KNOWLEDGE BASED REASONING ON CLINICAL INFORMATION SYSTEMS (CIS): IN-FOCUS OF COMMON & RARE DISEASES SYMPTOM FINDINGS

by

MAWAR MALISSA BINTI HARUN

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
Information Systems

JAN 2005

Universiti Teknologi Petronas
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

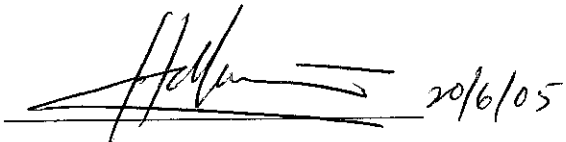
KNOWLEDGE BASED REASONING ON CLINICAL INFORMATION SYSTEMS (CIS): IN-FOCUS OF COMMON & RARE DISEASES SYMPTOM FINDINGS

by

Mawar Malissa Harun

A project dissertation submitted to the
Information Systems Programme
Universiti Teknologi PETRONAS
in partial fulfillment of the requirement for the
Bachelor of Technology (Hons)
(Information Systems)

Approved:



Mr Helmi Md Rais
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

January 2005

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Mawar Malissa Harun

ABSTRACT

Technology has put his hand into medical field back in the 70's. Computerized system is placed in every sector including medical. Hence, the need of expert system to assist the end users is practically relevant. This research will discuss about the expert system and the concept of artificial intelligence in medical field. Thus, explaining the methodology that goes behind developing the end product of this project. The expert system will become one platform for other medical system. The application is made available through wireless environment. Wireless infrastructure is shown with the usage of notebook (in case of this project). Medical information is gathered from books and experts before modeled out into the system. There are 3 main rare diseases that will be diagnosed from the common symptoms by showing the details and prescription. The system can later on be reproduced or enhanced with added disease information. Furthermore, the data can be updated with the features embedded into the system. The prototype is meant be one of the pioneers for another great invention in the future.

ACKNOWLEDGEMENTS

Assalamualaikum WBT.

Syukur alhamdulillah

I would like to thank Almighty God for His blessing throughout the project duration. Being able to cling upon and pray for success is one important factor to help me go on with this project.

I would like to give my highest gratitude to Mr. Helmi Md Rais, my supervisor for his support and encouragement. It has been a good experience to have the opportunity to work under his supervision. Thank you for the guidelines given and tolerance on my project.

I would also like to thank all other lectures who have been of great help while doing the project. They have been very helpful and supportive in guiding me for this project. Hence, I would say it has been nice to be part of UTP community.

My family and friends are among others who have always been there to motivate me doing the project. Not to forget, Dr. Zulkifli Mohamed Sharif, UTP panel doctor for his views and suggestion for the system. Last but not least, thank you to all and I hope this project would be of benefit to future reference.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ES	Expert System
LAN	Local Area Network
WLAN	Wireless Local Area Network
PDA	Personal Device Assistant
SARS	Severe Acute Respiratory Syndrome
DCD	Disease Control Decision
MSC	Multimedia Super Coridor
SDLC	System Development Life Cycle
ESDLC	Expert System Development Life Cycle
CBR	Case Based Reasoning
RBR	Rule Based Reasoning
FBC	Full Blood Count

CHAPTER 1
INTRODUCTION

Information technology has a vital role in everyday life. Even our country, Malaysia, has introduced Multimedia Super Corridor or MSC status within the government sector and private bodies. Hence, the trend in implementing IT in everyday life is now a common scenario. This research on developing an expert system to diagnose common and rare disease has taken medical field as the platform. Thus, the end product should act as an expert system shell that later on can be enhanced for better usage in the future. The prototype is meant to computerize the medical information that can be reached through wireless technology.

1.1 Background of study

Being in IT field, one should choose a platform to develop the IT application. As when the system connects to the people, that is when it is considered as an Information System. The product is yet another invention of medical diagnosing system in the market. This application has taken the hospital and medical practitioners as a platform. This type of application which can be access in through wireless device is the added advantage. Hence, with the current scenario that occur in south Asia, the tsunami, those medical practitioners would likely want to have a system that can be access wirelessly. Beside that, it is the trend nowadays when people go for wireless mode.

Why we choose medical as the platform? Since the end product is meant to aid new medical practitioners to do diagnose, we noticed how being healthy is important to any human being. Health as defined in Merriam-Webster's Medical Desk Dictionary

is the condition of an organism or one of its parts in which it performs its vital functions normally or properly: the state of being sound in body or mind, freedom from physical disease and pain. Hence disease is defined as an impairment of the normal state of the living animal or plant body or one of its parts that interrupts or modifies the performance of the vital functions and its response to environmental factors (as malfunction, industrial hazards, or climate), to specific infective agents (as worms, bacteria, viruses), to inherent defects or the organism (as genetic anomalies), or to combinations of these factors – sickness, illness. From the definition, it shows how health is important and that one should cure disease before it endanger our life. Hence, that is why it is best to increase the effectiveness and efficiency of today medical system through computerized system.

1.2 Product contribution to research area

For this time around, the application is made available through certain wireless technology. However, the prototype should be a starting point for future system to be implemented in the same manner. Hence, it will enhance our medical system into giving faster and accurate information to the designated users. Besides that, the prototype does not meant to overcome doctors or the experts but to assist them when attending a patient. It would be an added advantage to have an expert system even not in the hospital premises. In the era of MSC, the society is introduced to telemedicine in such a way it helps both the medical practitioners and end users to get medical information faster. A system for medical field is indeed a must have because it ensure the effectiveness and efficiency for medical practitioners.

1.3 Problem statement

Health is one crucial thing in our life. A good and healthy life leads to a better and happier person. In the society, people look up to medical practitioner namely doctors as someone responsible to look after them. Since the number of patients increasing, the proportion of doctors especially the specialist is insufficient. According to Dato' Dzulkifli Abdul Razak, the doctor-to-population ratio is said to be 1:650 in Malaysia

as a whole. Therefore, the country is lacking of professional in this medical field. Fresh or new doctors may not be well equipped in terms of expertise while attending their patients. Therefore, there should be one system to assist these new doctors to verify them without having to consult with the busy specialist.

The hospital itself may have to come out with a policy of imposing a standard treatment procedure to patients. This is shown by one of the private hospital called Mater Private Hospital in Dublin, Ireland. So many doctors in any hospital might have attended the same patient. Thus, when patients come and need consultation from different doctors, they might be given different prescription. This may lead to a complication later on whereby if the patients move to another hospital or the patient may have certain allergy that each doctor that may attend him should know. For that reason, more hospitals nowadays tend to opt for a standard treatment procedure where new medical practitioners will used while attending their patients.

Besides that, another problem these doctors face is when they are out of the hospitals premises. Hence, the mobility of that system is questioned by the end users. Therefore, the scope of this project is to develop a prototype of medical diagnosing system that is made available even in wireless environment. Thus, the end users can still connect to the application in remote area where wireless application can be reached. The wireless connectivity helps a lot in medical effectiveness as shown in WLANA Enterprise Application – St. Joeseph Hospital.

1.4 Objectives and scope of study

1.4.1 Objectives

The aim of this project is to develop a medical expert system that can be access even in unwired environment. Following are the objectives to be achieved throughout the research and development:

i. To identify the underlying concepts of Artificial Intelligence to be used in medical fields
ii. To identify medical procedures and treatment to be included into the system
iii. To develop a medical diagnostic system resulted from research.
iv. To be able to connect to the system using wireless technology.

1.4.2 Scope of study

The scope of the system is to detail out three (3) rare diseases namely infectious mononucleosis, typhoid fever and leptospirosis. This prototype will follow the model on how medical practitioners usually diagnose a patient. Thus, the system acts as an expert system shell that the contents can later be change accordingly. Therefore, easier for the knowledge engineer to capture new knowledge from domain experts and filled in the system. Plus, the system is easy to maintain from time to time.

1.4.3 Feasibility of the project within timeframe and scope

This project can be deemed as feasible within time and scope due to the following factors:

i. The medical study area is focusing on three (3) diseases only which can be done within time frame
ii. There is no additional cost needed for hardware because it is available in the computer laboratory
iii. There is also adequate resource of reference, books, online source and experts.
iv. The time allocated for this project is sufficient since the project scope has been identified and narrows down.

CHAPTER 2
LITERATURE REVIEW/ THEORY

Knowledge based system is also known as Expert System (ES) and part of Artificial Intelligence. Thus what does it mean by knowledge based reasoning or this expert system and what impact does it have in our lives. AI involves with developing an intelligent software and hardware systems that imitate the human expertise. In other words, AI as sub field of computer science try to model out the way human may think on one particular subject specifically the process of decision making. Hence, this kind of expert system is widely used in variety of application namely medical field and business industry.

2.1 Artificial intelligence (AI) in medical field

This research is to develop an intelligent system for medical practitioners. Thus, the concept of artificial intelligence is embedded within the system. According to Negnevitsky, in his book Artificial Intelligence, A Guide to Intelligent System, intelligence is the ability to learn and understand, to solve problems and to make decisions. Hence, an intelligent machine should be able to think or as he stated in his book. According to the Collin Dictionary, thinking is the activity of using your brain to consider a problem or to create an idea. He also stated that the goal of artificial intelligence (AI) as a science is to make machines do things that would require intelligence if done by humans (Boden, 1977). AI that is incorporated into a computer system is called an expert system. According to James (1991), expert system is defined as a computer program that exhibits, within a specific domain, a degree of expertise in problem solving that is comparable to that of a human expert. Among famous medical expert system is MYCIN and yet these expert systems acts as "intelligent assistant". Meaning to say that, having captured the domain expert's knowledge and expertise, human can actually rely on them.

2.1.1 Medical rule based reasoning – MYCIN

Back in the midst of 70's, a project called MYCIN was initiated by Feigenbaum and his colleague back at Stanford University. MYCIN was a rule- based expert system for the diagnosis of infectious blood diseases. It also provided a doctor with a therapeutic advice in a convenient manner.

According to Negnevistky, the characteristic of MYCIN is as follows:

- MYCIN could perform at a level equivalent to human experts in the field and considerably better than junior doctors.
- MYCIN's knowledge consisted of about 450 independent rules of IF – THEN from derived from human knowledge in a narrow domain through extensive interviewing of experts
- The knowledge incorporated in the form of rules was clearly separated from the reasoning mechanism. The system developer could easily manipulate knowledge in the system by inserting and deleting some rules. For example, a domain-independent version of MYCIN called EMYCIN (Empty MYCIN) was later produced at Stanford University (van Melle, 1979; van Melle et al., 1981). It had all the features of the MYCIN system except the knowledge of infectious blood diseases. EMYCIN facilitated the development of a variety of diagnostic applications. System developers just had to add new knowledge in the form of rules to obtain a new application.

From MYCIN application, the rule based approach model out the knowledge in a conditional mode. These condition or rules must be match in order to get the final output or result. As such the rule based reasoning is mainly about the IF THEN ELSE rule statement.

However, according to Howard Rheingold, MYCIN is defined as follows:

> MYCIN, for example, can be fed a configuration of symptoms exhibited by a patient. If these symptoms can lead to diagnosis of a disease the program "knows about," it will ask the attending physician for more input about specific symptoms to narrow down the possibilities until it can venture a diagnosis. When the physician questions the computer about the specific line of reasoning the program uses to make a decision, the expert system is able to explain its decision through a simple human-language dialogue:

MYCIN: HAS THE PATIENT RECENTLY HAD SYMPTOMS OF PERSISTENT HEADACHE OR OTHER ABNORMAL NEUROLOGIC SYMPTOMS (DIZZINESS, LETHARGY, ETC.)?
HUMAN: YES.
MYCIN: HAS THE PATIENT RECENTLY HAD OBJECTIVE EVIDENCE ABNORMAL NEUROLOGIC SIGNS (MUSCLE RIGIDITY, COMA, SEIZURES, ETC.) DOCUMENTED BY PHYSICIAN OBSERVATION OR EXAMINATION?
MYCIN: THE CSF CULTURES WILL BE CONSIDERED TO BE ASSOCIATED WITH MENINGITIS. PLEASE GIVE THE DATE ON WHICH CLINICAL EVIDENCE (SYMPTOMS, SIGNS OR LABORATORY TESTS) OF MENINGITIS FIRST APPEARED. PLEASE ENTER CSF FINDING. IS MENINGITIS A HOSPITAL-ACQUIRED INFECTION?
HUMAN: WHY?
MYCIN: THIS WILL AID IN DETERMINING THE ORGANISMS (OTHER THAN THOSE SEEN ON CULTURES OR SMEARS) WHICH MIGHT BE CAUSING THE INFECTION. IT HAS ALREADY BEEN ESTABLISHED THAT
(2.1) The infection which requires therapy is meningitis, and
(2.2) organisms were not seen on the stain of the pending csf culture, and
(2.3) the type of infection is bacterial, and
(2.4) neurosurgery is not one of the relevant items from the history of this patient, and
(2.5) the age of this patient is greater than ten days, therefore, if
(2.6) the infection was acquired while the patient was hospitalized then there is evidence that the organisms (other than those seen on cultures or smears) which might be causing the infection are e. coli, staphylococcus-coag-pos, pseudomonas-aeruginosa.

From the example above, it shows that how MYCIN has model out the data and knowledge from the experts. Then, using those data, it is transformed into rules that may lead to the final answer or possible solution. However, rules based is lacking in term of reasoning vague data. Since most information that is model out using rules is rigid, it may not cater incomplete or fuzzy information. These fuzzy data are maybe ranges for example; in rigid you may have either black or white. However, in a fuzzy data, the range might be from black to grey then to white. Henceforth, the AI experts have also come out with case based reasoning.

2.1.2 Medical case based reasoning

Instead of using rules, cased based reasoning depends on cases or previous records that can result to a solution. Cased based reasoning (CBR) started out in the 80's and according to Koton (Koton 1988), and Bareiss (Bareiss 1989), Case-Based Reasoning (CBR) appeared as an interesting alternative for building medical AI applications, and has since been further established in the field. The CBR takes the concept of patient and disease lends itself naturally to a case representation. When patients come and see the doctor, they actually giving out the case and later diagnose by the doctor.

The CBR works when the cases are compared with base cases stored within the database. Through past or medical history, the similar cases will be match with the current condition. The retrieved cases are used to suggest a solution which is reused and tested for success. If necessary, the solution is then revised. Finally the current problem and the final solution are retained as part of a new case.

According to Ian Harrison, the CBR process consists of the following:

- retrieve the most similar case (or cases) comparing the case to the library of past cases
- reuse the retrieved case to try to solve the current problem

- revise and adapt the proposed solution if necessary
- retain the final solution as part of a new case

The process basically takes the previous form or medical information to be match with the current condition. Thus, the base cases can be revised accordingly. Solution and previous treatment are treated as the base for future diagnostic.

Gierl and Schmidt (Gierl & Schmidt 1998) identify the following key advantages of medical CBR;

- *Cognitive Adequateness.* CBR resembles the way physicians are reasoning about patients and the way they use their case expertise.
- *Explicit Experience.* A CBR system is naturally suited for adjusting itself to the specific requirements of a certain clinic or a surgeon.
- *Duality of Objective and Subjective Knowledge.* Instead of using the subjective knowledge of one or more experts to build systems (as is done for e.g. rule-based expert systems) CBR systems are built upon existing cases (which may or may not be fully understood).
- *Automatic Acquisition of Subjective Knowledge.* CBR systems exhibit an incremental knowledge acquisition, and knowledge can be abstracted by generalizing cases.
- *System Integration.* Patient records are already being collected by hospitals and practitioners and stored on machine readable mediums, which simplifies integration with CBR systems which can utilize them (after varying degrees of modification).

These advantages show how case representative can be used in diagnosing disease as the cases act as benchmark to match with the current condition. As such, through past experience and similar cases, the case based medical system can be enhanced through time as more past cases are embedded within the system.

However, there are also disadvantages resulted from medical case-based reasoning as noted by Markus Nilsson and Mikael Sollenborn (Advancements and Trends in Medical Case-Based Reasoning: An Overview of Systems and System Development)

> •*Adaptation.* Because of the often extremely large number of features involved in a medical case, adaptation of cases becomes problematic. Generalization and efficient feature identification methods helps to partly remedy this issue, but generally the problem persists. (Schmidt & Gierl 2000)
>
> • *Unreliability.* Although the reliability of a CBR system increases with the proportion of coverage of the problem domain, reliability cannot be guaranteed. Adding new cases will not necessarily make a system converge towards greater reliability, as cases add only local improvement. Indeed, Bichindaritz argues that the strictly local properties of cases make convergence an inappropriate notion for CBR systems. (Bichindaritz 2003)
>
> • *Concentration on reference.* CBR systems are concentrated on reference as opposed to underlying diagnostic factors. Thus, systems cannot function as sources of previous experience unless a suitable case exists in the case base.

A study was done over medical CBR before the year 1998 by Gierl & Schmidt and one study area was on medical CBR diagnostic system. From the previous findings, examples of medical CBR include:

• *FM-Ultranet* (Balaa et al. 2003; Balaa & Traphoner 2003) is a medical CBR project implemented with CBR-Works. FM-Ultranet detects malformations and abnormalities of foetus through ultrasonographical examinations. The system first scans the mother's uterus and identifies abnormal organ and extremities. This is treated as the attribute then it will be compared through a look up table. *FM-Ultranet* used the object oriented concepts and hierarchy concept to arrange the cases.

• *Jaulent et al.* (Jaulent et al. 1997) is diagnosing histopathology in the breast cancer domain. Their system uses cases that are derived from written medical reports. A tree structure is used to arrange the cases and is compared with the similarity of the sample features.

• *Perner* (Perner 1999) proposes a system that uses CBR to optimize image segmentation at the low level unit according to changing image acquisition conditions and image quality. The system has been used to detect degenerative brain disease in particular Alzheimer disease in CT images of a patient. One main characteristic of the system is that it uses a rich knowledge base of prototypical cases and practice guidelines to interpret medical cases and guide the case based reasoning.

CBR approach flow is shown in **FIGURE 2.1**. As stated by Rainer Schmidt, Lothar Gierl on their article about *Case-based Reasoning for Medical Knowledge-based Systems*

> In medical knowledge based systems there are two sorts of knowledge, objective knowledge, which can be found in textbooks, and subjective knowledge, which is limited in space and time and changes frequently.

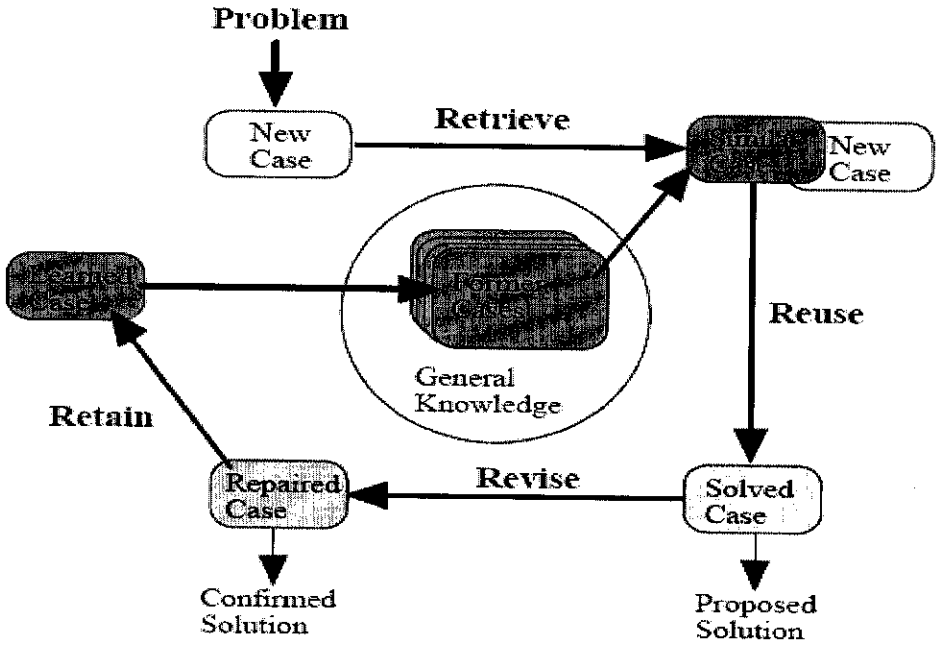


FIGURE 2.1: The Case-based Reasoning cycle developed by Aamodt

Hence, this CBR flow may not be used as exactly. There might be an attempt to use the CBR partially or when necessary.

A medical CBR approach is suitable to be embedded in a system if it matches the following situation:

- records of previously solved problems exist;
- historical cases are viewed as an asset which ought to be preserved;
- remembering previous experiences is useful;
- specialists talk about their domain by giving examples;
- experience is at least as valuable as textbook knowledge

Case-based reasoning is often used where experts find it hard to articulate their thought processes when solving problems. This is because knowledge acquisition for a classical knowledge based system (KBS) would be extremely difficult in such domains, and is likely to produce incomplete or inaccurate results. When using case-based reasoning, the need for knowledge acquisition can be limited to establishing how to characterize cases.

Case-based reasoning allows the case-base to be developed incrementally, while maintenance of the case library is relatively easy and can be carried out by domain experts.

2.2 Wireless local area network (LAN)

This system will be implemented in a wireless environment. As such, a portable device such as notebook or laptop and Personal Device Assistant (PDA) should be able to connect to the system. The device setting plays an important role to show how the application can be reach in unwired. Since the application will be web- based system, the concept of wireless web is implemented. Wireless LAN) is a Local Area Network that a mobile computer user can connect to through a wireless connection **(FIGURE 2.2)**

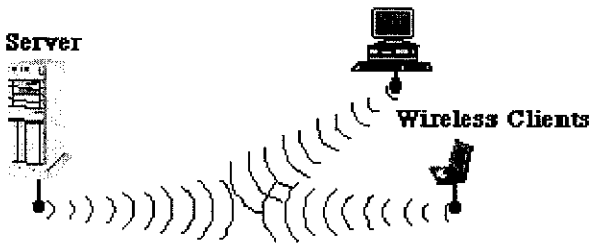


FIGURE 2.2: Wireless LAN architecture

Wireless is the "in thing" nowadays when organization move to broader aspect that need to get connected even in remote area. Many new applications has adopted wireless as in to connect computers, to allow remote monitoring and data acquisition, to provide access control and security, and to provide a solution for environments where wires may not be the best solution. The same philosophy will be used when implementing the medical system in wireless environment.

WLANs are based on the IEEE 802.11 standard. There are three physical layers for WLANs: 2 radio frequency specifications (RF - direct sequence and frequency hopping spread spectrum) and 1 infrared (IR). Most WLANs operate in the 2.4 GHz license-free frequency band and have throughput rates up to 2 Mbps. The new 802.11b standard is direct sequence only, and provides throughput rates up to 11 Mbps.

WLAN configurations vary from simple, independent, peer-to-peer connections between a set of PCs, to more complex, intra-building infrastructure networks. There are also point-to-point and point-to-multipoint wireless solutions. A point-to-point solution is used to bridge between two local area networks, and to provide an

alternative to cable between two geographically distant locations (up to 30 miles). Point-to-multi-point solutions connect several, separate locations to one single location or building. Both point-to-point and point-to-multipoint can be based on the 802.11b standard or on more costly infrared-based solutions that can provide throughput rates up to 622 Mbps (OC-12 speed). In a typical WLAN infrastructure configuration, there are two basic components:

1. Access Points - An access point/base station connects to a LAN by means of Ethernet cable. Usually installed in the ceiling, access points receive, buffer, and transmit data between the WLAN and the wired network infrastructure. A single access point supports on average twenty users and has a coverage varying from 20 meters in areas with obstacles (walls, stairways, elevators) and up to 100 meters in areas with clear line of sight. A building may require several access points to provide complete coverage and allow users to roam seamlessly between access points.

2. Wireless Client Adapter - A wireless adapter connects users via an access point to the rest of the LAN. A wireless adapter can be a PC card in a laptop, an ISA or PCI adapter in a desktop computer, or can be fully integrated within a handheld device.

2.3 Medical findings and issues in Malaysia

The three (3) rare diseases to be put into the system are Infectious mononucleosis, typhoid fever and leptospirosis. These three (3) rare diseases might happen from common symptoms. As shown in the statistic, typhoid fever is reported to be one of the communicable diseases (refer appendixes). Communicable disease can be defined as an infectious transmissible (as from person to person) by direct contact with an infected individual or the individual's discharges or by indirect means (as a vector) (Merriam – Webster's Medical Desk Dictionary, 2002). Diseases prevention has been taken into serious account by the Malaysian Health Department. Recently with the disease outbreak of Severe Acute Respiratory Syndrome (SARS) and the tsunami tragedy, this government bodies has come out with a Disease Control Division (DCD). Even in the whole world, these diseases are highly taken care off. (Appendix A). Hence, it shows how important such system to diagnose disease. The DCD is a means of control measure by the Malaysia Ministry of Health.

> The mission of the Ministry of Health is to build partnerships for health, to motivate and facilitate the people to attain fully, their potential in health, to appreciate health as a valuable asset, and to take positive action to improve and sustain their health status to enjoy a better quality of life.
>
> (Source: http://dph.gov.my/ddc/about.htm)

In the new era of Multimedia Super Corridor (MSC) that Malaysia is moving toward, the medical field has also change its management to Telemedicine. Hence the market for medical professional has also affected by this trend. Nonetheless, since the number of population is increasing, Malaysia may need more doctors in the future (refer **TABLE 2.1**)

TABLE 2.1: Healthcare Professionals by Category, 1990 – 2010

Category	1990	1995	2000	2010
MEDICAL PROFESSIONALS				
Doctors	7012	9504	14029	15510
Dentists	1471	1791	2243	2909
Pharmacists	1239	1622	2586	2909
RATIO TO POPULATION				
Doctors	1:2569	1:2177	1:1658	1:1500
Dentists	1:12245	1:11552	1:10370	1:8000
Pharmacists	1:14538	1:12756	1:8995	1:8000
ALLIED HEALTH PROFESSIONALS				
Dental Paramedics	2137	2720	4097	6361
Radiographers	508	530	1049	1297
Public Health Inspectors	1007	1418	2019	2695
Medical Assistants and Laboratory Technologists	4903	5392	8287	9482
Occupational Therapists	234	410	811	911
Nurses	28932	32401	47812	50551

(Source: Seventh Malaysia Plan 1996 – 2000)

The table shown has proven that how these medical professionals are very much in demand. Hence, building an expert system that can help assist diagnosis would be of great assistant to new medical practitioners.

Apart from that, Malaysia has also come out with telemedicine. This approach has eased both patients and also medical practitioners in improving the current medical status.

Telemedicine as defined by Dave Warner

> Telemedicine is the integration of telecommunications technologies, information technologies, human-machine interface technologies, and medical care technologies for the purpose of enhancing health care delivery across space and time. Telemedicine includes the transfer of medical information

(graphic, video, voice, etc.) between distant locations with patients, physicians, other health care providers, and medical institutions. It includes using telecommunications to link health care specialists with clinics, hospitals, primary physicians and patients in distant locations for diagnosis, treatment, consultation, and continuing education.

(Source: M3, Telemedicine in the age of MSC, April 1997)

These show that Malaysia current medical status is on good standing. Thus, government did take initiative for medical purposes and for the health of Malaysian people.

CHAPTER 3
METHODOLOGY / PROJECT WORK

This project is implemented through several stages or phases that are general in expert system development life cycle. The flow will basically start with defining the problem through research, gather the data and information, plan out the system flow, design, develop then test the system. Plus, the diagnosing part also has its own methodology on how to go about it. Expert system development life cycle as part of SDLC is meant to ensure the project meets the requirements in a structured manner. The project will basically start with defining the problem through studying the current situation, gathering the data and information, planning out the system flow, and designing, developing and testing the system. Medical treatment and disease diagnosing is a major part of the system that requires one acquire the information then model out in the system.

The requirements are important and so the method should be able to comply with it so that the output will match the project requirements. For this project, the life cycle is as follows: (refer appendix)

1) Problem identification
2) Preliminary requirements analysis and knowledge acquisition
3) Selection of expert tools
4) Knowledge acquisition
5) Prototype development
6) Verification and validation
7) Implementation
8) Operation and maintenance

ESDLC is chosen as compared to other methodology because of its suitability in handling user requirements efficiently. Hence, the 8 development phases are constructive and coherent to each other.

3.1 Problem identification

Prior in developing a system, one should identify the main problems that acquire the solution. In doing so, a study has been done through reading few papers on medical condition nowadays. Apart from that, few questions were given out to medical practitioner asking how they work and so on. Besides that, several discussions have been done with this project supervisor to clarify the main problems to identify the objective of this project. Nonetheless, survey has also been done to students here in UTP to have their views on medical system in Malaysia. Having a solid problem statement helps to narrow down the focus and scope of the project. The system should be able to provide solution to those problems. As stated in the project background, the problems are as follows,

a. New doctors that have not become a specialist need a system to assist them in verifying their decision apart from seeking help from specialist.
b. Medical practitioners need to be able to access one system even in remote area, or when there's no wire needed.

3.2 Preliminary requirements analysis and knowledge acquisition

At this stage, the problems condition need to be analyze. Identify the steps to be taken to solve the problems along with the alternatives. This stage requires answers to questions like what the system should have in terms of functionality. Besides that, medical practitioners' views on the system are important so that the final result will match or exceed their expectation. One solution for the problem is to build a system that has captured the specialist knowledge and can be used by other medical

practitioners. Hence, the solution should be able to work in a wireless environment. Therefore, basic ideas on what the systems should have and able to perform has been discovered from the preliminary requirement analysis. This data gathering on preliminary requirement is part of an early knowledge acquisition. Having all the requirements done, the end product will be a kind of prototype to show how to solve the problem. That is to build an expert system catering on finding three (3) diseases based on the common symptoms and result from differential investigation i.e. the laboratory test as part of phases usually done by medical practitioners.

3.3 Selection of expert tools

Since the system is mainly focusing on diagnosing three (3) kinds of diseases, the tool used for the implementation part is Exsys Corvid. The tool is able to capture and model the knowledge into the system (**FIGURE 3.1**). Hence, the output of Exsys file is in html format; therefore, it can be uploaded to a web server to make it available through the internet.

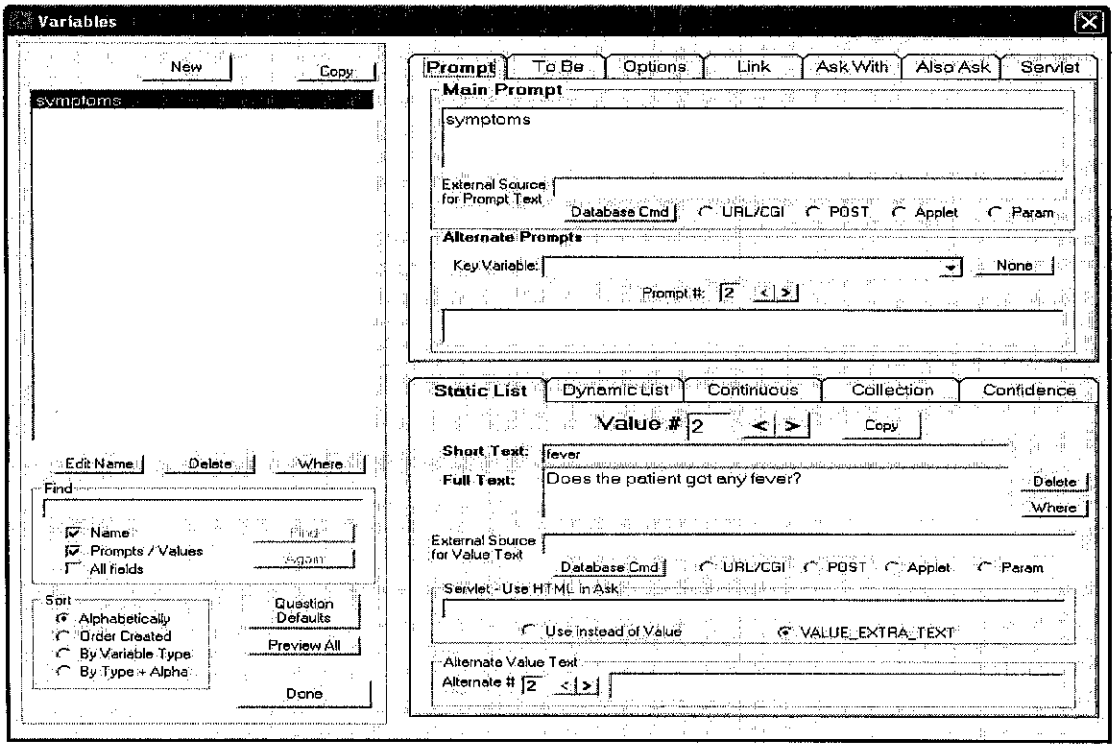


FIGURE 3.1: Setting variables in Exsys CORVID

The right tool helps one to develop the system faster and in more efficient manner. Exsys is proven tool for developing an expert system hence easy to use for both designer and end users.

3.4 Knowledge acquisition

In order to build an expert system, the experts' knowledge should be gathered and model out into the system or called as knowledge acquisition. Few techniques can be done in order to gather the information that is either through interview with the experts, observation, books and other resources available from the internet. Few medical books were used as reference apart from information available in the internet. However, since medical specialist time is hard to get, the prototype will cater most of the knowledge from other resources such as books. The theory is then verified by medical practitioners. There are five (5) stages in knowledge acquisition:

- Identification - This stage identifies the problems and the knowledge engineer becomes aware of the domain, its goals and selects the correct material.
- Conceptualization - This defines how the concepts or ideas and the associations between them are outlined and how they are related by experts.
- Formalization - Here the knowledge engineer organizes the concepts, tasks and other information into formal and clear representation.
- Implementation - Here the knowledge rules are put into a structured form for the expert system tool and a prototype (trial model) is created for testing out the design and the processes. The knowledge engineer has to produce a written documentation that will connect the knowledge base topics with the original data that were created earlier.
- Testing - The prototype system is tested for its efficiency and accuracy to see if it is working as required. In order to do this a small scenario or problem set is tested and the results from this system are used to alter or improve the prototype system

(Source: Karan.L. McGraw and Karan Harbison-Briggs)

As discussed above, some part of the knowledge acquisition is yet stages in the other expert system development life cycle. Therefore, throughout the development, the data will be needed. Hence, the data gathering and prototyping comes together during the development. Most data gathered will be model out in a decision tree or in a form that designer can see the flow of symptoms.

Next, the knowledge engineer will model out all these data into a model that can be used for system implementation such as the system flow diagram, storyboard, UML and decision tree.

The flow of the system is as follows: (refer appendix)

1) End user medical practitioners start the system
2) Select the symptoms
3) View the possible disease, an information will be displayed if the symptoms does not match the available diseases
4) View the treatment
5) Print out the record
6) End system

Basically, the UML diagram of the system is shown in **FIGURE 3.2**. The diagram indicates how the system can interact with the end users. The system gives responds or results to the end users request. In this case, the users simply identify the symptoms then the system will leads to possible disease and its treatment.

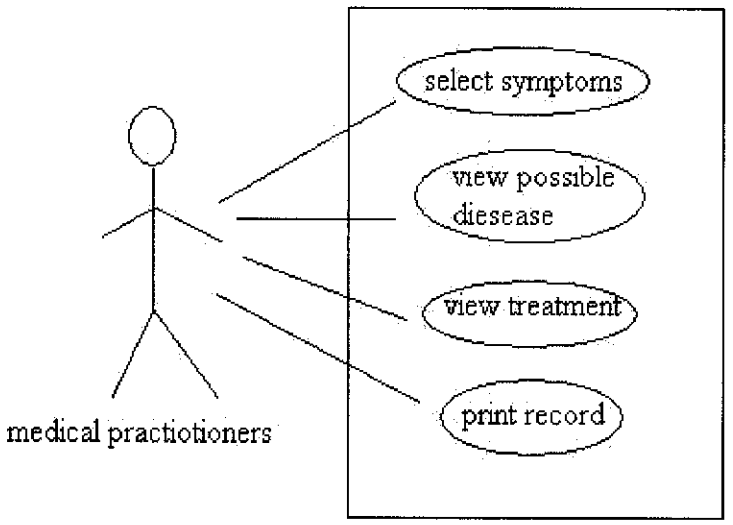


FIGURE 3.2: UML diagram

Having the flow and UML diagram, one can now plan the system storyboard or layout of the system. The system will start with the main page as shown in **FIGURE 3.3**

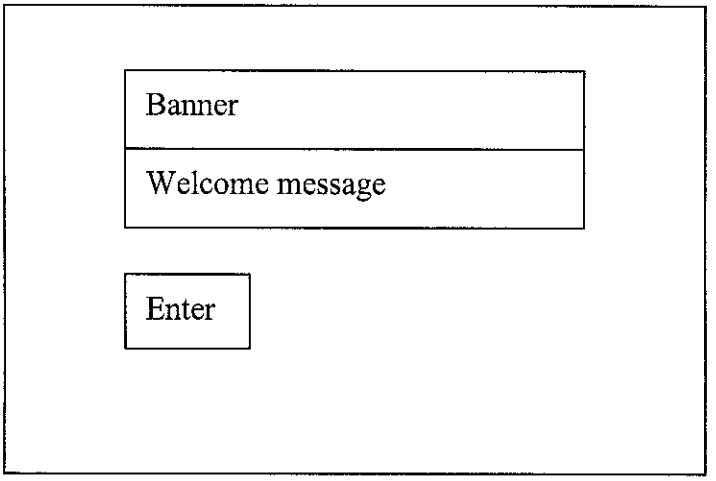


FIGURE 3.3: Landing page

From the main page, end users will be shown several symptoms. Then users need to select the symptoms from the options then proceed with the action button as shown in **FIGURE 3.4.**

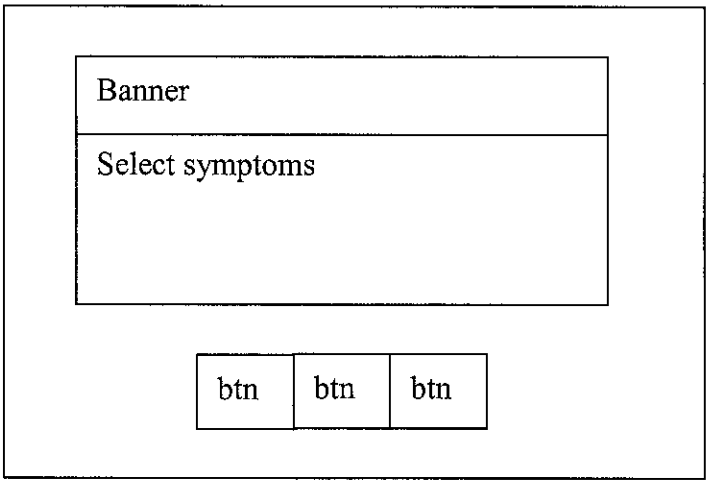


FIGURE 3.4: Symptoms pages

The same layout will be shown to users until they reach to the possible disease page as shown in **FIGURE 3.5**.

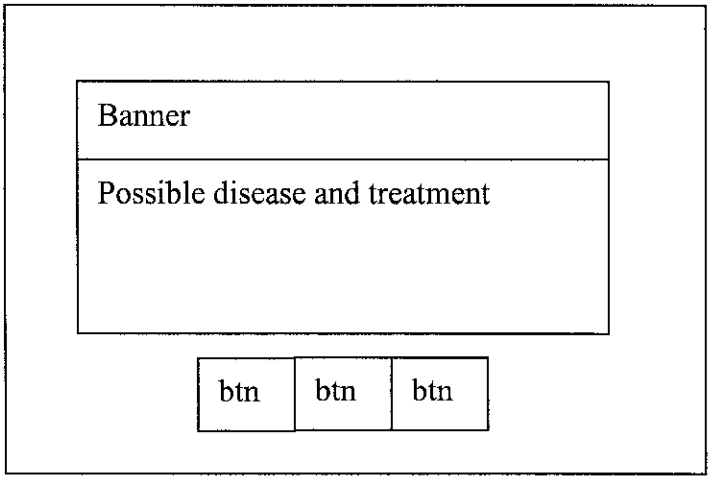


FIGURE 3.5: Possible disease page

Lastly, end user can simply print the report that is the whole selection from symptoms that lead to that disease with its treatment. The printed report can be used later on for further verification with specialist and kept for documentation purpose.

From the system perspective, the layout was planned that way. The diagnose itself has its own methodology. Since the system will be focusing on three (3) diseases, therefore the inference engine will start with having a goal. Therefore, in finding the symptoms, backward chaining will be used as shown in **FIGURE 3.6**.

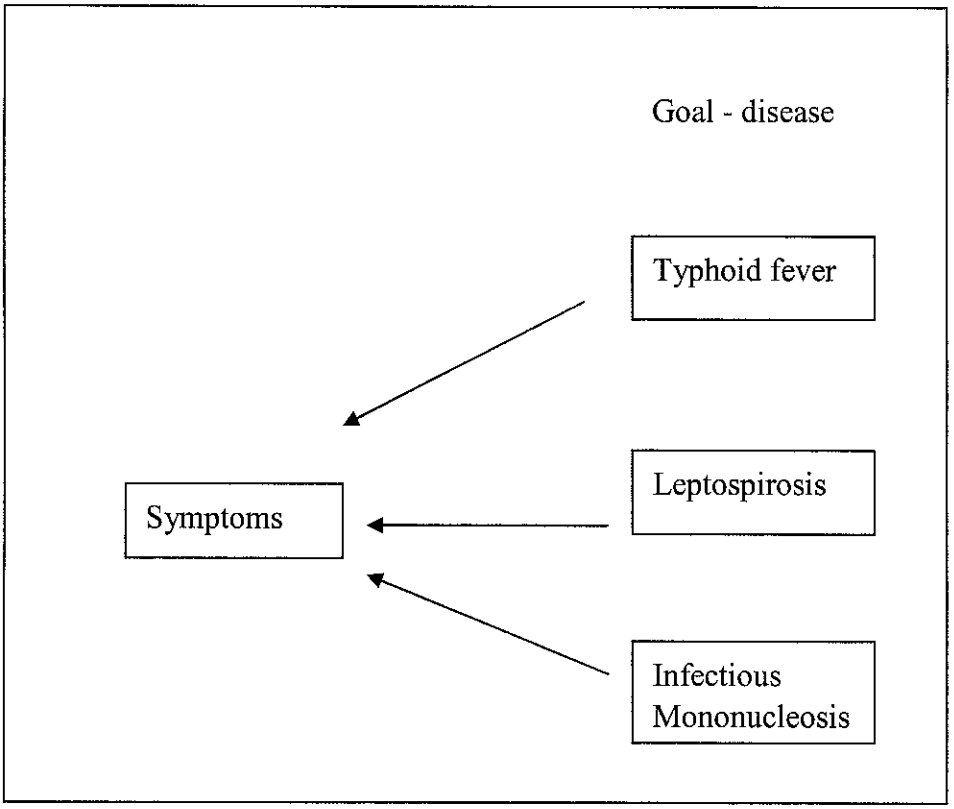


FIGURE 3.6: Backward in finding the symptoms.

This is because, from the scope of the project, we had already defined the 3 diseases. Therefore, the data gathering will be based from this diseases in findings what it is about, the common symptoms they share, the investigation and also the standard treatment.

However, during the implementation, the data found will be used in a forward manner. Meaning that end user will select first from the symptoms then lead to the possible disease. Therefore, in the system, the users will be prompted to select the systems first as shown in **FIGURE 3.7**.

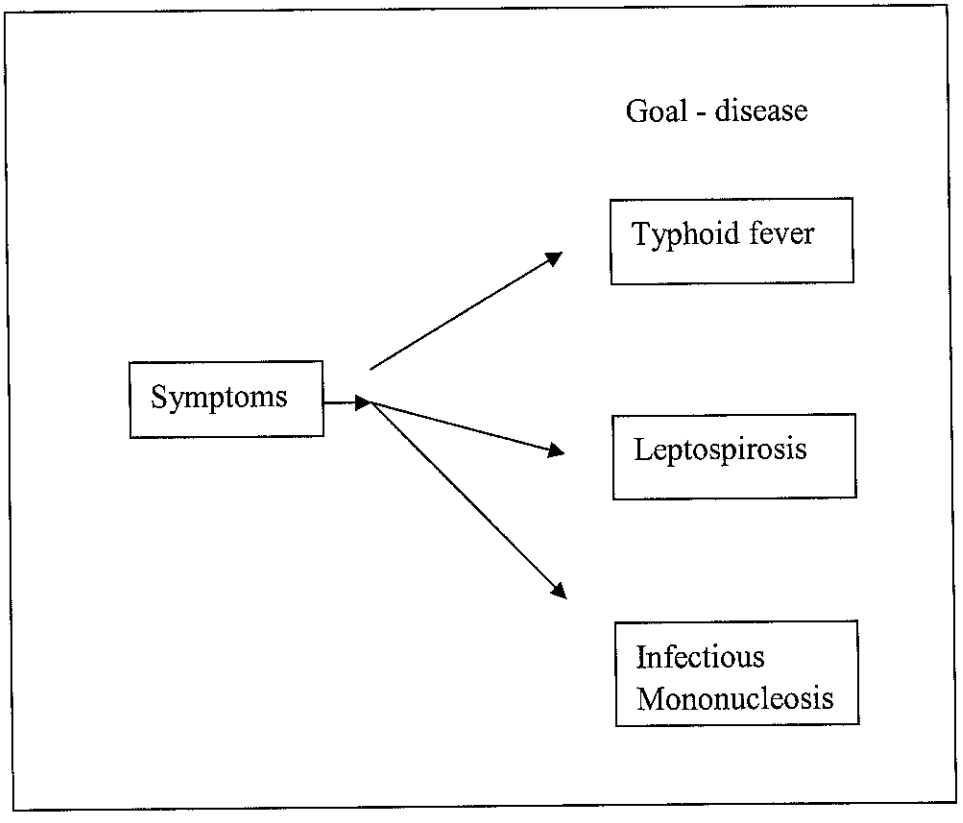


FIGURE 3.7: Selections from symptoms to possible disease.

As such, when transforming the data into Exsys model, it would be fairly easy if the rules and flow are done in tree diagram as shown in **FIGURE 3.8**

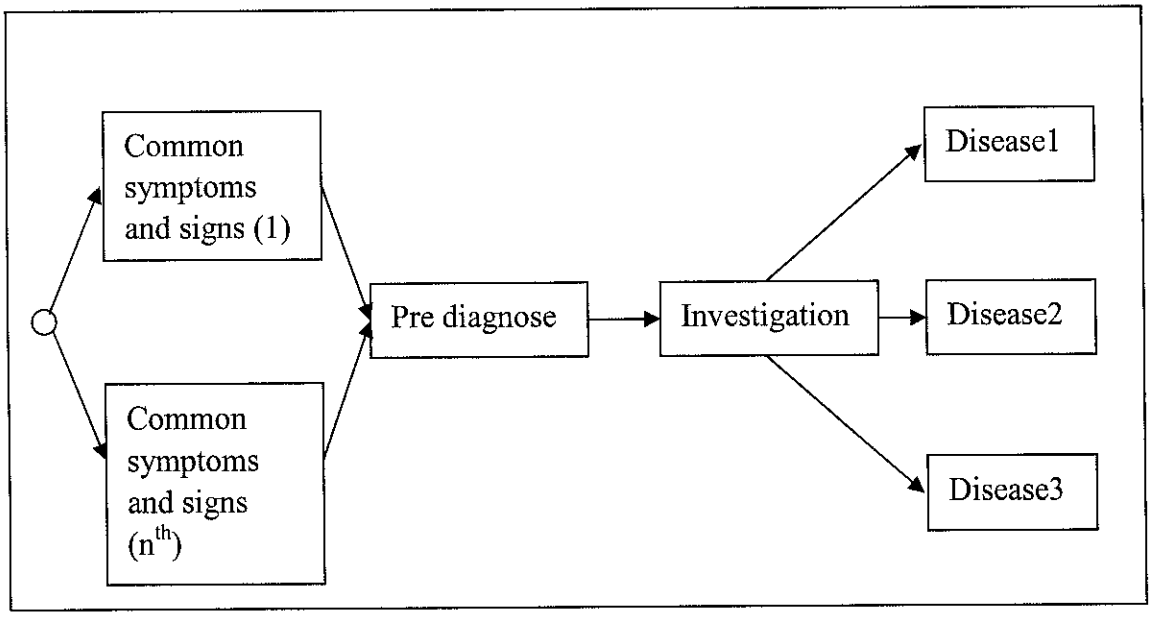


FIGURE 3.8: Tree diagram

During the development stage using Exsys CORVID, the rules are built in the logic block as shown in **FIGURE 3.9**.

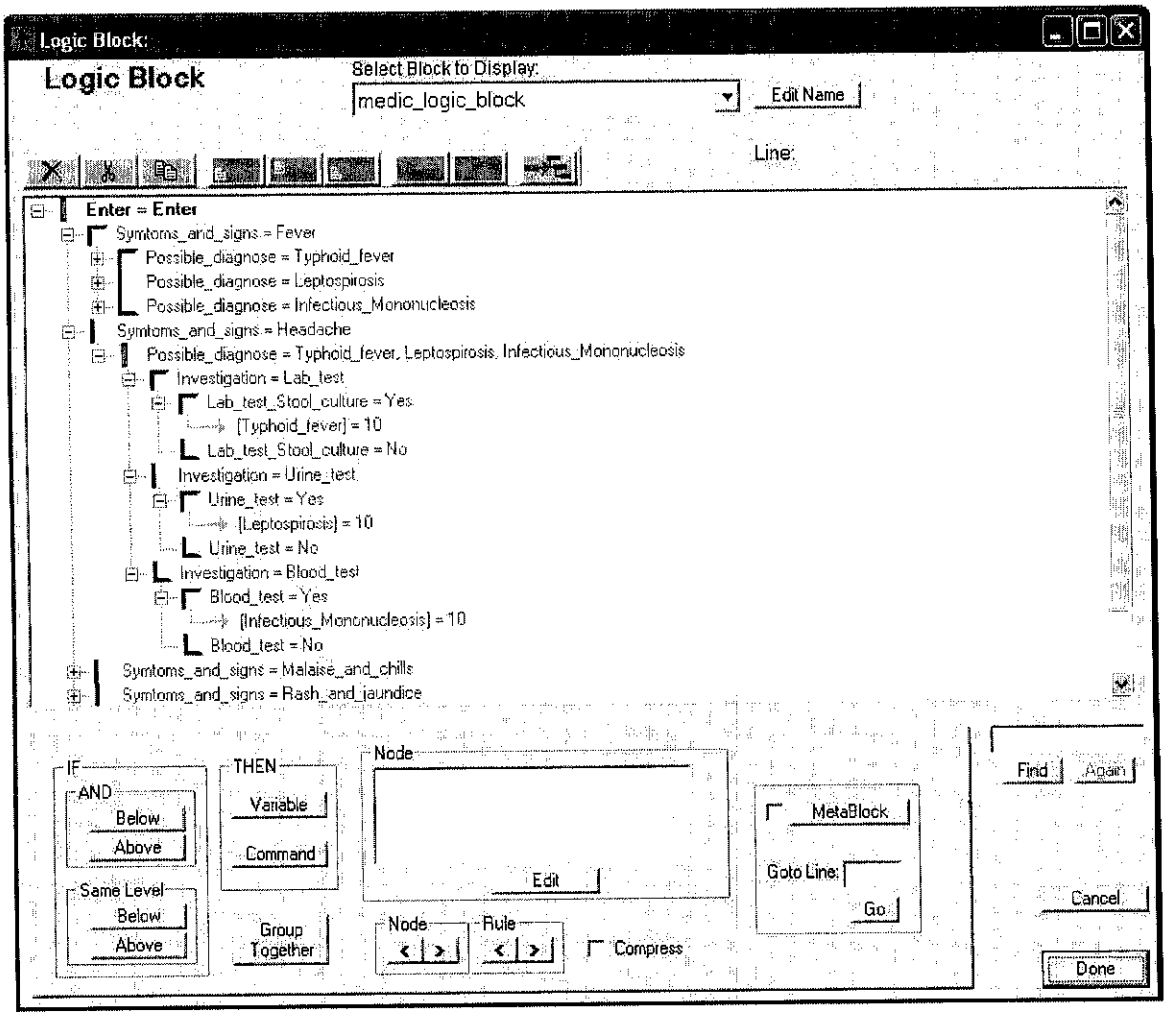


FIGURE 3.9: Logic Block

In order to run the system, define the command block after all the rules have already been created in the logic block. This command block can also be done in early stage after one rule is defined. The command block for this project is shown in **FIGURE 3.10.**

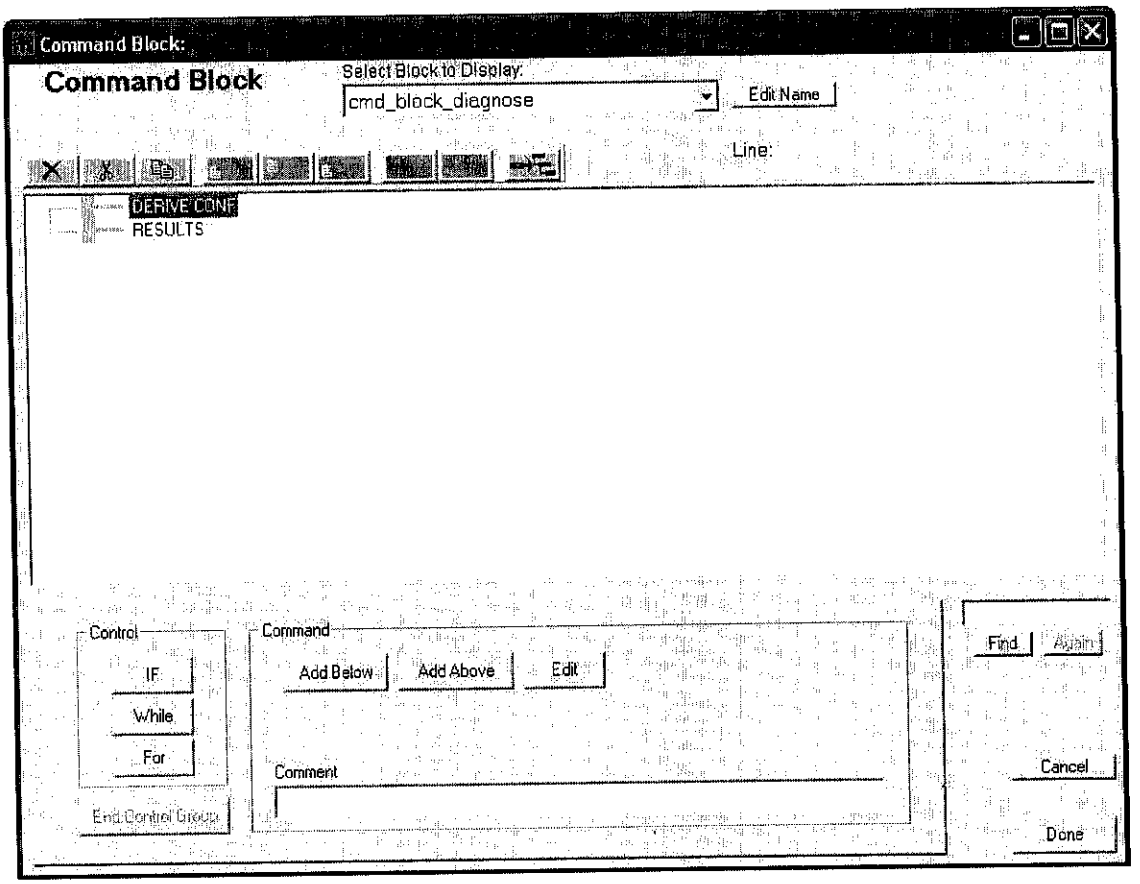


FIGURE 3.10: Command Block

3.5 Prototype development

Prototype is a small working system to show the output of the project. From the prototype develop, it can later on be enhanced or improved with added functionalities. Plus, smaller scale of work is easier to maintain and less prone to error.

The development is first started with a testing symptoms page as shown in **FIGURE 3.9**. From data gathered earlier, it is easier to build the system using Exsys. The

prototype done is based form IF – THEN statement whereby having certain conditions, then it will lead to a result. These rules are shown in the logic block (**FIGURE 3.8**).

3.6 Verification and validation

Verification and validation is meant to show that the system is right and it is a right system. This is when we need to show to the end users namely medical practitioners or doctors whether the system has met their requirements. Modification in terms of design and system flow can be done in this stage. This is one important part because system that does not meet the end users requirement will not be beneficial.

Other than that, I had also consulted with my project supervisor whether the system have meets his requirements. Since the system is build accordingly, the verification and validation happens throughout product life cycle.

3.7 Implementation

When the requirements have been finalized, the final system flow and design will be used to develop the system. The product is develop using Exsys Corvid and meant to be run using the internet browser. Since the output will be in HTML file, it would be easier to upload in the web server.

All the files will be uploaded in the root folder and viewed in an Internet browser. Besides that, it can also run as a stand alone system. The executable Exsys file can be run with the aid from java applet. Hence, the users need to have java applet in order to run the file.

3.8 Operation and maintenance

Later when the end product is finished, it will be tested by the end users. A usability test will be done to ensure the system efficiency. Observation will be done on how the end users might interact with the system to rectify the final product. Hence, the system can be identified as user friendly or not.

Thus, a survey on user acceptability will be conducted. Besides that, the system will be tested whether it can be access via wireless technology as in notebook or laptop. Evaluation is done to maintain the system for better performance.

3.9 Tools

Throughout the whole research and system development, various tools have been used to assist the project effectively. These tools are mainly software for developers in the project management team. As such, the tools used are as follows:

- MS Word for documentation purpose, reports, system storyboard and final dissertation to supervisor.
- PCMCIA card for the laptop. Setting up the wireless network at the lab
- Exsys Corvid for development and Apache as the web server. These open source software are available through the Internet and also at store.
- MS Vision for MS Paint for modeling the system flow and layout.

The basic hardware and software requirements are as follows:
Using laptop to show the system can be done using wireless technology:

- Mobile AMD Duron Processor
- 1.10 G Hz
- 352 Mb of RAM
- 40 Gbyte
- Microsoft Windows XP Home Edition
- PCMCIA card

To demonstrate the wireless LAN architecture, the laptop should be set up near an access point. Thus, it shows an overall wireless LAN architecture whereby client server accessing through the use of access point.

3.9.1 Network setup

There are 3 main tasks in setting up the wireless infrastructure namely

1. Identify or build a wireless network
    a. Install an access point
    b. Install a router
    c. Set up a peer-to-peer network
    d. Set up IP sharing on a host computer
    e. Expand an existing wireless network

2. Make your device wireless (laptop)
    a. Install a full-size PCI card
    b. Install a PC/PCMCIA card

3. Configure wireless connection setting for Windows environment
    a. Install a wireless network adapter
    b. Install drivers and card software for wireless adapter
    c. Configure TCP/IP setting
    d. Configure the wireless connection
    e. Test the wireless connection network

CHAPTER 4
RESULT & DISCUSSION

A web based expert system would be appropriate for this application. An online system is easily accessible by the end user rather than stand alone application. Thus, since the prototype will be running on wireless environment, it will enhance its functionality and efficiency in terms of attending users out of hospital or any other wired premises.

4.1 Integrating Medical Rule Based and Case Based Reasoning.

Both rule based and cased based has their own strength that work more effective when it is integrated together. Medical system trend nowadays has acknowledged the effectiveness when rule based is combined with case based reasoning. According to Stefania Montani and Riccardo Bellazzi in their research, when dealing with chronic diseases management, one of the most effective is Case Based Reasoning (CBR). In such a context, the data collected from patients' follow up (stored in the case library) embody an important knowledge source, to be integrated with the available declarative knowledge (that can be represented by other formalisms, e.g. rules). Besides that, the rules here can be form of knowledge representation for that system.

The system will have both the RBR and CBR tool. Montani and Bellazzi has shown in their research the model of RBR and CBR integration as shown in **FIGURE 4.1**

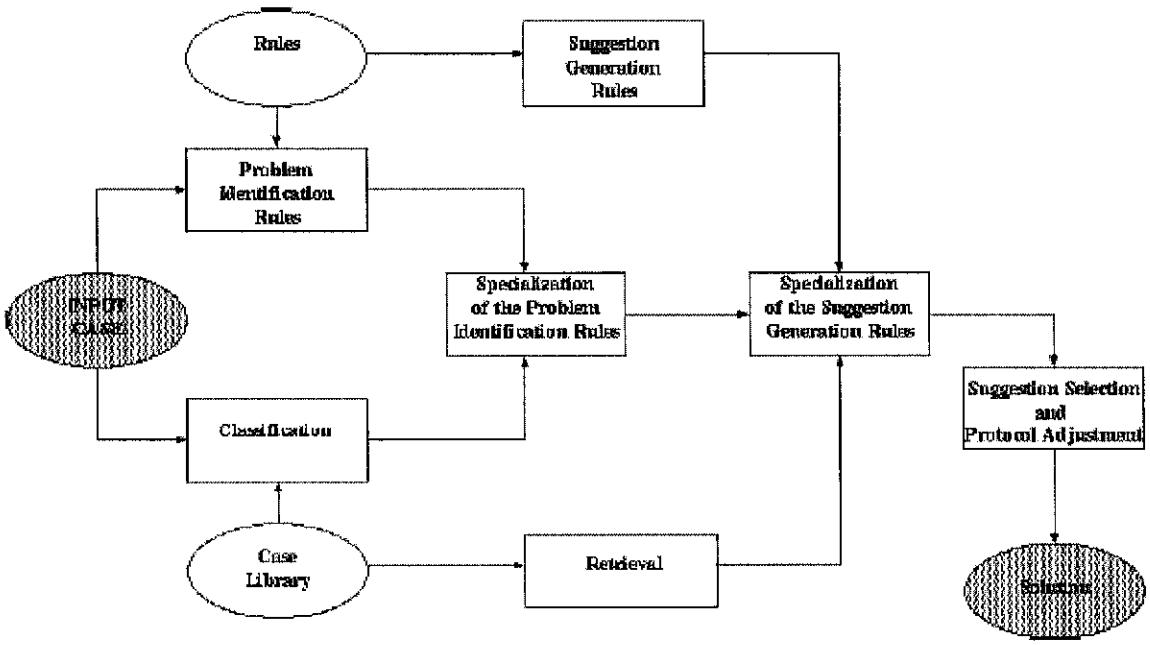


FIGURE 4.1: CBR – RBR integration

The medical system and other Expert system does not just contain rule based but also a mixture of textbook knowledge and experience. Hence, as shown in **FIGURE 4.1**, it does relate both case and rule based to form an expert system. Besides that, a medical field itself does not strict to rigid answers as plain Yes or No. However, in this system, we did one assumptions that is to hook one of the laboratory result to one particular disease. As such, that result is of significance factor to one particular disease.

From the findings, it is clearly shown that a medical expert system works best if both rule based and case based reasoning is combined together. Hence, based on the interview session with Dr. Zulkifli, he mentioned that when attending a patient, doctors basically will listen to the patient's complaint. That in the medical term is history and yet what the doctors might see is examination or signs. For an example, when a patient came and complain what he felt, the doctor will try to suspect what is the possible diagnose i.e. case based reasoning. Later on, when implementing into the system, the cased based reasoning will be model out into rules to fire for solutions.

From the interview done, Doctor Zulkifli has explained about the flow when diagnosing patients that is shown in **FIGURE 4.2**. Basically, there will be four (4) main tasks when attending patient and everything relates to one another.

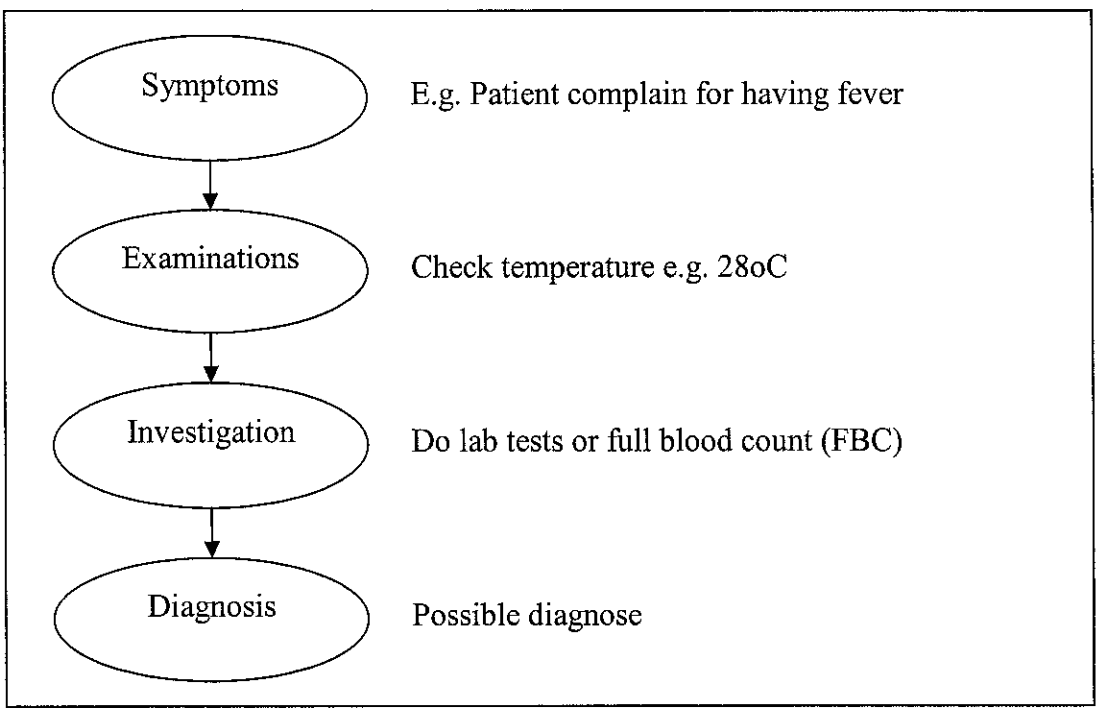


FIGURE 4.2: Doctors diagnosing flow

Doctors diagnose will start from the patient case as shown in **FIGURE 4.2**. Therefore, the theory of integrating the case and rule based is proven because both are needed when implementing the expert system. From the diagram above, there will be four (4) main processes to be embedded within the system. Hence, the symptoms and examination should come together before differential investigation is done. Differential investigation is when doctors or medical practitioners will do certain laboratory test such as blood culture, stool culture and urine test to determine the most possible diagnose for that particular symptoms. The laboratory result will identify whether what the doctor may suspect is correct or wrong. This flow will eventually be model out into the system.

4.2 Tools efficiency

Tool chosen that is Exsys Corvid is proven as an appropriate tool in developing an expert system. According to the Health Care Focus, journal by Exsys Company:

> Exsys software technology has been used worldwide by thousands of users. The Healthcare industry has certainly been one of our major markets and broad spectrums of systems have been built. As with all industries, the growth of the Internet will soon provide numerous benefits and opportunities for advisory interaction.

There have been few medical systems being developed using Exsys namely:

- *A Voice Driven Expert System to Aid in Medical Diagnosis*, Groves, E.W., Medical Univ. of South Carolina (used by the Family Medicine Center and its consortium.)
- *Pediatric Auditory Brainstem Response Interpretation*, Anne Marie Tharpe, James W. Hall, III, Gautam Biswas - Div. of Hearing and Speech Sciences, Dept. of Otolaryngology and Dept. of Computer Sciences, Vanderbilt University
- *Urodynamic Diagnosis in a Gynecologic-Urologic Outpatient Clinic*, P. Riss and H. Kolbl - OB/GYN Dept., University of Vienna, Austria
- *Respiratory and Anesthesia Monitoring*, Rader, C.D., Crowe, V.M., and Marcott, B.G.
- *Efficient Handling of Medical Information of Lung Cancer Patients*, Marchevsky, A.M., Cedars-Sinai Medical Center

(Source: Health Care Focus, Exsys 2002)

Exsys file can be run as hypertext markup language (HTML) file. Hence, it made possible to upload the files in web server. Besides that, it has a user friendly interface for knowledge engineer to develop the system. As such, the end users would also found that the product is easy to use. However, the interface or layout of the product may be quite limited to the one Exsys has set. Although some features can be edited

using the html tag, the main interface will somewhat remain similar. Besides that, this product does not store any data in the database because of its complexity in doing so. However, the end user can opt to print the result for documentation purpose.

4.3 The end product

Given the data and flow from the domain experts' i.e. medical practitioners, it has resulted to a product that is meant to aid the new doctors while diagnosing the patient. This product is called "Medical Aiding Solution (MAS)" is meant to help new medical practitioners that need to verify their diagnoses when there's no specialists available at the moment. The system is made web based and run from an Internet browser. When the system is run, the landing page is shown in **FIGURE 4.3**.

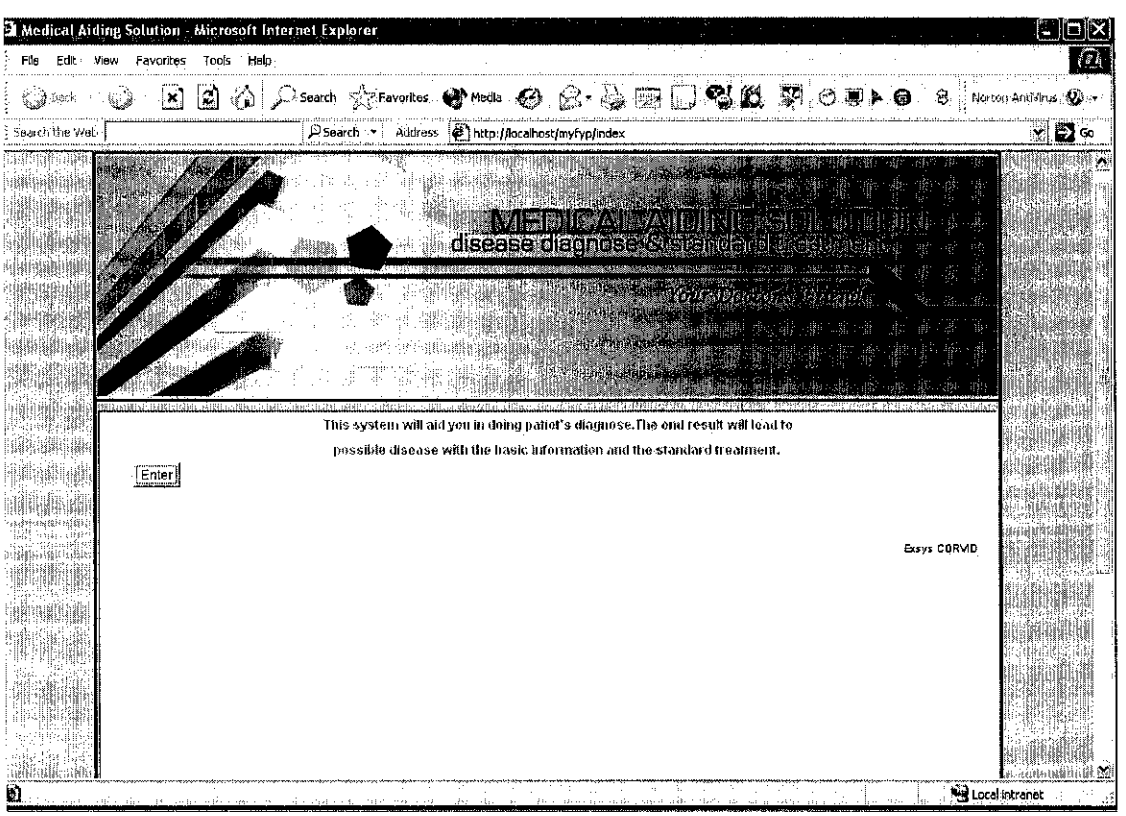


FIGURE 4.3: Diagnose landing page

The interface can later on be enhanced. Thus, since they are HTML file available, this page can be embedded and edit with HTML tag to make the layout more presentable. Henceforth since it is Exsys file is embedded and edited using Dreamweaver, one can also add images of the laboratory test such as the blood culture test result that can helps medical practitioners see more clearly rather than text itself.

Next, from the landing page, the medical practitioners will need to select the symptoms as shown in **FIGURE 4.4**. Assuming that medical practitioners will most likely choose all symptoms, the result from this selection will lead to all three (3) possible diagnoses. This is because these three (3) diseases that the system is focusing are sharing the common symptoms and signs. However, the check box is chosen for selection because later on, at the end of the result, the page will show what are the selections has been made. Therefore, the doctors can keep record of what are the particular symptoms and signs, the laboratory test and result that lead to that conclusion.

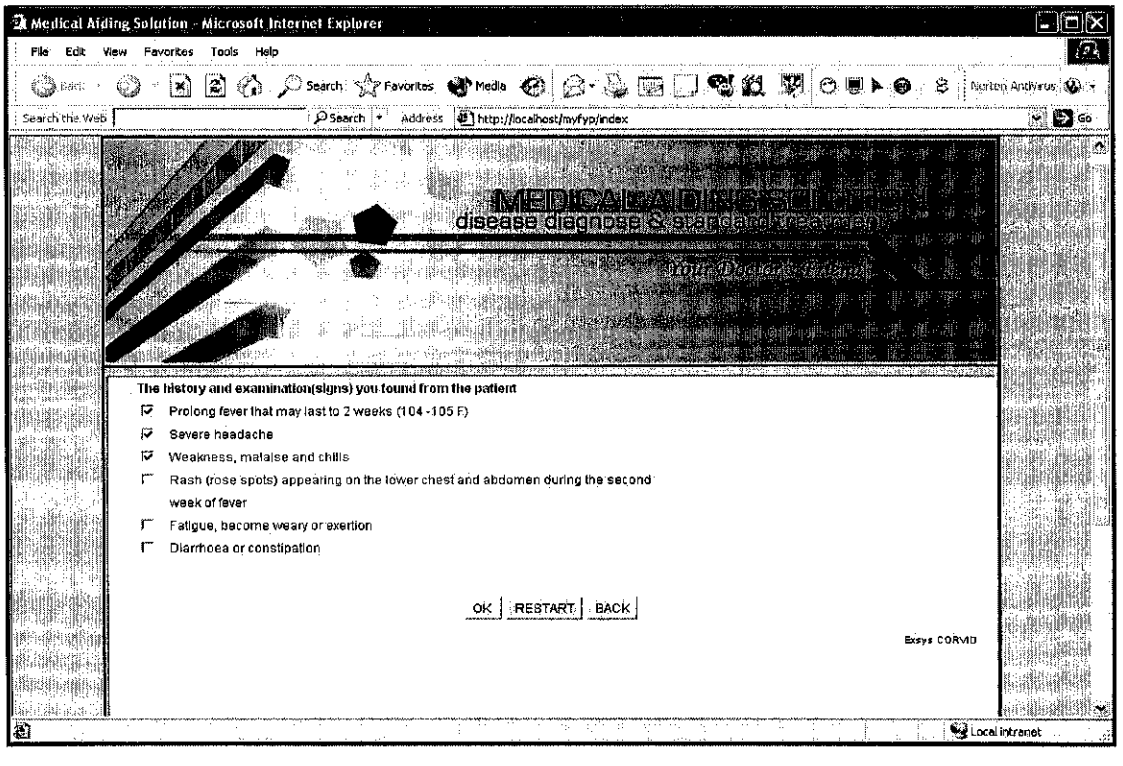


FIGURE 4.4: History and examination page

As shown in **FIGURE 4.4**, those symptoms are common that are shared by all three (3) diseases i.e. typhoid fever, leptospirosis and infectious mononucleosis. From the interview done, Dr. Zulkifli has mentioned that both history and examination should come together. And yet, the symptoms don't happen solely or one after another. That is why, in the symptoms, all is group together in one page. From the symptoms, medical practitioners will then be shown the possible diagnose as shown in **FIGURE 4.5**.

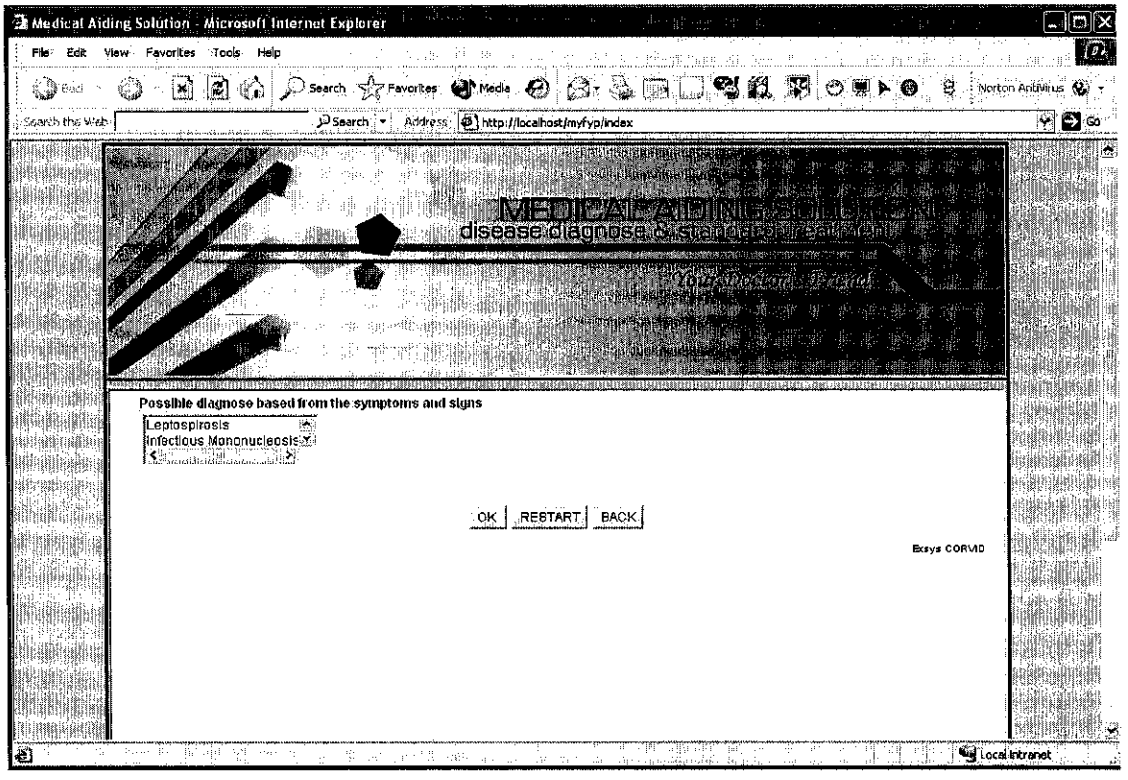


FIGURE 4.5: Possible diagnosis

As shown in **FIGURE 4.5**, the system will list all three (3) possible diagnose. However, the medical practitioners can also tick one or more even all of the possible diagnose according to their suspects. Point to consider is that, the medical practitioners will likely use the system after attending a patient, do diagnose and done the investigation. Hence, this system is meant to aid the final decision on what might be the most possible diagnose. After selecting the possible diagnose, medical practitioners need to select any laboratory test they had done as shown in **FIGURE 4.6**.

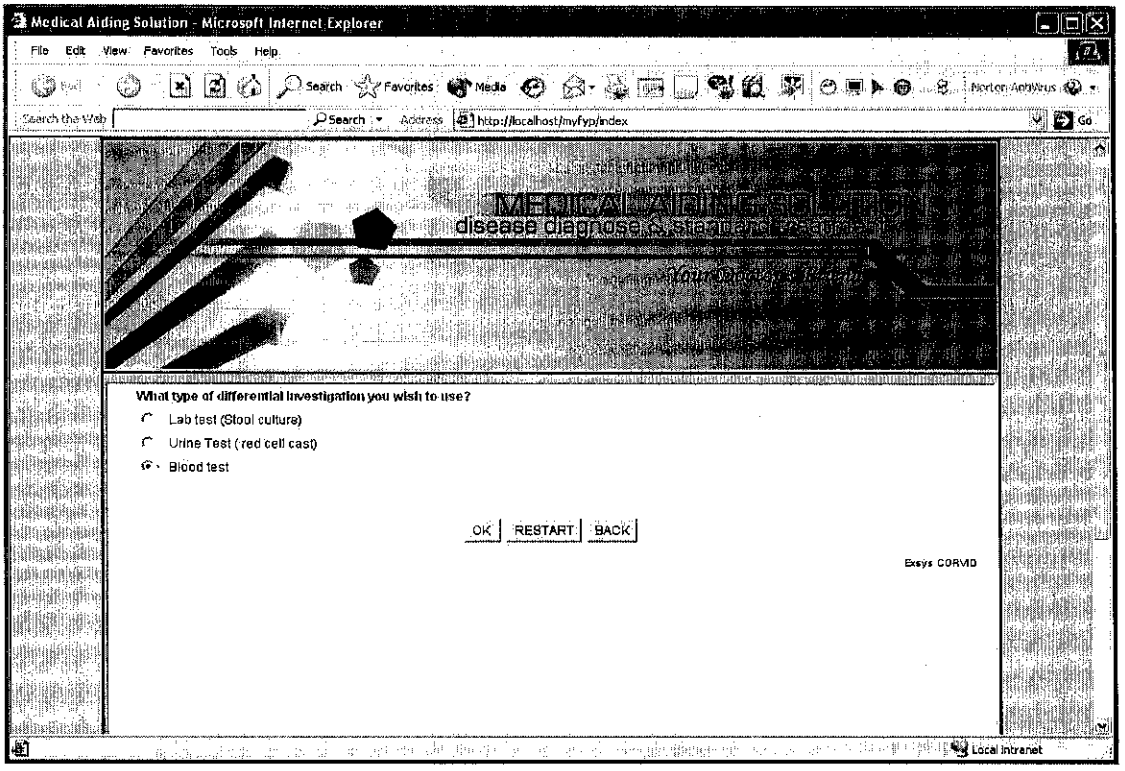


FIGURE 4.6: Differential Investigation

The differential investigation are laboratory test that must be done to identify the most possible diagnose result. In reality, medical practitioners can even do all three (3) laboratory tests. However, each result has significance on one particular disease. Therefore, to make the system simpler, medical practitioner will need to select any of the laboratory tests. Hence, the test result will be hook to one of the most possible disease as shown in **FIGURE 4.7**. In this snapshot, it is shown that if the medical practitioner clicks on Blood test.

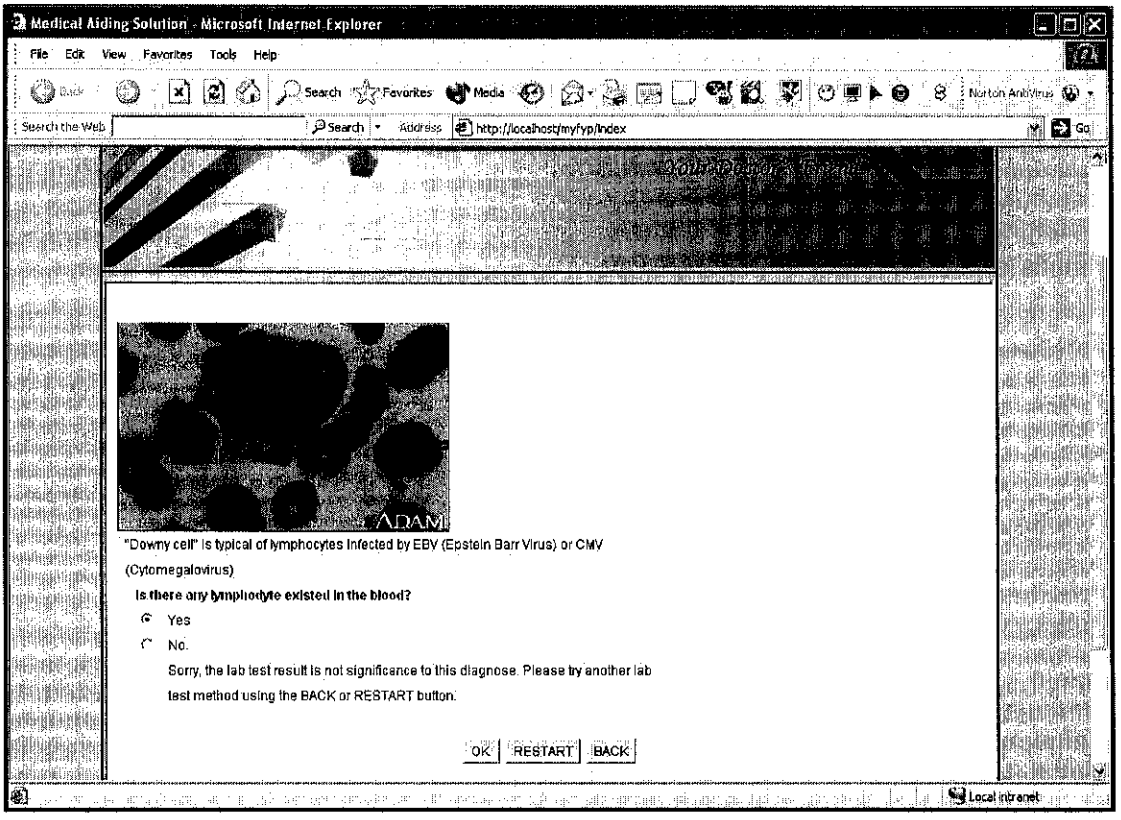


FIGURE 4.7: Laboratory result

As shown in **FIGURE 4.7**, the user will be prompted to answer Yes or No for that laboratory test. Meaning to say that, the medical practitioners will first need to do the laboratory test before using the system. So when the answer is Yes, the most possible diagnose is shown in **FIGURE 4.8**.

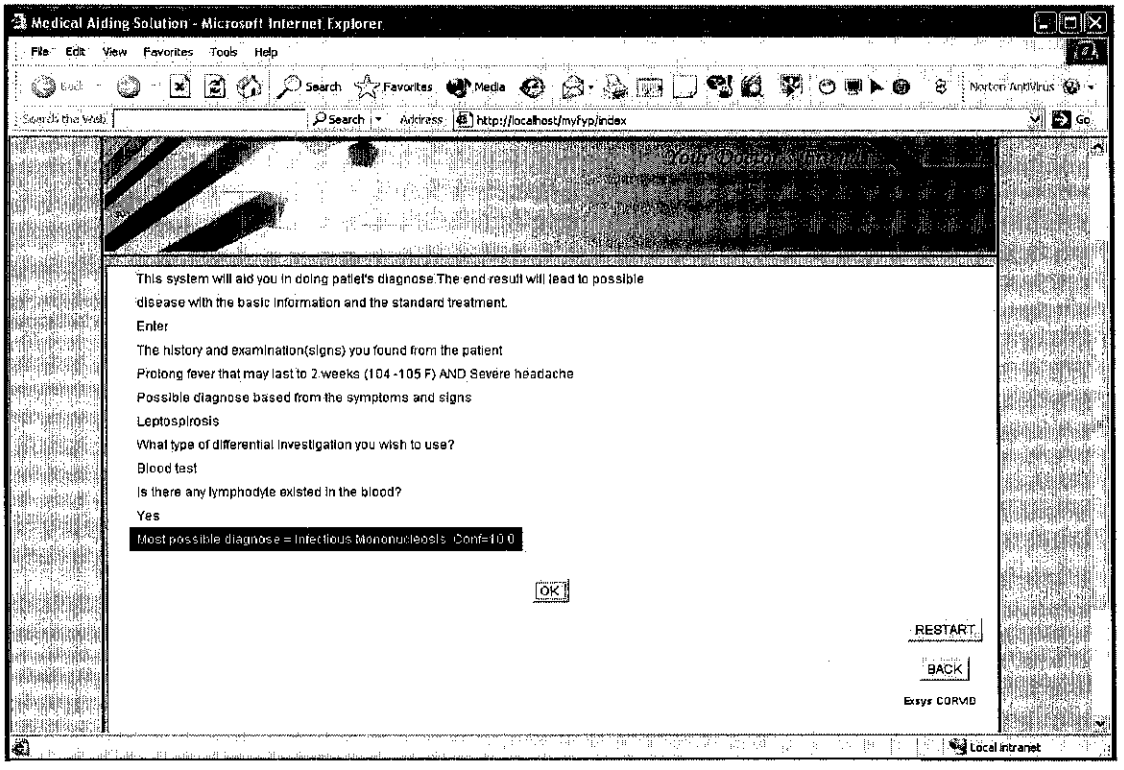


FIGURE 4.8: The final result

From the laboratory test, since we already hook down the most significance result to one particular disease, the result will lead to the disease and its treatment. End user can simply click on the highlighted text to see the disease information as shown in **FIGURE 4.9**. Besides that, the final result will also show all the selected choices that the medical practitioner has chose from the beginning of the system. Hence, it is advisable if medical practitioners print the final output for documentation purpose.

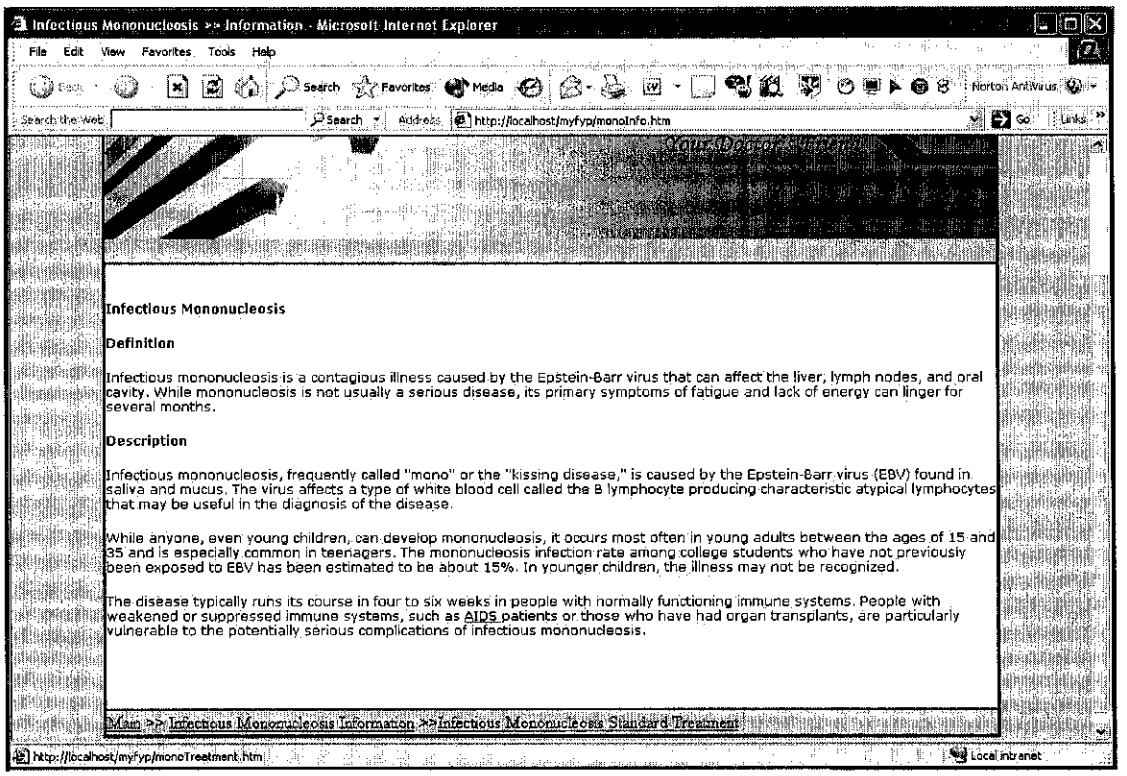


FIGURE 4.9: The disease information

Later on, medical practitioners can also click for that disease standard treatment. If however, previously in **FIGURE 4.7**, the laboratory result is No, then there will be no result in conjunction to that lab test. But since the system have Back button, therefore, user can still Back the system and try out another differential investigation (**FIGURE 4.6**).

4.4 Discussion

When the system is already implemented, few usability tests will be done to ensure system effectiveness and efficiency. Mainly, the test will cater on the layout and functionality of the system. Several interviews and survey will be done to find out the users acceptance of the system. As such, the interviews and survey namely questionnaire has been done according to the following group:

- Medical practitioners – to survey whether the system really meet their requirements as main end users for the system.
- HCI experts – to verify that the design meet the standards and does comply with any designing rules.
- Normal users – students and other lecturers to get the third party point of view on that system.

Basically, from users' point of view of the system, the system has been simplified enough and easy to understand. Thus, the flow is very quick and caters for faster decision for medical practitioners when they want to finalize their diagnosis. For the layout, the system has the features whereby medical practitioners can simply click the "Back" and "Restart" button to go to previous page and the latter is to restart the system again. Hence, this functionality is useful so that users can simply change the lab test for example if it leads to No answer (**FIGURE 4.6** and **FIGURE 4.7**). Besides that, the system is also easy to maintain and can later on be added extra details into it.

Since Exsys can be in HTML form, therefore it would be easier to build a web based expert system provided that the internet browser can support Java Applet. Thus, later developer can easily understand the project background and how about to continue developing it. This is because the nature of Exsys that is easily to learn and understand. As such, in order to enhance the system later on, the knowledge engineer can simply start out by drawing or editing the current tree diagram. The number of

levels in the tree diagram indicates how complex the decision going to be. Hence, this tree diagram denotes the process of domain experts' decision making.

Other view on the system is that, it has simple instruction. Any users can easily navigate through the system. Since it is meant for medical practitioners, the terms used within the system can easily be understood by them. Besides there will be a page regarding that disease information available.

Apart from these advantages, there is one main drawback. In this system, we assume that the medical practitioners will have to print the result for documentation purposes. No records available because the data selected is not stored in any database. Hence, the system is isolated from the main hospital database. However, since the system will cater mostly on diagnosing part, an assumption has been made. That is to assume that the medical practitioners already keep the records of their patients history and yet using this system to verify their decision. Besides that, they need to come out with the laboratory test before using the system so that they can get the result faster (refer **FIGURE 4.6**). In doing so, the doctors may need to do all three (3) kind of differential investigation in order to come out with the final result. Since, it is part of the procedure in diagnosing, the approach is logically true.

The system also did not cater on recording who is using the system. The hospital management who might need to use the system may have to keep different record on who use the diagnosis aiding system.

From the system view, one might both the advantages and features that can be added to improve the system in future. Nonetheless, this project also has shown the effectiveness of choosing the right tool in building an expert system. Apart from using other programming languages that has web based features like VB.Net, PHP and ASP, Exsys tend to be simpler when defining the rules. Unlike any other programming language, where you got to integrate with tool such as Dreamweaver MX to create the interface, there is no need to hard code each rules into IF THEN

ELSE statement. Hence, the database might be bit complicated where you got to manipulate each condition to certain rules in order to gain the desired result.

Besides that, certain HTML tag can be embedded for example
 into the Exsys variable windows. When modifying the interface of Exsys page, one can simply place certain HTML tag to make the interface more presentable. Hence, it also cater for images and links to other HTML files you have created. The font type, background color and images can make the display of the system seems more interesting.

Lastly, from the medical perspectives, the system has managed to follow the requirements and standard procedure that medical practitioners do while diagnosing a patient. None like any other expert system that caters the rules by one definite question, in this system, the common symptoms and signs are grouped together. Based on the interview had with Dr. Zulkifli, the flow of medical diagnose need to have the patients' history and sign together. Hence, the system is having fewer clicks to the end result because it does not ask the end user what is the symptoms then to the next symptoms after that.

CHAPTER 5
CONLUSION & RECOMMENDATION

5.1 Conclusion

The system is meant to be a platform for technology enablers together with medical experts to develop a better medical expert system. Enhancement can be done in terms of interface, flexibility, features and functionality, and adding more diseases in the system.

The prototype is meant to assist doctors while attending their patient as well as making hospital system more effective. Hence, medical practitioners can share their knowledge about that disease by adding more information into the expert system shell. As such, the system becomes more informative and reliable to the end users. The Medical Aiding System should act as an alternative solution to verify the new medical practitioners diagnose result when there is no specialist to turn to.

From the objectives laid out and the system itself, it does show several strengths and advantages of the system:

- A standing point for other system to be made applicable unwired. As such, the application can be access even when the doctors or medical practitioners are out of hospital premises. This helps because nowadays Malaysian needs doctors even in remote or rural area. The project will be demonstrated using a laptop connecting to another laptop through an access point. Hence, it manages to proof the system that can be access using wireless technology within a wireless LAN architecture.

- Meant to assist doctors and medical practitioners when dealing with common and rare diseases as when specialist is not available at the moment to verify the diagnosis. This is another solution to the problem and part of the objectives. Malaysia need more medical professional and we can't wait for them to be a specialist to cater the needs of increasing number of this country population.

- User friendly interface as in user can easily understand how to go about the system. Both medical practitioners and developer might find the system is easy to use. Hence, even other users can also use the system. However, since the aim is for medical practitioners, it would be quite difficult for other users to understand certain medical terms. And yet when developing the system, we assume that medical practitioners should know better about the terms they regularly used.

- Ease and fasten doctors' productivity while attending patients because reduce time and cost both when want to make final decision. The new medical practitioners no longer need to refer to the specialists. Instead, they can simply use the system in aiding their diagnosis. However, when there are specialists available, we do realized that we still depend on human capabilities. Besides that, the system can reduce cost of the hospital management because of the payment to the specialist is expensive. One consultation may require extra payment than meeting the usual medical practitioners.

- Help out new doctors while attending patient because we need more doctors to cater the Malaysian population today. As noted by Dato' Dzulkifli Abd Razak

> For Malaysia, the doctor-to-popu-lation ratio is said to be 1:650. As it stands today, it is not presumptuous to say that for most Malaysian urban centres, especially in the Klang Valley and Penang, the targeted ratio has been met.

(Source: New Straits Times, 11 July 2004)

The ratio has been improved as to back in 1990, the there was one doctor for 2,569 population and currently, there is one doctor for 1,521 population.

(Source: Malaysia Medical Association)

- The system has also come out with a standard treatment procedure. In conjunction to any hospital, the hospital management will likely come out with a standard treatment policy for the patients. This can standardized the prescription given to any patient having the common disease. Hence, it also helps to manage the pharmacy when dealing with drugs measurement to give to the patient. Since the diseases in the system are mostly for inpatient i.e. warded in the hospital, we assume other medical staff like nurse able to understand the terms used within the system.

Besides that, the survey done is also meant to introduce other people about the usage of Artificial Intelligence and IT as a whole in our everyday life. Apart from the usability testing that has been discussed in the Discussion (Chapter 4), we do notices few features that can be enhanced and improvise later on. Hence from the system testing, it shows that the project manages to achieve its objective both the system and developer herself.

5.2 Future enhancements

For future enhancement, the system is viewed to be capable of handling more disease rather then the three (3) diseases as shown in the product. As such, more medical studies got to be done both in how about to design an expert system and the medical information itself. When the system is able to cater more diseases, then it would be one stop solution to refer when medical practitioners need to verify their diagnosis. Besides that, these diseases information should be able to be update, add, delete and edit by the designated users. Next enhancement would need to cater on how Exsys should be able to capture the data inserted by the medical practitioners and later on update the system as a whole.

Hence, it would be very beneficial and an added advantage if later developer would have more time to actually seek the information and requirements from medical practitioners especially the specialist themselves. One point of view may not be as good as having different view from medical practitioners with different background. Thus, when the requirements are gathered, the developer can see the trend on how actually the medical practitioners want the system to perform. By then, the end product would be either meet or exceed their expectation and need. And that is one of the most important factors when developing a system for the clients, in this case the medical practitioners.

Besides that, enhancement can be done in terms of the features and functionalities. One can develop a bigger scope than for one unit of hospital only. Besides that, include more functions that handle the hospital management as a whole or integrated system. As such, the system can be more centralized and having all the functions needed at one place. For the system, one can assumed that it is not connected to the hospital or clinic patient database. Therefore, to increase its effectiveness, the system should be integrated into hospital system. By then, the new doctors can improve their skills in diagnosing patient. As such, those records of verifying the suspected disease are documented and can later on be referred. Exsys does provide database but somewhat complicated in doing so for the time being. Therefore, next enhancement

can try out to build Exsys database to be link with other system. Since the system should be web enable, embed features like user login or doctor login to keeps the records remain confidential from the public. Besides that, other users such as nurse, administrator, and hospital staff can also use the system provided that each users have their own session when browsing the site. In doing so, one can try to have the system being made using PHP and mySQL with Dreamweaver MX but the diagnosing engine would still be Exsys CORVID.

Other recommendation would be the layout. As time goes by, a fresh new look and more creative and dynamic system can be implemented. Add multimedia effects to make the system more reliable and interesting. Since there are laboratory test and result needed, add more pictures or any other media to make the system more comprehend to users. Beside that, an added features on how about to go the lab test can also make the system more informative. The new medical practitioners would find it very much useful to have that kind of information in the system. Hence, an explanation with a diagram or other multimedia form is easier to understand than full text.

REFERENCES

1. Barbara Hamann, 2000. *Disease Identification, Prevention and Control,* 2nd Edition, Mc-Graw Hill, UK

2. Blaxter.H, Hughes.C, Tight. M. 2002. *How to research* 2nd Edition, Viva Books Private Limited, Kalkota.

3. Dr.Zulkifli bin Mohamed Sharif, Pegawai Perubatan, Pusat Rawatan ISLAM AR – RIDZUAN (2005, April 24), *interviewed by Mawar Malissa Harun* UTP Panel Doctor

4. Frank P. Coyle, 2001. *Wireless Web, a Manager's guide.* Addison Wesley, USA.

5. Howard Rheingold, *EXPERT SYSTEMS Computers as sages,* < http://www.atariarchives.org/deli/expert_systems.php>, (12 January, 2005)

6. Ian Harrison < http://www.aiai.ed.ac.uk/links/cbr.html > (28 January, 2005)

7. Kolodner JL.Case-Based Reasoning, Morgan Kaufmann, 1993.
   Stefania Montani, Riccardo Bellazzi,
   "Integrating Case Based and Rule Based Reasoning in a Decision Support System: Evaluation with Simulated Patients", Dipartimento di Informatica e Sistemistica, Università di Pavia

8. Kumar & Clark, 1994. *Clinical Medicine* 3rd Edition, Saunders, London

9. Negnevitsky.M, 2002. *Artificial Intelligence, a Guide to Intelligent System,* Pearson Addison Wesley, UK.

10. *No quick fix in sight over shortage of government doctors*, Dr. Dzulkifli Abdul Razak,VCArticle,
    < http://www.prn2.usm.my/mainsite/bulletin/article/7dar04.html >

11. *Overcoming the shortage of professionals*, Graduan
    < http://www.graduan.com.my/graduan/annuals/overcome.taf>

12. P Ignizio. James, 1991. *Introduction to Expert Systems,*

The development and implementation of rule – based expert systems.

Mc – Graw Hill, Singapore.

13. "*PRESIDENTIAL ADDRESS BY THE NEWLY INSTALLED MMA PRESIDENT, DR N ARUMUGAM DURING THE 43RD MMA AGM ANNUAL BANQUET*",

23rd May 2003

< http://www.mma.org.my/current_topic/presidential03.htm> (2 February, 2005)

14. R.A.Hope et.al. , 1989. *Oxford Handbook of Clinical Medicine, 2nd Edition.* , oxford University Press, New York

15. Russell Kay
http://www.computerworld.com/developmenttopics/development/story/0,10801,71151,00.html (28 February, 2005)

16. http://www.moh.gov.my/Facts/2002.htm#subtitle2 (2 January,2005)

17. http://www.wlana.org/ent/user/stjoe.htm (2 January, 2005)

18. http://www.materprivate.ie/NS/ (2 January,2005)

19. http://219.94.76.20/wchm/technology.htm (4 January, 2005)

20. http://www.heartcenteronline.com/healthyliving/profile/index.cfm?fuseaction=firstpage&hcoref=pu_full (4 January, 2005)

21. http://computer.howstuffworks.com/wireless-network.htm (6 January, 2005)

22. http://www.cs.purdue.edu/homes/fahmy/reports/leynawap.htm (6 January, 2005)

23. http://www.cis.ohio-state.edu/~jain/cis788-97/wireless_lans/index.htm
(10 January, 2005)

24. http://dph.gov.my/ddc/index.html (18 January, 2005)

25. http://medicine.com.my/Addmoh.html (24 January. 2005)

26. http://www.prohighway.com/article/default.asp?head=h (31 January, 2005)

27. http://www.hospitals-malaysia.org/index.cfm?menuid=4 (31 January, 2005)

28. http://medicine.com.my/prof.html (2 February, 2005)

29. http://medicine.com.my/mblog/2004_12_01_archive.html (2 February, 2005)

30. http://portal.acm.org/citation.cfm?id=97711 (2 February, 2005)

31. http://www.ohsu.edu/ohsuedu/central/itg/sdlcpm/sdlc-process.cfm (14 February 2005)

32. http://oldweb.uwp.edu/academic/mis/baldwin/sysdelec.htm (14 February, 2005)

33. http://www.developer.com/design/article.php/2109801 (16 February, 2005)

34. http://www.smartdraw.com/tutorials/software-uml/uml4.htm (20 February, 2005)

35. http://www.exsys.com/pdf/BackwardChaining.pdf (22 February,2005)

36. http://www.utexas.edu/its/wireless/install/config_winall.html (24 February, 2005)

37. http://www.mrtc.mdh.se/publications/0638.pdf (25 February, 2005)

38. http://www.uptodate.com/index.asp?usd=775852445&r=/index.asp&server=www.uptodate.com&app=mktg (28 February, 2005)

39. http://wireless-internet.wireless-computernetworking.com/wireless_modems.htm#top (1 March, 2005)

40. http://www.pacificbridgemedical.com/publications/html/MalaysiaJune99.htm (7 March, 2005)

41. http://www.pulsar.org/febweb/papers/m3web.htm (10 March, 2005)

APPENDICES

APPENDIX A

Incidence rate and mortality rate of communicable diseases per 100,000 populations, 2002

COMMUNICABLE DISEASES	INCIDENCE RATE	MORTALITY RATE
AIDS	4.86	3.59
HIV	30.35	0
Chancroid	0.01	0
Cholera	1.49	0.02
Dengue Fever	63.17	0.27
Dengue Haemorrhagic Fever	7.99	0.28
Diphtheria	0.03	0
Dysentery (All Format)	1.19	0
Food Poisoning	28.63	0
Gonococcal Infections	3.93	0
Leprosy	0.73	0.02
Malaria	44.91	0.18
Measles	3.67	0
Relapsing Fever	0	0
Syphilis (All Forms)	4.36	0
Tetanus Neonatorum	0.04	0
Tetanus (Adult)	0.10	0
Tuberculosis (All Forms)	58.60	5.27
Typhoid and Paratyphoid	3.48	0.01
Typhus	0.07	0
Viral Encephalitis	0.15	0.01
Viral Hepatitis (All Forms)	14.68	0
Whooping Cough	0.11	0
Yellow Fever	0	0
Hand, Foot & Mouth Disease	10.58	0
Ebola	0	0
Other Venereal Disease	0	0

Source: Ministry of Health

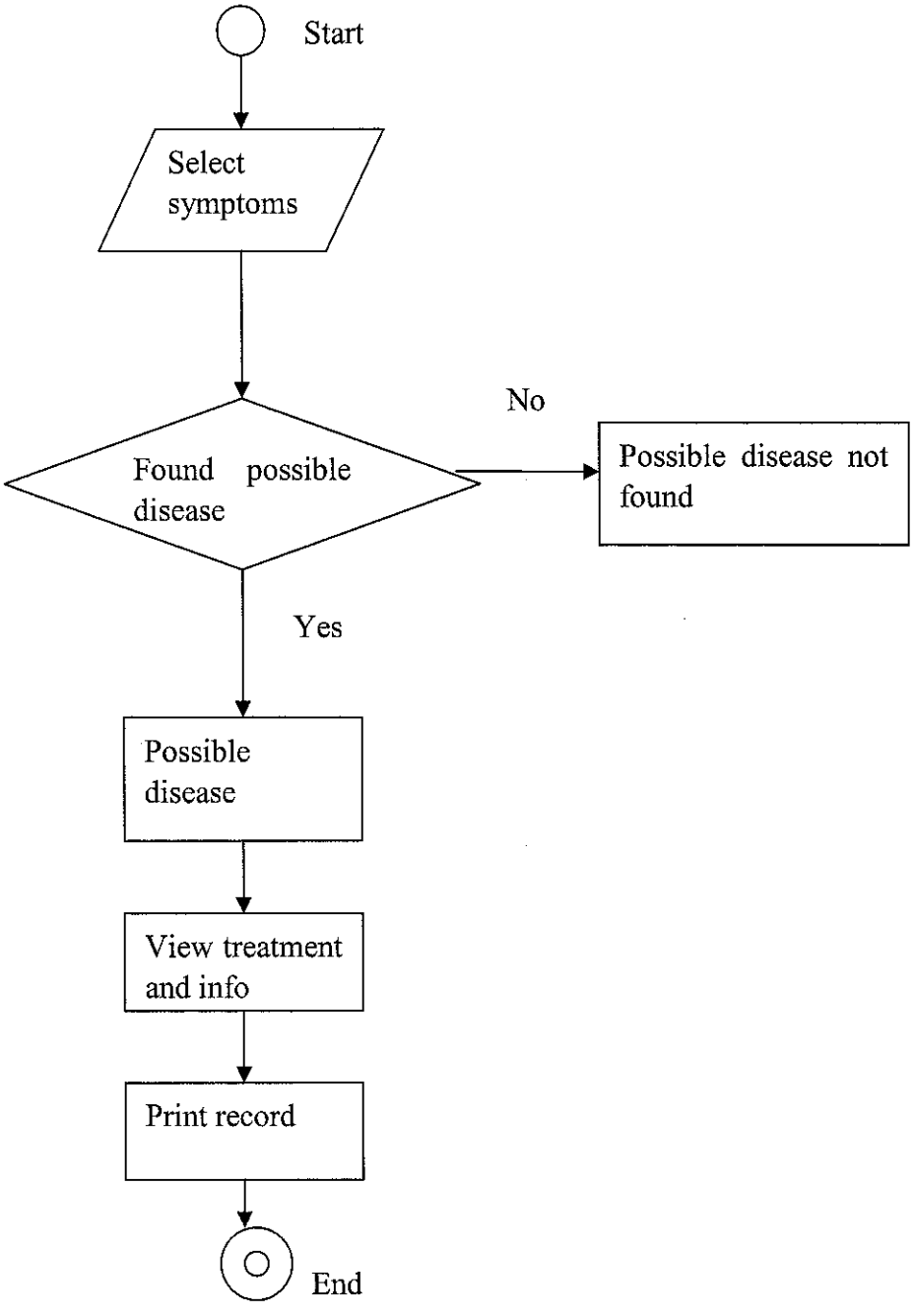
APPENDIX B

RARE DISEASES

Disease	Symptoms	Treatments
Infectious mononucleosis	Constitutional fever, headache, malaise and fatigue 3-5 days fever, swollen lymph glands, and sore throat develop Enlarged spleen, liver involvement, tonsillitis and pharyngitis.	Treatment is symptomatic. Patients are restricted from any contact sports because of the danger of ruptured spleen. Use antibiotics if a secondary bacterial infection is present,
Typhoid fever	Osteomyelitis has an abrupt onset with sudden pain in the affected bone, tenderness, heat, swelling and restricted movement over the bone. Fever, tachycardia(fast heartbeat), nausea and malaise	4-8 weeks antibiotic therapy, surgical debridement (removal of dead tissue) and drainage. Chloramphenicol Ciprofloxacin 500mg twice daily Co-trimoxazole 960mg daily and amplicin 6g daily
Leptosphirosis	High grade fever and headache , with chills and rigour, malaise, vomiting, muscle aches and watery eyes. Sometimes meningitis, rash, jaundice, renal insufficiency, anemia and hemorrhages in the skin and mucous membranes occur. Severe recto-orbital or occipital headache	Penicillin and other antibiotics. Some cases may require kidney dialysis.

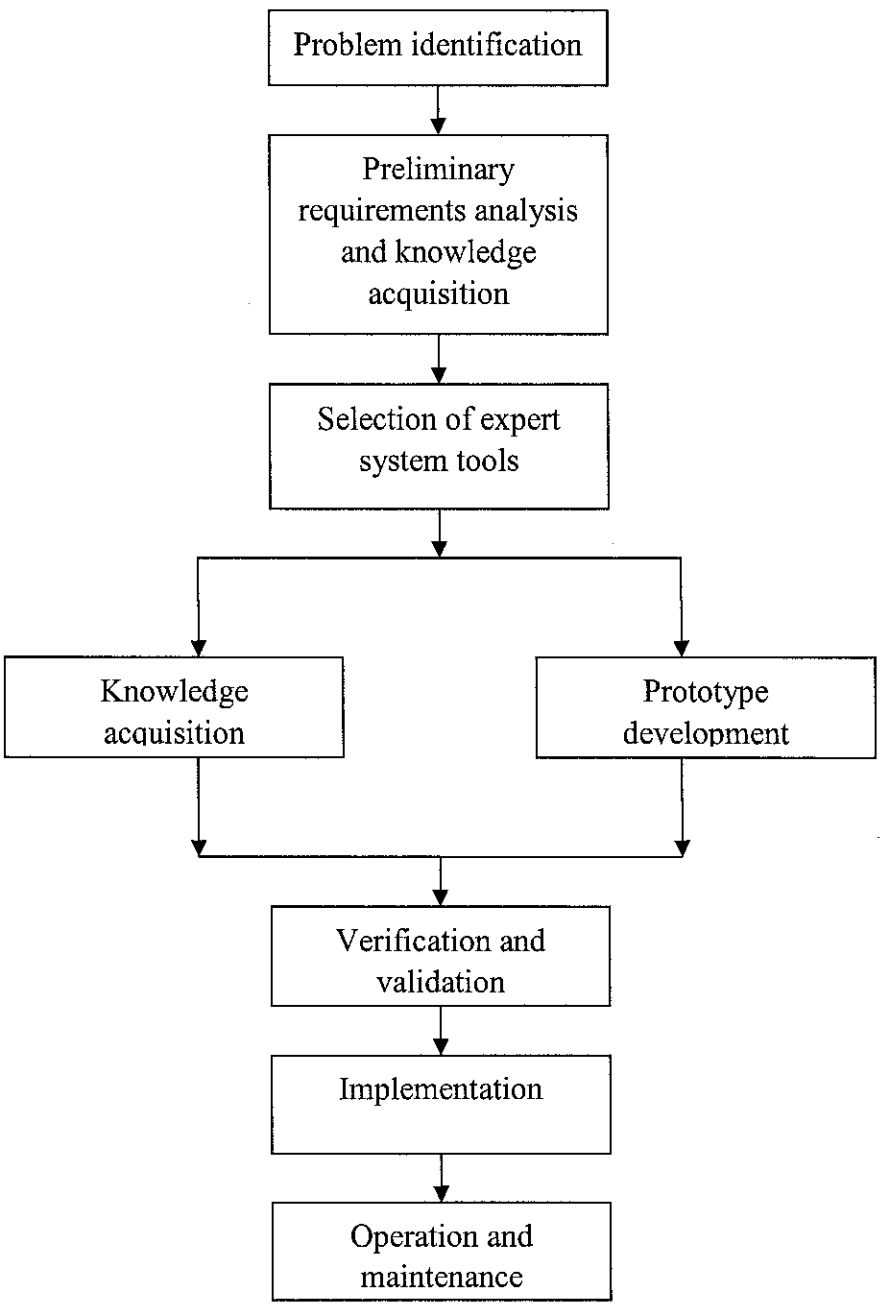
APPENDIX C

SYSTEM FLOW



APPENDIX D

EXPERT SYSTEM DEVELOPMENT LIFE CYCLE



APPENDIX E

QUESTIONNAIRE

Questionnaire with Medical Practitionars

These are the question given to Dr. Zulkifli during our interview session.

1. What do you usually do while attending a patient?
2. What is the normal flow in diagnosing a patient?
3. How long does it take to diagnose a patient?
4. What are the differences of when attending inpatient and outpatient?
5. How do you come out with a suspect?
6. What is the difference between symptoms and signs?
7. What is differential investigation? Why do you need it?
8. What does medical practitioners look for in a medical aiding system?
9. Does the system meant to replace or simply to aid doctors?
10. What do you require the system to have?

APPENDIX F

PROJECT TIME LINE

No.	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	**Introduction**																	
	- Prelim report																	
	- Submit Prelim																	
2	**Preliminary Research Work**																	
	- Gathering data																	
	- Modeling data																	
3	**Project Work**																	
	- Design																	
	- Build Prototype																	
	- Build system																	
	- Progress Report Submission																	
	- Build System																	
	- Revamp method and tools																	
	- Dissertation Draft Submission																	
	- Dissertation Final Draft Submission																	
	- Oral Presentation																	

APPENDIX G

Source Code

Index source code:

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Medical Aiding Solution</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
body,td,th {
        font-family: Verdana, Arial, Helvetica, sans-serif;
}
body {
        background-color: #dcc2db;
}
-->
</style></head>

<body text="#669966" link="#009900" vlink="#336633" alink="#00FF00">

<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033" >
 <tr>  <td width="842" height="225"><div align="center"><img src="banner2.jpg" width="820" height="220"></div></td>
 </tr>
 <tr>
  <td height="496"><APPLET
CODEBASE = "./"
CODE = "Corvid.Runtime.class"
NAME = "CorvidRuntime"
ARCHIVE = "ExsysCorvid.jar"
WIDTH = 820
HEIGHT = 479
HSPACE = 1
VSPACE = 1
ALIGN = middle
>
    <PARAM NAME = "KBBASE" VALUE = "" >
    <PARAM NAME = "KBNAME" VALUE = "medic.CVR">
    <PARAM NAME = "KBWIDTH" VALUE = "700">
 The expert system would be running here but your browser has Java Applets disabled or does not support Java Applets.
  </APPLET></td>
 </tr>
```

```
</table>
<p> </p>
<p> </p>
<p> </p>
</body>
</html>
```

Leptospirosis pages

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Leptospirosis&gt;&gt;Information</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
.style2 {
        font-family: Verdana, Arial, Helvetica, sans-serif;
        font-size: 12px;
}
body {
        background-color: #dcc2db;
}
-->
</style>
</head>
<body>
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
  <td width="875" height="225"><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
  <td bgcolor="#FFFFFF"><p class="style2"><strong>Leptospirosis</strong></p>
   <p class="style2"><a name="Definition"><strong>Definition </strong></a></p>
   <p class="style2"> Leptospirosis is a rare, severe, and contagious bacterial infection caused by several species of the genus Leptospira , a spiral-shaped microorganism (spirochete). </p>
   <p class="style2"> <a name="Description"><strong>Description </strong></a></p>
   <p class="style2">Leptospirosis is a bacterial disease that affects humans and animals. It is caused by bacteria of the genus Leptospira . In humans it causes a wide range of symptoms, and some infected persons may have no symptoms at all. Symptoms of leptospirosis include high fever, severe headache, chills, muscle aches, and vomiting, and may include jaundice (yellow skin and eyes), red eyes, abdominal pain, diarrhea, or a rash. If the disease is not treated, the patient could develop kidney damage, meningitis (inflammation of the membrane around the brain and spinal cord), liver failure, and respiratory distress. In rare cases death occurs. <br>
    <br>
Many of these symptoms can be mistaken for other diseases. Leptospirosis is confirmed by laboratory testing of a blood or urine sample. </p>
  <p> </p></td>
 </tr>
 <tr>
```

```
  <td><a href="index.htm">Main</a> &gt;&gt; <a href="leptoInfo.htm">Leptospirosis Information</a> &gt;&gt;<a
href="leptoTreatment.htm">Leptospirosis Standard Treatment</a></td>
 </tr>
</table>
</body>
</html>



<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Untitled Document</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
.style1 {
        font-family: Verdana, Arial, Helvetica, sans-serif;
        font-size: 12px;
}
.style2 {color: #9900FF}
body {
        background-color: #dcc2db;
}
--></style>
</head>
<body>
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
  <td width="840" height="226"><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
  <td bgcolor="#FFFFFF"><p class="style1"><strong>Leptospirosis</strong></p>
  <p class="style1">Standard Treatment Procedures:</p>
  <p class="style1"> Leptospirosis is treated with antibiotics, such as doxycycline or penicillin, which should be given early in
the course of the disease. Intravenous antibiotics may be required for persons with more severe symptoms. Persons with
symptoms suggestive of leptospirosis should contact a
health care provider. </p>
  <p class="style1">Penicillins, tetracyclines, chloramphenicol, and erythromycin can be given to treat leptospirosis. Supportive
care needs to be given in complicated cases. </p>
  <p> </p></td>
 </tr>
 <tr>
  <td class="style2"><a href="index.htm">Main</a> &gt;&gt; <a href="leptoInfo.htm">Leptospirosis Information</a>
&gt;&gt;<a href="leptoTreatment.htm">Leptospirosis Standard Treatment</a></td>
 </tr>
</table>
</body>
</html>
```

Infectious Mononucleosis pages

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Infectious Mononucleosis &gt;&gt; Information</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
.style1 {
        font-family: Verdana, Arial, Helvetica, sans-serif;
        font-size: 12px;
}
body {
        background-color: #dcc2db;
}
-->
</style>
</head>

<body>
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
  <td width="858" height="222"><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
  <td bgcolor="#FFFFFF"><p class="style1"><strong>Infectious Mononucleosis</strong></p>
  <p class="style1"> <a name="Definition"><strong>Definition </strong></a><br>
</p>
  <p class="style1">Infectious mononucleosis is a contagious illness caused by the Epstein-Barr virus that can affect the liver, lymph nodes, and oral cavity. While mononucleosis is not usually a serious disease, its primary symptoms of fatigue and lack of energy can linger for several months. </p>
  <span class="style1"><a name="Description"><strong>Description </strong></a><br>
  </span>
  <p class="style1">Infectious mononucleosis, frequently called "mono" or the "kissing disease," is caused by the Epstein-Barr virus (EBV) found in saliva and mucus. The virus affects a type of white blood cell called the B lymphocyte producing characteristic atypical lymphocytes that may be useful in the diagnosis of the disease. </p>
  <p class="style1">While anyone, even young children, can develop mononucleosis, it occurs most often in young adults between the ages of 15 and 35 and is especially common in teenagers. The mononucleosis infection rate among college students who have not previously been exposed to EBV has been estimated to be about 15%. In younger children, the illness may not be recognized. </p>
  <p class="style1">The disease typically runs its course in four to six weeks in people with normally functioning immune systems. People with weakened or suppressed immune systems, such as <a href="http://www.chclibrary.org/micromed/00036520.html">AIDS </a> patients or those who have had organ transplants, are particularly vulnerable to the potentially serious complications of infectious mononucleosis. </p>
  <p class="style1">  </p></td>
 </tr>
 <tr>
  <td><a href="index.htm">Main</a> &gt;&gt; <a href="monoInfo.htm">Infectious Mononucleosis Information</a>
&gt;&gt;<a href="monoTreatment.htm">Infectious Mononucleosis Standard Treatment</a></td>
 </tr>
```

```
</table>
</body>
</html>



<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Infectious Mononucleosis&gt;&gt; Standard Treatment</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
.style1 {
        font-size: 12px;
        font-family: Verdana, Arial, Helvetica, sans-serif;
}
body {
        background-color: #dcc2db;
}
-->
</style>
</head>

<body>
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
  <td width="861" height="223"><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
  <td bgcolor="#FFFFFF"><p align="justify" class="style1"><strong>Infectious Mononucleosis </strong></p>
  <p align="justify" class="style1">Standard Treatment Procedures:</p>
  <p class="style1">The most effective treatment for infectious mononucleosis is rest and a gradual return to regular activities. Individuals with mild cases may not require bed rest but should limit their activities. Any strenuous activity, athletic endeavors, or heavy lifting should be avoided until the symptoms completely subside, since excessive activity may cause the spleen to rupture. </p>
  <p class="style1">The sore throat and <a href="http://www.chclibrary.org/micromed/00044950.html">dehydration </a> that usually accompany mononucleosis may be relieved by drinking water and fruit juices. Gargling salt water or taking throat lozenges may also relieve discomfort. In addition, taking over-the-counter medications, such as <a href="http://www.chclibrary.org/micromed/00035840.html">acetaminophen </a> or ibuprofen, may relieve symptoms, but <a href="http://www.chclibrary.org/micromed/00038730.html">aspirin </a> should be avoided because mononucleosis has been associated with <a href="http://www.chclibrary.org/micromed/00063770.html">Reye's syndrome </a>, a serious illness aggravated by aspirin. </p>
  <p class="style1">While <a href="http://www.chclibrary.org/micromed/00037680.html">antibiotics </a> do not affect EBV, the sore throat accompanying mononucleosis can be complicated by a streptococcal infection, which can be treated with antibiotics. Cortisone anti-inflammatory medications are also occasionally prescribed for the treatment of severely swollen tonsils or throat tissues.</p>  <ul><li class="style1"> Avoid alcohol. </li>
  <li class="style1">Consider prednisolone po for severe symptoms or complications (80mg, 45mg, 30mg, 15mg, and 5mg on successive day, then stop). </li>
  </ul></td>
 </tr>
```

```
 <tr>
   <td><a href="index.htm">Main</a> &gt;&gt; <a href="monoInfo.htm">Infectious Mononucleosis Information</a>
&gt;&gt;<a href="monoTreatment.htm">Infectious Mononucleosis Standard Treatment</a></td>
 </tr>
</table>
</body>
</html>
```

Typhoid fever pages

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Typhoid fever &gt;&gt; Information</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--
.style1 {
        font-family: Verdana, Arial, Helvetica, sans-serif;
        color: #000000;
        font-size: 12px;
}
body {
        background-color: #dcc2db;
}
.style5 {color: #000000}
-->
</style>
</head>

<body text="#996699" link="#3333FF" vlink="#333366" alink="#0000CC">
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
   <td><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
```

<td bgcolor="white"> Typhoid Fever

 Definition

Typhoid fever is a severe infection caused by a bacterium, Salmonella typhi . S. typhi is in the same family of bacteria as the type spread by chicken and eggs, commonly known as "salmonella poisoning ," or food poisoning . S. typhi bacteria do not have vomiting and diarrhea as the most prominent symptoms of their presence in humans. Instead, persistently high fever is the hallmark of S. typhi infection.

<img src="salmonella.JPG">   Description

S. typhi bacteria are passed into the stool and urine of infected patients. They may continue to be present in the stool of asymptomatic carriers, who are persons who have recovered from the symptoms of the disease but continue to carry the bacteria. This carrier state occurs in about 3% of all individuals recovered from typhoid fever.

Typhoid fever is passed from person to person through poor hygiene, such as incomplete or no hand washing after using the toilet. Persons who are carriers of the disease and who handle food can be the source of epidemic spread of typhoid. One such individual gave her name to the expression "Typhoid Mary," a name given to someone whom others avoid.

Reference :http://www.chclibrary.org/micromed/00045300.html

    </td>

</tr>

<tr>

<td>Main >> Typhoid Fever Information >>Typhoid Fever Standard Treatment</td>

</tr>

</table>

</body>

</html>

<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>Typhoid Fever >> Standard Treatment</title>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<style type="text/css">
<!--

```
.style1 {
	font-size: 12px;
	font-family: Verdana, Arial, Helvetica, sans-serif;
}
body {
	background-color: #dcc2db;
}
-->
</style>
</head>

<body>
<table width="820" height="725" border="2" align="center" cellpadding="0" cellspacing="0" bordercolor="#990033">
 <tr>
  <td width="841" height="222"><img src="banner2.jpg" width="820" height="220"></td>
 </tr>
 <tr>
  <td bgcolor="#FFFFFF"><p align="justify" class="style1"><strong>Typhoid Fever </strong></p>
  <p align="justify" class="style1">Standard Treatment Procedures :</p>
  <ul>
   <li class="style1">Treat with fluid replacement and adequate nutrition. </li>
   <li class="style1">Chloramphenicol is the treatment for choice : </li>
   <li class="style1">1g/8h po until pyrexia diminsihes, then 500mg/8h for a week and 250mg/6h to make up 14 days: </li>
   <li class="style1">Second line drugs: amoxylin 1g/6h po for 14 days; co-trimoxazole 960mg/12h po for 14 days.IV therapy is an alternative. In encephalopathy, give a course of dexamethasone, 3mg/kg IV stat, then 1mg/kg/6h for 2 days</li>
   <li>
    <div align="justify" class="style1"><a href="http://www.nlm.nih.gov/medlineplus/ency/article/002383.htm">Intravenous </a> fluids and <a href="http://www.nlm.nih.gov/medlineplus/ency/article/002350.htm">electrolytes </a> may be given. Appropriate antibiotics are given to kill the bacteria. There are increasing rates of antibiotic resistance throughout the world, so the choice of antibiotics should be a careful one. </div>
   </li>
  </ul>  <p align="justify" class="style1">Reference: <a href="http://www.nlm.nih.gov/medlineplus/ency">http://www.nlm.nih.gov/medlineplus/ency/</a></p>
  <p class="style1"> </p></td>
 </tr>
 <tr>
  <td><a href="index.htm">Main</a> &gt;&gt; <a href="typhoidInfo.htm">Typhoid Fever Information</a> &gt;&gt;<a href="typhoidTreatment.htm">Typhoid Fever Standard Treatment</a></td>
 </tr>
</table>
</body>
</html>
```