ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

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DEPARTMENT OF COMPUTING

A WEB BASED KNOWLEDGE BASE SYSTEM FOR DIAGNOSIS AND TREATMENT OF PREGNANCY INDUCED HYPERTENSION

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BY

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LIST OF ACRONYMS AND ABBREVIATIONS

AI	Artificial intelligence
CBR	Case-based reasoning
CLIPS	C Language Integrated Production System
ICT	Information and Communication Technology
IE	Inference engine
JESS	Java expert system shell
KB	Knowledge base
KBS	Knowledge base system
KR	Knowledge Representation
LISP	Lots of Irritating Superfluous Parentheses
mmHg	Millimeters of mercury
PIH	Pregnancy induced hypertension
Prolog	Programming in Logic
WBKBSPIHDT	Web based knowledge base system pregnancy induced hypertension Diagnosis and treatment
WHO	World Health Organization
WM	Working memory
WWW	World-wide-web

ABSTRACT

Pregnancy induced hypertension is an obstetric disorders leads to death for both mother and unborn baby. It is an elevation of blood pressure and proteinuria either in the first or second half of pregnancy. In Ethiopia, studies indicate that 29% of mother's death occurred due to pregnancy induced hypertension. These disorder worse due to the scarcity of specialists, practitioners, health and skill gap in diagnosis and treatment of pregnancy induced hypertension on low level medical professionals.

However, there is an increasing appreciation of the role that computers are playing to improve the overall health delivery systems. Particularly, knowledge based technology plays a great role in medicine domain area.

This research amid to develop a web based knowledge base system to provide advice for medical professionals in diagnosis and treatment of pregnancy induced hypertension disorder. To achieve research objective, knowledge is acquired using both unstructured and structured interviews with four experts, which are selected purposively from Debre berhan zonal referral hospital and Ayu private hospital. Additionally, knowledge is acquired from secondary sources by using document analysis method of knowledge elicitation. Then acquired knowledge is modelled using decision tree structure that represents concepts, parameters and procedures involved in pregnancy induced hypertension disorders diagnoses. Based on the model, the prototype is developed with e2gRuleEngine, Adobe Dreamweaver, uniform server tools and php, Java (applet and java script) programming languages. The developed prototype uses rule based techniques and extract conclusions and treatment.

Moreover, in system evaluation of the prototype seven close-end questions are used in order to test the accuracy of the prototype system and also for ensuring whether the prototype system satisfies the requirements of its end-users or not. Thus, the overall total performance of the prototype system is 85.67% .The prototype system achieves a good performance and meets the objectives of the study. However, in order to make the system applicable in the domain area for diagnosis and treatment of obstetric disorder additional study is needed on obstetric medical disorders like nausea and vomiting of pregnancy, anemia in pregnancy and cardiac disorder.

Keywords: Web based system, knowledge-Based System, pregnancy induced hypertension.

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Around the world there are many kinds of humans related disease that affect human beings in different aspect. Hypertension disorder is one of humans related disease that affect human being at different economic, educational and age levels. It refers to a condition in which the blood pressure in the arteries is elevated. The normal level for blood pressure is below 120/80 mmHg where 120 represent the systolic measurement and 80 represent the diastolic measurement. Blood pressure of 140/90 mmHg or above is considered as hypertension (Rupinder, 2014).It is a silent killer, can cause serious problem left untreated in time (Sujit Das, 2006).

According to Molla (2015) hypertension disorder is a global burden over 25% of the world's adult population had hypertension in 2000 and the proportion is expected to increase 29% by 2025.For low-income countries, this disorder is the leading cause of death. Specifically hypertension complication more affect women with pregnancy, named as pregnancy induced hypertension. It is a multi-system diseases, which include chronic hypertension, gestational hypertension, pre-eclampsia, eclampsia, and superimposed pre-eclampsia/eclampsia (Program, 2000). These disorders are leading causes of maternal and perinatal mortality and morbidity worldwide (Vest, 2014).

In Ethiopia from 1980 to 2012 around 19% death occurred by the cause of this disorder (Berhan, 2014). In addition to this an analysis of World Health Organization (WHO) perinatal mortality in women with these disorder was reported for two towns Addis Ababa and Jimma respectively 165/1000 births from Addis Ababa (Teklu, 2006) and 317/1000 births from Jimma /Ethiopia (Wolde, 2011). This shows that PIH disorder is still a problem in Ethiopia. Therefore, these disorder need appropriate medication, follow up and management at each level health institutes (health centers, hospitals) to reduce the maternal death. However, all health institutes doesn't have sufficient number of specialists and medical professionals work in those institutes may not have sufficient knowledge in diagnosis and treatment of PIH disorder. Those medical professionals who do not have sufficient knowledge create medical error in diagnosis process and providing appropriate treatment. This increase burden of pregnancy induced hypertension. However, there is

an increasing appreciation of the role that computers are playing to improve the overall health delivery systems. Particularly, knowledge based technology plays a great role in medicine (Rajendra, 2010).

Knowledge based systems are one of the specialized branch of artificial intelligence functioning in a specific domain to offer wise decisions with reasoning. This system can be developed by imitating human intelligence to assist general practitioner and health professionals in making decision without consulting specialists. The system is not meant to replace the specialist, but it is developed to help general physicians and specialists in diagnosing, predicting condition of patient, and providing treatments from certain grounds or experiences. Hence, knowledge base system overcome difficulties in providing appropriate diagnosis and treatment (Ishak, 2002).

At this time, knowledge based systems are receiving much attention in many domain areas. The major domain includes medical diagnosis, plant disease diagnosis, crop management problem diagnosis and identification of hardware problems. From those major domain areas Medical diagnosis is the one which employed this technology because of the potential benefits that can be gained from knowledge based system particularly to overcome shortage of human experts and to provide error free medical diagnosis, drug advisory and interpretation for clinicians (Gulavani, 2009).

In this study, the researcher aimed to develop a web based knowledge based system incorporating the skills of experts to help health professional (nurses, midwifery, health officers) during diagnosis and treatment of PIH patients.

1.2 Statement of the Problem

As stated above pregnancy induced hypertension is a challenge for Ethiopia. It represents a group of conditions associated with blood pressure elevation during pregnancy and the presence of protein in urine. It has serious consequences for the mother and the baby (Hutcheon, 2011). Globally hypertensive disorders of pregnancy complicate roughly 5–10% of pregnancies (Vest, 2014). According to world health organization analysis hypertensive disorders of pregnancy are annually responsible for 25,000 maternal deaths in Africa, 22,000 maternal deaths in Asia, 3,800 maternal deaths in Latin America and the Caribbean and 150 maternal deaths in industrialized countries (Khan, 2006). This disorder has remained public health peril for both developed and

developing countries. However, the impact of the disease is felt more severely in developing countries.

Ethiopia is one of the developing countries largely affected by this disorder. According to hospital based cross-sectional study conducted by Jimma University Specialized Hospital from April 1, 2009 to March 31, 2010 show that 52.5% of the mothers were in the age group of 25 - 34 years and the overall prevalence of hypertensive disorders of pregnancy was 8.5% and Severe preeclampsia accounted for 51.9% of the cases followed by eclampsia (23.4%) (Wolde, 2011). Additionally, another study conducted on the proportion of maternal mortality in Ethiopia due to hypertensive disorder between 1980 and 2012 in different hospitals (Tikur Anbesa hospital, Jima hospital, Adigrat hospital and Ambo hospital) from those missioned hospitals 21% maternal death occur at in the year between 2001 -2002. Additionally in a year between 2011-2012 the maternal death increases by 29% (Berhan, 2014).

Hence, hypertension disorder of pregnancy is still the leading causes for mother's death in Ethiopia and death rate increase day to day due to several challenges. Some challenges are insufficient delivery of health service, in availability diagnosis and treatment guidelines for all health institutes, shortage of specialist in health institutes specifically in health center. Most of rural areas was served by health centers. Medical professionals work in those centers are nurses, midwifery and health officers which have limited skill in diagnosis, treatment, management of PIH disorder compared to specialists.

To lessen the above mentioned problems, this study attempts to give light as alternative means of diagnosing pregnancy induced hypertension. In this regard, the application of knowledge based system technology, particularly in the area where highly qualified shortage of experts there, is the solution to support low level professional by transferring knowledge from qualified experts and used as clinical guidelines during diagnosis and treatment.

In the last decade limited studies were conducted from international side where as locally as per researcher knowledge no research was conducted in diagnosis and treatment of pregnancy induced hypertension disorder. Those limited studies conducted from international side describes as follows:

Rivas-Echeverra (1999) develop an expert system for the diagnosis and treatment of pre-eclampsia.It is a rule based medical expert system that support diagnostic and therapeutic decision

of pre-eclampsia.Even though good attempts were made by the researcher the following gaps are shown, researcher doesn't cover all the categories of PIH disorders such as chronic, gestational, eclampsia, superposed pre-eclampsia/eclampsia and also doesn't incorporate pre-eclampsia follow-up diagnosis and management. Additionally, develop prototype dependent on windows platform this implies that users using other platform does not use the system. Related to accessibility it is not efficient because system is standalone. Lastly, the researcher didn't messure performance of developed system.

Matamoros (2005) developed a prototype of expert system for the pre-eclampsia prevention program (ESPPP).It support diagnostic and therapeutic decision of pre-eclampsia. Researcher use rule-based representation techniques to represent acquired knowledge from experts and for developing prototype visual basic 6.0 programming tool used to design interface and visual fox pro 6.0 used for database.But developed system was designed in context of Venezuela using Spanish language and it only diagnosis pre-eclampsia. Additionally, developed prototype is totally dependent on windows platforms and it is not web based. As a result, system knowledge base cannot update centrally, these leads knowledge base in one place differ from similar system in another place this problem affects the knowledge acquired from the system and thus influence the decision made by the system. Researcher also didn't determine performance of developed prototype.

In general the above researches in diagnostic and therapeutic decision of pre-eclampsia rule based expert system is not sufficient to diagnosis all pregancy induced hypertension catagories. Therefore, researcher is motivated to model and represent domain knowledge of experts using web based knowledge based system.

To this end, the study attempts to explore and find solutions for the following research questions

RQ 1 What suitable domain knowledge exists in an explicit and tacit form for diagnosis and treatment of pregnancy induced hypertension?

RQ 2 How to acquire, model, represent, and implement a web based knowledge-based system for the diagnosis and treatment of pregnancy induced hypertension?

RQ 3 Is the developed web based knowledge-based system is suited for diagnosis and treatment of hypertension disorder of pregnancy?

RQ4 What is the extent of user satisfaction with the proposed web based knowledge base system?

1.3. Objectives of the Study

The research has the following general and specific objectives.

1.3.1 General Objective

The principal objective of this study is to design and develop a web based knowledge base system for diagnosing and treatment of pregnancy induced hypertension.

1.3.2 Specific Objective

The following are the research specific objectives that help to achieve the general objective of the study.

- To review literature in order to have an understanding on concepts, principles and technologies of knowledge based system.
- Acquiring necessary knowledge from primary and secondary sources using interview, detailed discussion with domain experts and document analysis.
- To model and represent the domain knowledge using suitable knowledge representation techniques.
- To develop a prototype web based knowledge based system that demonstrates the capacity of a knowledge based system for diagnosing and treating patients with pregnancy induced hypertension.
- To test and evaluate the effectiveness of developed prototype using user acceptance.
- To draw conclusions based on the findings and possible application of the developed web based knowledge based system and forward appropriate recommendations as future research directions in the area of web based expert system.

1.4 Scope and Limitation of the study

The scope of this study was to develop a prototype web based knowledge based system that diagnose and treat patients with pregnancy induced hypertension disorder and giving an advice service for health professionals during diagnosis and treatment of pregnancy induced hypertension disorder. There are about six common obstetric disorder such as pregnancy induced hypertension, nausea and vomiting of pregnancy, anemia in pregnancy, cardiac disorder in pregnancy,deep vein

thrombosis or thromboembolism and diabetes mellitus in pregancy. The research concerns only on pregnancy induced hypertension disorders. This disorder has six sub sections in it, specifically chronic, superimposed pre-eclampsia/eclampsia, pre-eclampsia, gestational and eclampsia disorders.

Although acquiring tacit knowledge about pregnancy induced hypertension from gynecologist and obstetricians form Debre Berhan zonal referral hospital and Ayu private hospital using interviews in order to have detail understanding on domain knowledge, it was difficult to interview them at any time because they have a shortage of time. Due to this reason, the knowledge acquisition process is challenging task and took too much time. Besides, adequate knowledge may not be extracted from domain experts due to the personal nature of tacit knowledge.

The developed prototype provide diagnosis and treatment both pharmacological and non-pharmacological. Nevertheless, it does not provide diagnosis and treatments facilities for other pregnancy complications. In addition, because of limited time developed system doesn't have learning capability and designed using only English language.

1.5. Significance of the Study

The developed prototype of web based knowledge based system has significance in diagnosis and treatment of pregnancy induced hypertension disorder where specialists not there. The immediate beneficiaries of the study are health professional's work in different health centers and hospitals. Particularly, the developed prototype have significance for health officers, midwiferies and nurses to improve their problem solving capabilities in diagnosis and treatment of this disorder. As a result, those health professionals can use the system in diagnosing pregnancy induced hypertension disorder on health institutes where highly qualified health professionals are unavailable. It also has significance for medical schools to train medical student.

Additionally, the prototype is already codified by using appropriate domain knowledge it can be used as a guideline to provide right diagnosis and give the right treatment. It can also solve the difficulty of remembering all critical symptoms and signs of each disorders. Although, it solves the problem of forgetting the important issues and concepts of the domain knowledge by remembering the facts and rules already feed. In general the developed system have great significance to reduce maternal mortality.

1.6 Organization of the Thesis

The study is organized in to six chapters. Chapter one is the introduction part, which contains the background, statements the problem, objectives, scope and limitations and significance of the study.

Chapter two discusses literature review including information communication technology to health care, web and web technologies, conceptualizing the basic ideas of knowledge based system is essential to understand sufficiently the notion of knowledge based systems, state the merits of knowledge based systems, assess the architecture of knowledge based systems, discusses the knowledge based system development phases as well as the performance evaluation and development tools.

Chapter Three discusses the methodology used to carry out the research including knowledge acquiring techniques, knowledge modeling and representation techniques, knowledge base system implementation tools and system evaluation.

Chapter four deals about knowledge acquisition procedures followed are explained. The representation of acquired knowledge using decision tree was employed to show the generic representation of the system.

Chapter five discusses web based knowledge based system development including architecture of proposed system, knowledge representation, implementation of proposed system, system evaluation of proposed system and performance comparison with existed systems are explained.

The last chapter, chapter six deals about summarizes the basic concepts in the entire body of the research and forwards some future directions on top of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Information communication technology in Health care

Information communication technology (ICT) refers to technologies that provide access to information through telecommunications. It includes the internet, wireless networks, cell phones, and other communication mediums. In the past few decades, this technology has provided society with a vast array of new communication capabilities. Although, these modern technologies have created a global village in which people can communicate with others across the world as if they were living next door (Christensson, 2010).

Research and development efforts within the healthcare industry and the rapid advancement in ICT over the last two decades have brought about significant advances in the quality of medical services. Developed countries are spending a lot of resources for the improvement of the health care systems and their integration with information technology (Chandrasekhar, 2001). Hence, quick and fast access to the medical data is available to all the stakeholders through internet and the developing countries may take advantage of it (Slawson, 1997). Conceptually, this implies that the potential of ICTs in the health area lies in their mediatory role between differentially endowed segments of the health system and between the health systems, health service provider, beneficiaries and also it a bridge between health professionals and the communities they serve and between the producers of health research and the practitioners who need it (Storey, 2014).

2.2 Web Technologies and Web Based Applications

Before the widespread use of the Internet, computer applications primarily deployed on standalone systems where each computer systems operate in isolation, which in turn limits the boundaries of services of organization in reaching their potential users. This paradigm has a major impact in improving work efficiency and achieving strategic advantage. Currently, the usage of World Wide Web (WWW) is growing rapidly as a result of information communication technology. By enabling this technology it is possible to deliver different services in health area such as e-health, telemedicine, M-medicine, over the global network to reach target users without distance barrier (Kondwani, 2012).

The utilization of the different web technologies has saved the way for many organizations to offer web based services for their users. Web services are self-contained, modular and dynamic applications that can be published and invoked over the network (Kondwani, 2012).Recently web technologies and web application applied in different domain those are education, business, and medical and research development. Related to this research web technologies are applied in diagnosis and treatment of diseases.

Ishak (2002) tried to show the advantages of web based over standalone application in medical diagnosis. In medical system standalone application implies that one system can only be used by particular place and additional systems require for other patients. Another problem with standalone system is that knowledge updating in one place is different in another place using similar systems. This problem affects the knowledge acquired from the system and thus influence the decision made by the system. To give solution for this problem Ishak (2002) states web based medical diagnosis and prediction model to provide electronic medical information through internet.

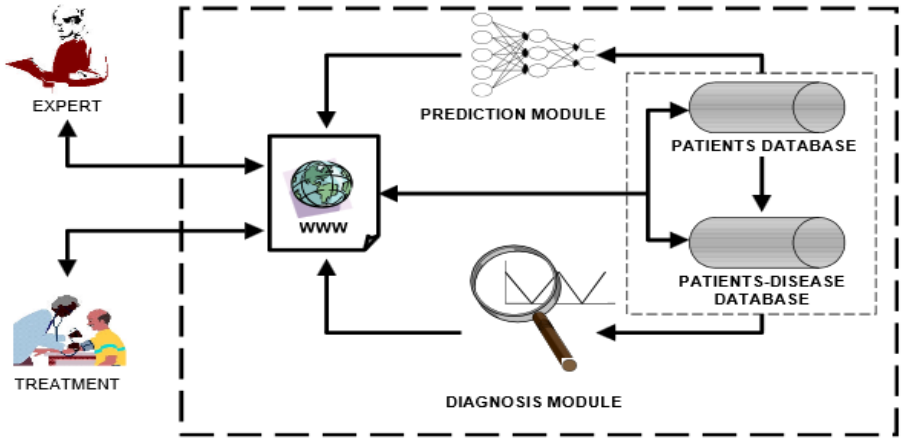


Figure 2.1 A model for Medical Diagnosis and Prediction (Ishak, 2002)

2.3 Intelligent Information Systems in the Healthcare

The implementation of intelligent systems has gain a wider acceptance in various fields since 1970s (Shortliffe, 2012). As a matter of fact, numerous artificially intelligent systems implementation and research works had been done in the area of AI, intelligent systems and their implementation in various fields. Among the various AI systems, MYCIN is considered as one of the earlier AI program, an expert system specially developed in the medical world for the treatment

of blood infections. It was designed to diagnose patients based on signs, symptoms and other diagnostic results such as laboratory test results (Clancey, 1983).

According to Clancey (1983), MYCIN was an intelligent system capable of performing additional tasks such as raising further queries about a patient in order to gain further information about the condition of the patient. It also capable of recommending appropriate laboratory examinations so that it will be possible for it to arrive at probable diagnosis (Shortliffe, 2012). Further, based on request MYCIN capable of reasoning in which it forwards the logic it followed to reach its goals, the diagnosis and recommendations.Therefore, intelligent system have vital role in health care.

2.4 Overview of Artificial intelligent

Artificial intelligence (AI) is concerned about how to build an intelligent machine. It solve unstructured and complex problems as human does and also able to reason and analyze data or information. It is a concept of study applying in different domains areas to solve complex problems and to represent knowledge in different form (Owaied, 2010).

According to Ishak (2002), application of AI in the field of medical Science can be used for identification and treatment of different diseases and also used to emulating human intelligence to assist the doctors in making decision without consulting the specialists directly. This was not meant to replace the specialist or doctor, yet it was developed to assist low level medical professionals and specialist in diagnosing and predicting patient's condition from certain rules or experience. AI consists different family group one of the major family member is knowledge based system(KBS) .KBS act as an expert on demand without wasting time and applied anywhere (Akerkar, 2010). Employing KBS in medical domain area used to reduce cost, time, human expertise and medical errors. Therefore, by using the potential of KBS it is possible to provide support in diagnosis and treatment of human and non-human related diseases

2.5 Knowledge base system

Knowledge based systems is a computer program that attempts to replicate the reasoning processes of a human expert (Rajendra, 2010). It consists of a repository of expert knowledge with utilities designed to facilitate the knowledge retrieval in response to specific queries, along with learning and justification, or to transfer expertise from one domain of knowledge to another. Particularly, KBS focus on using knowledge base techniques to support human decision making. It is capable

of cooperating with human users and are being used for problem solving, training, and assisting users and experts of the domain for which the system are developed (Akerkar, 2010).

KBS consists of a knowledge base, working memory and inference engine for interpreting the fact using the knowledge supplied in the knowledge base. All this different components interact together to simulating the problem solving process (Konar, 1999).KBS knowledge usually represented in some form of human logic, programmed using declarative programming languages (Prolog, Lisp, CLIPS) and expert system shells (JESS and E2gRuleEngine). Those languages allow the programmer to define knowledge of human experts in a descriptive manner to provide solution for a problem. Furthermore, easy and flexible to represent expert knowledge (Leondes, 2000). Generally the primary goal of KBS is to make expertise available to decision makers who need answers quickly.

2.5.1 Advantage of knowledge base system

According to (Akerkar, 2010)KBS are more useful in many situations than the traditional computer based information systems. Some of the situations are:-

- Expert is unavailable.
- Intelligent assistance and/or training are required for the decision making for problem solving.
- More than one experts' knowledge have to be grouped at one platform.

In addition to described situations knowledge-based systems also offer several advantages over natural intelligent systems (humans). Some of the major advantages are listed below (JM, 1997; Rajendra, 2010).

Permanent Documentation of knowledge: A Knowledge engineer acquires knowledge from multiple experts and other resources, such as guidelines, research papers and internet. He/she represent it in a well-designed knowledge base.

Easy availability of knowledge: KBS development is often considered large, complex, and costly. However, creating the knowledge base is one-time cost. After cloning it into multiple copies, it is easy to utilize the knowledge among multiple sites. This breaks monopolies of experts and makers knowledge acquisition and utilization easier.

Consistency and reliability: Knowledge-based systems offer more than human expert knowledge in an integrated and proportional means whereas human experts are influenced by most recent

information. Therefore, this increases the amount of important knowledge for reliable decision-making and decreases the amount of errors might be created.

Justification for better understanding: The reliability of the domain experts relies on the capability to explain their decisions. This can be offered by using the reasoning and justification component of the KBS to the end-users. If there is a well understanding of the decisions made by end-users of the system, then it increases the quality and trustworthiness of the system.

Timeliness: Fraud and/or errors can be prevented. Information is available sooner for decision making.

Completeness: An expert system can review all the transactions, a human expert can only review a sample.

2.6 Knowledge base system architecture

In computer industry architecture is critical to design and develop a given system. It is a blue print that helps to represent the structure of an object or a system and also it is the conceptual model that defines the structure and guidelines of the system (Gacek, 1995). It also helps to describe set of convections, rules, tools and standards that should be incorporated in the corresponding systems. Similar to other systems, knowledge based system has its own architecture that describes the main components of it, the core functionalities that are carried out in the system and the basic tools that aid for development of KBS (Akerkar, 2010).

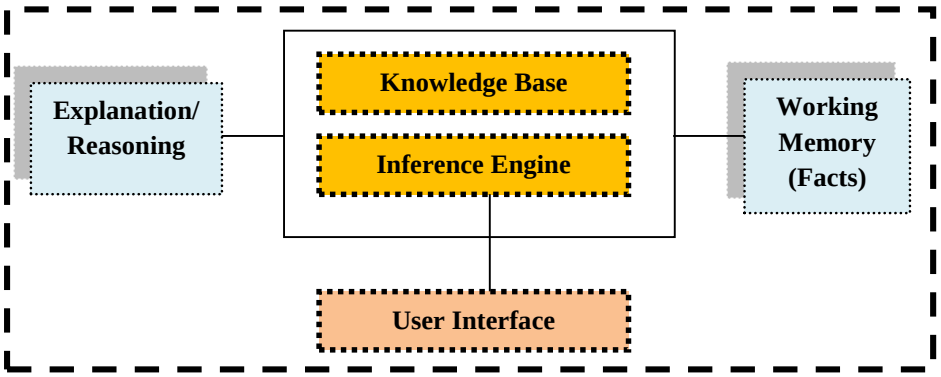


Figure 2.2 Architecture of Knowledge based system (Akerkar, 2010)

2.6.1 Knowledge base

Knowledge base (KB) is the heart of a knowledge-based system, which contains the necessary knowledge for problem solving. It represent repository of knowledge for specific and narrow domain (Owaied, 2010). Knowledge engineer creates the knowledge base, conducting a series of interviews with the experts and organizes the knowledge in a form suitable to the system (Tripathi, 2011).In rule based knowledge base system, KBs can be represented by production rules (Krishnamoorthy, 1996). Production rules consist of conditions or premises followed by an action or conclusion (IF condition...THEN action). It allow the knowledge base to be broken down into manageable units. During consultation, conditions satisfied facts supplied by the user. The operation is performed by the inference engine.

2.6.2 Inference Engine

Inference engine (IE) controls structure in KBS and provides a reasoning methodology. It is the KBS interpreter, which analyzes and processes the rules. It is used to perform the task of matching antecedents (IF parts) from the responses given by the users and firing rules (Tripathi, 2011).The function of the IE is to explore information and relationships from the knowledge base to provide predictions and suggestions in away a human expert would understand.Inference engine consist algorithms for manipulating the knowledge represented in the knowledge base to solve a problem presented to the system (Konar, 1999). In rule-based reasoning system, backward chaining and forward chaining are the two common strategies to reach a conclusion (Abraham, 2005).

Backward chaining inference method can be described as working backward from the goal. In this method, an IE searches the inference rules until it finds one where the IF clause is known to be true. This means it starts with some facts and applies rules to find all possible conclusions. Goal driven is a commonly used term for describing backward chaining which refers to the method used to process the rule. In this method, the IE identifies one or more hypotheses and begins searching for rules that contain the hypothesis as a consequent (Wilson, 2012; Krishnamoorthy, 1996).

On the other hand, forward chaining is a data driven inference process in which the system starts with the initial set of elements (facts) in the working memory. Then, it keeps on firing rules until there are no rules, which can be applied, or the goal has been reached. In this strategy, rules are applied when left-hand-side conditions are satisfied. Forward chaining is very popular, as is

evidenced by the fact that it is known by so many different names such as bottom-up, data-driven control, pattern-directed, or antecedent reasoning (Wilson, 2012; Krishnamoorthy, 1996).

2.6.3 Explanation or reasoning

Explanation subsystem helps in justification of KBS conclusions by tracing conclusions to their sources and showing how was a certain conclusion reached. With this capability a knowledge base system can explain how it arrives at conclusions. Providing explanations is vital in all non-trivial domains for the user to understand how the system works and determine conclusion. Typically, the system will keep track of what rules (knowledge) it is using and provide explanations based on a translation of these rules into English (Khosla, 2005).The explanation facility helps the knowledge base system to clarify and justify why such a deviation might be needed.

2.6.4 Working memory

The working memory (WM)is the storage medium that represents the set of facts known about the domain. In knowledge based system, the working memory typically contains information about the particular instance of the problem being addressed (Krishnamoorthy, 1996). For example, in pregnancy induced hypertension disorder, the working memory could contain the details of the PIH disease being looked at.

2.6.5 User interface

The User Interface is one of the major components of knowledge based system which allows bi-directional communication between system and user is considered to be a critical part of the success of an expert system. The user interface consists of all screens of interaction between the user and the KBS. The purpose of the user interface is to ease use of the knowledge base system for developers, users, and administrators **(Abraham, 2005)**.

2.7 Development of Knowledge based system

2.7.1 Knowledge Acquisition

Knowledge acquisition is the process of eliciting, structuring and representing knowledge from knowledge source in order to construct a knowledge based system. It is the process of transferring knowledge from the knowledge source to knowledge engineer (knowledge based system

developer).Byrd (1995) verified that knowledge acquisition is a crucial stage in the knowledge based systems development process and recognized as the bottleneck and challengeable in KBS development.On the other hand knowledge acquisitionis a collection of knowledge from knowledge rich sources and its orderly placement into the knowledge base (Konar, 1999).

In building knowledge based system, the knowledge acquisition process incorporates typical fact finding methods such as interviews, questionnaires and record reviews. However, these methods not effective to extract tacit knowledge which is stored in subconscious mind of expert's.For this kind of knowledge, techniques such as concept sorting, concept mapping, and protocol analysis are being used. These are important techniques for extracting or obtaining useful knowledge from experts for developing knowledge based systems (Okafor, 2006). As Vlaanderen (1990) noted methods or techniques incorporate into knowledge acquisition fall into one of the two categories manual or automated knowledge acquisition strategies. Selection of strategies depend on knowledge engineer.

2.7.1.1 Manual knowledge Acquisition methods

Interview:The most commonly used forms of tacit knowledge acquisition, which involves a direct dialog between the domain expert and the knowledge engineer. This technique includes structured and unstructured interviews with challenging problem scenarios. For the unstructured interview, the knowledge engineer must remain in touch of new trends and problems in the environment. The knowledge engineer asks different unstructured questions informally based on the response of the experts. This saves time and opens new dimensions and aspects of the knowledge acquisition process. A structured interview is a systematic, goal-oriented process and an organized communication (Burge, 2001).

Tracking methods:It is a collection of techniques that try to track the reasoning process of an expert. It is a widely held approach among cognitive psychologists who are interested in discovering the expert's train of thought in reaching a conclusion. The knowledge engineer can use the tracking process to find what information is being used and how it is being used (Rajendra, 2010)

Observation: In many ways, this is the most obvious and straight forward approach to knowledge acquisition. Through this technique knowledge engineer directly observe how problems are solved by domain expert. Observation was particularly fruitful in seeing what the expert physically does

when solving diagnostic problems. It was useful in determining what types of knowledge the human expert used to solve problems and the forms in which the knowledge were stored. Observations are used primarily as a way of supporting verbal protocols. Generally, acquiring knowledge through observation is expensive and time-consuming task (Burge, 2001).

2.7.1.1 Automatic Knowledge Acquisition methods

In addition to manual knowledge Acquiring method, knowledge acquisition process can also performed by computer-based tools. Computer-based tools for helping the knowledge acquisition process are also possible to extract knowledge automatically from the set of data. The process of finding useful information and patterns from the set of data using computers is known as knowledge discovery. In early 1990s, the process was also known as machine learning. But, currently knowledge discovery and data mining are becoming widely used terms (Rajendra, 2010).

2.7.2 Knowledge Modeling

Knowledge modeling (conceptual modeling) is one of knowledge acquisition activities that help to shed light on the structure of knowledge based systems. It is the process of expressing the analyzed knowledge in an understandable and usable form such that preparing the knowledge for knowledge representation phase (Leondes, 2000).It used to capture the essential features of real systems by break down into manageable parts that are easy to manipulate and understand. During the knowledge acquisition, most of the knowledge is unstructured and often in tacit form. Then knowledge engineer understand both tacit and explicit part of the knowledge and represent using visual diagrams to stimulate discussion amongst users and knowledge experts (Abdullah, 2002). Knowledge engineer construct conceptual model from what has been discussed during the knowledge acquisition stage. Then transform the model into workable computer programs or codes. Before knowledge based system built, knowledge must somehow be identified, collected and a model of domain knowledge must be constructed (Owoc, 1999).

As Speel (2001) noted, knowledge modeling provides an implementation independent specification of knowledge in the application domain. Typically, a knowledge model provides formats for writing down both static domain knowledge (rules, classes, relations) as well as reasoning strategies in which domain knowledge is used to solve a particular problem. In knowledge modeling the most common and flexible modeling tool is decision tree. It is a collection of nodes representing goals and links representing decisions. The major advantage of decision

trees is to simplify the knowledge acquisition process.Decision tree is often more natural to experts than formal representation methods and it can easily be converted to rules (Almuallim, 2002).

2.7.3 Knowledge Representation

Knowledge representation (KR) is the process of encoding human knowledge in computer understandable form. It is concerned with designing and using systems for storing knowledge (Tanwar, 2010; Abdullah, 2002). Therefore, the knowledge acquired from experts or induced from a set of data must be represented in a format that is both understandable by humans and executable on computers (Venumadhav, 2013).KR is a methodology by which a suitable structure is selected to represent a given knowledge component in such a way that operations like storage, retrieval, inference, and reasoning are facilitated without disturbing the required characteristics of the knowledge components (Brachman, 2004).

To develop knowledge based systems there are several knowledge representation techniques. The same piece of knowledge can be represented using more than one formal scheme, but with varying degrees of difficulty. The selection of a scheme depends on the domain knowledge it represents and the inference mechanism it uses (Kong, 2008). A knowledge representation method should allow adequate representation of knowledge that is needed for a problem domain.Production rules, frames, case based and semantic network are the typical examples of knowledge representation scheme. Some of them are described as follow:

2.7.3.1 Semantic network

Semantic networks is one form of knowledge representation. A semantic network is often used as a form of knowledge representation with graphs consisting of vertices that represent concepts, and edges to represent semantic relations between the concepts (Venumadhav, 2013) . Semantic network also called as Associative Network (Sharma, 2011). Although, Petrik (2004) define semantic network as a classical representation of hierarchical relational knowledge in AI. It is basically a graph where the nodes are labeled and arcs represent relations between them. The nodes in the graph represent entities and classes of entities. Generally Semantic representation consists of four parts lexical, structural, procedural and semantic (Sharma, 2011).

- Lexical deals with symbols represented in the vocabulary. Nodes denote objects, links denote relation between objects, and link-labels denote particular relations.

- Structural describes constraints on how the symbols can be arranged. Nodes are connected to each other by links.
- Procedural specifies the access procedures (to create, modify, answer questions). Procedures are classified as constructor procedure, reader procedure, writer procedure and erasure procedure.
- Semantic establishes the way of associating the meaning. Nodes and links denote application specific entities.

Semantic networks have some limitations. One major problem semantic is difficult to distinguish between nodes which representing classes of things and nodes representing individual objects. Additionally, similar to frames, it is difficult to implement some logical relationships between concepts (Okafor, 2007).

2.7.3.2 Frame

Frame is an extension to semantic network. Semantic network are used to labeled connections between objects. But when the task becomes complex the representation becomes more complex for such task the frame representation will be more beneficial. It is a collection of attributes or slots and their associated values which describe the real world entity (Tanwar, 2010).

A frame-based representation is ideally suited for object-oriented programming techniques. It provide a concise structural representation of knowledge in a natural manner (Abdullah, 2002). The knowledge in a frame is partitioned into slots. A slot can describe declarative knowledge or procedural knowledge and each slot represent one or more facets. The facets (sub slots) describe some knowledge or procedural information about the attribute in the slot. Most artificial intelligence systems use a collection of frames linked together in a certain manner to show their relationship. This is called a hierarchy of frames .The hierarchical arrangement of frames permits inheritance frames (Venumadhav, 2013)

Advantages of frames (Okafor, 2007)

- Used to structure KB, frame system represents knowledge much like they appear ordinarily. This structure assists both humans and machines in understanding. Also, a number of different objects may share the same frame.Hence, it assists in data compression.

- Frames provide a natural hierarchy and inheritance of properties through the sub-frame structure, thusknowledge representation is easier.
- The structure of frames supports smooth system query since each frame contains related information in the slot.
- Finally, it support procedural attachment which could be used to provide more information to slots. Hence allowing the system to adjust to new situations.

Disadvantages of frames (Okafor, 2007)

- Frames lack semantics. In other words, there is no standard definition of links used to depict generic frames from specific frames.
- Default values may be over written, one crucial type of representation becomes impossible that of composite description whose meanings are functions of the structure and interrelation of their parts
- Overwriting default values may become very problematic because of inheritance feature down the hierarchy.

2.7.3.3 Case-Based

Case-based representation is a reasoning mechanism that utilizes the specific knowledge of previously experienced and concrete problem situations (cases). A case is a contextualized piece of knowledge representing an experience and knowledge at an operational level which contains specific knowledge or strategy that was applied for solving a problem (Krishnamoorthy, 1996). According to Aamodt (1994) a case usually denotes a problem situation previously experienced situation, which has been captured and learned in a way that can be reused in the solving of future problems and is referred to as a past case, previous case, stored case, or retained case. Correspondingly, a new case or unsolved case is the description of a new problem to be solved.

Case-based reasoning (CBR) is a process of considering past cases and arriving at decisions on comparison between the current situation and the old cases. The solutions to problems are accomplished from past experience, stored in the form of cases (Krishnamoorthy, 1996).CBR has the ability to utilize the specific knowledge of previously experienced, concrete problem situations. A new problem is solved by finding a similar past case, and reusing it in the new problem situation. Additionally, CBR has also been an approach to incremental, sustained learning, since a new

experience is retained each time a problem has been solved, making it immediately available for future problems (Aamodt, 1994).

2.7.3.4 Rule-based (Production rules)

A production system (rule based system) is a computer simulation of one or more tasks. Normally, the tasks have some form of goal to accomplish (for example, making a medical diagnosis based on symptoms data).It applies rules from a given starting position until a goal is reached with certain sets of further constraints.Production rule used to simulate how people perform tasks (particularly those of a problem solving nature, which are well suited to the framework of production system) (Jones, 2003). Production rules are simple but powerful forms of knowledge representation providing the flexibility of combining declarative and procedural representation for using them in a unified form. It has a set of antecedents and a set of consequents, the antecedents specify a set of conditions and the consequents a set of actions (Krishnamoorthy, 1996). According toLewis (2003) production rule is one of the most popular approaches to knowledge representation is to use production rules, sometimes called IF-THEN rules.

IF condition THEN action

IF premise THEN conclusion

IF proposition p1 and proposition p2 are true

THEN proposition p3 is true

IF this condition occurs, THEN some action should occur. Rules are used for a simulation of the cognitive behavior of human experts. It represents a model of actual human behavior, not a neat formalism to represent knowledge in a computer.

On other hand Rules are called production rules because new information is produced when the rule fires. Production Rules are linked into chains of reasoning by the knowledge based system, which can use either backward chaining or forward chaining. This method is similar to the way in which experts formulate knowledge in a “cause-and-effect” fashion. It is useful when representing heuristics (rule of thumb) of how the expert does things or what he does and does not know why (implicit knowledge) (Okafor, 2007). Rules represented either backward chaining or forward chaining (Wilson, 2012).

Backward Chaining is used to determine if a decision should be made, work backwards looking for justifications for the decision. Eventually, a decision must be justified by facts.

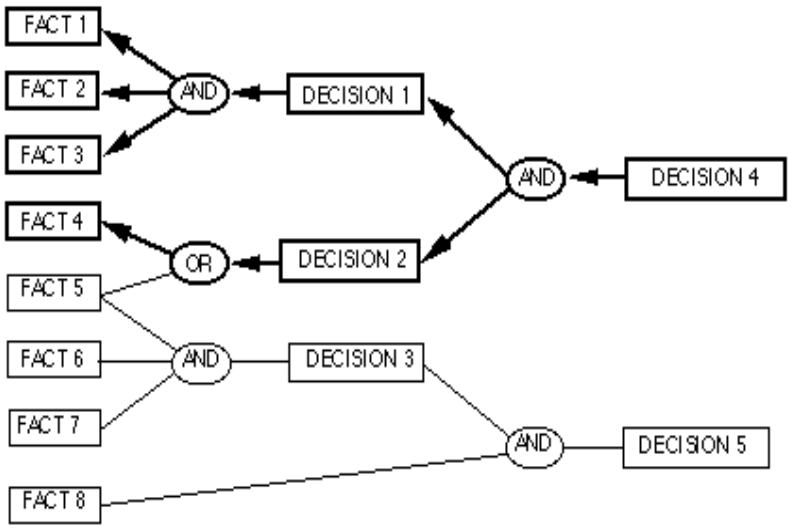


Figure: 2.3 Backward chaining (Wilson, 2012).

Forward Chaining given some facts, work forward through inference net. It discovers what conclusions can be derived from data.

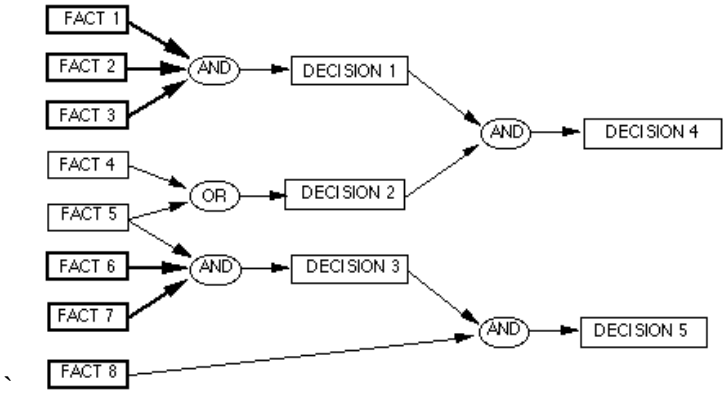


Figure 2.4 Forward chaining (Wilson, 2012)

In general rule-based systems consist of a set of rules, a working memory and an inference engine. The rules encode domain knowledge as simple condition-action pairs. The working memory initially represents the input to the system, but the actions that occur when rules are fired can cause the state of working memory to change. The inference engine must have a conflict resolution strategy to handle cases where more than one rule is eligible to fire.

Advantage of Production rule

Production rules have the following advantages used to represent knowledge in the knowledgebase (Okafor, 2007; Tripathi, 2011).

- Naturalness of expression, the "cause-effect" or "situation-action" format of production rule models the expert's knowledge in a natural way much like the way the expert reasons.
- Modularity, the use of production rules to represent the expert's knowledge enforces modularity since each rule stands as a module on its own. As a result KB structures using production rules are very easy to debug modify and maintain.
- Provision of explanations,the capability to offer justifications for the drawn conclusions in a direct manner is a key characteristic, given that justifications in specific problem domains are considered necessary.

Disadvantage of production rule

- Possibility of contradictions: the modification of knowledge base can be complicated when introducing new knowledge to solve some specific problems and change existing rules.
- Inefficiency:because rules require pattern matching, computational cost of rule-based system can be very high.
- Opacity : it is very difficult to examine a rule based system to determine what actions are going to happen, and when.
- Complex domains: some domains are so complex that tens or thousands of rules would be needed to represent the large number of possible situations.

2.8 Performance evaluation

Evaluation can be defined as an iterative process of systematic assessment of knowledge based System. Hence Knowledge acquired from experts need to be evaluated for quality using validation and verification (Akerkar, 2010). According to Guesh (2012) Effective knowledge based system evaluation process incorporates both technical and non-technical aspects. The technical aspects include exploring of the code, examining the correctness of reasoning techniques, checking the efficiency and performance of the system and debugging errors in the early age of a system development. The non-technical aspect includes system compatible with users' satisfaction, the easiness of the system, the quality of the user interface and the acceptability of the system in the real world environments.

2.8.1 Evaluation method of Knowledge based system

Evaluation method of knowledge based system start during program development and can be split in to verification, validation and assessment of human factors (Thomas, 2001).

Verification is an evaluation process that should be implemented during system design and development to answer the question 'did the system build correctly?'. Verification checks whether the system has been developed according to its specification and confirms consistency, completeness and correctness of the system. Specification assessment includes user interface, explanation facility, real time performance and security provisions specified in the system design.

Validation: Validation checks that the system performs the tasks for which it has been designed in the real working environment. Test strategies are the methodology of choice. Content validity compares program results with the expected results. The system test examines the complete system in its working environment. It is an important step in KBS evaluation.

Evaluation of human factors: used to determine usefulness and usability of Knowledge based system by select appropriate quality indicators. Usefulness of a system is often measured by examining user satisfaction. User satisfaction is system dependent aspects, such as content satisfaction and interface satisfaction.

2.9 Implementation tools for knowledge base system

A KBS tool is a set of software instructions and utilities taken to be a software package designed to assist the development of knowledge-based systems. It provides a range of facilities for representing knowledge, reasoning with knowledge and supplies an inference engine alongside frameworks for entering facts and facilities for building a user interface (Rajendra, 2010). According Kruger (2011)knowledge base tools classified as

- **General purpose conventional (procedural) languages**

  It may be possible to develop a knowledge base system using any general purpose procedural language for example FORTRA, BASIC, Pascal, and C. Since these languages are procedural rather than declarative, the inherent language structure is awkward and not really suitable· for the development of relative complex expert systems. However, a significant number of expert systems, as well as expert system development software, have been developed using these languages especially the C language.

- **Low level Artificial Intelligence (declarative) languages**

  Declarative programming is constructing a program in terms of high level descriptions of a problem's constraints, rather than procedural programming style, writing programs as a sequence of instructions for performing an algorithm. Programming language such as Lisp and Prolog are low level declarative languages.

  LISP: Stands for "List Processing," because one of his key ideas was to use a simple data structure called a list for both code and data. There are various versions of Lisp available namely KLISP and C Language Integrated Production System (CLIPS). It is the foundation of many expert systems and shells such as CLIPS (Sajja, 2010).

  Prolog:is logic programming general-purpose fifth generation (AI) language. It is a true declarative language with a build-in inference engine and backward-chaining inference engine mechanism (Sajja, 2010).

- **Knowledge based System Shells**

  An expert system shell consists of a ready-made expert system, including the inference engine, user interface, knowledge representation scheme and various built-in utilities, but with an empty knowledge base. It is therefore relatively easy to develop an expert system using, a shell. Java expert system shell (JESS) and e2gRuleEngine are the two most popular expert system shells.

  JESS provides fully developed Java application program interface for creating rule base knowledge base system. JESS is very simple and easy to learn and it is small, light and fastest rule engine available. JESS matches facts in the fact base to rules in the rule base. It used to develop web based knowledge based system but it is commercial (Shruthi, 2014).

  The other type of KBS shell e2gRuleEngine is a free rule based expert system tool which comprises of Java applet and is a development toolkit (a 'shell') developed by eXpertise2GO which was developed with Java.

- **Higher level development environments (toolboxes)**

  Hybrid expert system development environments such as Goldworks and RuleMaster was developed in an effort to maintain some of the flexibility of low level declarative languages but at the same time to provide the user with some of the power, convenience and ease of use of a shell.

2.10 Related work

The Medical diagnostic Systems have undergone many changes and are using new techniques to generate better results. Knowledge based system in artificial intelligence is one of the techniques used in Medical diagnosis and treatment to support patients and health professionals. These sections summarize limited researches conducted using Expert (knowledge base) system in health domain from both local and international side respectively.

Guesh (2012) developed knowledge based system for blood transfusion. The researcher uses rule-base representation techniques in knowledge representation. The study aimed to fill the gap among experts in blood transfusion accordingly to patient requirement.Researcher use interview and observation to acquire tacit knowledge from experts and document analysis for secondary document. The acquired knowledge modeled using hierarchal representation techniques .Researcher also use backward inference engine mechanism. SWI-prolog used in the implementation of prototype to run production rules .The performance evaluation of prototype is 82.5 %.The study limited to laboratory diagnostic result. Researcher recommended for further research to make full-fledged system that includes both blood screening and transfusion of blood practices and work on user interactivity make life easy for potential users, other visual user interface tools should be used, such as .NET and C#.Researcher explores the applicability of knowledge based system in assisting blood transfusion.

Tagel (2013) Develops Knowledge based system for Pre-Medical triage treatment at Adama University Asella Hospital. During the development of knowledge based system in his research interview and document analysis used to acquire knowledge from experts and secondary document in knowledge acquisition process. Then the acquired knowledge model using decision tree in conceptual modeling phase. After modeling the researcher represents using rule-based representation techniques. Prolog used as implementation tool for development of prototype and then the validation was 85%. He recommends for further research to work on user interface design enable users to communicate using their language with the KBS.Researcher explores the applicability of knowledge based system in pre-medical triage treatment.

Solomon (2013) Built up a prototype self-learning knowledge based system that can offer advice for physicians and patients to assist the diagnosis and cure of diabetic patients. Knowledge is acquired from domain experts which are chosen using purposive sampling technique from Black

Lion Hospital Diabetes Center and document analysis is used to acquire knowledge from secondary documents. For knowledge modeling and representation decision tree and backward chaining rule-based techniques used respectively. SWI-prolog used in the implementation of prototype to run production rules. The general total performance of the prototype system is 84 %. Researcher recommended for further research regarding the usability of the user interface of the system graphical user interface must be designed like using VB.net and local language used to easily understand the advices offered by the system making the system easily usable by the end-users.

Rivas-Echeverra (1999)present an expert system for the diagnosis and treatment of preeclampsia (ESPRE). It is a rule-based medical expert system that support diagnostic and therapeutic decision in the realm of the disease. The aim of ESPRE is to support independent learning and decision making regarding the diagnosis of preeclampsia while physicians are actively engaged in clinical practice. The system was developed using visual basic programming language run on IBM compatible personal computer and system work on windows 3.1 and above platforms. In addition, researcher only focus on only one category of hypertension disorder of pregnancy and system developed in context ofVenezuela.

Djam (2011) developed web-based fuzzy expert system for management of hypertension. Researcher use systolic blood pressure, diastolic blood pressure, age, and body mass index as input parameter to fuzzy expert system. Based on the input parameters the triangular membership function of fuzzy logic was determined as low, normal, high and very high blood pressure result. Developed system was designed using php programming language and MySQL relational database on Apache Sever. Researcher computed the develop system on 50 patient data.However, the developed system perform only determine the risk level of hypertension using limited parameters and the system doesn't provide treatment after identification of risk level. In addition, researcher doesn't address hypertension disorder of pregnancy and dosen't messure system performance.

Rupinder (2014)developed fuzzy expert system for diagnosis hypertension. Researcher use blood pressure, body mass index, age, heart rate, diabetes and life-style of the patient to diagnosis hypertension. The fuzzy rules to determine the risk factor of having blood pressure or not .Methodology used by the research is Data collection designing and development of fuzzy expert

system using MATLAB R2010a.Developed system determine level of hypertension as mild, moderate and severe. However, It cann't provide any treatment.

A numbers of local researches have been done research in the medical domain. The main intension of researchers (Guesh (2012), Tagel (2013) and Solomon (2013)) is to investigate the applicability of knowledge based system in the medical domain area. Most of researcher employ similar approaches such as rule based techniques to develop the knowledge based system. In addition, most of the researches are implemented for specific domain area and all of three researchers developed standalone systems.

The proposed system in this study is conducted to explore the applicability of knowledge based system in medical domain specifically diagnosis and treatment of pregnancy induced hypertension. Furthermore, researcher applies e2gRuleEngine rule based and web based techniques. Therefore, the proposed web based knowledge based systems can assist medical experts during the diagnosis process and in providing appropriate treatments.

CHAPTER THREE

RESEARCH METHODOLOGY

In this section, the research design and methodology is elaborated. The techniques carried out in this study were knowledge acquisition, modeling, and knowledge representation and implementation method using appropriate knowledge programming tool. In order to achieve the objectives of this research the following methods and techniques are employed.

3.1 Literature Review

In order to have deep understanding on the problem of this study, it is vital to review several literatures that have been conducted in the field so far. For this reason, related literature such as books, articles, proceeding papers and online tutorial that are retrieved from the internet will be consulted so as to understand the domain knowledge, concepts, principles and methods that are important for developing web based knowledge base systems.

3.2 Data collection method

For the purpose of this study, both primary and secondary data collection methods are employed to collect the required domain knowledge. As primary sources, medical experts (obstetrician or gynecologist) from Debre berhan zonal referral hospital and Ayu private hospital have been interviewed. In addition, relevant literature from all possible sources including journal articles, health manuals, and guidelines were reviewed.

During gathering primary information from experts, sampling has a vital role hence the right choice of sampling techniques makes research effective. According to Barreiro (2001) there are three types of sampling techniques; those are probability sampling (random sampling, stratified sampling, cluster sampling and systematic sampling), purposive sampling and no-rule sampling. From those sampling techniques purposive sampling is the one that makes conscious selection of certain subjects or elements to be included in the study. Therefore Purposive sampling techniques are employed to select sample which can help to acquire the required knowledge from the domain experts (Tongco, 2007). Domain experts are selected based on their educational qualifications

related to the domain area and willingness.Therefore in this thesis purposive sampling is used to select domain experts to elicit required knowledge.

After selecting Domain experts using purposive sampling method different elicitation techniques applied to elicit knowledge from experts. Interviewing is the most commonly used forms of tacit knowledge acquisition, which involves a direct dialog between the domain expert and the knowledge engineer. There are three form of interviewing methods structured, unstructured and semi-structured interviewing techniques (Burge, 2001). For this study structured and unstructured interview techniques have been employed to acquire the required knowledge from the selected domain expert. It allows the interviewer to change the order of the questions and add new question based on the participant response (Burge, 2001).

3.3 Knowledge modeling and representation methods

In development of knowledge based system knowledge modeling and representation are the two important steps for structuring acquired knowledge from experts. To ensure well-formed models selecting appropriate knowledge modeling methodology would be a critical task. Additionally, reusing models can significantly reduce the time and costs of building a new application. Modeling is the process of expressing the analyzed knowledge in an understandable and usable form such that preparing the knowledge for knowledge representation phase (Leondes, 2000). Therefore the acquired knowledge from the domain expert has been represented by using decision tree modeling in a formal language logic which is suitable for the selected rule based reasoning mechanism were employed for the inference engine.

During the development of knowledge based system different reasoning mechanisms are applied among them the most commonly used are rule-based and case-based reasoning.Case-based reasoning (CBR) is a process of considering past cases and arriving at decisions on comparison between the current situation and the old cases. The solutions to problems are accomplished from past experience, stored in the form of cases (Krishnamoorthy, 1996).Rule-based reasoning on the other hand,it is simple ,powerful and flexible knowledge representation techniques.It has a set of antecedents and a set of consequents, the antecedents specify a set of conditions and the consequents a set of actions (Krishnamoorthy, 1996).It is the most popular approaches to knowledge representation represented in form of IF-THEN rules (Lewis, 2003).

3.5 Implementation tools

In prototyping web based knowledge based system, selecting appropriate developing tool is an important part for successful implementation of the system. Developers say that selecting the correct tool is a vital in design and development of an expert system (Akerkar, 2010). A KBS tool is a set of software instructions and utilities used in development of knowledge-based systems (Rajendra, 2010). KBS can be developed using general purpose conventional languages (LISP, prolog) and knowledge based system shells (JESS and e2gRuleEngine). General purpose conventional or procedural languages used to develop desktop based standalone system where as knowledge based system shells used to develop web based system.

JESS provides fully developed Java application program interface for creating rule based knowledge based system. Its syntax is similar to LISP. It is simple, easy to learn, small, light and fastest rule engine. It is java tool used to develop web based knowledge base system but the tool is not free it is commercial (Shruthi, 2014). The other type of KBS shell e2gRuleEngine is a free rule based expert system tool which comprises of Java applet and is a development toolkit (a 'shell') developed by eXpertise2GO which was developed with Java and it designed for the purpose of developing prototype.

Therefore for this thesis Java, e2gRuleEngine, Adobe Dreamweaver, uniform server and php are used to develop the web based knowledge based system. Java and php are used as programming languages. E2gRuleEngine is used as an knowledge base system shell. To design the web interface of the system, adobe dreamweaver is used. Similarly, uniform server is used as a web server.

3.4 System evaluation

The evaluation process is more concerned with system user acceptance of the developed prototype. User acceptance efforts are concerned with issues impacting how well the system addresses the need of the user (Thomas, 2001). To assess human factors visual interaction together with questionnaires methods are used. During testing the domain experts monitor and automatically test the execution of the knowledge based system in Web browser and this is achieved with the help of e2gRuleEngine a rule based knowledge based system shell. Then they evaluated the system by using appropriate cases and closed ended questionnaires to determine performance of the developed system.

CHAPTER FOUR

KNOWLEDGE ACQUISITION AND MODELING

4.1 Introduction

Knowledge acquisition is the process of eliciting, structuring and representing knowledge from some knowledge source in order to construct a knowledge based system. Knowledge acquisition is the process of transferring knowledge from the knowledge source to knowledge engineer (knowledge based system developer). It is the most significant step in the development of knowledge based systems, but at the same time it is the most difficult one that needs great care, patience and attention (Krishnamoorthy, 1996).

Knowledge acquisition is a prerequisite and an important phase of knowledge based system development that deals with the activities of capturing knowledge from human experts, books, documents or computer files. The objective of knowledge acquisition is to analyzing and interpreting the knowledge that human experts uses when solving problems and then transferring these knowledge in to machine representation (Chandrasekhar, 2001).

Moreover, the main objective this chapter is to elicit and analyze the basic domain knowledge regarding to pregnancy induced hypertension and the fundamental concepts that are gained about the diagnosis's and treatment procedures that help to develop the proposed web based knowledge based system. Generally this chapter covers knowledge analysis collated during knowledge elicitation, structuring of analyzed knowledge in an understandable and usable form and lastly modeling knowledge that facilitates knowledge representation in next chapter (chapter five).

4.2 Knowledge Acquisition process

The process of knowledge acquisition of this research encompasses some basic activities such as gathering the required knowledge, analyzing gathered knowledge, identifying important concepts and finally modeling them in using decision tree structure. In order to acquire required knowledge from a given specific domain there are different techniques available such as interview, protocol analysis, document reviews and questionnaires which can be used to acquire both tacit and explicit knowledge. From those techniques, researcher use both structured and unstructured interviews

(interview questions presented in Appendix I) to acquire primary knowledge from various experts in the domain area.

Primary sources of knowledge are collected from human experts in the domain area at Debre berhan referral hospital and Ayu private hospital. For this reason, four domain experts were selected using purposive sampling technique. During interview phase, the main challenge is willingness of domain expert to share their expertise and experience, which is important to acquire the relevant knowledge. To handle this challenge domain expert were selected based on their interest in addition to purposive sampling technique.

The researcher tries to acquire relevant tacit knowledge from those domain experts showing willingness to provide basic information by extensive discussion. In addition the domain experts were actively participated throughout the research work and they were consulted to confirm the correctness of the acquired knowledge.

Table 4.1 Profile of experts who participated in the knowledge acquisition

No.	Education level	Specialization	Role
1	MSC	Emergency surgery and Gynecology Obstetrics	Team coordinator
2	MSC	Gynecologist	Gynecologist
3	MSC	Emergency surgery and Gynecology Obstetrics	Surgical
4	MSC	Obstetrician	Medical director

In addition, for better understanding on the domain area secondary source of knowledge have been gathered from internet, medical books, guidelines, research papers and articles. On the discussion with the experts some of the experts use international guidelines as it is and other expert's user local guidelines which is guideline for general hospitals prepared by drug administration and control authority of Ethiopia. The international guidelines used by experts are hypertension in pregnancy which is developed by American society of obstetricians and gynecologists and the other international guideline is the management of hypertensive disorders during pregnancy which is developed by Royal College of obstetricians and gynecologists. Therefore, based on acquired knowledge from both the domain expert and secondary sources pregnancy induced hypertension

classified in to six parts those are Chronic hypertension, Gestational hypertension, Pre-eclampsia, Eclampsia, Superimposed pre-eclampsia and Superimposed eclampsia.

4.3 Pregnancy Induced Hypertension

Pregnancy induced hypertension is one of obstetric disorder that complicate pregnant patient. Complication of this disorder results a substantial burden for both industrialized and less industrialized countries. It associated with higher rates of maternal, fetal, infant mortality and severe morbidity (Hutcheon, 2011). This disorder is the most common medical disorders in pregnancy contributing significantly to maternal and perinatal mortality and morbidity worldwide. The incidence is around 3-10% of all pregnancies (sushrut, 2013)

Drug administration and control authority of Ethiopia (2010) defines pregnancy induced hypertension as a systolic blood pressure greater than or equal to 140 mmHg or diastolic blood pressure greater than or equal to 90 mmHg in two occasions at last 6 hours apart, but not more than 7 days or a single blood pressure recording of 160/110mmHg in a woman prior to 20 weeks of gestation. It also define as a significant rise of blood pressure during pregnancy occurring after 20 weeks. The underlying pathology, either pre-exiting or appears for the first time during pregnancy and also occur with pre-existing chronic hypertension or the occurrence new onset hypertension in the second half of pregnancy (Desforges, 1992).

Furthermore, blood volume increased by 50% during pregnancy. This extra blood volume places stress up on the maternal vasculature if the body is unable to effectively adapt such blood volume increase pregnant women will develop a hypertensive disorder. Early identification of clinical entity and effective management plays significant role in the outcome of pregnancy for both mother and her unborn baby.

Generally, based on domain experts, drug administration and control authority of Ethiopia standard treatment guideline and journals papers these disorder classified in to six part as shown in the figure 4.1

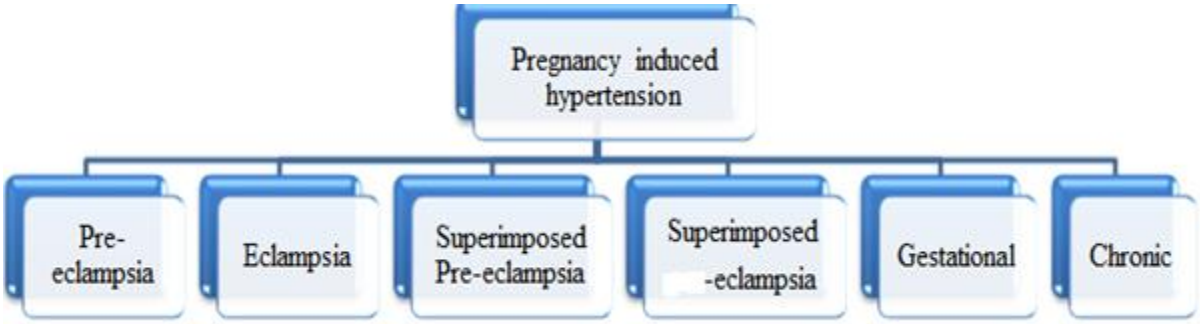


Figure 4.1 classification of pregnancy induced hypertension (Mammaro, 2009; Program, 2000)

4.3.1 Chronic hypertension

Chronic hypertension is one of the disorder in pregnancy that cause different problems in both mother and the baby.The prevalence of chronic hypertension among women of childbearing age increases from 0.6–2.0% for women 18–29 years old to 4.6–22.3% for women 30–39 years old. Chronic hypertension in pregnancy will continue to rise because of current trend of childbearing in an older age. During normal pregnancy, maternal blood volume increases by 40% to 60% and cardiac output and renal blood flow increase significantly (Desforges, 1992).

Drug administration and control authority of Ethiopia (2010) defines chronic hypertension as systolic blood pressure 140 mmHg or diastolic blood pressure 90 mmHg diagnosed before pregnancy or before 20 weeks gestation. On the other hand hypertension diagnosed after 20 weeks gestation, and which persists 12 weeks postpartum, is also considered as chronic hypertension (Hutcheon, 2011). In chronic hypertension the diagnosis might difficult in women with previously undiagnosed chronic hypertension which begins prenatal care after 16 weeks gestation because a physiologic decrease in blood pressure usually begins at diagnostic time. This decrease result in normal blood pressure findings, which will eventually increase again during the third trimester.
According to gynecologist the common symptom of chronic hypertension includes headache, burring vision, and tinnitus and right upper quadrant pain. In addition to blood pressure end organ involvements such as abnormal renal function and cardiac involvement are used to provide appropriate treatment either pharmacological or non-pharmacological.

4.3.2 Gestational Hypertension

Gestational hypertension is characterized by the new onset of hypertension after 20 weeks gestation without any maternal or fetal features of preeclampsia, followed by return of blood pressure to normal within three months post-partum. Some women initially diagnosed in this category will manifest persistent blood pressure elevation beyond 12 weeks post-partum and eventually be classified as having chronic hypertension (Hutcheon, 2011).

According to Drug administration and control authority of Ethiopia (2010) clinical diagnosis of gestational hypertension defined as systolic blood pressure greater than 140 mmHg and diastolic blood pressure greater than 90 mmHg after 20 weeks of gestation with no sign of and symptoms of preeclampsia.

4.3.3 Superimposed preeclampsia/eclampsia

Superimposed pre-eclampsia defined as a new-onset proteinuria, thrombocytopenia or any of the other pre-eclampsia signs after 20 weeks gestation with pre-existing chronic hypertension (Hutcheon, 2011). Distinguishing superimposed pre-eclampsia from benign gestational increases in blood pressure and proteinuria that are often observed in women with chronic hypertension (Lowe, 2014). Given the higher risk of adverse pregnancy outcomes with superimposed pre-eclampsia, over diagnosis may be preferable, with the goal of increasing vigilance and preventing catastrophic maternal and fetal outcomes. Alternatively, a more specific and stratified approach based on severity and predictors of adverse outcome is useful in guiding clinical management and avoiding unnecessary preterm births.

According to Gynecologist clinical symptom associated with superimposed preeclampsia includes right upper quadrat pain, vomiting, vaginal bleeding and the absence of seizure. Whereas superimposed eclampsia is defined as the presence of seizure with sever sign of pre-eclampsia.

4.3.4 Preeclampsia

Pre-eclampsia is a one the complication in pregnancy induced hypertension. It is characterized by new-onset hypertension and proteinuria. Proteinuria defined as the urinary excretion of 300 mg of protein in 24 hr. Although, pre-eclampsia is characterized by lowplacental perfusion and a systemic disease process that can involve multiple organ systems.

According to Vest (2014)pre-eclampsia is determined when hypertension arises after 20 weeks gestation and elevation of blood pressure greater than 140/90 mmHg with existence of proteinuria on two random urine dipstick specimens. The two criteria, presence of protein in urine and new onset of hypertension are considered the classic definition of preeclampsia (Program, 2000). Proteinuria is diagnosed when 24-hour excretion equals or exceeds 300 mg in 24 hours or measured protein to creatinine ration in a single voided urine measures or exceeds 3.0 mg/dl, termed the protein/creatinine ratio. On the other hand in diagnosis of hypertension recommended that at last two determinations and 4 hours apart, although on occasion especially when faced with severe hypertension, the diagnosis can be confirmed within a shorter interval to facilitate timely antihypertensive therapy (Lowe, 2014).

Gynecologists states the sign and symptoms of pre-eclamptic patient including persistent headache, visual disturbances (blurring, flashing, dark spot in the field of vision) , abdominal pain , right upper quadrant, epigastric pain and chest pain or shortness of breath raise are the clinical suspection for pre-eclampsia. Additional findings that warrant close observation for the subsequent development of preeclampsia include fetal growth restriction or new-onset proteinuria in the second half of pregnancy (Lowe, 2014). In addition different risk factors are available for preeclampsia some of them are multiple gestation, pre-existing chronic hypertension and renal disease. Those sing and symptoms with a critical measurement of blood pressure and protein in urine preeclampsia can be classified as mild and severe.

4.3.4.1 Classification of preeclampsia

According to Drug administration and control authority of Ethiopia standard treatment guideline (2010), preeclampsia can be classified as mild and sever based on the presence or absence of clinical features and the severity of sign and symptoms.

Table 4.2 classification of pre-eclampsia

Classification	
Mild Preeclampsia ☑ Blood pressure >= 140/90 mmHg but less than 160/110 mmHg on two occasions at last 6 hour apart. ☑ Proteinuria of 2+ (or 1 with specifications given in the definition). ☑ No other symptoms and signs of sever pre-eclampsia.	**Sever preeclampsia** ☑ Blood pressure 160/110 mmHg on two occasions at last 6 hours apart while the patient is on bed rest. ☑ Proteinuria of 5 g or higher in 24 hour urine specimen or greater on two random urine samples collected at last 4 hours apart. ☑ Headache, clouding visions (blurred vision/photophobia) ☑ Upper abdominal pain (right upper quadrant pain) ☑ Epigastric pain ☑ Shortness of breath or chest pain

4.3.5 Eclampsia

Eclampsia is defined as development of convulsions and unexplained coma during pregnancy in patients with signs and symptoms of preeclampsia (Program, 2000). Gynecologist defined eclampsia as a neurologic involvement in the form of generalized tonic-colonic convulsions in a women with preeclampsia is termed as eclampsia and seizures symptom cannot be attributed to any other cause such as epilepsy, cerebral infection, tumour or ruptured aneurysm. It most commonly affects women in their first pregnancies, with teenagers and women with multiple pregnancies at highest risk. However, one quarter of cases occur in second or later pregnancies.

The diagnosis of eclampsia is secure in the presence of hypertension, proteinuria, and convulsions. Eclampsia shows a wide spectrum of signs, ranging from severehypertension, severe proteinuria to low urine outcome. According to obstetricians and gynecologists hypertension, proteinuria and seizure are considered as the hallmark for the diagnosis of eclampsia. In addition almost without

exception, preeclampsia precedes the onset of eclamptic convulsions. Depending on occurrence of convulsions appear before, during, or after labor, eclampsia is designated as antepartum, intrapartum, or postpartum.

4.4 Criteria for Diagnosis of pregnancy induced hypertension

In diagnostic and test procedures of pregnancy induced hypertension, physical examination and laboratory tests are considered. According to Drug Administration and control authority of Ethiopian, common symptoms, blood pressure measurement, protein assessment in urine and gestational age are required in diagnosis and treatment of PIH disorder. Blood pressure measurement is considered for all types (Categories) of PIH to assess the presence of hypertension and its severity were as assessment of protein in urine is used to diagnosis superposed pre-eclampsia/eclampsia, pre-eclampsia and eclampsia. It also used to determine the severity of the disease and providing appropriate treatment. In addition to blood pressure measurement, proteinuria assessment and gestational age is critical in management and treatment of PIH disorder.

4.4.1 Blood pressure measurement

According to national blood pressure group, blood pressure measurement is required to make sure that if there is an elevation of systolic and diastolic blood pressure of the patient. Systolic blood pressure refers the degree of force when the heart is pumping (contracting) and Diastolic blood pressure is the degree of force when the heart relaxed (Program, 2000). Experts use Manometer equipment to measure and determine level of Blood pressure.

Table 4.3 Blood pressure measurement

Blood pressure measurement	Mild	Systolic	140 mmHg
		Diastolic	90 mmHg
	Sever	Systolic	160 mmHg
		Diastolic	110mmHg

4.4.2 Proteinuria assessment

According to Drug administration and control authority of Ethiopian (2010) assessment of proteinuria includes taking urine at offices of medical institution and sending urine sample to a laboratory for examination. Laboratory testing of urine required to make sure test results are correct. Urine testing helps medical instructions to discover and provide treatment for proteinuria related disorders such as preeclampsia and eclampsia (Mammaro, 2009).

- ✓ An automated reagent-strip reading device or a spot urinary protein creatinine ratio for estimating proteinuria in a secondary care setting.
- ✓ An automated reagent-strip reading device is used to detect proteinuria and a result of 1+ or more is obtained, use a spot urinary protein: creatinine ratio or 24-hour urine collection to quantify proteinuria.
- ✓ Creatinine ratio is greater than 300 mg/dl or a validated 24-hour urine collection result shows greater than 300 mg protein. Where 24-hour urine collection is used to quantify proteinuria, there should be a recognized method of evaluating completeness of the sample. Below table 4.4 describes the level of protein in urine during laboratory test.

Table 4.4 Protein level and Related PIH disorders (Mammaro, 2009).

Urine test for protein	Level	Severity
	<300 mg/dl	No diagnostic value for PIH
	300 mg/dl or 1+	Mild proteinuria
	>300 mg/dl or 3+	Sever proteinuria

4.4.3 Summarized of PIH Diagnostic criteria

4.5 Table Summarized form of PIH Diagnostic criteria

PIH disorders		BP level	Proteinuria	Time HTN dx GA
Chronic		≥140/90 mmHg	Doesn't exist	Occur Before 20 weeks gestation
Superposed Pre-eclampsia	Mild superposed pre-eclampsia	≥140/90 mmHg	Mild proteinuria (300 mg or 1+)	Occur before 20 weeks' gestation
	Severe superposed pre-eclampsia	≥160/110 mmHg	proteinuria (>300 mg or 3+ Sever)	
Superposed Eclampsia		≥160/110 mmHg	Sever proteinuria (>300 mg or 3+)	Occur Before 20 weeks gestation
Pre-eclampsia	Mild pre-eclampsia	≥140/90 mmHg	Mild proteinuria (300 mg or 1+)	Occur After 20 weeks gestation
	Sever pre-eclampsia	≥160/110 mmHg	Sever proteinuria (>300 mg or 3+)	
Eclampsia		≥160/110 mmHg	Sever proteinuria (>300 mg or 3+)	Occur After 20 weeks gestation
Gestational		≥140/90 mmHg	Doesn't exist	Occur After 20 weeks gestation

4.5 Management and treatment of pregnancy induced hypertension

Nowadays, there are operational management and treatments for PIH to keep mother and baby health. If pregnant women's are able to get the proper hospitalization, quality of care, medical treatment and well medical advice, then you can have a healthy life for both baby and the mother as well as decrease complications.

According to Ethiopian drug administration and control authority standard guideline (2010) and Ethiopian federal obstetricians and gynecologist treatment guidelines, 2011 (2011) confide procedures are listed. Those treatment and management procedures are discussed below.

4.5.1 Chronic hypertension

Management and treatment of chronic hypertension provided to patient in both pharmacological therapy and non-pharmacological therapy by considering blood pressure range and end organ involvement (abnormal renal failure).

Non pharmacological treatment

- ✓ weight reduction : maintain normal body weight (body mass index 18.5-24.9 kg/m^2)
- ✓ Adopt DASH eating plan : consume a diet rich in fruits, vegetables, low fat dairy product with a reduced content of saturated and total fat
- ✓ Dietary sodium restriction : reduce dietary sodium intake to no more than100 mmol per day(2.4 g sodium or 6 g sodium chloride)
- ✓ Physical activity : engage in regular aerobic physical activity

Pharmacological treatment

- ✓ **Acute treatment**

  -Hydralazine (5-10 mg)

  -Labetalol (20-40 mg)

  -Nifedipine (10-20 mg)
- ✓ **Long term treatment**

  -Methyldopa 250 mg bid

  - Thiazide diuretic 12.5 mg bid

Table 4.6 Chronic hypertension treatment conditions

	Condition	Management and Treatment
Chronic hypertension	-BP>140/90 -End organ involvement(abnormal renal function, cardiac left vitriol or hypertrophy)	Pharmacological treatment
	-BP>=150/90 with no end organ involvement	Pharmacological treatment
	-BP<150 /90 with no end organ involvement	Non pharmacological treatment

4.5.2 Pre-eclampsia

Management and treatment of pre eclampsia is varying based on level of severity, mild preeclampsia has their own management and treatment procedures and severe preeclampsia also have its own treatment procedure. Below the management and treatment provided respectively

Mild pre-eclampsia

The management of Mild preeclampsia is depend on the patient condition, if the patent is compliant treated as outpatient otherwise the patent treated as in patient.

Table 4.7 Mild pre-eclampsia treatment

Mild preeclampsia	Out patient	- Home Blood pressure monitoring - Fetal movement counting - Weekly or twice weekly follow up (weight and proteinuria, blood pressure measurement. - Fetal growth checking every three week (ultra sound) -Counsel about the danger signs (symptoms and signs of severe pre eclampsia) - Encourage additional period of bed rest - Encourage the women to eat normal diet (Salt restriction should be discouraged) - **No medications** (do not give anticonvulsant, anti-hypertensive, sedatives or tranquillizers)

	Inpatient	- Bed rest - Blood pressure measurement every 4 hour - Provide normal diet (no salt restriction) - Daily review of weight, urine output, deep tender reflex, fetal movement count - End organ involvement checking - If patient gestational age reach >=37 weeks plan for delivery - Provide Anticonvulsant during in labour and 24 hr. after delivery

Severe pre-eclampsia and sever superimposed pre eclampsia

The management and treatment of severe preeclampsia and sever superimposed pre eclampsia is different from mild preeclampsia because of its severity the patient treated as inpatient either in health center or hospital.

Table 4.8 severe pre-eclampsia treatment

Severe preeclampsia	Level of health institutes	Health post	-Diagnosis and provide first Aid treatment -Refer to hospital
		Health center	-Stabilizing severity condition -Give short acting anti-hypertensive drag until BP<160/110 -Anti-hypertensive therapy -Nifedipine -Hydralazine -Methyldopa - Anticonvulsant therapy (seizure prophylaxis) -Magnesium sulfate -Diazepam -Assess labour condition , if labour condition exit plan for delivery -Assess labour condition ,if labour condition doesn't exist refer to hospital
		Hospital	-Admit patient -Stabilizing severity condition with anti-hypertensive and anticonvulsant drag Anti-hypertensive therapy

			-Nifedipine -Hydralazine -Methyldopa - Anticonvulsant therapy (seizure prophylaxis) -Magnesium sulfate -Diazepam -Assess labour condition if exist In labour , if not check gestational age(GA) -GA>=34 weeks , deliver -GA 28-33 weeks , control BP and provide medication ,if BP not controlled provide delivery GA<28 weeks , terminate pregnancy for the health of mother

4.5.3 Eclampsia and superimposed eclampsia

Management and treatment of Eclampsia and superimposed eclampsia is provided as follows

Table 4.9 Eclampsia and superposed eclampsia treatment

Eclampsia	Level of health institutes(health center)	- Control of seizure - Protect from hazard during seizure - Control airway and ventilation - O_2 by mask - Immediate refer to hospital

	Level of health institutes(hospital)	- Control of seizure - Protect from hazard during seizure -Padded tongue depressor -Put her on her side -Release tight cloths and avoid unnecessary stimuli - Control airway and ventilation - O_2 by mask - Section air way - Broad spectrum antibiotics - Treat hypertension using anti-hypertension drugs -Deliver the fetus after stabilization(by induction or cererian section -limit fluids -follow progress of labour

4.5.4 Gestational hypertension

Management and treatment of Eclampsia is provided as follows

Table 4.10 Gestational hypertension treatment

Gestational hypertension	- Follow up for increase blood pressure and fetal condition weekly - Counsel the woman and her family about danger signals indicating severity signs. - Provide first line treatment with oral labetalol to keep blood pressure below 140/90mmHg - Provide Anti-hypertensive therapy -Nifedipine -Hydralazine -Methyldopa - If hypertension remain stable, allow to proceed with normal labor and childbirth (but better not to post term) - If gestational age>37 weeks, plan for delivery

4.6 Conceptual modeling

As stated in the literature review section of this thesis, conceptual modeling is the heart of knowledge acquisition phase. It is the crucial step to understand well the problem domain and to prepare for the knowledge representation phase. In addition, conceptual modeling is a technique that helps to clarify the structure of a knowledge intensive business tasks. The knowledge model of an application provides a specification of the data and knowledge structures required for the application. A knowledge model provides formats for writing down both static domain knowledge (rules, classes, relations) as well as reasoning strategies in which domain knowledge is used to solve a particular problem. As the result, knowledge acquisition ends with the creation of a knowledge model (Speel, 2001; Rajendra, 2010). Hence, designed models should be valid, credible, feasible and useful. Consequently the knowledge engineer should select appropriate and good modeling technique to reduce the amount of model ambiguity.

Among many techniques used for knowledge modeling such as decision tree, semantic network, UML, and frames, decision tree is used for conceptual modeling during the knowledge acquisition phase. Decision tree is used for the search space of a certain problem and presented by a graph. A node in the tree denotes a decision to be attained when finding a solution to certain problem, and the branches extended from the node show the potential values of the decision. To find the solution of a certain problem, anyone then traces by way of its tree using data of a certain problem to select a branch at every node. The structure of decision tree allows users to take a problem with multiple possible solutions and displays in a simple, easy-to-understand format that shows the relationship between different decisions (Krishnamoorthy, 1996).Decision tree is represent knowledge in form of antecedent-consequent form mean that it easily represent if-then production rule.

Moreover, in this research decision tree has been used as knowledge modeling tool. The reason choosing this modeling tool is that decision trees depict a strong sense of cause and effect relationships of types of pregnancy induced hypertension disorder and the associative symptoms that lead to the identification of those diseases.Decisively, decision trees can easily be converted to if-then rules that are suitable and understandable by computer programs. So, the conversion easily executed by a computer program**.**

4.6.1 Pregnancy induced hypertension Diagnosis and treatment decision tree

Diagnos is and treatment involves many steps that analyze the existing cause and provide specific treatment for a particular disease based on the analyzed result. It is the process of understanding what is wrong in a particular situation. Thus, gathering information and then interpreting the gathered information is an important step in diagnostic problem solving. Pregnancy induced hypertension diagnosis and treatment involves multi steps activity, first the diagnosis started by physically examining is the patient and deciding the patient pregnant or not and asking questions about the patient's problem. For the effectiveness of diagnosis, it is must to gather sufficient information from the patient or her family members. During the diagnosis session the critical step is getting history of the patient which is important to understand the manifestation of hypertension before or after gestation. During this time the general practitioners try to extract important symptoms of the disease to identify its category. Finally, the practitioner assigns the patient into correct category then provides treatment.

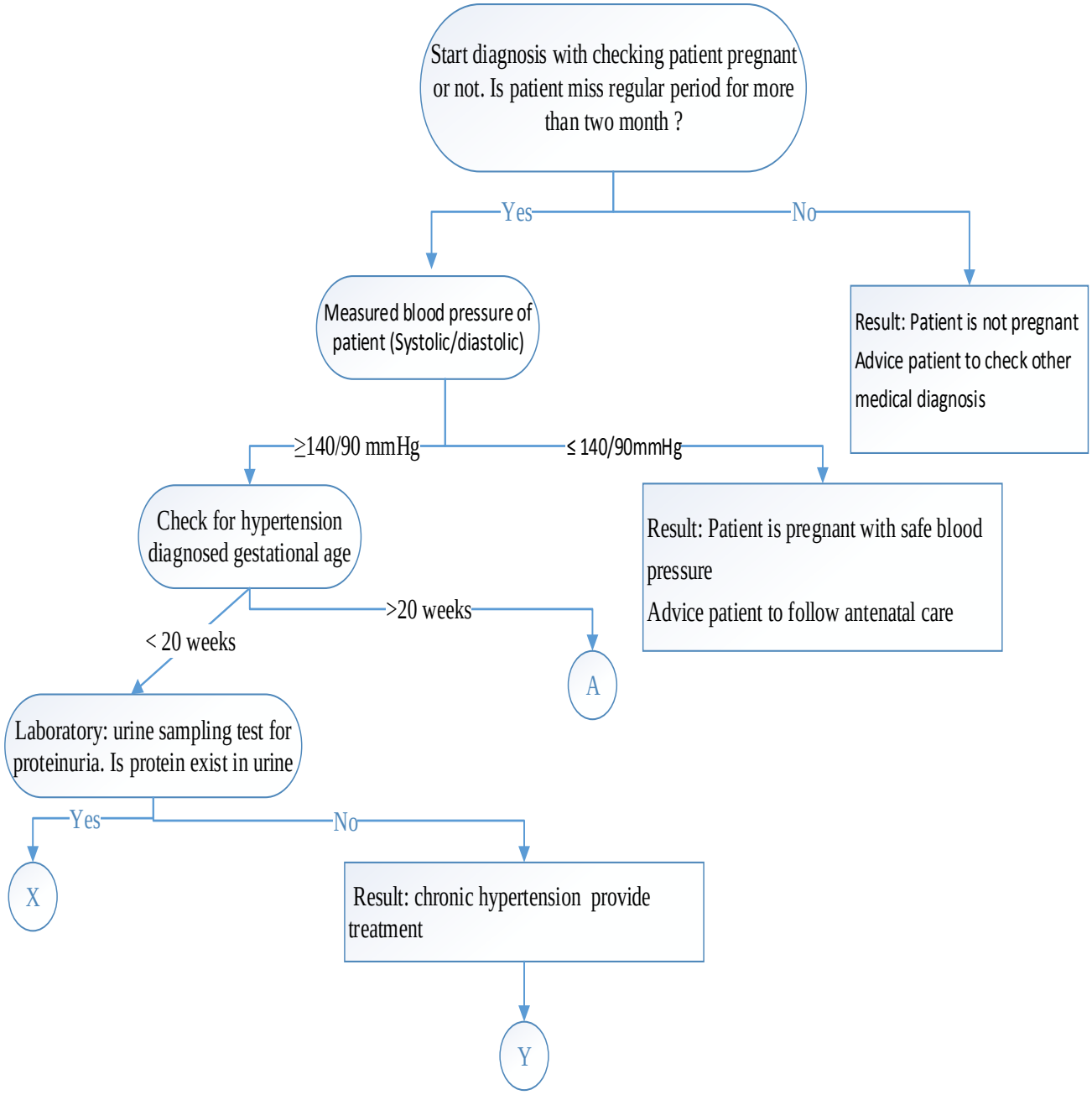
To summarize, during the diagnosis of pregnancy induced hypertension disorders a doctor performs the following activities:

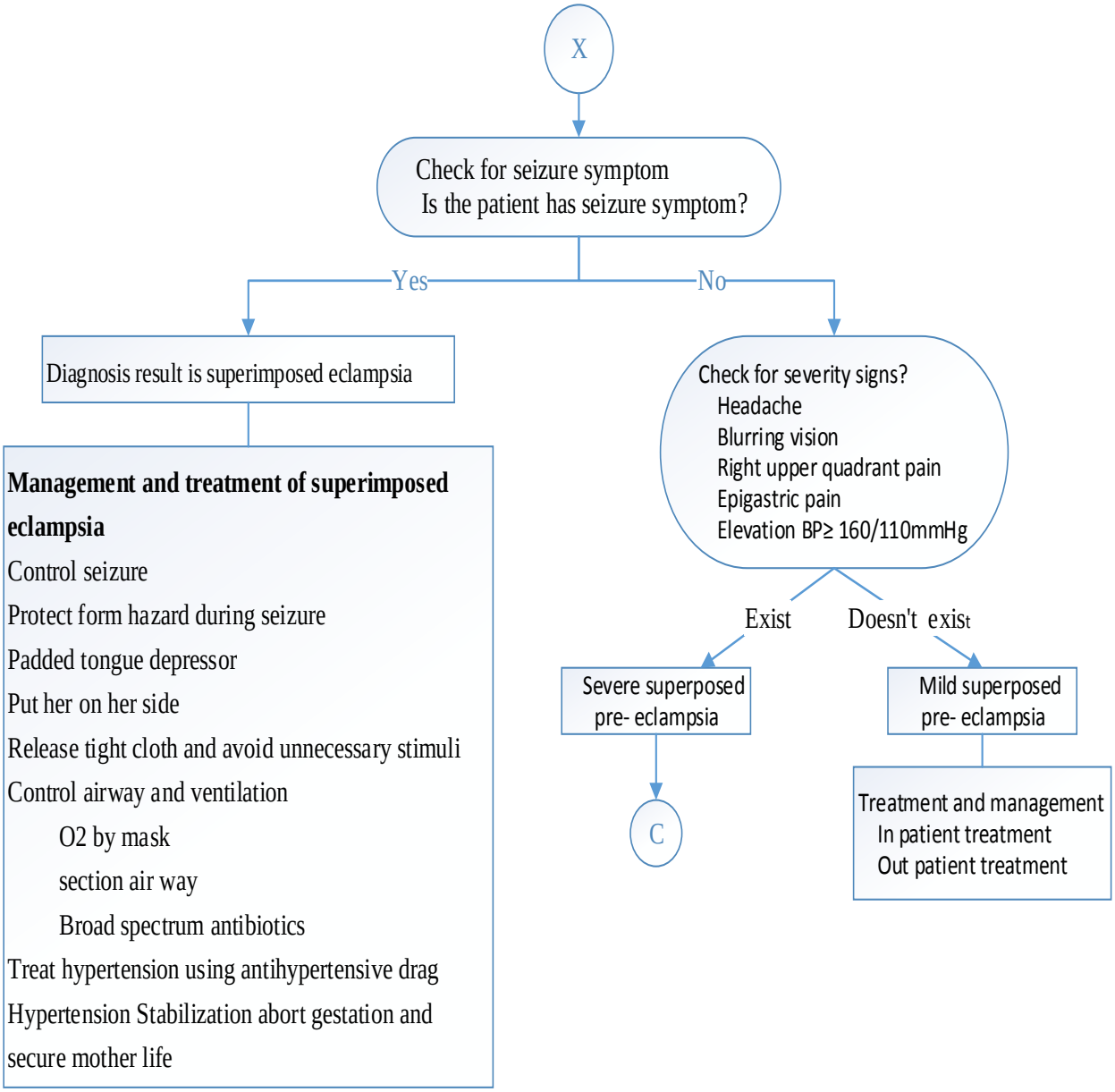
- ✓ Acquiring sufficient information from patient or her family members.
- ✓ Asking patient history related to existence of hypertension before pregnancy.
- ✓ Follow diagnosis criteria (measure blood pressure of patient and urine laboratory test)
- ✓ Rule out a general medical condition as direct physiology cause of the symptom.
- ✓ Rule out a substance use as the direct physiological cause of the symptoms.
- ✓ Rule out general and specific treatment.

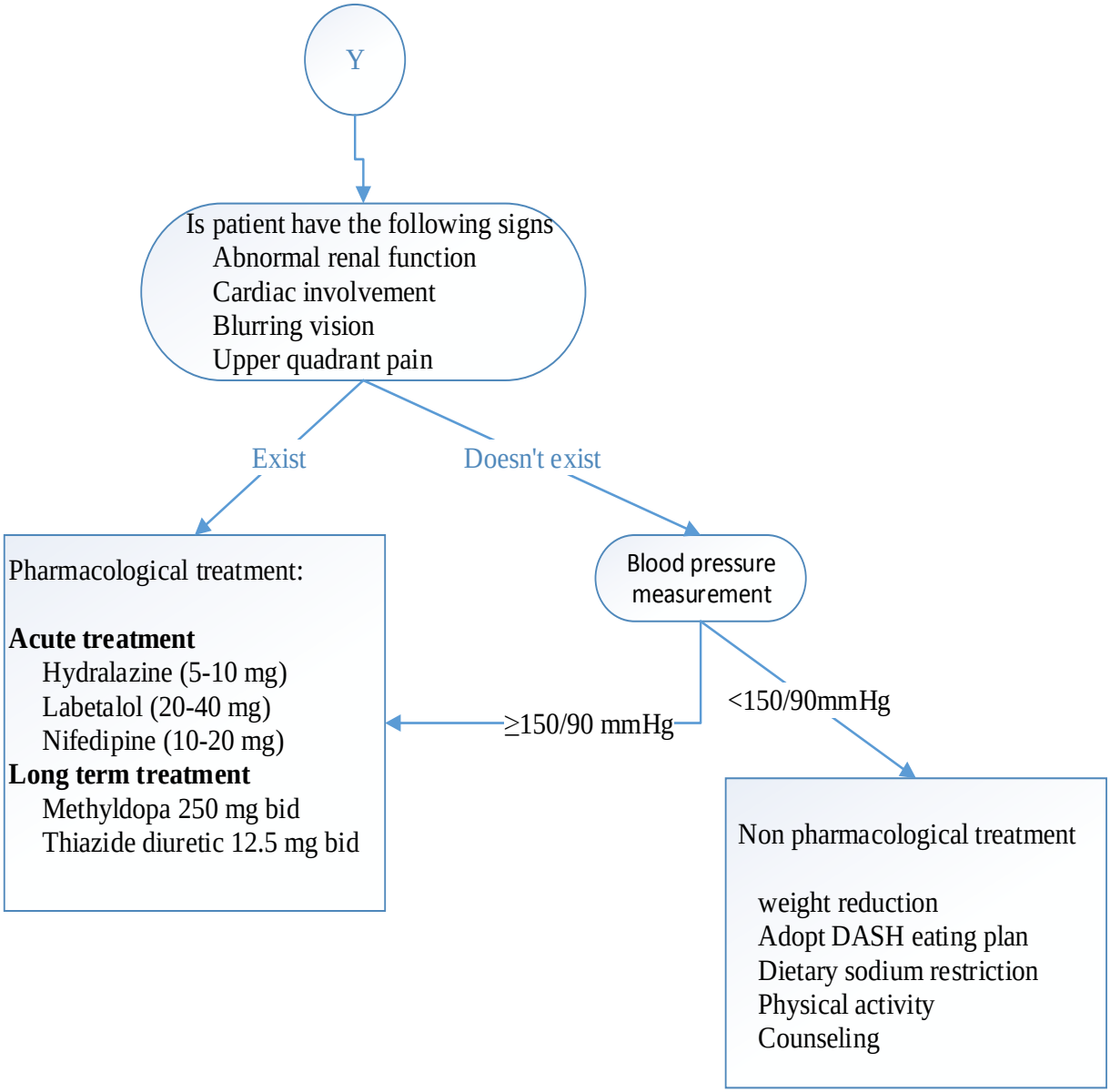
During acquiring information from patient's response of patient may be ambiguous when describing symptoms and even cannot specify the details of their feeling clearly. Therefore, the first screening question(s) on the symptoms alone are insufficient to diagnose the patient health problem. To complete the diagnosis successfully and reach at certain conclusion further assessment on physical examination and laboratory test has a great value.

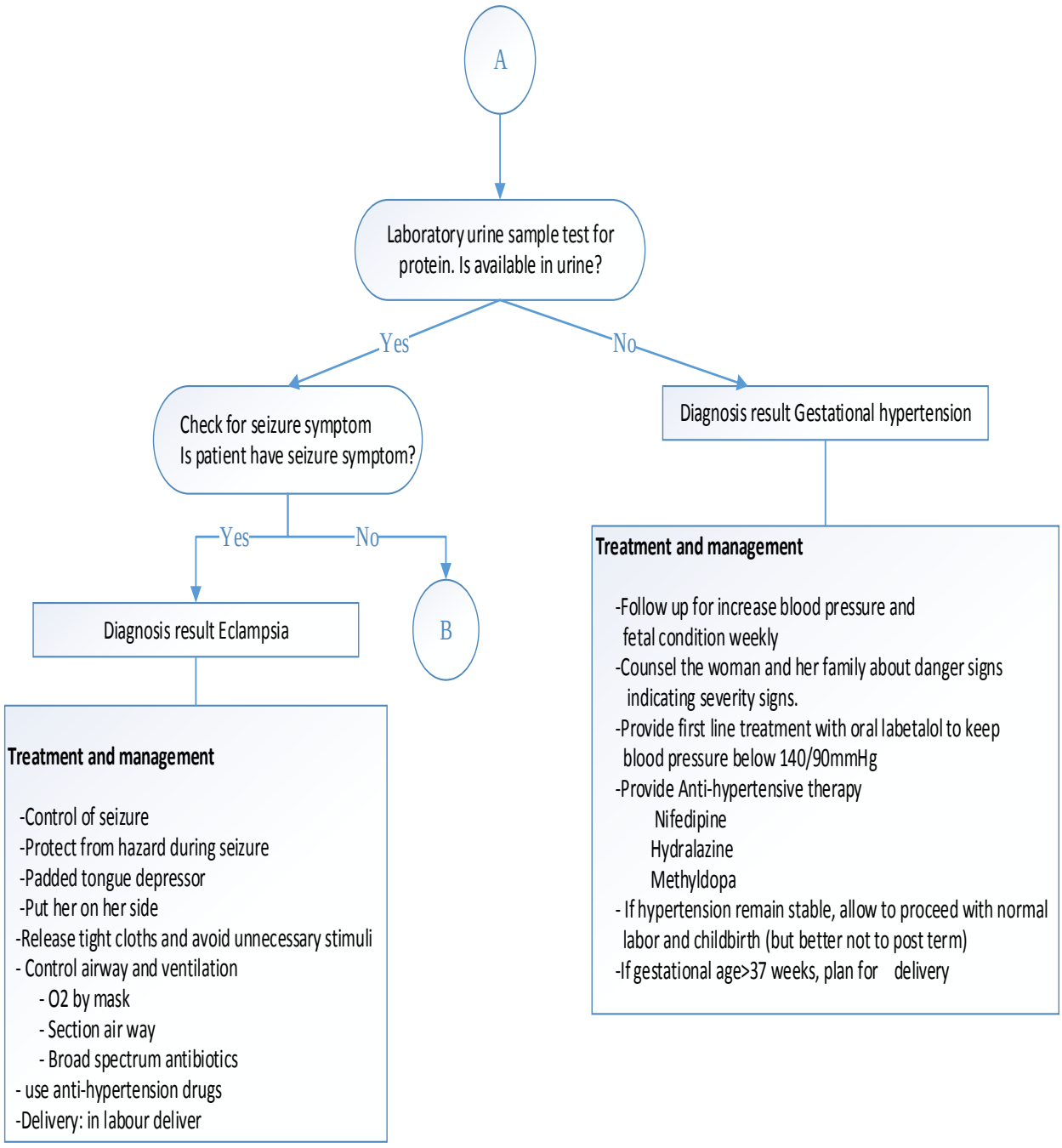
Finally, to make the acquired knowledge sensible, it is modeled using decision tree structures. In the context of this study, decision tree is used to demonstrate clearly the diagnosis and treatment procedures of pregnancy induced hypertension disorders which is implemented using

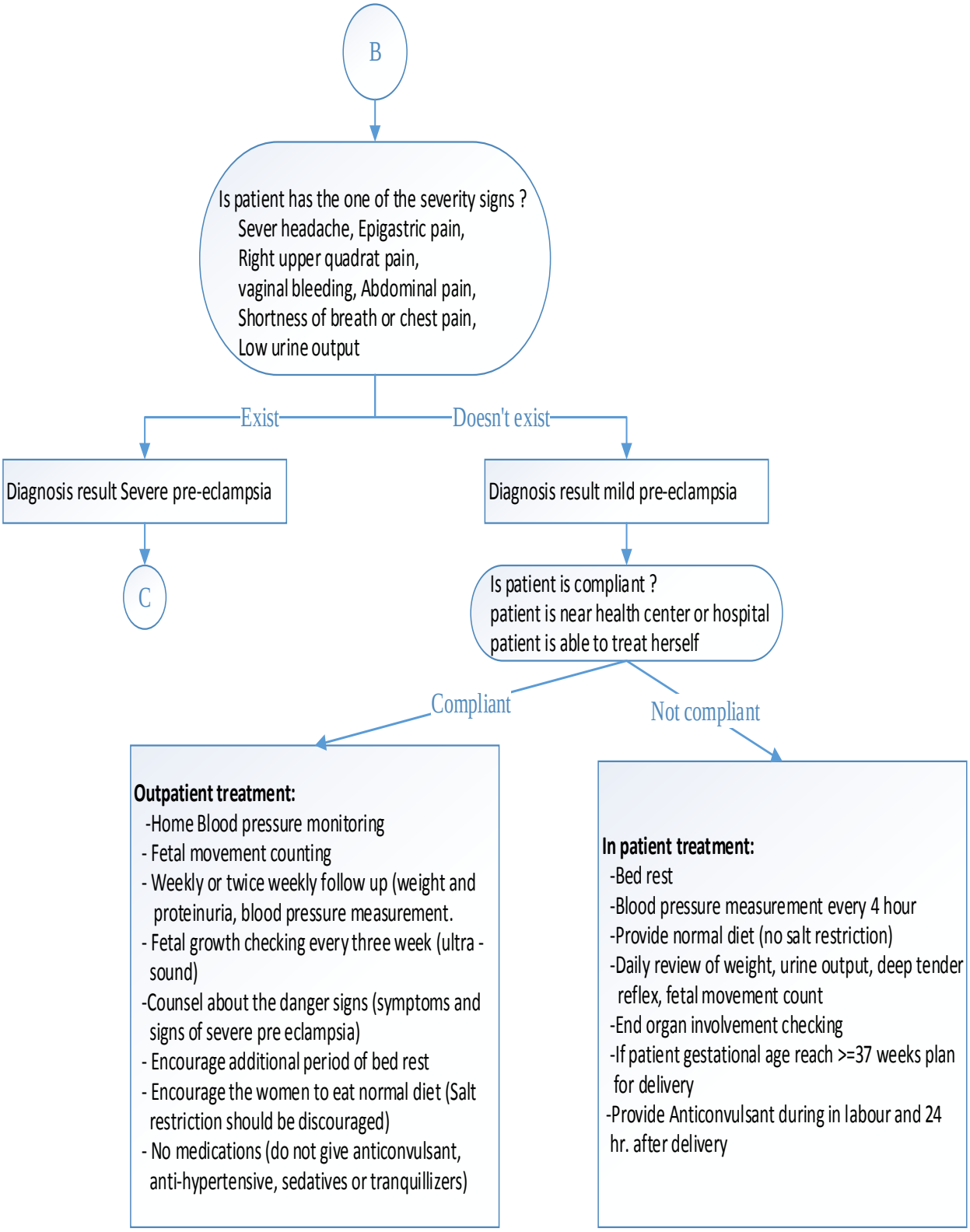
E2gRuleEngine in the next chapter (chapter five).The decision tree structures (Figure 4.2) are derived from the knowledge acquired from experts and secondary sources in the consultations and confirmations of experts. This decision tree structures are the bases for the prototype web based knowledge based system development. The prototype was developed based on the model presented in these decision tree structures and it follows the same procedures presented in the decision trees to diagnosis PIH disorders and provides treatment.


Start diagnosis with checking patient pregnant or not. Is patient miss regular period for more than two month ?
Yes
No
Measured blood pressure of patient (Systolic/diastolic)
Result: Patient is not pregnant
Advice patient to check other medical diagnosis
≥140/90 mmHg
≤ 140/90mmHg
Check for hypertension diagnosed gestational age
Result: Patient is pregnant with safe blood pressure
Advice patient to follow antenatal care
>20 weeks
< 20 weeks
A
Laboratory: urine sampling test for proteinuria. Is protein exist in urine
Yes
No
X
Result: chronic hypertension provide treatment
Y


X
Check for seizure symptom
Is the patient has seizure symptom?
Yes
No
Diagnosis result is superimposed eclampsia
Management and treatment of superimposed eclampsia
Control seizure
Protect form hazard during seizure
Padded tongue depressor
Put her on her side
Release tight cloth and avoid unnecessary stimuli
Control airway and ventilation
O2 by mask
section air way
Broad spectrum antibiotics
Treat hypertension using antihypertensive drag
Hypertension Stabilization abort gestation and secure mother life
Check for severity signs?
Headache
Blurring vision
Right upper quadrant pain
Epigastric pain
Elevation BP≥ 160/110mmHg
Exist
Doesn't exist
Severe superposed pre- eclampsia
C
Mild superposed pre- eclampsia
Treatment and management
In patient treatment
Out patient treatment


Y
Is patient have the following signs
Abnormal renal function
Cardiac involvement
Blurring vision
Upper quadrant pain
Exist
Doesn't exist
Pharmacological treatment:
Acute treatment
Hydralazine (5-10 mg)
Labetalol (20-40 mg)
Nifedipine (10-20 mg)
Long term treatment
Methyldopa 250 mg bid
Thiazide diuretic 12.5 mg bid
Blood pressure measurement
≥150/90 mmHg
<150/90mmHg
Non pharmacological treatment
weight reduction
Adopt DASH eating plan
Dietary sodium restriction
Physical activity
Counseling


A
Laboratory urine sample test for protein. Is available in urine?
Yes
No
Check for seizure symptom Is patient have seizure symptom?
Diagnosis result Gestational hypertension
Yes
No
Diagnosis result Eclampsia
B
Treatment and management
-Follow up for increase blood pressure and fetal condition weekly
-Counsel the woman and her family about danger signs indicating severity signs.
-Provide first line treatment with oral labetalol to keep blood pressure below 140/90mmHg
-Provide Anti-hypertensive therapy
Nifedipine
Hydralazine
Methyldopa
- If hypertension remain stable, allow to proceed with normal labor and childbirth (but better not to post term)
-If gestational age>37 weeks, plan for delivery
Treatment and management
-Control of seizure
-Protect from hazard during seizure
-Padded tongue depressor
-Put her on her side
-Release tight cloths and avoid unnecessary stimuli
- Control airway and ventilation
- O2 by mask
- Section air way
- Broad spectrum antibiotics
- use anti-hypertension drugs
-Delivery: in labour deliver


B
Is patient has the one of the severity signs ?
Sever headache, Epigastric pain,
Right upper quadrat pain,
vaginal bleeding, Abdominal pain,
Shortness of breath or chest pain,
Low urine output
Exist
Doesn't exist
Diagnosis result Severe pre-eclampsia
Diagnosis result mild pre-eclampsia
C
Is patient is compliant ?
patient is near health center or hospital
patient is able to treat herself
Compliant
Not compliant
Outpatient treatment:
-Home Blood pressure monitoring
- Fetal movement counting
- Weekly or twice weekly follow up (weight and proteinuria, blood pressure measurement.
- Fetal growth checking every three week (ultra - sound)
-Counsel about the danger signs (symptoms and signs of severe pre eclampsia)
- Encourage additional period of bed rest
- Encourage the women to eat normal diet (Salt restriction should be discouraged)
- No medications (do not give anticonvulsant, anti-hypertensive, sedatives or tranquillizers)
In patient treatment:
-Bed rest
-Blood pressure measurement every 4 hour
-Provide normal diet (no salt restriction)
-Daily review of weight, urine output, deep tender reflex, fetal movement count
-End organ involvement checking
-If patient gestational age reach >=37 weeks plan for delivery
-Provide Anticonvulsant during in labour and 24 hr. after delivery

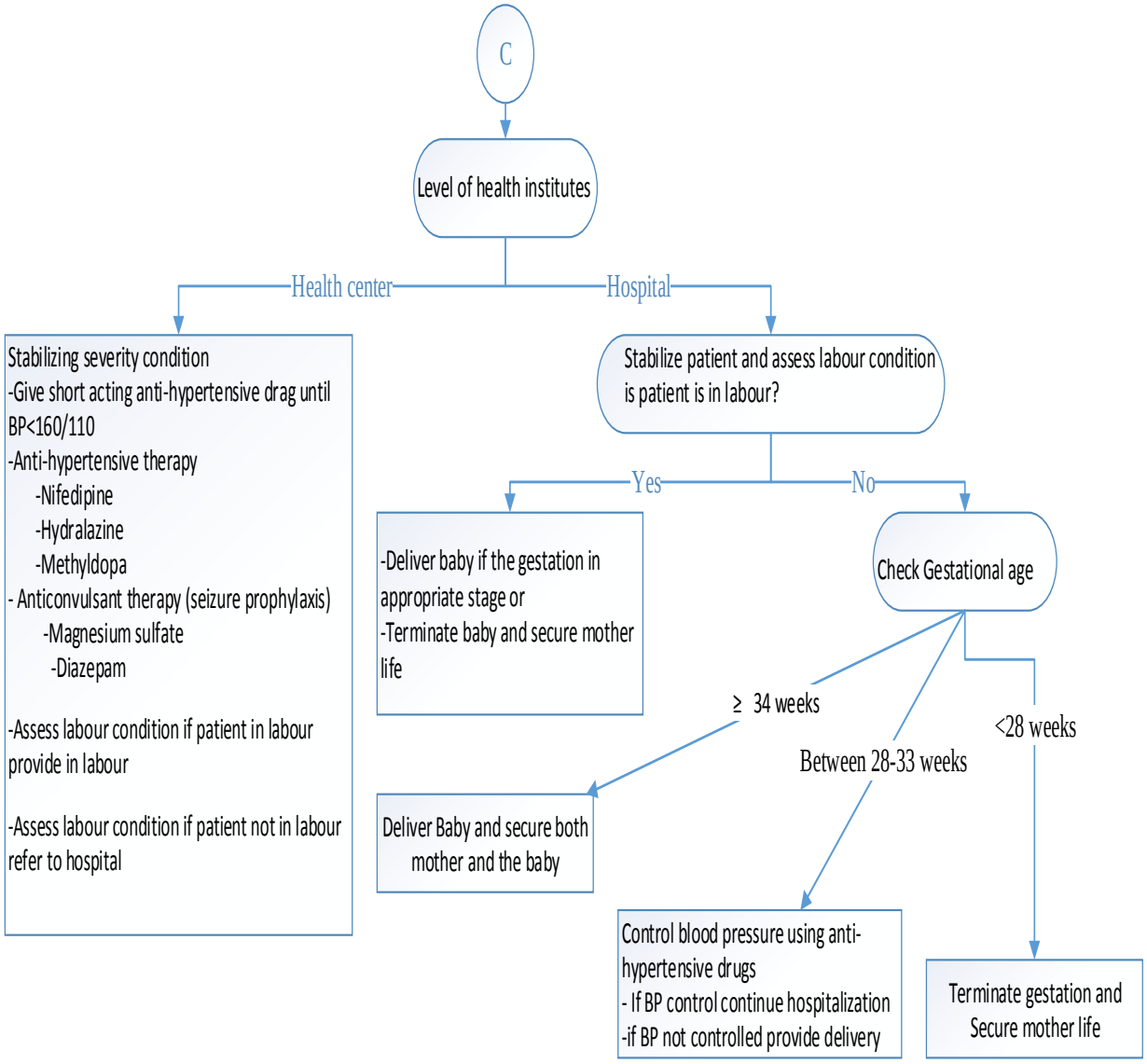


Figure 4.2 Decision Trees for the diagnosis and treatment of pregnancy induced hypertension Disorders

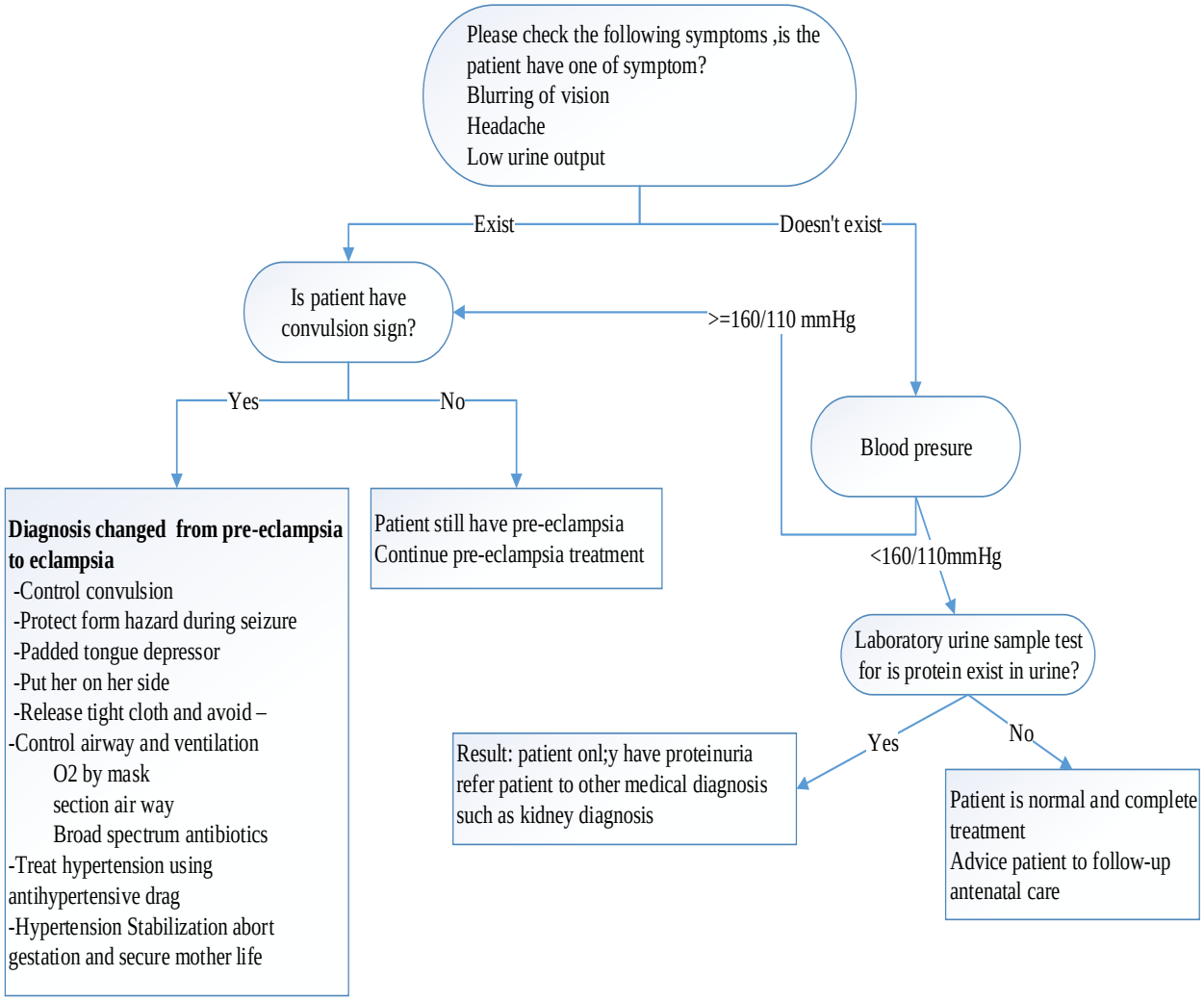


Figure 4.3 Decision Trees for pre-eclamsia follow-up

To summarize the chapter, the transformation process of acquiring required knowledge from domain experts and document analysis was helpful in pinpointing the specific parameters fundamental for the diagnosis and treatment ofPIH disorders. From thereon it is possible to arrive at the ‘Goals’ and build the ‘Rule Base’ by formulating the rules, which is discussed in the next chapter.

CHAPTER FIVE

WEB BASED KNOWLEDGE BASED SYSTEM DEVELOPMENT

5.1 Introduction

This chapter discusses web based knowledge based system development that encompasses architecture of proposed system, system evaluation and coding process. In designing and developing web based knowledge based system has it's own developing steps like other software development that follow software development life cycle. It also has the system evaluation phase which measures the performance of knowledge based system through user satisfaction and test cases. Implementation phase of a knowledge based system represents the transformation of acquired expert knowledge into automated system. In the previous chapter (chapter four), appropriate knowledge from human experts of the problem domain has been thoroughly exploited to obtain the relevant medical information, modeled and represented the acquired knowledge to develop the proposed knowledge based system.

Web based knowledge based system implemented using appropriate knowledge representation approach and tools. As mentioned in research methodology chapter three of this document production rule used for representing acquired knowledge and e2gRuleEngine, PHP and Uniform server used as a tool to design and develop proposed system.

5.2 Architecture of system

Architecture is a blueprint showing how the components interact and interrelates each other (Gacek, 1995). The proposed web based knowledge based system implementation depends on the tree structure. It describes the acquired knowledge form domain experts. Modeled knowledge represented in form of if-then rule based representation techniques that appropriate for e2gRgueEngine. The architecture of pregnancy induced hypertension diagnosis and treatment web knowledge system incorporate various components each of which are intended to perform different tasks such as user interface used as a bridge between used and system, inference used for reasoning, pre-eclampsia database used for follow up pre-eclampsia diagnosis and explanation component provide more information and explanation about recommend ion and conclusions. The general architecture of the system is presented in the following diagram figure 5.1

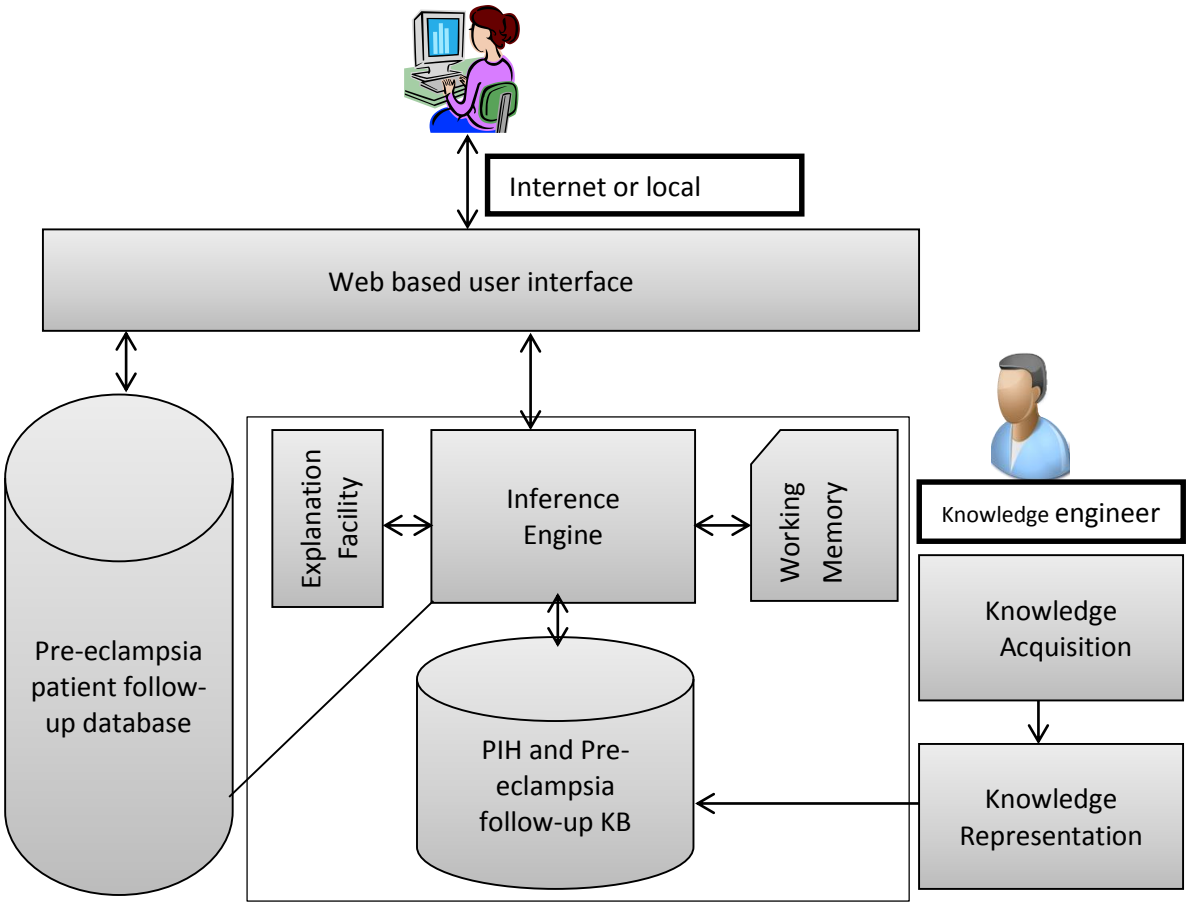


Figure 5.1 Architecture of the system

As shown in Figure 5.1 at the front-end the system has user interface through which users will have access to knowledge base and database using internet or local network address.The interface is a web based interface that will serve as a link between the users of the system and the knowledge base. In general the architecture used to implement a prototype web based knowledge based system diagnosis and treatment of pregnancy induced hypertension disorder.

5.3 Knowledge base

The knowledge base contains a set of rules and premises which are used as input to the inference engine. As presented in chapter two literatures review the knowledge base is a repository, which the domain expert's knowledge acquired during knowledge acquisition phase. The acquired domain knowledge is represented using rule based representation method as a set of "if-then" rules in the clause section of the program. "If " side of the representation states the condition or

conditions that must be true to apply an action and “then” part of the representation recommend or specify the appropriate action to take.The inference engine preform, when the “if”part holds true the “Then”part, the goal, of the rule is fired. However, if the condition or the “if”part does not fit the goal the inference continues to search for another condition until the goal satisfied. The knowledge base of the prototype contains the domain knowledge which used to identify the types of disease, description and treatment in the diagnosis hypertensive pregnant patient. Based on this, the knowledge base is constructed by using e2gRuleEngine tool in the forms of ‘if then’ rule.

In e2gRuleEngine rule is defined by the keyword ‘RULE’ followed by a short description of the rule enclosed in square brackets. This is followed by the rule premise with the key word ‘if’. The logical expression consists of an attribute name, a relational operator or any comparison quantity. The rule consequent is mentioned with the key word ‘Then’. Rule elements are not case sensitive. Attributes in the rule engine can be one of three types: String (text), numeric or boolean. The keyword “REM” is used as a single line comment. These lines are ignored when the knowledgebase is processed and the keyword “PROMPT” used for user prompt.e2gRuleEngine rule representation is easy to understand and have similarity with English like statement (natural language) if-then rule representation. Table 5.1 shows both representations.

Table 5.1 Rule representation of e2gRuleEngine and English like statement (natural language)

e2gRuleEngine rule representation	English like statement (natural language) if-then rule representation
RULE [is patient pre-eclamptic] If [Is patient miss regular period for more than two month] = "Yes" and [Systolic blood pressure] >139 mmHg and [Diastolic blood pressure] >89 mmHg and [Gestational age] >19 weeks and [Proteinuria] = "Yes" and [Seizure] = "No" Then [PossibleResult] = "Pre-eclampsia"	If patient miss regular period for more than two month= “yes” and And systolic blood pressure = “> 139 mmHg” And diastolic blood pressure= “> 89 mmHg” And gestational age= “> 19 weeks” And lab urine test for proteinuria=” Yes” And presence of seizure symptom=” No” Then the possible result is pre-eclampsia

In pregnancy induced hypertension diagnosis and treatment 14 rules are used.Here, below sample rules are described which used to diagnosis and provide treatment for pregnant patient affected by hypertension. Rules are presented in acceptable form of e2gRuleEngine.The rest of rules of the prototype web based knowledge based system are presented in Appendix II.

Sample rules used in PIH diagnosis and treatment (pre-eclampsia)

RULE [is patient pre-eclamptic]
If [Is patient miss regular period for more than two month] = "Yes" and
[Systolic blood pressure] >139 and
[Diastolic blood pressure] >89 and
[Gestational age] >19 and
[Proteinuria] = "Yes" and
[Seizure] = "No"
Then [PossibleResult] = "Pre-eclampsia"

Pre-eclampsia classification and Treatment:

RULE [Severe pre-eclampsia health center treatment]
If [Server symptom] : "Severe headache" "Epigastric pain" "Right upperquadrat pain" "vaginal bleeding" "vaginal bleeding" "Abdominal pain" "Shortness of breath or chest pain" "Low urine output" and
[institutes] = "health center"
Then [Diagnosis result of patient is] = " sever per-eclampsia" and
[Action] = "health center treatment"

RULE [pregnancy delivery]
If [Server symptom] : "Severe headache" "Epigastric pain" "Right upperquadrat pain" "vaginal bleeding" "Abdominal pain" "Shortness of breath or chest pain" "Low urine output" and
[institutes] = "hospital" and
[In labour]= "yes" and
Then [Diagnosis result of patient is] = " sever per-eclampsia" and
[Action] = "Deliver pregnancy"

RULE [Severe pre-eclampsia delivery pregnancy]
If [Server symptom] : "Severe headache" "Epigastric pain" "Right upperquadrat pain" "vaginal bleeding" "Abdominal pain" "Shortness of breath or chest pain" "Low urine output" and
[institutes] = "hospital" and
[In labour]= "no" and
[gestational age] = "gestational age greater than 34 weeks"
Then [Diagnosis result of patient is] = " sever pre-eclampsia" and
[Action] = "Deliver baby and secure both mother and baby life"

RULE [Severe pre-eclampsia termination]
If [Server symptom] : "Severe headache" "Epigastric pain" "Right upperquadrat pain" "vaginal bleeding" "vaginal bleeding" "Abdominal pain" "Shortness of breath or chest pain" "Low urine output" and
[institutes] = "hospital" and
[In labour]= "no" and
[gestational age] = "gestational age less than 28 weeks"
Then [Diagnosis result of patient is] = " sever eclampsia" and
[Action] = "Terminate pregnancy and secure mother life"

RULE [Severe pre-eclampsia treat patient until gestational delivery]
If [Server symptom] : "Severe headache" "Epigastric pain" "Right upperquadrat pain" "vaginal bleeding" "Abdominal pain" "Shortness of breath or chest pain" "Low urine output" and
[institutes] = "hospital" and
[condition]= "no" and
[gestational age] = "gestational age between 28-33 weeks"
Then [Diagnosis result of patient is] = " sever pre-eclampsia" and
[Action] = "Treat pregnancy until deliver"

RULE [Mild preeclampsia outpatient treatment]
If [Server symptom] = "no sign or symptom" and
[Systolic blood pressure] <159 and
[Diastolic blood pressure] <110 and

[compliant] : "patient is near health center or hospital" "patient able to treat herself"
Then [Diagnosis result of patient is] = "Mild pre-eclampsia" and
[Action] = "Outpatient treatment"

RULE [Mild pre-eclampsia inpatient treatment]
If [Server symptom] = "no sign or symptom" and
[Systolic blood pressure] <159 and
[Diastolic blood pressure] <110 and
[compliant] : "patient unable to treat herself" "patient need frequent follow up" "far from hospital or health center"
Then [Diagnosis result of patient is] = "Mild pre-eclampsia " and
[Action] = "Inpatient treatment"

Sample Prompt command

PROMPT [Pregnancy] YesNo
"Is patient miss regular period for more than two month?"

PROMPT [Blood Pressure measurement] ForcedChoice CF
"Patient is pregnant please measure enter blood pressure."
"Blood Pressure >=140/90 mmHg"
"Blood Pressure <140/90 mmHg"

PROMPT [Gestational age] MultChoice CF
"Is patient diagnosis for hypertension before or after 20 weeks gestation?"
"Gestational age before 20 weeks"
"Gestational age after 20 weeks"

5.4 Inference engine

The inference engine simulates the domain expert reasoning process. It works from the facts in the working memory (fact base) and stored knowledge in the knowledge base to fire the rule. The main function of the inference engine in a proposed system is to apply rules to data which is held with java applet objects (working memory). It controls the whole process of applying the rules to the transient java object to obtain the output of the system. Relevant information is collected from the user and stored in the working memory as objects. Then, the inference engine matches all rules to the transient object to decide which rules should be activated. The activated rules and with any other rules activated in previous cycles will also be ordered to form the output. The inference engine matches the data and rule's premises from the knowledge base. Finally, the solutions are delivered to the user through the user interface.

As the result, the proposed system uses rule base technique. During the reasoning process, the inference engine start from checking the existing of pregnancy using sign of pregnancy then check the occurrence of hypertension to category patient in pregnancy induced hypertension disorder. If certain antecedents sign or symptoms are evaluated as true, then it logically follows the consequent are proven and then the category, description and treatment of the disease is provided. As the decision tree models indicate in (chapter four the real expert first check is the patient miss regular period or not. Next the expert measure the blood pressure to decide the patient is hypertensive or not then check for gestational age in a week form and also the expert check the presence of proteinuria, severity signs then determine the resulting disease. The inference engine of e2gRuleEngine rule based system follow similar procedures like the real expert(s).

5.4 user interface

The user interface of the knowledge based system has a web interface that will function as a gateway between user to the knowledge base system.The acceptability of a knowledge based system depends on the quality of the user interface. Mainly the content of the web interface has been developed using PHP, java applet programming language and uniform server used as web server to run the whole system. For the proposed knowledge based system, users interact with the system through graphical user interfaces. Based on the user response the system draws a conclusion for each rule in the knowledge base.

Therefore to access the system users use http://localhost/PIH/home.php URL address using any browser then home page of the system display.

The proposed system incorporates six modules each of them serve different task. Those are home,diagnosis, disease details, downloads, help and pre-eclampsia follow-up (register inpatient, view follow-up and search for profile).The first page displayed is home is welcoming page of the system which contains general information as shown in Figure 5.2.

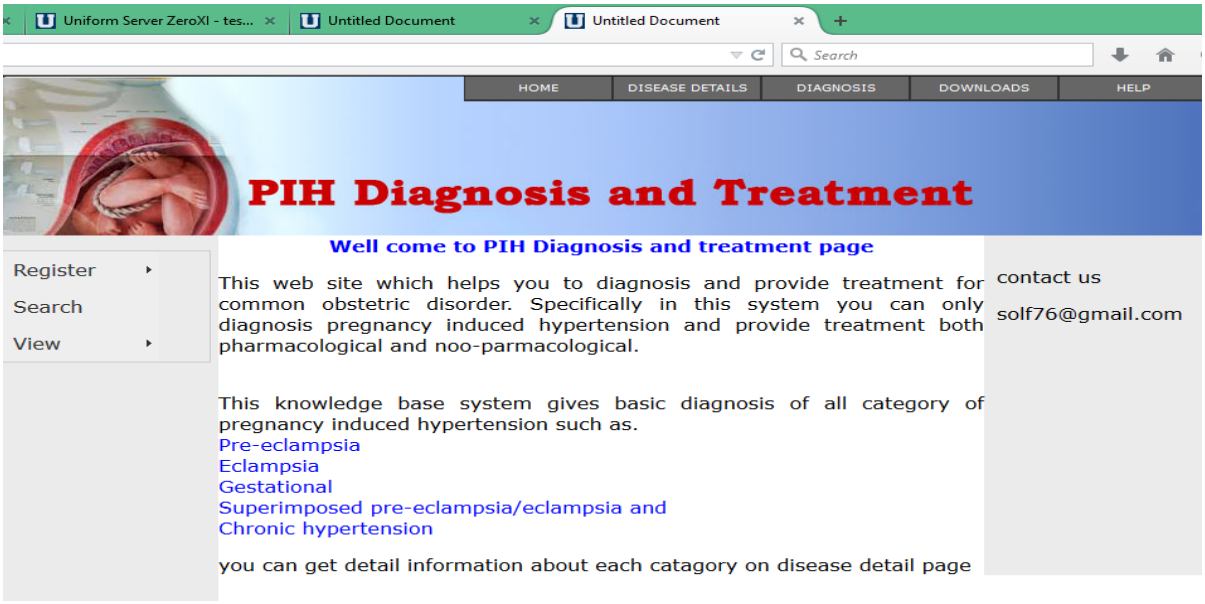


Figure 5.2 The Home page of the system

When the user clicks on “Disease Detail” on the menu under home page it provid information about each categories of pregnancy induced hypertension as shown in figure 5.3.

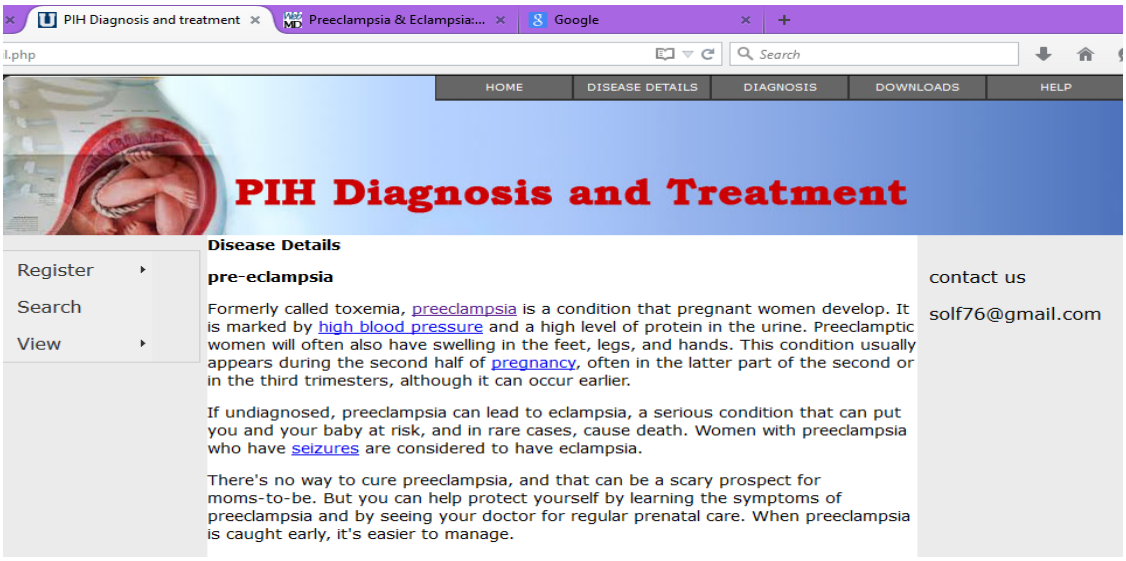


Figure 5.3 Disease details system page

On the other side, diagnosis of pregnancy induced hypertension is the main part of this research. If the user clicks on diagnosis link on the home page, pregnancy induced hypertension diagnosis and treatment will start. The user, he/she must feed necessary information according to the question generated from the system. The diagnosis start form checking the presence of pregnancy then based on user response system will procede to next step. For example if users respond "yes" the diagnosis continue to the next step where as system leads to conclusion.

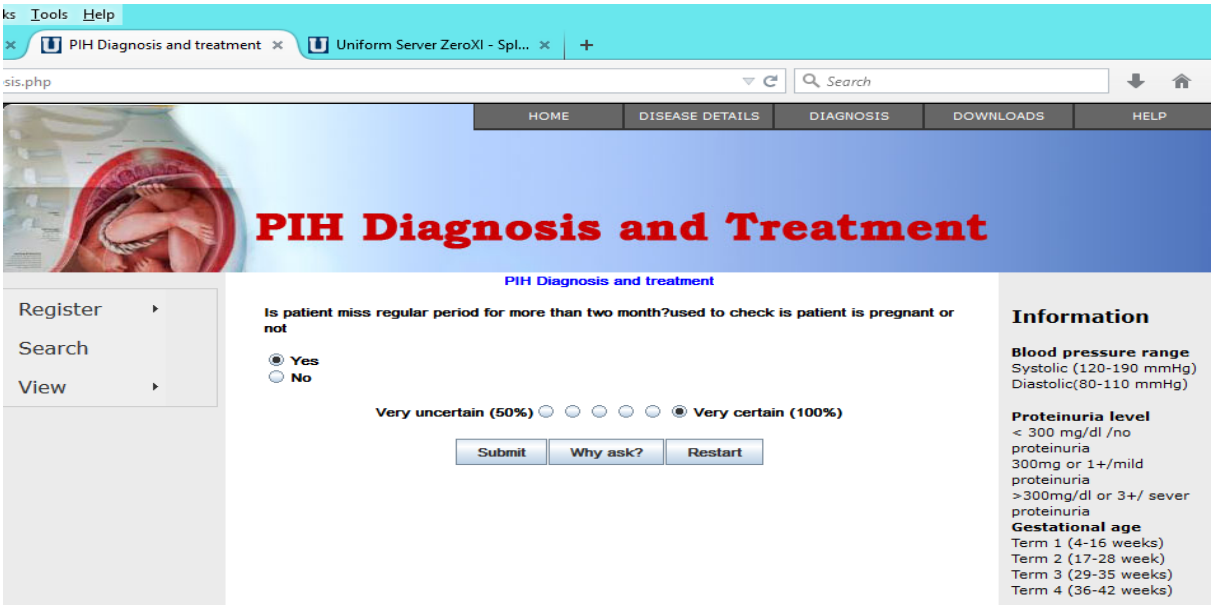


Figure 5.4 pregnancy induced hypertension diagnosis and treatment page

If the user selects “yes”from the option and submit the response, the next page will be displayed to obtain patient blood pressure both systolic and diastolic. It used to check is patient has blood pressure rated greater than or equal to 140/90 mmHg.Therefore, if blood pressure greater than 140/90 mmHg patient has hypertension then system proceed to next step to check the time of hypertension diagnosis based on gestational age in a week’s form. After this question, system proceed to check proteinuria using sample urine laboratory test then user confirm either the presence or absence of protein in urine. Based on the laboratory result, time of gestational age and appropriate blood pressure measurement pregnancy induced hypertension classified .

If user clicks on the “Why ask?” button, he/she can see the goal or sub goal the inference engine is currently working on, the attribute it's trying to find and the rule that needs the value of this attribute.

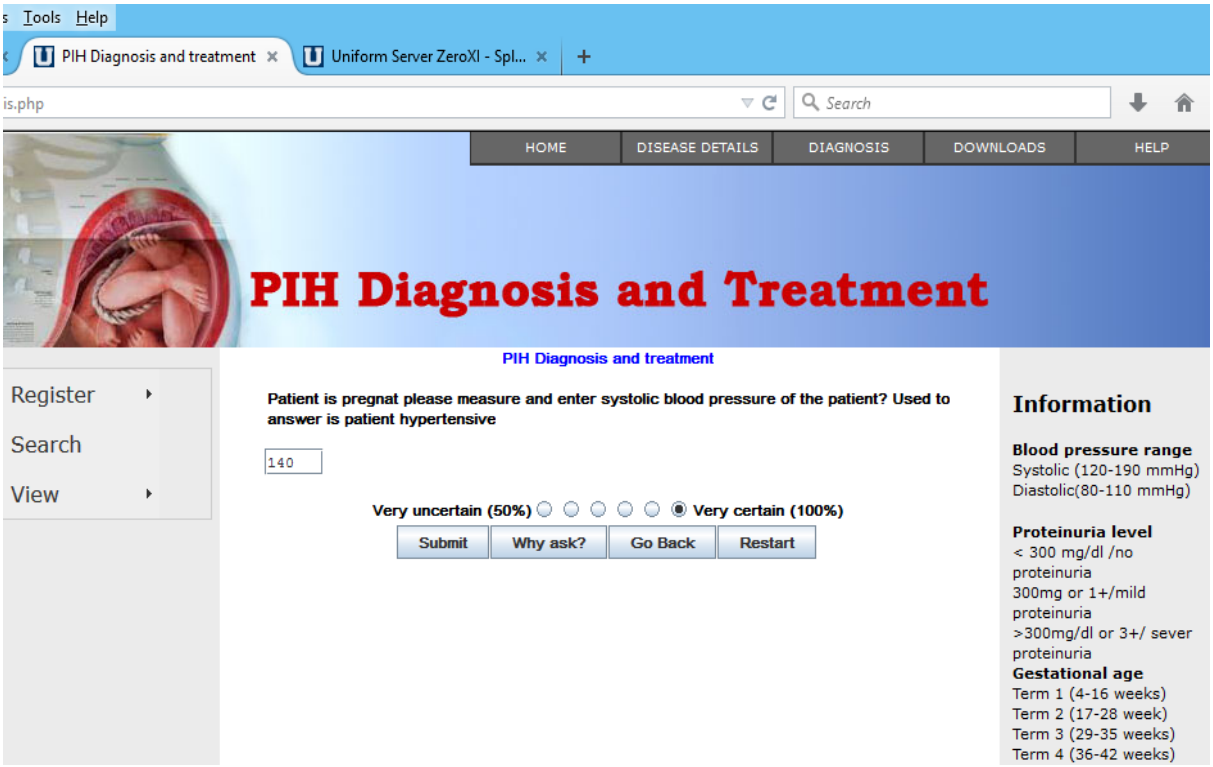


Figure 5.5 Blood pressure measurement page

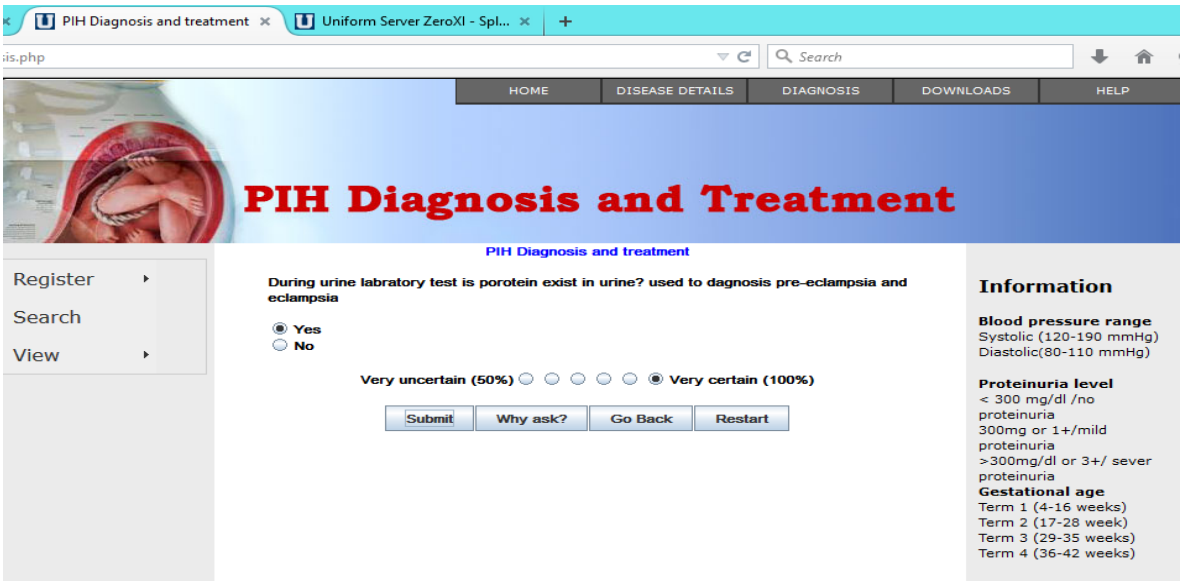


Figure 5.6 Laboratory result check for presence of proteinuria

In the above figure after checking the presence of pregnancy and hypertension system will proceed to laboratory test for proteinuria based on the result another diagnosis criteria will check to assure the presence or absence of seizure symptom. For example if the seizure symptom doesn't exist on the patient then pre-eclampsia diagnosed. After per-eclampsia diagnosed severity signs will be checked to determine severity and to appropriate treatment.

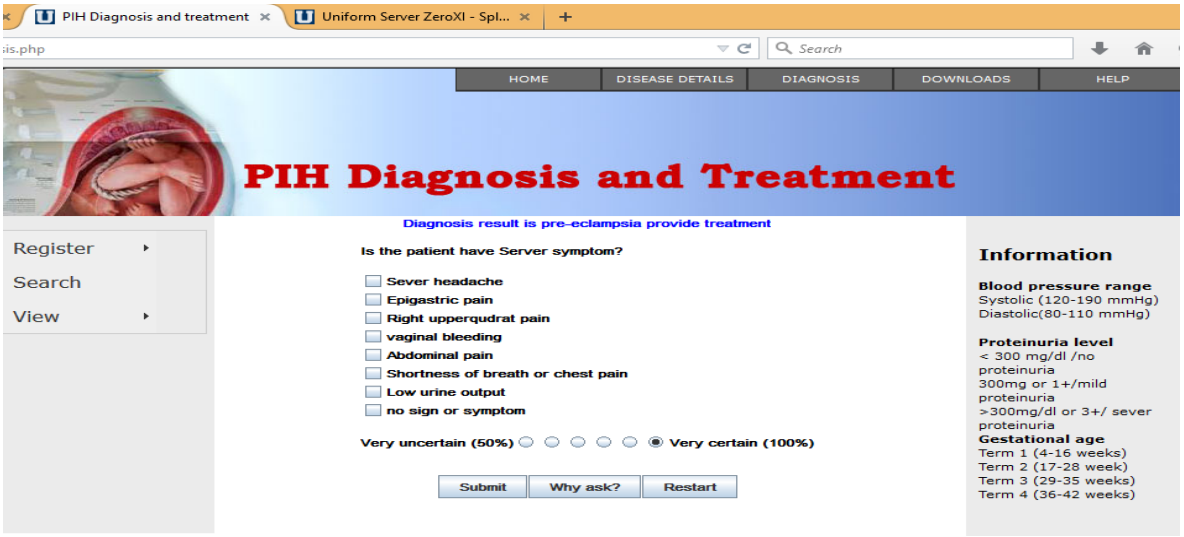


Figure 5.7 severity sign of pre-eclampsia selection page

When the user select one of severity sign and submit the response system will provide severe pre-eclampsia diagnosis result and their cross ponding treatment where as user select no sign or symptom option then system check specific blood pressure measurement to determine either severe or mild pre-eclampsia then system provide crossponding treatment. For example treatment of mild pre-eclampsia provide in to two forms inpatient treatment and outpatient treatment. The classification of those treatment is based on user compliance. User compliance refers to the patient condition and the environment is patient near health institutes or patient is able to manage herself at home conditions after checking those conditions either inpatient and outpatient treatment provided to the patient . Below figure 5.8 describe compliancy of patient

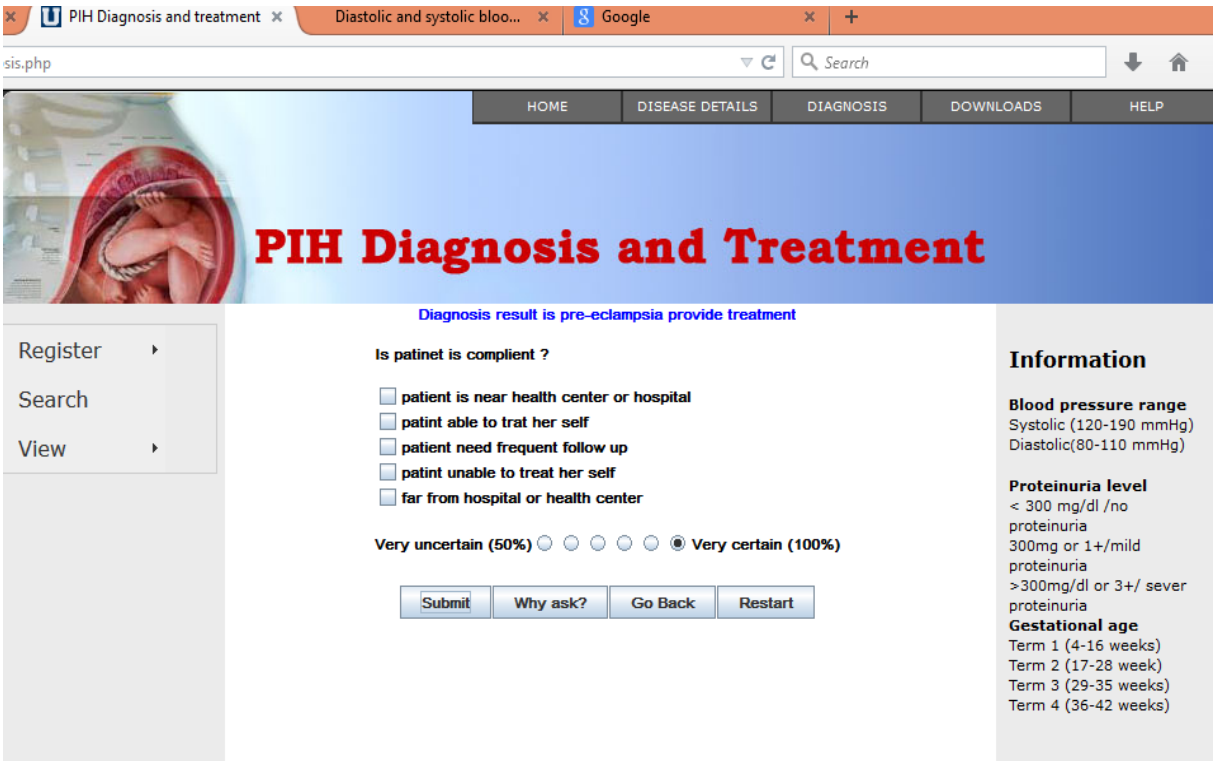


Figure 5.8 patient compliance of pre-eclampsia selection page

When the user selects one of the options with some confidence value the system will provide the diagnosis result and appropriate treatment. For example if user select “patient is near health center or hospital the system will provide outpatient treatment. On the other hand if the user select “patient need frequent follow-up” system will provide inpatient treatment. Below figure 5.9 and figure 5.10 shows inpatient treatment.

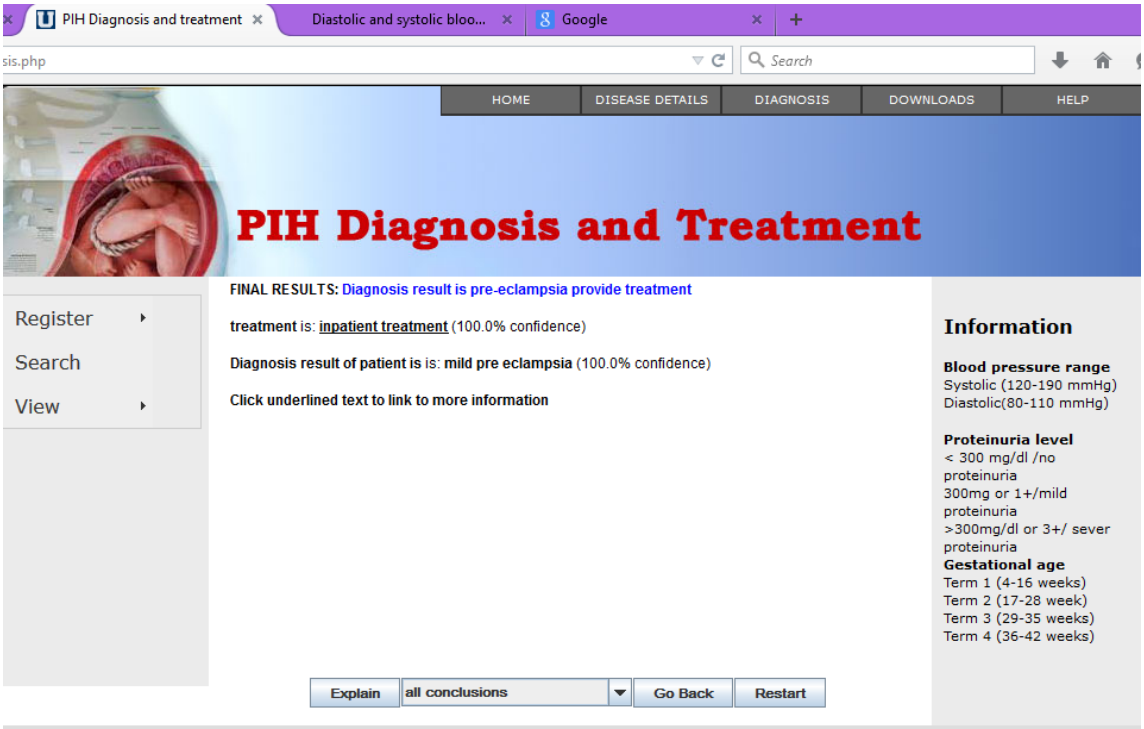


Figure 5.9 mild pre-eclampsia diagnosis result page

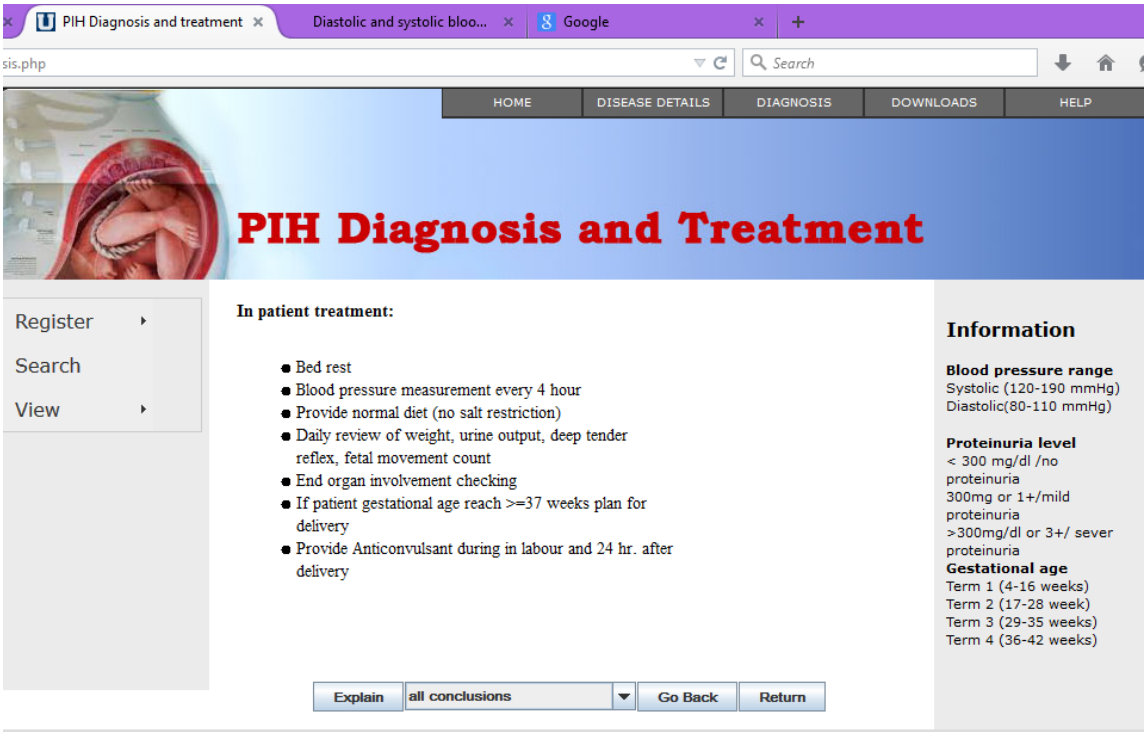


Figure 5.10 mild pre-eclampsia in patient treatment page

The next two figures shows pre-eclamsia in patient follow-up profile and diagnosis

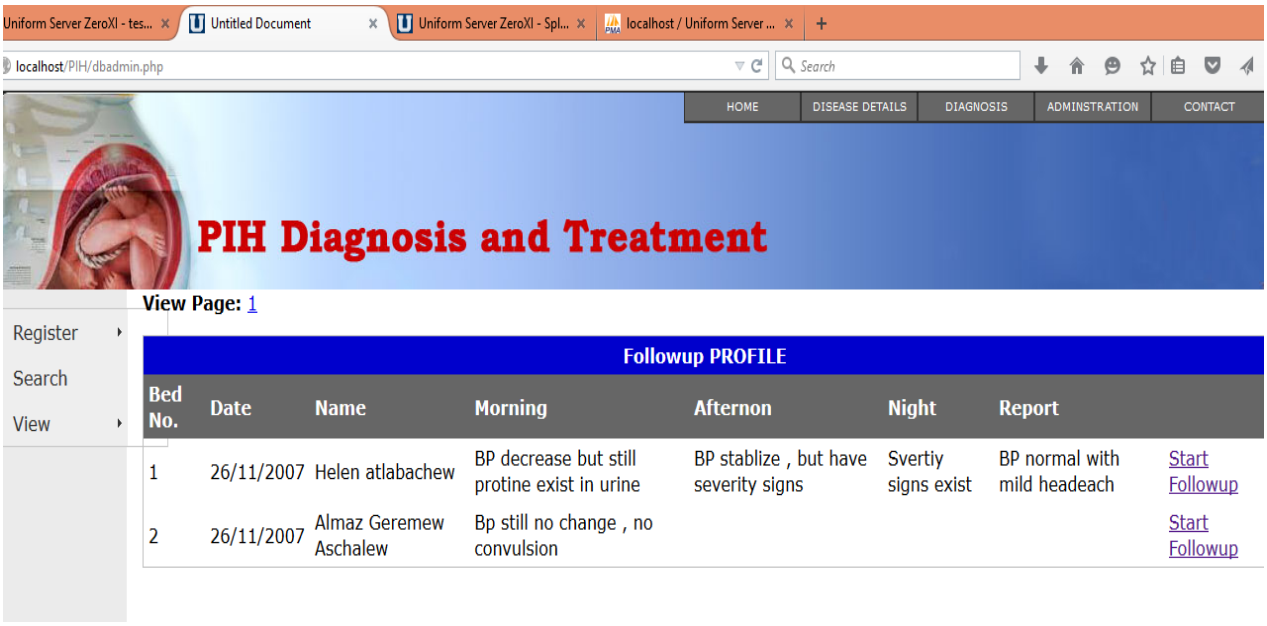


Figure 5.11 pre-eclampsia in patient followup profile

To continue patient followup diagnosis user of the system must use start followup link as shown in figure 5.11 then dagnosis will start on specfic patient. Next figure 5.12 show this procedure

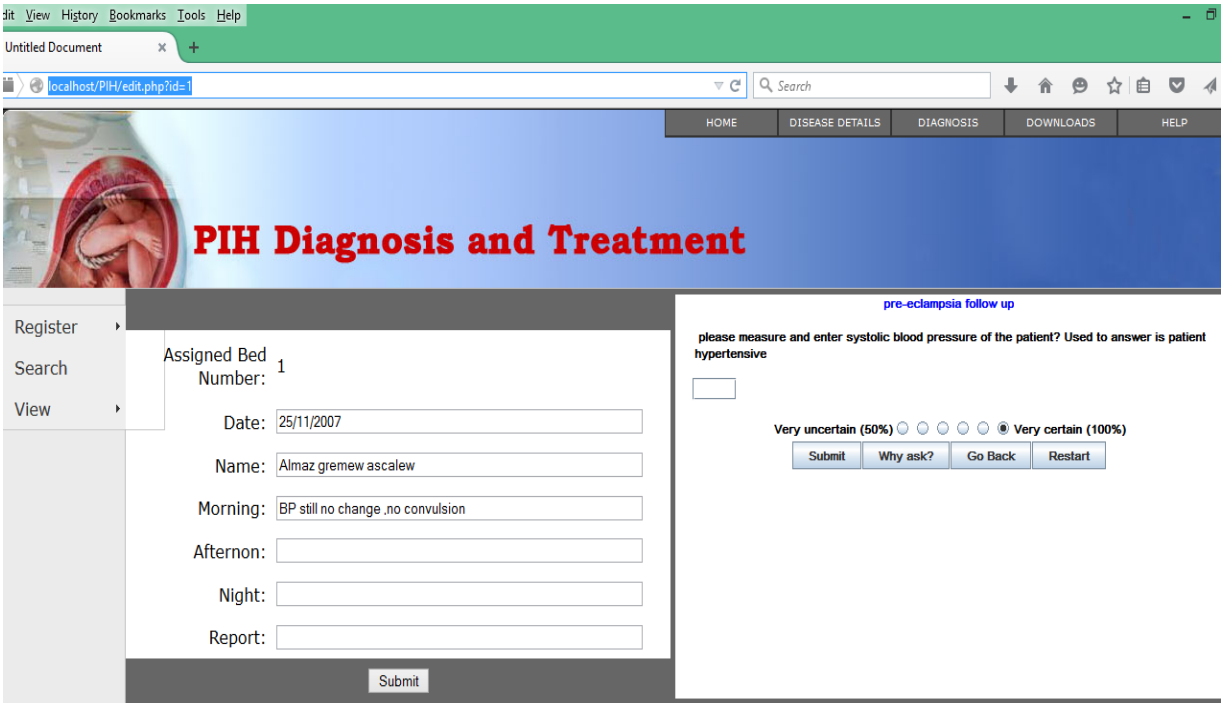


Figure 5.12 pre-eclampsia in patient Follow-up page

After the prototype is built, it should be extensively tested and evaluated to make sure that the system is accepted by the end-users and the performance of the system is accurate. Testing and evaluation of the prototype system is discussed in system evaluation section 5.5.

5.5 System Evaluation

The developed system, web based knowledge base system diagnosis and treatment of pregnancy induced hypertension is tested and evaluated to check whether the objectives of the research are achieved or not. The evaluation and testing issue of the system is summarized by the question "does web based knowledge base system give acceptable and accurate service to diagnosis pregnancy induced hypertension?".

In this research also visual interaction method is used to address user acceptance issue and helps to assess the performance of the system from user's perspective. As discussed in the literature review chapter system evaluation is the basic issue for the application of successful and effective knowledge base system. To address the issue of user acceptance, the researcher uses visual interaction along with close ended questionnaires.

The closed end questionnaires are helped to assess and evaluate the acceptability and applicability of the prototype in the domain area. These questioners are attached in appendix III.

Therefore, for the purpose of system evaluation, eight domain experts five from Debre berhan zonal referral hospital and three from Ayu private hospital selected as system evaluators. Those experts are selected purposive sampling technique from obstetric department. All of the selected experts are working in obstetric related issues. Before starting the evaluation process, the researcher gave explanation about the system. This explanation help experts to avoid the variation of awareness among them about the prototype web based knowledge based system. After the evaluators are interacting with the system by using test cases which have similar parameter with the rules in the prototype, they give their feedback on the questionnaires.

The questionaries' includes both closed and open ended questions are prepared for system evaluators. The questions are divided into two parts: the first seven questions are closed end questions and the rest of questions are open ended questions which used to collect constrictive feedback from the system evaluator's.

Format of closed-end questionnaire adapted from Solomon (2013), which is used to evaluate self-learning knowledge based system for diagnosis diabetes. The adapted questionnaires where modified in the context of web based knowledge based system for diagnosis and treatment of pregnancy induced hypertension.

The evaluation start with closed question, those closed end questions answered based on a given scale excellent, very good, good, fair and poor. The researcher assigned numeric value for each of the options given in words. The values are given as **Excellent** = 5, **Very good** = 4, **Good** = 3, **Fair** = 2, and **Poor** = 1. The Table5.2 below indicates the feedbacks obtained from the domain experts

Table 5.2 WBKBSPIHDT user performance evaluation results

System evaluation							
No.	Closed end questions	Poor(1)	Fair(2)	Good(3)	V.good(4)	Excellent(5)	Average
1	The easiness of the system to use and interact with it is	0	0	1	2	5	4.5
2	Is user interface of the prototype attractive and consistent	0	0	0	2	6	4.75
3	The efficiency of the system in time is	0	0	2	3	3	4.13
4	The accuracy of the system to reach the decision about pregnancy induced hypertension identification	0	0	0	6	2	4.25
5	Dose the proposed system incorporate sufficient knowledge to diagnosis pregnancy induced hypertension disorder?	0	0	1	5	2	4.13
6	The accuracy of the system in providing the right treatment and explanation for the identified diagnosed result	0	0	2	4	2	4.00
7	How do you rate the significance of the system in the domain area?	0	0	1	4	3	4.25
		Total average					4.28

As shown in table above (table 5.2) 12.5 respondents respond good, 25% of the respondents rated easiness to use and interact with it as very good while the remaining 62.5% respond the same question as excellent. In the same way, for question 'user interface attractive and consistency' 25% of the respondents evaluated as very good 75% of them evaluated as excellent. Similarly, 25% of the respondent rated the efficiency of time as good and 37.5% of the respondent rated as very good and the remaining 37.5% of them as excellent. Additionally 12.5% of them responded as good, 62.5% of them as very good and the rest 25% as excellent for the criteria "accuracy of the system to reach the decision about pregnancy induced hypertension identification". Likewise for the question 'Dose the proposed system incorporate sufficient knowledge to diagnosis pregnancy induced hypertension disorder' 12.5% of them respond as good, 62.5% of them rated as very good and the rest 25% as excellent. As well for the criterion 'accuracy of the system in providing the right treatment and explanation for the identified diagnosed result' respondents respond as 75 % very good and 25% of them rated as excellent. Lastly, concerning to the question related to the significance of the prototype 12.5% respond as good,62.5% of the respondent evaluated as very good and the rest 37.5% as excellent. Based on the results obtained the overall average performance of theprototype with user's point of view is 4.28 on a scale of 5. This result indicates that the overall average performance of the prototype knowledge based system is about 85.6%. This implies that the modeled prototype was performs well in making right decisions on the diagnosis and treatment of pregnancy induced hypertension.

In addition to the close ended questions, the evaluators give their feedbacks on open ended questions. Their feedbacks include the missed knowledge from the system, the limitations, strengths, and so on.

The open ended questions consisted of eight questions. The first question deals with the differences among human experts and the prototype web based knowledge based system in diagnosing pregnancy induced hypertension disorders. Most of the evaluators reply the same answer. They said that there is higher similarity between the expert and the knowledge based system. As they said, the difference only occurs in the case of assessing end organ involvement, multiple pregnancy and blood testing. Domain experts assessing end organ involvement, multiple pregnancy and blood test examination during the diagnosis of pregnancy induced hypertension. They look the patient's related problems end organ involvement such as renal damage and liver damage. They also check

blood test result to count platelets in blood and multiple pregnancy, those are the cause and diagnosis way to know the pregnant women is safe from pregnancy related disease. Nevertheless, the prototype does not have such kinds of ability. As a result, it lacks a bit of flexibility. On the other hand, some respondents said that no difference except experts make misdiagnosis and the knowledge gap from expert to expert might lead to unwanted kinds of diagnosis. Similarly, one respondent suggested that "there is a difference between them because the system is accurate decision no room for guess and it is important for storing reliable knowledge.

Additionally, the other two questions are regarding to issues that are covered and uncovered knowledge by the system. All of them except two (who do not say anything) said that pregnancy induced hypertension disorders are well covered. These include the identification of a person with pregnancy induced hypertension disorders (sign and symptom of pre-eclampsia, eclampsia, gestational hypertension, superimposed pre-eclampsia/eclampsia, and chronic hypertension) and treatment for each. On the other hand, regarding to the uncovered areas and missed knowledge from the system question, most of the evaluators said that nothing is uncovered for pregnancy induced hypertension disorders diagnosis except the assessment of end organ involvement, multiple pregnancy and platelets.

In the next open-ended question the respondents where asked was "In your opinion, can knowledge based system (such as the prototype presented by WBKBSPIHDT) handle the diagnoses task of pregnancy induced hypertension disorders?" This criterion is set to get users' outlook about the prototype knowledge based system in the domain area (pregnancy induced hypertension disorders diagnoses). All of them said yes. They said, since it is working based on experts knowledge, it handles the diagnoses tasks of pregnancy induced hypertension disorders.

Furthermore, concerning to the adequacy of the knowledge in the knowledge based system, most of the respondents reply that the knowledge of the system is adequate, but the system must be updated as science and technology advances. The other two respondents answered no because the system should include other disorders to make full diagnoses of obstetricmedical disorders. Likewise, about the significance of the system in the domain area, all respondents respond that the system has significance in the domain area. As one respondent said, "the system has indispensable importance to people working in the area. Firstly, it can save experts' time and energy that theywaste while referring books. Secondly, it can help to diagnose the disorder accurately."

Similarly, others said that the system has great importance in the domain area, particularly for nurses and midwiferies. In addition, the evaluators make suggestion about the limitations and strengths of the prototype. Some of the limitations are:

- ✓ Exclusion of assessment of multiple pregnancy, end organ involvement and platelets those are important for confirmation and reaching diagnosis.
- ✓ Probably people who lack computer skills and computer access might not implement it.
- ✓ It has language barriers.

On the other hand, some of the strengths of the system mentioned by the respondentsare:

- ✓ Save time and man power
- ✓ More accurate
- ✓ Applicable any where for those read and write English language
- ✓ Easy to use
- ✓ Increase early detection and treatin of pregnancy induced hypertension disorders
- ✓ Improve health care System (HCS)

5.6 Discussion

The evaluation and testing procedures help to address the question of user acceptance and accuracy of the prototype. Visual interaction and questionnaire methods are used to assess user's acceptance issues and applicability of the prototype. Based on the evaluation results obtained from visual interaction with closed ended questions none of the evaluators respond as poor or fair. On the other hand evaluators reply good seven times (14.28%), very good twenty six five times (44.64%) excellent twenty three times (41%) the following table summarizes the results obtained on close ended questions

Table 5.3 summary of system evaluators result on close ended questions

Respondants Who repond as	Poor(1)	Fair(2)	Good (3)	V.good(4)	Excellent(5)	average
Total number	0	0	7	26	23	4.28
%age of 100%	0	0	12.5%	46.42%	41%	85.67

As shown in the above table 5.3 the overall average user acceptance evaluation of the prototype web based knowledge based system is about 85.67%, this means the prototype is accepted by

85.67% of respondents. Therefore, approximately 86% of users are satisfied with the easiness, attractiveness, speed, accuracy, adequacy problem solving ability and the significance of the prototype web based knowledge based system in the domain area. This implies that the prototype modeled relevance and satisfactory domain knowledge in useful way and it performs well in making right decisions on the diagnosis and treatment of pregnancy induced hypertension disorder.

Therefore, regarding comparison with other systems, as mentioned in related work chapter two of this document several studies were conducted locally on knowledge-based systems in order to support reasoning and finding solutions for certain problems in the area of health and medicine.These are knowledge based system for blood transfusion which is developed by Guesh (2012).Researcher use rule base technique to develop knowledge based system. Similarly proposed system use rule base technique to develop web based knowledge base system. In addition, related to accessibility and easiness proposed system more accessible because it's has web based feature than the KBS developed by Guesh (2012). Likewise Solomon (2013) developed a self-learning knowledge based system. Researcher also used rule base technique and it is standalone system. The system have better self-learning ability than proposed system but considering system accessibility propsed system have better than the system developed by Solomon (2013) because of web based feature. Similarly, Tagel(2013) developed Knowledge based system for Pre-Medical triage treatment at Adama University Asella Hospital performance of the system is rated 85.4% and like other systems Tagel use rule based techniques and system is standalone while proposed system have web based feature.

Additionally, other researches Djam (2011) developed fuzzy expert system for the management of hypertension and Rupinder(2014) developed an fuzzy expert system for diagnosis hypertension use fuzzy logic tecniques to develop a system.while proposed web-based knowledge based system use production rule techniques. In general developed web based knowledge based system has good preformace which is 85.67 but both reserchers dosen't evaluate performance of developed fuzzzy expert system and related to accseablity propoesd system accesable in any platform.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Pregnancy induced hypertension is one of the disorders in obstetric medical disorder that happens in the first or second half of pregnancy. These disorder occur because of the elevation of patient blood pressure and the presence of protein in urine. It create danger on mother and baby leads to death for both of them. Therefore, pregnancy induced hypertension need early detection, frequent control and consistent treatment. But, in our country, there are no sufficient numbers of physicians and skilled medical professionals. This condition leads to disproportional numbers of physicians and patients. Because of this problem, pregnancy induced hypertensive patients are not getting enough diagnosis and treatment. Hence, in this study an effort has been made to design and develop a prototype of a web based knowledge-based system that can provide advice for health professionals to facilitate the diagnosis and treatment of patients with pregnancy induced hypertension.

In developing the prototype system, knowledge is acquired using both structured and unstructured interviews with domain experts and from relevant documents by using documents analysis method to find the solution of the problem. The acquired knowledge is modeled using decision tree that represents concepts and procedures involved in diagnosis and treatment of pregnancy induced hypertension. Then, the validated knowledge is represented using rule-based representation technique and coded using e2gRuleEngine, php, uniform server, Dreamweaver and java(applet and script) tool for building the web based knowledge-based system .

Also to address the issue of system evaluation, visual interaction along with close and open ended questionnaires are used. Visual interaction evaluation method allows the domain expert to make comments by interacting with the system. It is used to evaluate the performance of the prototype from the users' point of view. Similarly the questionnaires are helped to assess and evaluate the acceptability and applicability of the prototype in the domain area. For the purpose of system evaluation process, eight domain experts five from Debre berhan zonal referral hospital and three from Ayu private selected as system evaluators. These experts are selected purposively from obstetric department. Selected domain experts test the proposed web based knowledge based

system and provide their pertinent feedbacks along with long discussion with the developer. Moreover, the accuracy of WBKBSPIHDT using user acceptance evaluation is 85.67%.

WBKBSPIHDT has been adequate in providing diagnosis of pregnancy induced hypertension disorders but it cannot perform satisfactorily in cases the problem is outside its knowledge domain. WBKBSPIHDT has also been able to provide useful advices on each pregnancy induced hypertension disorder types and the necessary treatment that the patient should to take.

The prototype web based knowledge based system performs well and meets the objectives of the research. This prototype provides clear view for the developer and domain experts about the integration of web based knowledge based system technology in diagnosis and treatment of pregnancy induced hypertension disorders. Through little modification of it and/or addition of new rules, to include other obstetric medical disorders, the knowledge based system can be applied fully in the diagnoses of obstetric medical disorders.

Generally, in this research, the applicability of knowledge based system is proved as useful approach for facilitating obstetric disorder diagnoses services, and the research will initiate interests in to its use in the country.

6.2 Recommendations

The system achieves its objectives by demonstrating the applicability of rule based system by developing a web based knowledge based system for diagnosis and treatment of pregnancy induced hypertension disorder with hopeful of performance and user acceptance. This thesis research is the promising study for further research works to fully implement the web based knowledge based system in the health domain area. As a result the following recommendations are given based on the observed opportunities and uncover areas by this research. These recommendations are made for further investigations to fully implement the functionality of the prototype or to develop a new knowledge based system in the domain area.

- Due to short of time available, the study attempted to develop web based knowledge based systems for pregnancy induced hypertension under obstetric medical disorder. But, the scope of the knowledge based system should be expanded to include other obstetric medical disorder nausea and vomiting of pregnancy, anima in pregnancy and cardiac disorder in pregnancy and incorporate additional diagnosis criteria for pregnancy induced hypertension.

- This rule based system is unable to learn from experience and does not operate with cases which do not have matching facts in the rule base of the system. As a result, the development of self-learning system should be considered by using appropriate machine learning techniques like neural network and Bayesian networks.
- The researcher identified the availability of accumulated data and records.Therefore, we can discover a new pattern by implementing data mining techniques whichhelp us to improve the content of knowledge that we acquire manually from the domainexpert.
- The system should be implemented in other local languages such as Amharic language. So that it would easily be understood by all low level medical professionals.

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Appendix I

Interview questions

After introducing the objective of the study and requesting the respondents' participation in the study the interviewer records their answers for the following interview questions.

1. What is pregnancy induced hypertension?
2. What are the common sign and symptoms of pregnancy induced hypertension?
3. What are the different types of pregnancy induced hypertension?
4. How does the identification of each pregnancy induced hypertension disorder approval process go on?
5. How does diagnosis for each type of pregnancy induced hypertension proceed?
6. What are the laboratory testing methods used for diagnosis of pregnancy induced hypertension? Which one is the most common laboratory testing method used for diagnosis of pregnancy induced hypertension?
7. How can we differentiate each types of pregnancy induced hypertension during diagnosis?

8. What are the treatment recommended for each types of pregnancy induced hypertension disorder?
9. Do you have standardized guidelines for diagnoses usage?
10. If your answer for question number nine, to what extent do you followthe guideline?
11. What are the major difficulties and challenges in pregnancy induced hypertension disorders diagnosis

Appendix II

Sample codes used in diagnosis and treatment of knowledge base , the code contain link of different knowledge bases

REM Main knowledge base:

PARAM [BGCOLOR] = "#FFFFFF"

PARAM [APPTITLE] = "PIH Diagnosis and treatment"

PARAM [TITLECOLOR] = "#0000ff"

RULE [Is she pregnant?]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] <20 and

[Proteinuria] = "No"

Then [PossibleResult] = "chronic hypertension.kb"

RULE [superposed eclamptic]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] <20 and

[Proteinuria] = "Yes" and

[Seizure] = "Yes"

Then [PossibleResult] = "superposed eclampsia .kb"

RULE [superposed pre-eclamptic]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] <20 and

[Proteinuria] = "Yes" and

[Seizure] = "No"

Then [PossibleResult] = "superposed Pre-eclampsia.kb"

RULE [eclamptic]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] >20 and

[Proteinuria] = "Yes" and

[Seizure] = "Yes"

Then [PossibleResult] = "Eclampsia"

RULE [pre-eclamptic]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] >20 and

[Proteinuria] = "Yes" and

[Seizure] = "No"

Then [PossibleResult] = "pre-eclampsia.kb"

RULE [gestational]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] >139 and

[Diastolic blood pressure] >89 and

[Gestational age] >20 and

[Proteinuria] = "Yes"

Then [PossibleResult] = "Gestational hypertension.kb"

RULE [is patient not pregnant]

If [Is patient pregnant] = "No"

Then [PossibleResult] = "nopregnacy"

RULE [no hypertension]

If [Is patient miss regular period for more than two month] = "Yes" and

[Systolic blood pressure] <139 and

[Diastolic blood pressure] <89

Then [PossibleResult] = "no hypertension"

PROMPT [Is patient pregnant] ForcedChoice CF

" Is patient miss regular period for more than two month?"

"Yes"

"No"

PROMPT [Systolic blood pressure] Numeric CF

"Patient is pregnant please measure and enter systolic blood pressure of the patient? Used to answer is patient hypertensive"

"120.0"

"180.0"

PROMPT [Diastolic blood pressure] Numeric CF

"Patient is pregnant Please measure enter diastolic blood pressure of the patient? Used to answer is patient hypertensive"

"60.0"

"110.0"

PROMPT [Gestational age] Numeric CF

"Please enter gestational age of the patient in a week form? Used to provid specific diagnosis"

"4.0"

"40.0"

PROMPT [Proteinuria] ForcedChoice CF

"Is protein available during urine laboratory test? (Required for Diagnosis eclampsia and pre eclampsia)"

"Yes"

"No"

PROMPT [Seizure] ForcedChoice CF

"Is the patient have Seizure symptom? (Required to diagnosis eclamptic patients)"

"Yes"

"No"

GOAL [PossibleResult]

MINCF 80

Sample chronic hypertension treatment diagnosis

REM chronic hypertension treatment

PARAM [BGCOLOR] = "#FFFFFF"

PARAM [APPTITLE] = "PIH Diagnosis and treatment"

PARAM [TITLECOLOR] = "#0000ff"

RULE [chronic Pharmacological condition one]

If [sign]: "Severe headache" "Blurring vision" "Right upper quadrant pain" "Low urine output"

Then [Diagnosed Result] = "chronic hypertension” and

[Treatment] = "Pharmacological treatment” and

[Advice] = "Provide Advice to patient"

RULE [chronic Pharmacological condition one]

If [sign]: "Patient has no symptom" and

[Systolic] >159 and

[Diastolic] >90

Then [Diagnosed Result] = "chronic hypertension” and

[Treatment] = "Pharmacological treatment” and

[Advice] = "Provide Advice to patient"

RULE [chronic non-Pharmacological]

If [sign]: "Patient has no symptom" and

[Systolic] <159 and

[Diastolic] <90

Then [Diagnosed Result] = "chronic hypertension” and

[Treatment] = "Non-pharmacological treatment” and

[Advice] = "Provide Advice to patient"

PROMPT [sign] AllChoice CF

"Is the Patient have the following symptoms?”

"Severe headache"

"Blurring vision"

"Right upper quadrant pain"

"Low urine output"

"Patient has no symptom"

PROMPT [Systolic] Numeric CF

"Please enter the measured Systolic Blood pressure of the patient? [Range between 120-180]"

"120.0"

"180.0"

PROMPT [Diastolic] Numeric CF

"Please enter the measuredDiastolic Blood pressure of the patient? [Range between 60-150]"

"60.0"

"150.0"

GOAL [Diagnosed Result]

GOAL [Treatment]

GOAL [Advice]

MINCF 80

HYPERLINK [Treatment] = “Pharmacological treatment “ “Pharmacological. Php”

HYPERLINK [Treatment] = “Non-Pharmacological treatment “ “Non-Pharmacological. Php”

Sample java script code used to link different knowledge base

```
<script language="JavaScript">
//create arrays to store known attributes to move between knowledge bases
var attrName = []; //names of attributes
var attrValue = []; //values in these attributes
var attrCF = []; //certainty factors for values
var nAttrs = 0; //number of attribute values determined by one knowledge base
var attrIx; //used to store index of attribute
var PossibleResult; //name of linked knowledge base
var o = document.e2g;
//function called when any button pushed
function buttonPush(buttonNumber) {
   //if response (2) button pushed and goal stack is empty, may need to load new knowledge base
   if (buttonNumber == 2 && o.getGoalAttr() == 0) {
         attrIx = o.getAttrIx("PossibleResult",1); //assumes a rule provides kb name in "PossibleResult "
         if (attrIx == 0) return; //end of the line: no value of PossibleResult
```

```
        else PossibleResult = o.getAttrValue(attrIx);
                nAttrs = 0;
        for (var i=1; i<=o.getAttrCount(); i++) {
           tempStr = o.getAttrName(i);
           //zero length returned value means CF < minCF; don't store metarule or final goal values
           if (""+o.getAttrValue(i)).length > 0 && tempStr != "PossibleResult" &&
                tempStr != "Diagnosed  Result ") { //goal name(s) is/are application specific
              attrName[nAttrs] = tempStr; //store name, value & CF
                attrValue[nAttrs] = o.getAttrValue(i);
                attrCF[nAttrs] = o.getAttrCF(i);
                nAttrs++;
           }
        }
if (PossibleResult.length > 0) {
                    o.restartE2g(PossibleResult, false);
        }
} else if (buttonNumber == 0 && nAttrs > 0) {
for (var i=0; i<nAttrs; i++) {
           o.loadValue(attrName[i], attrValue[i], attrCF[i]); //ignored if attribute not used in new KB
        }
} else if (buttonNumber == 6) { //restart with initial knowledge base
        nAttrs = 0; //don't reload attributes from current run
        o.restartE2g("1.kb", false); //restart with initial KB on "restart"
   }
} </script>
```

Appendix III

Questionnaires to evaluate Knowledge based system for coffee diseases diagnosis

1. The easiness of the system to use and interact with it is

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

2. Is user interface of the prototype attractive and consistent

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

3. The efficiency of the system in time is

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

4. The accuracy of the system to reach the decision about pregnancy induced hypertension identification

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

5. Dose the proposed system incorporate sufficient knowledge to diagnosis pregnancy induced hypertension disorder?

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

6. The accuracy of the system in providing the right treatment and explanation for the identified diagnosed result

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

7. How do you rate the significance of the system in the domain area?

   Poor ☐ fair ☐ good ☐ very good ☐ excellent ☐

8. How is WBKBSPIHDT differ from a diagnosis conducted by a human obstetricians?
9. What issues are covered by the advisory services of the system?
10. Do you feel any uncovered areas by the prototype about pregnancy induced hypertension disordersdiagnosis and treatment? If you feel, please state them.

11. In your opinion, can knowledge base system (such as the prototype presented by WBKBSPIHDT) handle the diagnoses task of pregnancy induced hypertension disorders?
12. Do you think that the system incorporates sufficient knowledge to diagnoses pregnancy induced hypertension disorders?
13. Does the system have any significance in the domain area?
14. What are the limitations of WBKBSPIHDT?
15. What are the strengths of WBKBSPIHDT?

DECLARATION

This thesis is my original work and has not been submitted as a partial requirement for a degree of master in any other university

Solomon Degef

September 2015

Advisor : Tibebe Beshah (PHD)