code. Furthermore, all the data gathered from knowledge base stage is implemented to develop the prototype. In addition, the prototype will be tested and validated to meet the user needs and requirement with the knowledge acquisition gained from the expert. At the end, implement the prototype as final product that ready to use by the user.

3.1 Expert System Development Life Cycle (ESDLC)

ESDLC is the steps through which an expert system project goes before it becomes operational [27]. ESDLC will address the following questions as shows in Table 3.1

No	Questions
1	What is the problem that warrants a solution by an expert?
2	How important is the problem?
3	What clues indicate that the system should be build?
4	What will the user gain from the system?
5	What development strategy should be considered?
6	Who is going to build the system?
7	What process will be used to build the system?

Table 3.1 *Questions addressed by ESDLC [27].*

Furthermore, the phases of ESDLC are described in Figure 3.1

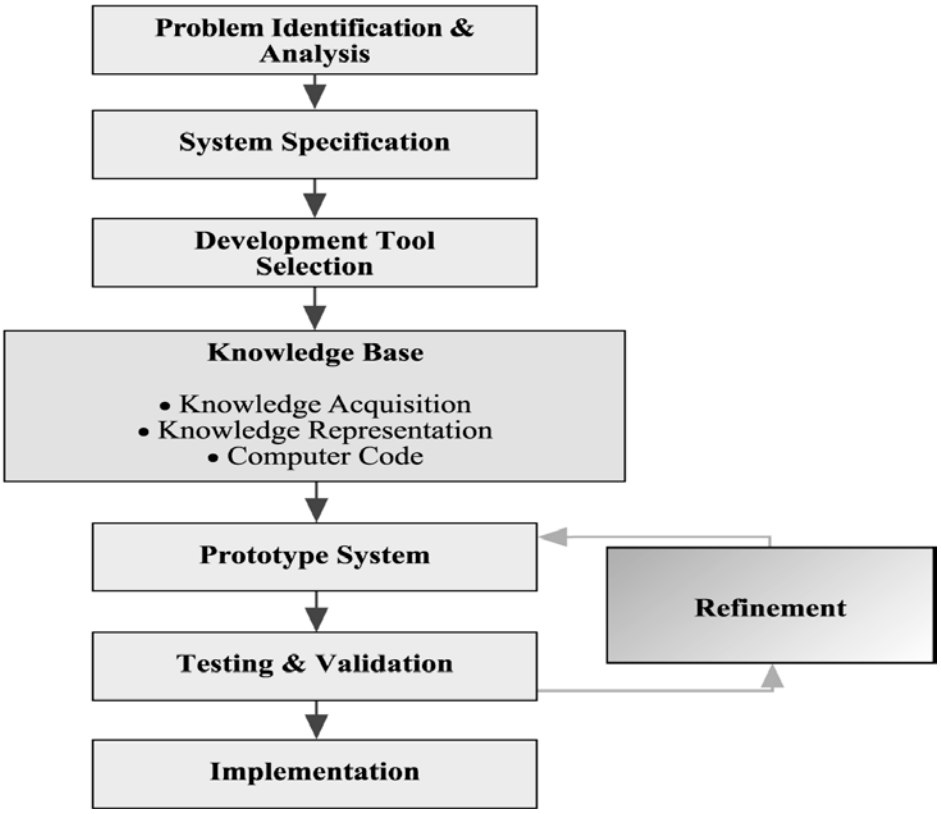

Figure 3.1 *Expert system development approaches [22]*

3.1.1 Problem Identification & Analysis

The first step in building an expert system is the identification of a unique problem potentially solvable with an expert system [27]. Identifying several problems will become an input in this step. After that, the problem will be analyzed. Furthermore, selected problem will become an output from this step.

The first step in indentifying the problem for this project is by conduction an interview to the young parent. The aim of the interview is to obtain the current problem which are facing by the parent which related to their infant-sick. Furthermore, all the input gained from the interview will be collected and analyzed.

3.1.2 System Specification & Development tool selection

This step will obtain selected problem which lead in developing this project. After analyzing the problem, this step will select the tool which required in developing this project. Appropriate hardware and software will be selected as an output from this step.

First of all, this project needs the software which can provide if then statement. After that, need an output screen to display the result. Finally, after analyzing the software that needed to develop this project, exsys corvid software is selected to develop this project.

3.1.3 Tools

For the software, this project uses ExSys Corvid. [28] Furthermore, an ExSys Corvid knowledge automation system has two parts, the logic of the decision-making process, and the end user interface rule-based. The logic is run using the Exsys Corvid runtime programs that incorporate the Exsys Inference Engine, and provides the user interface. The core logic of a system determines what information is needed, when it is needed and if the user should be asked to provide it. The questions and results are visually displayed in the screen design. There will be controls used to ask questions, radio button to answer the questions.

Other than that, Table 4.1 shows the sample of minimum requirement as primary hardware for the support of this expert system development.

CPU	800 Mhz Pentium III
Memory	256MB
Monitor	14”
Hard Drives	40 GB
OS	Windows 95 & above
Network Card	10mbps-100mbps

Table 4.1 Software Selected & Sample Hardware & Requirements

3.1.4 Knowledge Base

After required tools are selected, the next step will be conducting knowledge base. [1] Knowledge base is a body of knowledge codified in a way that can be manipulated by an interference engine for the purpose of delivering new inferences. It contains the domain knowledge needed to solve problems coded in the form of rules.

In short, in this stage the development of the project will focus on IF and THEN statements. The result of this step is representing expertise knowledge that will be applied in this project.

There are three main components in the knowledge base. The first one is knowledge acquisition, the second one is knowledge representation and the third one is computer code.

3.1.4.1 Knowledge Acquisition

Human expert should also know the extent of their knowledge and quality their advice as the problem reaches their limits of ignorance [29]. Therefore, tools and techniques required in this step are choosing experts and identify technical resources [27]. This step will obtain information from the expert. As a result, expert's knowledge will become a goal of this step and it will be applied in the appropriate tools.

There are several ways to acquire the knowledge which needed to develop this project. The first one is through research from the books and journals. The second one is through interview. The interview is conducted with the parent and also the expert who is doctor.

3.1.4.2 Knowledge Representation

Once knowledge has been acquired, the next step is knowledge representation [27]. The activity in this step is translating the data and information gained from knowledge-acquisition step into the system. The most popular mode of knowledge representation within expert system is through the use of rules [30].

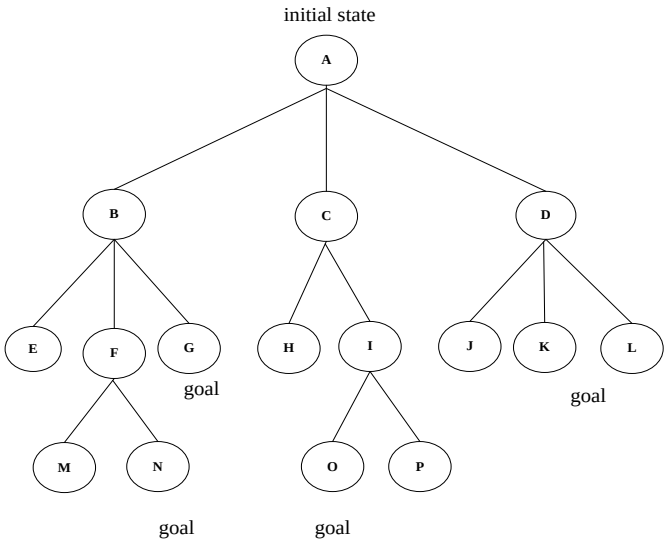

Figure 3.3 Forward Chaining

Figure 3.3 shows inference engine part which is used in this project. Forward reasoning algorithm, move from the input toward the conclusion. Inputs are used to satisfy the premises of certain rules. This allows them to be executed, and values to other intermediate parameter set [1].

This step will represent acquired knowledge from the expert as an input data. All the data that have been obtained from the doctor will represent it in a form of if rules statement which are ready to be coded.

3.1.4.3 Computer Code

Specific rule that obtained from knowledge representation will be coded into the system. Rule is a formal way of specifying a recommendation, directive, or strategy, expressed as a premise and conclusion [27].

As a result, in this stage IF-THEN statement will be applied in a form of code inside the software. At the end, the result or conclusion will be obtained from those if and then rules.

3.1.5 Prototype system

After the rules are coded and stored in the system, prototype system needed to connect the user with the system. Though prototype system architecture, user will be able to interact with the system via user interface, in a form of computer screen. At the end, inference engine will derives recommendations from the knowledge base and inserted data in working storage, therefore user will be able to see the solution as a final result from the expert system.

3.1.6 Testing & Validation

In order to ensure correctness of the result, the project will do several testing, verification, validation and evaluation. In this stage, the project will be tested. The testing of this project consists of verifying and validating the system. All the inputted knowledge is expected to be the same with the expected output. Furthermore, verification consists of putting the expert system through a procedure to ensure that the system is right- that the programs do what they are design to do [27].

In this step, all the rules will be rechecked to make sure that the conditions is match with the conditions from information obtained. Otherwise, validation involves testing the system to ensure it is the right system- that it meets the expert's expectation [27]. In this project, the activity involve is validating the accuracy of the solution that will be given to the end user. This step will make sure that the solution will be exactly the same as the knowledge obtained from the experts. After all those process, then the system will be evaluated. There will be some improvement taken if the system has not exactly match with the procedure on what the system are designed to do.

In this project, the testing is tested with the doctor. The aim of this testing is to validate the prototype so that the project can be used by the user.

3.1.3 Implementation

Implementation is the process of organizing the knowledge and integrating it with the processing strategy (inference engine) for testing [27]. This step is the final step in developing this project. After the system is tested, verified, validated, and evaluated then the system ready to be implemented and used by the users.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter will present the result of the project. It includes result and discussion of the selected ESDLC, decision tree of the system, proposed interface design, and conclusion from the interview with parent as target user of this project.

4.1 ESDLC

The first stage in developing this project is identifying & analyzing problems that currently become hindrance and issue in preliminary diagnosing infant illnesses. There are three main problem encourage the development of this project. The first one is parent (as target user) is not always able to preliminary diagnose on what happen exactly to their infant. The second one is the need of an expert system is crucial, which allows parent to preliminary diagnoses the common infant illnesses. The third one is the current available expert system, for instance MYCIN, NATEX, INTERNIST (CADUCEUS), PUFF, has not focus on diagnosing common infant illnesses.

4.1.1 Knowledge Base

There are two sources to acquire the knowledge needed for this project. The first one is by choosing doctors as the experts. The aim is to gather information and knowledge from doctors who have expertise in the infant illnesses field. The second one is identify technical resources. It is needed to retrieve and explore the data and additional information needed. For instance, Infant health and expert system books from library and explore some supported journals from internet are used as technical resources to build this project.

Furthermore, Figure 4.1 illustrates the knowledge acquisition techniques that are used to retrieve the data or the knowledge to build this system.

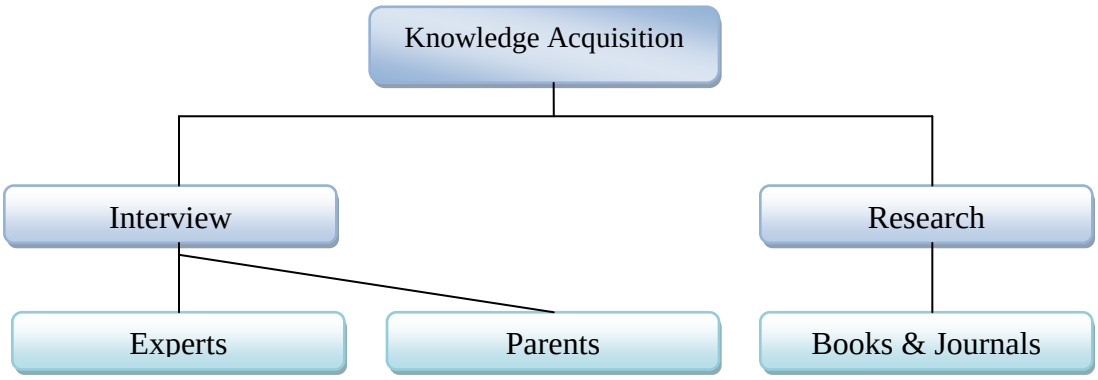

Figure 4.1 Knowledge Acquisition techniques

Interview will be conducted to get the user knowledge, parent, on infant illnesses and will find the feedback on how this expert system will help them. The type of survey will be both paper and online based. Interview will be conducted with the experts, doctor, to get the knowledge on common infant illnesses.

Research will be conducted to get the information on how to develop and retrieve the basic theory of this system. For instance, reading the expert system book, which available in the library, to get the knowledge on how to develop the system. In addition, reading some infant illnesses journals/ books to get the information on the common illnesses that attack most of the infant.

Furthermore, the system will provide several questions and the user begins to respond that session by filling all the possible answer. For instance, the symptoms that are chosen by user are runny nose, nasal congestion, low-grade fever (100 degrees F or less), coughing & sneezing, difficulty sleeping, irritability, decreased appetite, trouble breathing, and lips or nails turn blue.

After that, the expert system will process inputted data, by matching all the condition or premises from of all questions answered by user. For instance the conclusion from the previous sample given is Colds. As a result, the expert system will shows Cold as the nearest possibility illnesses suffered by the infant.

Other than that, the system will provide the definition of the illnesses to increase parent's knowledge and also the tips to assist parent to take preliminary action. In which,

coding the symptoms rules gained from the experts to make conclusion on the possible illnesses that suffered by the infant.

The uses of IF-THEN statement in preliminary diagnose common infant illnesses are as followed:

- IF the symptoms are frequent spitting up or vomiting, movements such as throwing the legs up, arching the back, frequent wet burps, & throaty gagging noises THEN the conclusion is Gastroesophageal Reflux (GER).

- IF Infant touches something contaminated, or just touched, kissed with the infected person, and the symptoms are cold, runny nose, low fever, cough, & wheezing THEN the conclusion is Respiratory Syncytial Virus (RSV)

- IF the symptoms are itching or changes in skin within a few minutes to an hour of eating, excess gas/wind, nausea, vomiting,, possible blood in stools, runny nose, watery or red eyes, & wheezing THEN the conclusion is Food Allergies.

- IF the symptoms are temperature of >100.4 F, Change in aleretness & activity, noisy respirations, ear pain, cough, lethargy, rash, vomiting, diarrhea, cheats paint, & dysuria THEN the conclusion is Fever.

- IF the symptoms are Cranky, Wake up during the night, Unwilling to lie flat, Cry during feeding THEN the conclusion is Ear Infection.

- IF the symptoms are Earache, Dysuria, Coryza, High fever, Bbloody diarrhea, Increasing abdominal pain, Vomiting, Dehydrated or losing weight, Infant's bowel movements become much more frequent and watery all of a sudden THEN the conclusion is Diarrhea.

- IF the symptoms are Hard pebble-Like stools, Pain in the lower abbdoment, Blood on nappy or underpants THEN the conclusion is Constipation.

- IF the symptoms are Runny nose, Nasal congestion, Have a low-grade fever (100 degrees F or less), Coughing & Sneezing, Difficulty sleeping, IrritabilityDecreased appetite, and Trouble breathing, THEN the conclusion is Colds.

4.1.2 ES-4i Prototype System

Figure 4.2 is used to develop the prototype of this project.

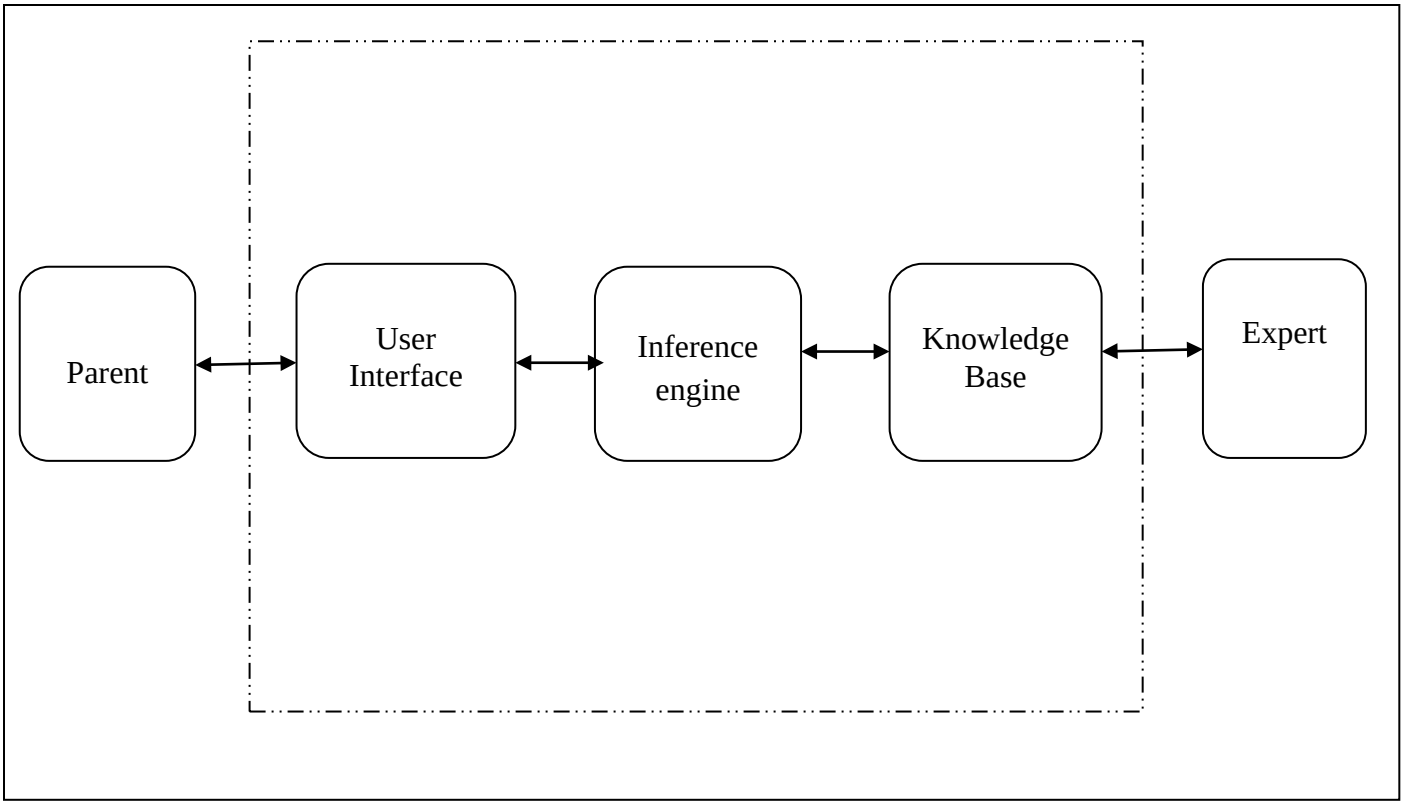

Figure 4.2 Prototype System Architecture [20]

In the project prototype, parent will interact through user interface, in a form of computer screen. Next, they will be able to input the data into the system and inference engine which will derives recommendations from the knowledge base and

problem-specific data in working storage [16]. Furthermore, the knowledge base will set IF THEN rules from the inputted symptoms from parent and matched with the symptoms from the expert. After that, system will show the conclusion trough user interface and at the end parent are able to see and get the result.

4.2 Decision Graph

Figure 4.3 shows the decision graphs that represent the knowledge of the expert.

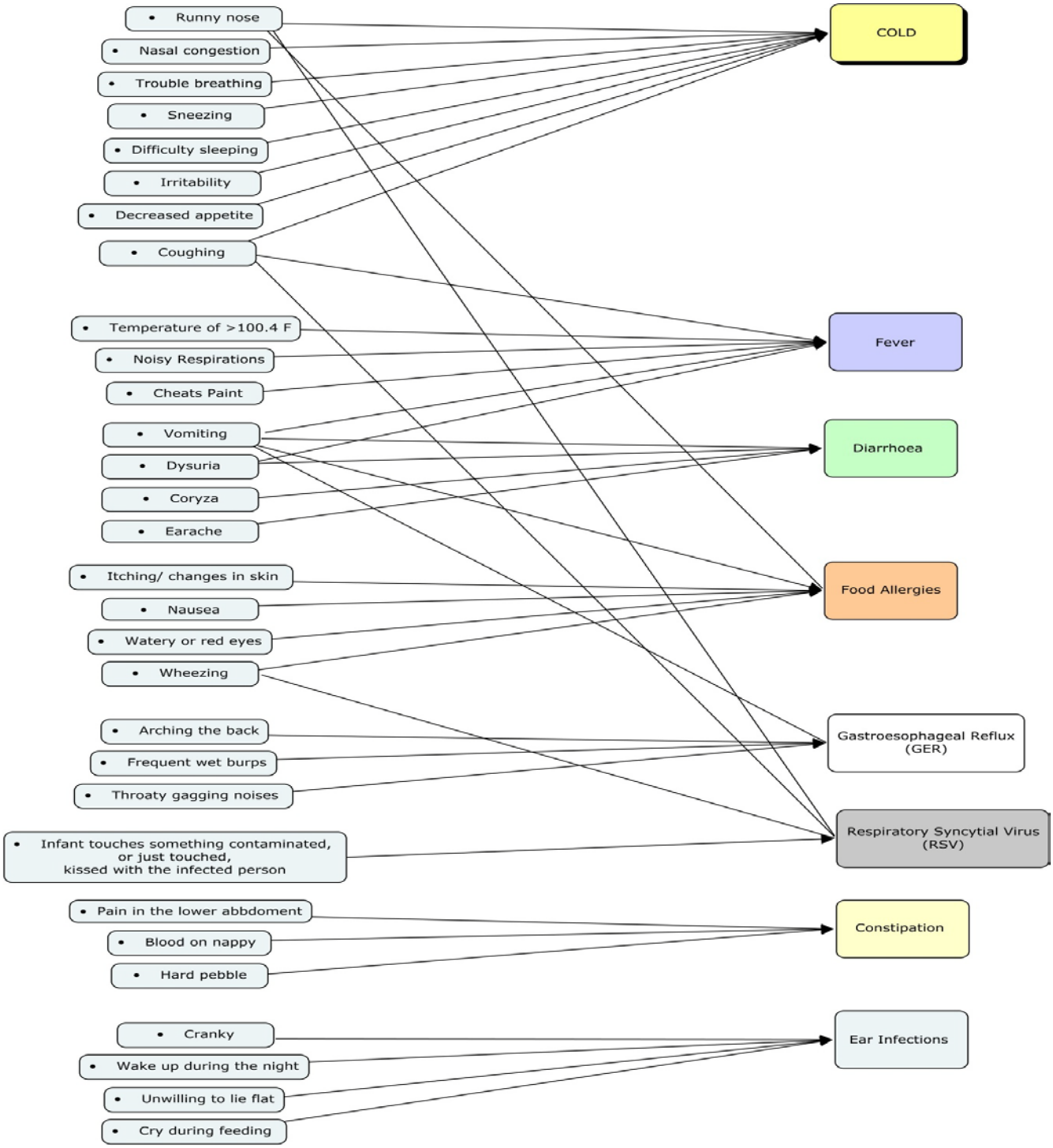

Figure 4.3 Decision Graph

4.3 Interface Design

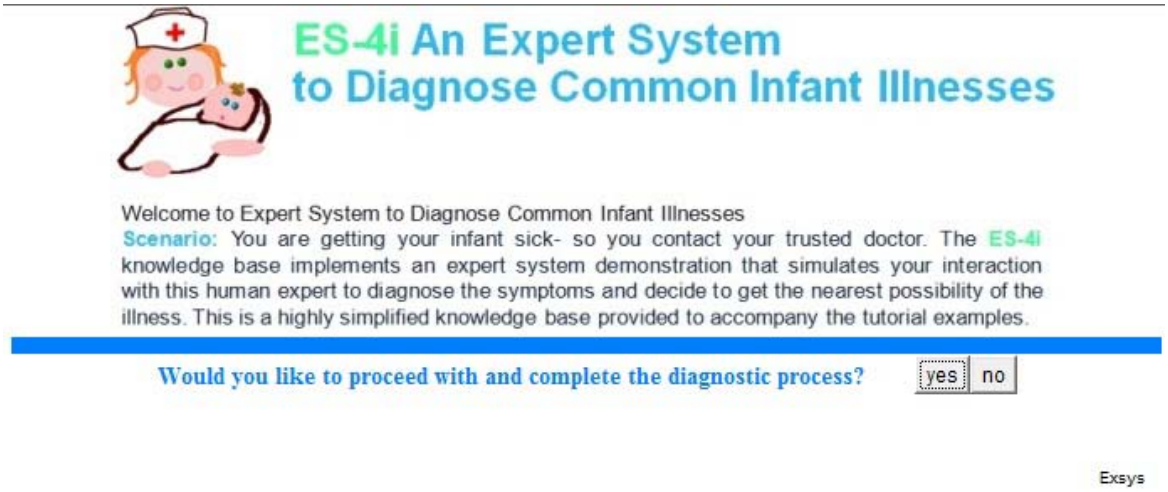

Figure 4.3 Front Page of ES-4i

This project developed by using ExSys Corvid software which allows the developer to build the rules and the interface for the user at the same time. The home of this project's interface will seek the user agreement to use the system, by providing the yes or no button to enter onto the system.

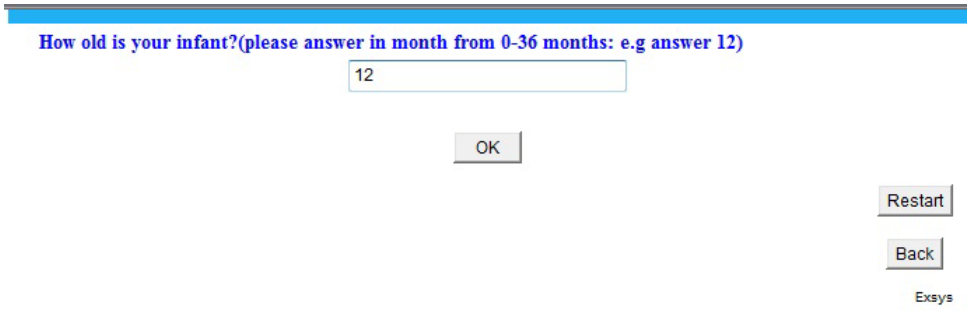

Figure 4.4 Sample Questions 1

The first question that will be asked to the user is how old their infant. Based on interview with general doctors and pediatric, the first question that will be addressed to parent who bring their sick-infant is how old is the infant. They mentioned that by knowing the age of the infant it will ease to sharpen the diagnosis.

The second question that will be asked to the user is the most frequent symptom. Based on interview, the expert mentioned that by identifying the most frequent symptom of the infant it will ease them to sharpen the possibility of one illness.

For instance, the user select runny nose as the most frequent symptoms that suffered by their infant. Hence, there will be some following questions will be addressed to the user to make the probability of suffering one illness is higher.

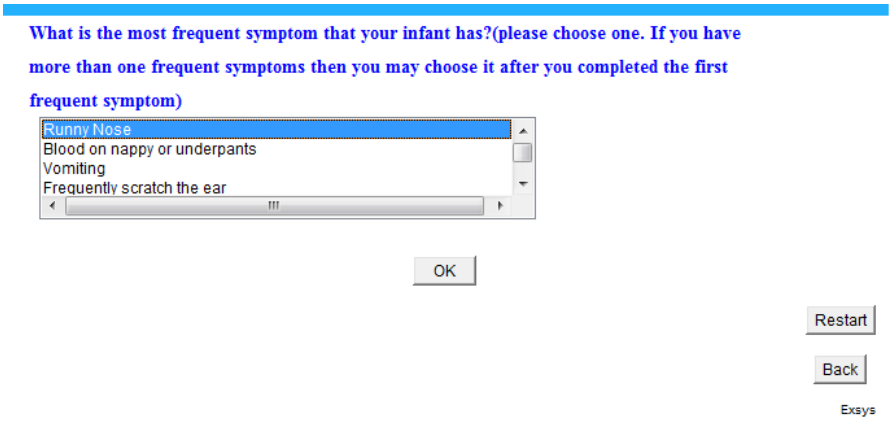

Figure 4.5 Sample Questions 2

The next questions that will be asked to the user are whether their infant has nasal congestion or no. The system provides yes or no radio button so that the user have to choose one as an input. Apart from that, the next question is when the nasal congestion happens. Both questions are important to seek the accuracy of possible illness.

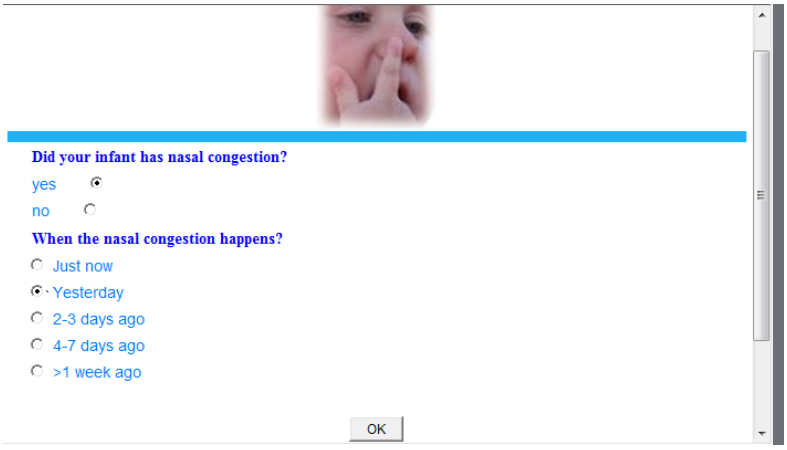

Figure 4.6 Sample Questions 3

The next questions that will be asked to the user are whether their infant frequently sneezing or no. The system provides yes or no radio button so that the user have to choose one as an input. Apart from that, the next question is when their infant starts sneezing frequently. Both questions are important to seek the accuracy of possible illness.

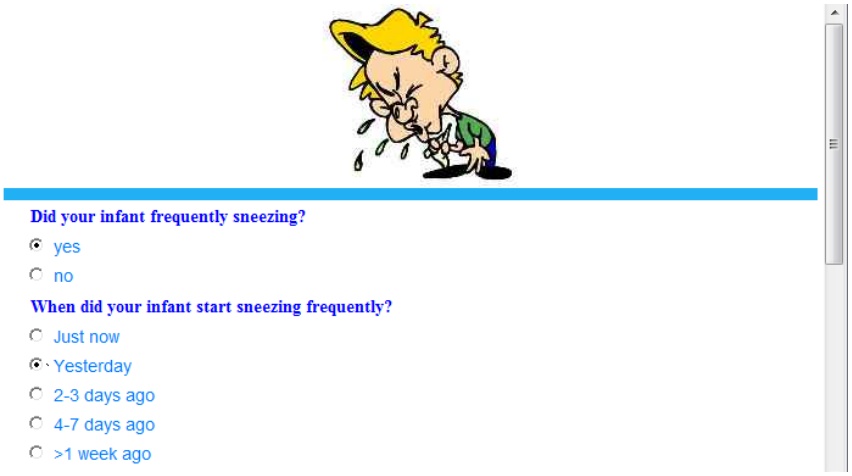

Figure 4.7 Sample Questions 4

Other than that, the frequency level also will be asked to the user. This question is to make sure what level the illness is. The system provides five possible answers. The first one is 'always' which mean the infant frequently sneezing more than five times in a day. The second one is 'often' which measure sneezing for three to five times. The third one is 'sometimes' which only twice a day the infant is sneezing. The forth one is 'seldom' which means only once in a day the infant is sneezing. However, the system also provide 'not sure' button for unsure answer. All these questions are obtained from the interview with the expert.

Figure 4.8 Sample Questions 5

The next questions that will be asked to the user are whether their infant always coughing or no. The system provides the user with 'yes' or 'no' radio button so that the user have to choose one as an input. Apart from that, the next question is when their infant starts coughing. Both questions are important to seek the accuracy of possible illness.

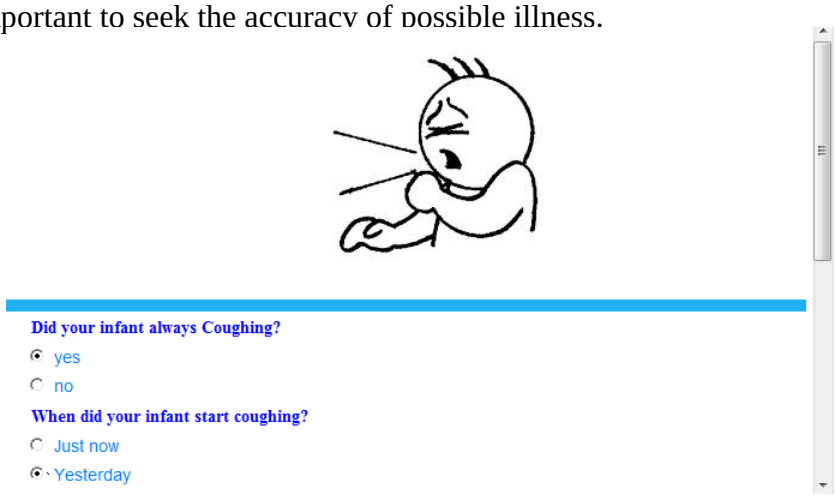

Figure 4.9 Sample Questions 6

Other than that, the frequency level also will be asked to the user. This question is to make sure what level the illness is. The system provides five possible answers. The first one is 'always' which mean the infant frequently coughing more than five times in a day. The second one is 'often' which measure coughing for three to five times. The third one is 'sometimes' which only twice a day the infant is coughing. The forth one is 'seldom' which means only once in a day the infant is coughing. However, the system also provide 'not sure' button for unsure answer. All these questions are obtained from the interview with the expert.

Figure 4.10 Sample Questions 7

At the end, the system will pop up with the nearest possible conclusion. This possible illness is obtained from the inputted symptoms by the user. For instance, the conclusion is ‘colds’ when the user said that the infants is running nose so frequent, has nasal congestion, often sneezing and always coughing. Apart from that, the system also provides the confidence level of suffering the illness. In this example, the confidence level is 100% which mean that the probability of the infant get colds is high. The confidence level is measured from the symptoms which closely related or caused the illness. The more symptoms that inputted onto the system, the higher the confidence level will be.

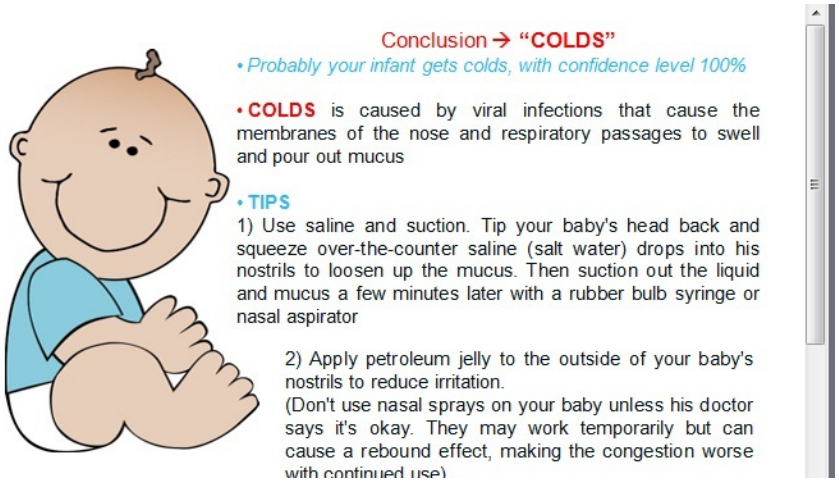

Figure 4.11 Sample Output

Furthermore, the system also provides the tips on conquering the illness. For instance, for colds the parent or user need to use saline and suction and tip it to the baby’s head back and squeeze over-the-counter. Hence, by providing the tips it can ease the parent in treating and also preventing the infant from the worst situation.

4.4 Prototype Testing

The final prototype has been tested with the expert. The first step is demonstrating the prototype from the beginning until the end. The expert acts as the user. She put the input for each of the questions. After that, she gives the comment on the usefulness of the system and suggestion for improving the system.

The first evaluation is in term of the usefulness of the system. She mentioned that this project is very useful for the parent as the user. The parent can use this system to preliminary diagnose, at the same time the will gain some knowledge on common infant illnesses. It is because the system will provide some general information on the possible illnesses of their infant. For instance, when the system gives ‘colds’ as the result of possible illnesses, the system will provide the general term of illness and also the first aids tips on how to handle the infant.

Next, her advice is to improve user friendliness of the system. It means that, in term of the language, the system need to limit the jargon when asking the question or providing the information to the user.

4.5 Findings

Interview has been conducted in this project. Figure 4.10 are five main questions to discover the patent of the user behavior while their infant unwell.

User
1) If your infant is sick, who would you go to?
2) What are the motivations when you go to that particular answer? **based on the answer form question number one*
3) What is the level of satisfaction? **based on the answer form question number one*
4) Have you ever looked through the internet to try and find related information?
5) What are the challenges if you have been referred to the internet?

Figure 4.12 Interview Questions

Ten respondents have been interviewed. Figure 4.12 shows where parents would go to when their infant is sick. 20% of them go to the general doctor to check their infant. 30% of them call their parent/ neighbor/ best friends who have the same experience to seek some advice from them. 30% of them will go to the pharmacy and discuss with the pharmacist in deciding the right medicine that they have to give to their infant. In conclusion most of the parents will not go directly to the Pediatrics, only 20% of them will go directly to the pediatrics.

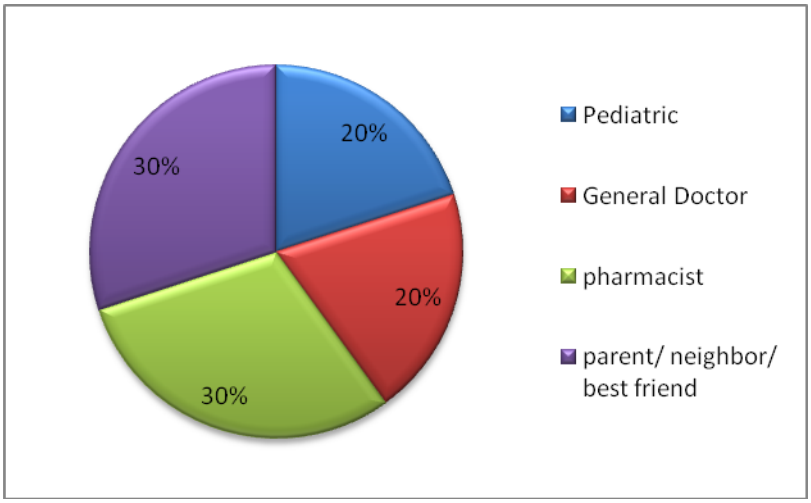

Figure 4.13 Question on where does parent go when their infant is sick

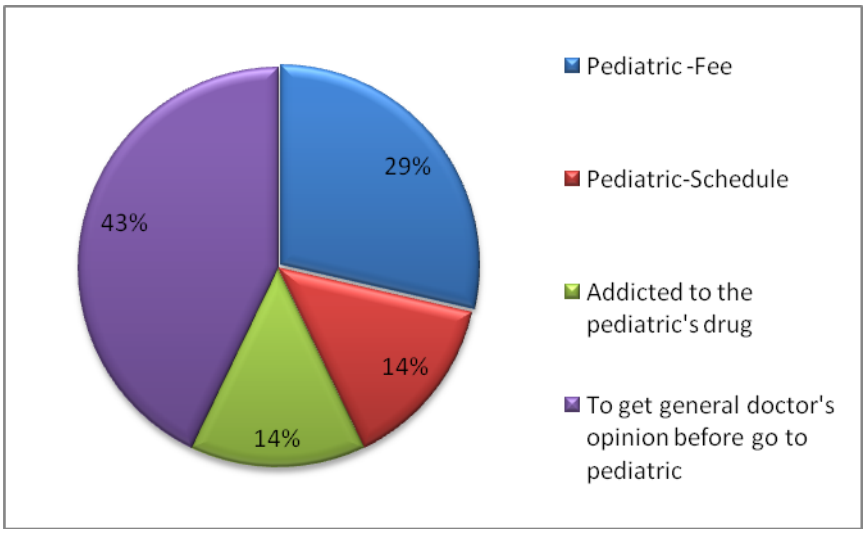

Figure 4.14 Motivation when parent doesn't go to the pediatric

Figure 4.13 shows some reasons why parents didn't go to the pediatric directly. 29% of the respondents said that they can save the money. One of the respondent said that she prefer go directly to buy medicine from the pharmacy instead of spending the money for pediatric-fee. 14% of the participant said that there was a hindrance with pediatric working-schedule. She said that when her infant got sick, she could be able to bring her infant to the pediatric because already midnight and that time was weekend also. So she decided to go to 24hours pharmacy and bought some medicine over there. Other than that, 43% of them want to seek first opinion by check with the general doctor before further check with the pediatric. However, all of the respondents said that they will bring to the pediatric if their infant still unwell.

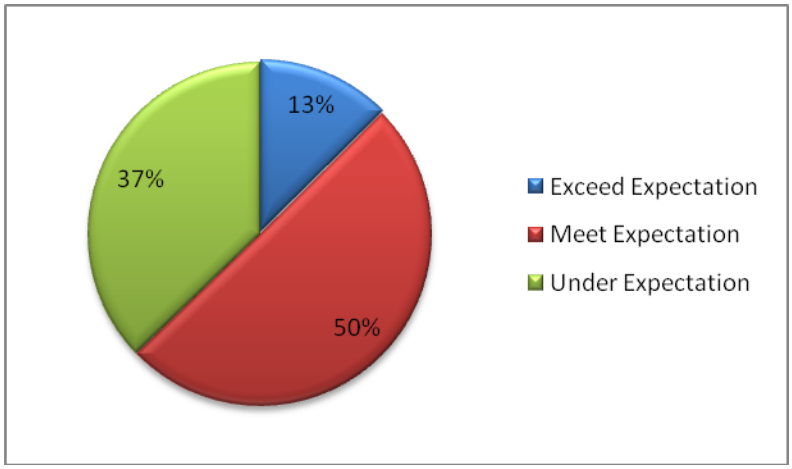

Figure 4.15 Level of satisfaction from the answer given in the first question

Based on the interview, 50% of the respondent said that they are satisfied with information or services given by the general doctor and pharmacist. A part of that, 13% respondent said that very satisfied and it exceed their expectation in the information given. It really help them in reducing their level of panic. However, 37% of the respondent said that they need further information and services to handle their unwell-infant.

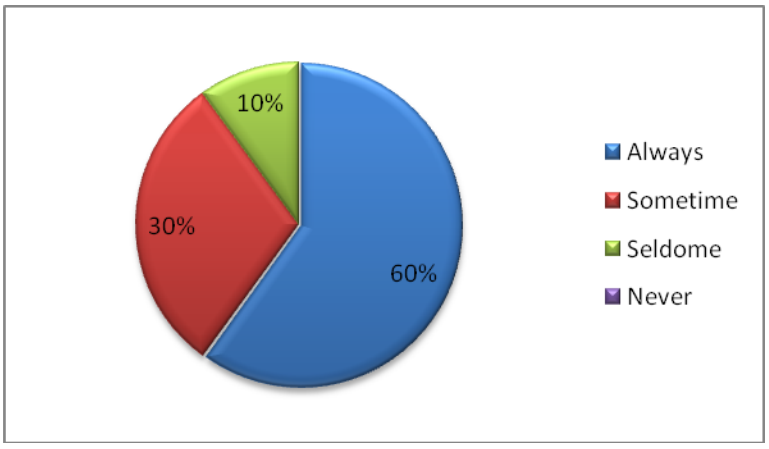

Figure 4.16 Using internets to try and find related information

Based on the interview, when their infant get sick all the respondent said that they have an experience in utilizing the internet to find the related information. Specifically, 60% of the respondent said that they always refer to the internet before bringing their infant to the expert. A part of that, 30% respondents said that they sometimes use the internet to obtain the information.

In addition, only 10% of the respondents seldom utilize internet to help them in giving an input on what happen to their infant.

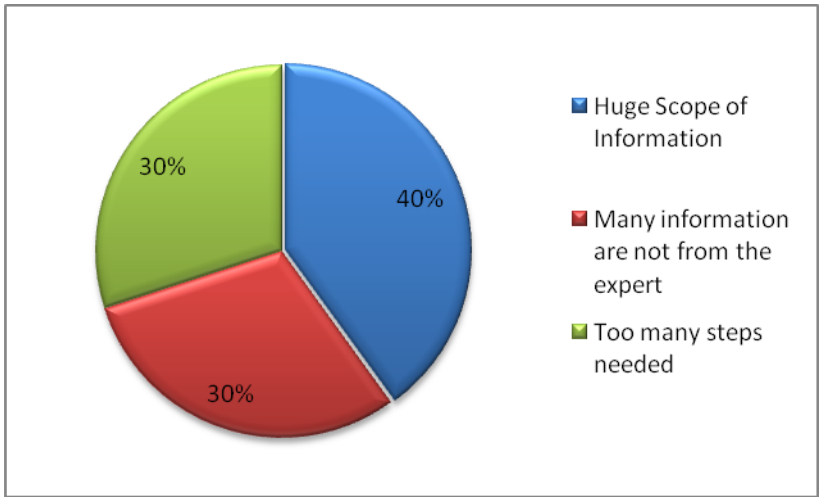

Figure 4.15 Challenges while using internets

Figure 4.15 shows the challenges that parent faced while seeking the information through the internet. 40% of them said that the available information in the internet is too huge. It made them difficult, take time, in finding the specific information that they looked for. A part of that, 30% of them said that the available information is not all come from expert's knowledge.

As conclusion, based on interview with the parents, most of them have high level of panic when their infant gets sick. A part of that, they will not directly go see the pediatric to seek the information and to check their infant. Furthermore, lot of them will utilize internet to obtain the information. However, there are some difficulties while their utilizing internet. For instance, there are huge numbers of information & steps to be followed which drive the parent to the level of depression in finding suitable information. Therefore, this project tries to ease parent in obtaining some preliminary diagnosis information.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Infant health is important to all parents in all over the world. However, infants are susceptible to disease. It is because the immune systems that are in the infant's body have not been built properly. Apart of that, most of the parent also get confuse to preliminary diagnose the disease in their infant's body.

In short, they doest know what happen exactly to their infant. Hence, this expert system project developed to diagnose several common infant illnesses, which are colds, constipation, diarrhea, ear infection, fever, food alelergies, gastroesophageal reflux (GER), and respiratory syncytial virus (RSV).

The initiate of developing this project are to ease the parent to preliminary diagnose potential common illnesses suffered by their infant and also to increase parent's knowledge on common infant illnesses. The application will ask the parent to input the symptoms and at the end the system will generate the conclusion as the nearest possible income. Apart from that, the system will also provide some knowledge on the illness and the tips on how to handle it before going to the doctor.

Other than that, current available system has not focus on diagnosing common infant illnesses. Hence, hope this system able to ease the parent to preliminary diagnose the potential common illness suffered by their infants. Furthermore, this expert system uses forward chaining, method move from the input toward the conclusion by matching a path between the inputted data from the user and known data in the system.

As a conclusion, the result of this expert system is the user, especially parent, will get information about the nearest possibility illnesses suffered by their infant.

5.2 Recommendation

There are several recommendations and suggestions that can be done in the future works. The first recommendation is interview process can be conducted with lots pediatrics to seek the highest accuracy of the diagnosis.

The second one is in term of the scope of study which can be expanded to a broader range, more command infant illnesses and inputted the number of symptoms of the illnesses which can be specific to the particular diseases.

The third recommendation would be utilizing the licensed-software which can use more than 150 nodes as the rules in the data base of the system.

REFERENCES

[1] Becerra-Fernandez, I., Gonzalez, A. and Sabherwal, R. (2004). *Knowledge Management Challenges, solutions, and Technologies*. NJ, United State of America: Pearson Education Inc

[2] Suri, R.P. (2007). *Introduction to prolog.* Oxford, UK: Alpha Science International Ltd.

[3] Dr.Stoppard, Miriam. (1998). *Child Heath.* London, UK: A Dorling Kindersley Book

[4] Guide to the Top 7 Infant Illnesses, retrieved from http://www.parenting.com/article/dr-sears-guide-to-the-top-7-infant-illnesses?page=0,1 on February, 15 2012.

[5] Infant Cold Symptoms, retrieved from http://www.ehow.com/about_5410883_infant-cold-symptoms.html on February, 15 2012.

[6] Oates, K., Currow, K. and Hu, Wendy. (2001). *Child Health A Practical Manual for General Practice*. NSW, Australia: MacLennan & Petty Pty Limited

[7] Rudolf, M.C.J., and Levene, M.I (1999). *Paediatrics and Child Health*. London, UK: Blackwell Science Limited.

[8] Common Infant Ilnesses, retrieved from http://www.iloveindia.com/parenting/common-infant-illnesses/index.html on February, 15 2012.

[9] What is a Fever? Fever Symptoms and Causes, retrieved from http://www.medicalnewstoday.com/articles/9895.php on February, 15 2012.

[10] Treating Common Illness, retrieved from http://children.webmd.com/treating-common-illness-10/slideshow-infant-symptoms on February, 15 2012.

[11] Food Allergy, retrieved from http://www.medicinenet.com/food_allergy/page2.htm on February, 15 2012.

[12] Baby Food Allergies, retrieved from http://www.homemade-baby-food-recipes.com/babyfoodallergies.html accessed in February, 15 2012.

[13] Safe Sleep for Babies, retrieved from http://www.snoozaboo.com/safe-sleep-for-babies on February, 15 2012.

[14] What is Expert System, retrieved from http://www.sil.org/lingualinks/literacy/ReferenceMaterials/GlossaryOfLiteracyTerms/WhatIstnExpertSystem.htm pn February, 15 2012.

[15] Mission Statement, retrieved from http://www.blurtit.com/q889820.html on February, 15 2012.

[16] Expert System in Prolog, retrieved from http://www.amzi.com/ExpertSystemsInProlog/01introduction.htm on February, 15 2012.

[17] Expert System in Prolog, retrieved from http://wiki.answers.com/Q/What_are_the_advantages_and_disadvantages_of_expert_system on February, 15 2012).

[18] Project N, retrieved from http://www.naimath.com/?q=content/getting-started on February, 15 2012.

[19] CS237 Intelligent System Expert, retrieved from http://www.it.bton.ac.uk/staff/lp22/CS237/CS237MedicalXSys.html on February, 15 2012,

[20] Expert System, http://www.igcseict.info/theory/7_2/expert/index.html on February, 15 2012,

[21] Industrial Management & Data System Journal, retrieved from http://www.it.bton.ac.uk/staff/lp22/CS237/CS237MedicalXSys.html on February, 15 2012,

[22] Industrial Management & Data Systems Journal, retrieved from http://www.emeraldinsight.com/journals.htm?articleid=850085&show=html on March, 11 2012.

[23] An expert system to support diagnostic decision making by a neonatologist, retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10198896 on March, 14 2012.

[24] Crying and fussing in an infant, retrieved from http://www.healthofchildren.com/C/Crying-and-Fussing-in-an-Infant.html#b on March, 14 2012.

[25] Why Children are at Higher Risk, retrieved from http://www.afhh.org/chil_ar/chil_ar_why_children.htm on March, 21 2012,

[26] What You Should Know About High Fever in Teething Infants, retrieved from http://voices.yahoo.com/what-know-high-fever-teething-2584585.html on March, 21 2012,

[27] Award, Elias M., I. (1995). *Building expert system: principle, procedures, and application*. MN, United State of America: West Publishing Company.

[28] How are expert system corvid knowledge automation system fielded, retrieved from http://www.exsys.com/faq.html on April, 5 2012.

[29] Giarratano, J.C., and Riley, G.D (2005). *Expert system: principle and programming*. LV, Canada: Thomson Learning Inc

[30] Ignizio, James P. D (1991). *Introduction to expert system: the development and implementation of rule-based expert system.* United State of America: McGrew-Hill, Inc.

[31] Bouhaddou O, Frucci L, Cofrin K, Larsen D, Warner H Jr, Huber P, Sorenson D, Turner C, Warner H. Implementation of practice guidelines in a clinical setting using a computerized knowledge base (Iliad). Proc Annu Symp Comput Appl Med Care. 1993;:258-62.

[32] Expert system for internal medical diagnosis, retrieved from http://www.openclinical.org/aisp_iliad.html on April, 5 2012.

[33] Lincoln MJ, Turner CW, Haug PJ et al. Iliad training enhances medical students' diagnostic skills. J Med Syst. 1991 Feb;15(1):93-110.

[34] Wolfram, D (1995). "An appraisal of INTERNIST-I". Artificial Intelligence in Medicine 7 (2): page 1.

[35] Janice S. Aikins, John C. Kunz, Edward H. Shortliffe, and Rohert J. Fallat (2000) *PUFF an expert system for interpretation of pulmonary Function Data.* United State of America: McGrew-Hill, Inc.

[36] Medical Diagnosis Expert System, retrieved from http://home.pacific.net.au/~med5gl/sftdoc.htm on April, 5 2012.

APPENDICES