SAADU UMAR ADAMU DEVELOPMENT OF MALARIA DIAGNOSIS SYSTEM USING VP-EXPERT SYSTEM NEU 2018

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A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
SAADU UMAR ADAMU

In Partial Fulfilment of the Requirements for the Degree of Master of Science in Mechatronics Engineering

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Approval of Director of Graduate School of Applied Sciences

Prof. Dr. Nadire ÇAVUŞ

We certify this thesis is satisfactory for the award of the degree of Master of Science in Mechatronics Engineering

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that I have fully cited and referenced all material and results that are not original to this work, as required by these rules and conduct.

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Date: 22/11/2017

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ABSTRACT

Currently, Expert systems which are class of Artificial intelligence are broadly used in medicine for diagnosis, medical examination, and treatment of different types of diseases. Most of the results obtained from various types of Diagnosis experts systems are closed values to the human decision, in some cases exact values are obtained. An inclusive system for the diagnosis and treatment of various kinds of Malaria is still deficient.

This thesis aimed at developing a malaria Diagnosis system, the knowledge acquisition procedure in the development of this system were done through direct interviewing with the medical specialists and the knowledge was represented in the rule-based procedure. These rules determine whether a person is healthy or malaria patient with it types such as simple malaria, severe malaria or at risk. VP expert software is used for the design of this system and the system was tested on 35 patients with 93% accuracy and the results were compared with the specialists' diagnosis and advice. The consistency of the 2 procedures was approved by the related internists board.

The developed system can be used efficiently for diagnosis of malaria were the number of patients is increasing daily, hence the designed system will help the medical specialists with fast and accurate diagnoses, and save time for both the doctors and patients as well.

Keywords: Expert system; Artificial intelligent; VP Expert; Malaria; Malaria Diagnosis System

ÖZET

Uzman sistemler halihazırda, teşhis koymakta, tıbbi muayenede ve farklı hastalıkların tedavisinde tedavisinde geniş biçimde kullanılmaktadır. Uzman tani sisteminden elde edilen sonuçlanr çoğu insanoğlu kararlarına yakın değerler olup, bazı durumlarda kesin sonuçlar elde edilmektedir. Kapsamlı bir sistemle malaria hastalığının tanı ve tedavisi halen daha yetersizdir.

Bu tezin amacı malaria tanı sistemi geliştirmek olup, bu sistemin geiştirilmesinde yer alan bilgi edinme prosedürü tıp uzmanlarıyla birebir görüşme sonucu oluşturulmuştur ve bilgi, kural tabanlı prosedürle gösterilmiştir. Bu kurallar kişinin sağlıklımı yoksa malaria hastasımı olduğunu ve bu hastalığın türlerini, basit, şiddetli ve ya hastanın risk altında olup olmadığını belirler. Sistemin tasarımında VP uzman sistem kullanılır ayrıca bu sistem 35 hastanın üzerinde% 93 doğrulukla denenmiş ve sonuclar uzmanlarin tanı ve önerileriyle karşılaştırılmıştır. 2 prosedürün de tutarlılığı ilgili dahiliyeciler tarafından onaylanmıştır.

Geliştirilmiş bu sistem malaria hastalığının tanı ve teşhisi icin verimli bir şekilde kullanılabilinir. Hastaların sayısı gün geçtikçe arttığından dolayı, tasarlanış bu sistem doktora bağımlılığı azaltıp doktorların ve hastaların zaman kazanmasına olanak sağlayacaktır.

Anahtar Kelimeler: Uzman sistemler; Yapay akıllı; VP uzman; Malaria; Malaria tanı sistemi

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LIST OF ABBREVIATION

AI:	Artificial Intelligence
AGI:	Artificial General Intelligence
ANI:	Artificial Narrow Intelligence
ASI:	Artificial Super Intelligence
CLIPS:	C Language Integrated Production System
DDeX	Diabetics Diagnosis Expert System
DSCG:	Delivery System for Clinical Guidelines
ES:	Expert System
HIV:	Human Immunodeficiency Virus
KB:	Knowledge Base
KBES:	Knowledge Base Expert System
LIPS:	Linear Program Solver
MALX:	Malaria Diagnosis Expert System
MAI:	Medical Artificial Intelligence
MFES	Mobile Fuzzy Expert System
MYCIN:	Bacteraemia and Meningitis Treatment Expert System
PBS:	Peripheral Blood Smear
PBS1:	First Peripheral Blood Smear
PBS2:	Second Peripheral Blood Smear
PBS3:	Third Peripheral Blood Smear
PSGEx	Sleeping Disorders Diagnosis Expert System
TxDENT	Dental Screening and Tracking Expert System
WHO:	World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter presents the basic information about Artificial intelligence, Expert system, malaria and the research objective. Section 1.1 Explains the concept of Artificial intelligence in relation to the medical field and Section 1.2 Briefly explains Expert systems, its applications and component. In Section 1.3 Brief definition of malaria have been discussed and the concept of malaria demography. Section 1.4 explains the problem statement and Section 1.5 states the research objective. Lastly, the thesis organization was present in Section 1.6.

1.2 Artificial Intelligence (AI)

Artificial Intelligence is a coordination of designing a computer, a software that thinks logically, just the way intelligent humans think or a computer-controlled automation or robot. AI is bright by investigating how human being brain reasons, and how humans make a decision, and work despite the fact trying to answer a problematic assignment, and then applying the results of this investigation as a root of developing intelligent software and systems. Expert systems are the class of Artificial Intelligence system. The stated area of Artificial Intelligence (Al) study is to copy-cat the working of human intellect by computer programs or computers with the capacity to copycat or replicate the tasks of human intelligence. The area of Artificial intelligence is enormous in scope and size. While continuing, we reflect the largely common and prospering research areas in the area of AI which are; Expert system, Neural network, Neural Language processing, Robotics and Fuzzy logic (Mishkoff, 1985).

Artificial intelligence is used in an everyday cycle of life. AI is widely used in medicine and the healthcare sector. The main advantages of AI in the world of medicine would be discussed briefly.

- Transforming the healthcare sector: with recent Used of artificial intelligence in medications changes the way healthcare sector collaborates with education, businesses, and industrial. It brings fresh possibilities for advancement and collaboration. The advanced in the healthcare sector is certain and its benefits should be utilised intelligently.
- Decreasing mortality rate: Reducing the period patients spend waiting for attention from specialists, artificial intelligence in medicine lessens the mortality rate and has an optimistic effect on the superiority of this care. Having such help, doctors have extra time for development. There wasn't need to treat artificial intelligence in the medical arena as an effort to replace doctors. Supplementary, it's the effort to assist doctors.
- Making diagnostics more precise: As medical artificial intelligence systems have the capacity to learn from previous cases, they offer doctors access to the information about the latest news in medicine, the healthcare sector, and some areas of study in particular. A human can't combine following the newest leanings and treating patients at the same time. There wasn't sufficient time for that processes but an AI system can. That's why it becomes a vital assistant.
- Decreasing the dependence on social services: Another way to utilise artificial intelligence in healthcare and medicine is to permit robots to take care of some patients. For instance, therapeutic robots help Alzheimer's patients improve the quality of life, reduce the reliance on social services, and increase the time a person may stay at home without human medical assistance.
- Decreasing human errors: With more than 100 patients in a week, doctors find it tough to offer everyone with the similar volume of care. Also, there is a so-called human factor. Humans likely make mistakes. Artificial intelligence in medicine is a technique to eradicate errors related to human tiredness and relieve doctors of some repetitious tasks.
- Reducing medical costs: Being able to submit information online, patients don't

have to go to hospitals frequently. Medical records and effective diagnosis making will lessen the medical expenses of office visits and the number of human mistakes connected with record custody.

- Supporting in movements: The influences stated above are practical and valuable. Nevertheless, this benefit is the most real life. Health care specialists frequently encounter the need to move heavy items or carry out some repetitive tasks like giving out pills. Robots may be the desired change. Medicine specialists may use machines as a technique to outsource these repetitive tasks.
- Enhancing invasive surgery: Surgical robotics is a device that offers doctors with accuracy, comfort, and superior visualization. With the help of type such robots, surgeons get the support that shortens patients' hospital stay, lessens pain and medical expenses.

At the year 2020, the market for machine learning applications may reach $40 billion. Currently, only 1% of all applications are made with artificial intelligence features. Though, by 2018 their number will raise up to 50%. Now you understand the meaning of artificial intelligence in medicine (Peleg, 2011).

Artificial intelligence is generally divided into 3 phases: Artificial narrow intelligence (ANI), Artificial general intelligence (AGI) and Artificial superintelligence (ASI).

The ANI, as its name implies, is partial in scope with intelligence limited to only one useful area. The AGI is at an advanced level and it shelters more than a single arena like cognitive power, problem-solving and mental thinking, which is mostly equivalence with adults. ASI is the last phase of the intelligence explosion, in which AI exceeds human intelligence across all fields.

The transition from the first to the second phase has taken a long period, but we believe we are presently on the point of completing the transition to the second phase by the year 2020, in which the intelligence of machines can equal humans. The transition from second to the third phase is aimed at early 2050.

1.3 Expert System (ES)

In the universe of Artificial intelligence, an Expert system is a computer system with the capacity to copycat or replicate the tasks of human's intelligence by making decisions just the way a skilled human expert does.

Human experts are capable of solving problems at a high level because they exploit information about their area of proficiency. This information provided the basic for the design of programs with expert-based problem-solving proficiencies. An expert system, which such a program is frequently called, uses explicit data about an area in order to gain competence equivalent to that of a human expert. The explicit information may be gained by questioning one or more experts in the area in question. The area expert systems are possibly the sub-area of artificial intelligence that has reached the maximum commercial success. Nowadays expert systems are used in a huge number of topic areas, ranging from medicine, chemistry, and geology to law, politics, and economics. Any area in which decisions are to be made is a potential application of expert systems (Mishkoff, 1985).

Expert systems are developed to solves difficult problems by cognitive thinking about knowledge, expressed mainly as if-then rules quite than through predictable procedural code. AI programs that attain competency at expert level in solving problems in some task areas by conveying to endure a frame of knowledge about specific tasks are termed expert systems or knowledge-based.

Frequently, the word Expert systems are earmarked for a program whose knowledge base has the knowledge which is used by human experts, in comparison to the knowledge acquired by non-expert and textbooks. The synonymous used the 2 terms, Expert systems (often called ES) and knowledge-based systems (often called KBS), are used frequently. Considering the two terms, expert systems and knowledge-based systems represent the greatest common types of AI application. In an expert system, the area which human intellectual endeavor to apprehend is identified as the task domain. Task means some goal-oriented, problem-solving activity and Domain means the exact area in which the task is being accomplished.

The Expert system involves 5 main components namely which are User interface, Inference engine, Knowledge base, Knowledge acquisition and Solutions display.

1.3.1 Application of expert system

Some of the applications of the expert system are Knowledge Domain which is used in Finding out faults in vehicles and computers. It also applied in Finance and Commerce for Discovery of possible fraud, doubtful transactions, stock market trading, Airline scheduling and cargo schedules. Another application is a Design Domain where the Camera lens is designed and automobile design. It also used in Monitoring Systems for Equating data continuously with the experimental system or with prescribed behaviour such as outflow monitoring in long petroleum pipeline. Another potential application is Medical Domain for Diagnosis Systems to reduce the cause of disease from experimental data and conduction medical operations on humans.

1.3.2 Expert systems in medicine

Medicine always looked like an ideal Artificial Intelligence application area. Medical Artificial Intelligence (MAI) was defined as the use of Artificial Intelligence methods and computational support to simulate the mental processes a physician applies when treating patients. This definition permitted computer scientists to consider what was obligatory to apprehend and simulate the expertise of the specialist.

After the patient data have collected, the analyzed or diagnosed is based on the stored medical acquaintance or knowledge. The facts on signs or symptoms, distinct facts of research laboratory tests are processed by the method of defined rules to achieve the possible diagnoses. Extra data such as the existence or absence of positive signs and symptoms assist in deciding a final diagnose.

The rationale for creating diagnoses or hypotheses of diagnoses is recognized as well as the strategies for other analyses or examinations and for patient treatment. Similarly, it is shown once there are strange signs, symptoms or laboratory facts. They comprise the realization of a set of some questions, individualized to each question and the collection of data that is going to be acquired answering the questions (Cleancy, 1984).

1.4 Malaria

Malaria is a serious blood ailment produced as a result of parasites spread to humans through the mouthful of the Anopheles mosquito, called malaria vectors. As soon as infected mosquito bites a human and spreads the parasites, those parasites reproduce in the host's liver before infecting and rescinding red blood cells. Malaria surfaces when a feminine Anopheles mosquito bites human, which then poisons the body with the organism or parasite Plasmodium.

This is the only category of mosquito that has the possibility of causing malaria. After the infected mosquito bite a human host, the parasite goes into circulation and places dormant inside the liver. For the subsequent 5-16 days, the host will show no signs but the malaria organism will commence multiplying asexually.

Malaria symptoms or signs can be characterized into two; simple (uncomplicated) and severe (complicated) malaria. The symptoms of malaria generally grow in Ten to 28 days resulting in the infection. In many people, symptoms may not grow for several months. Some of the malaria pests can pass into the body but will be inactive for long periods (WHO, 2010).

1.4.1 Malaria demography

So Many individuals are significantly at higher danger situation of contracting malaria, and rising severe disease, than the others. These comprise infants, children below five years of age, conceived women and patients carrying HIV/AIDS.

In regions where the spread of malaria is on the increase, children below five years of age are mostly disposed to infection, sickness and death, in addition, 2/3 (70%) of all malaria deaths befall in this age group. It has been investigated in 2015 that approximately 1/2 of the world's populace existed at risk of malaria.

Furthermost, malaria cases and deaths take place mostly in sub-Saharan Africa. Though, Latin America, South-East Asia and Mid East, are also at risk. In 2015, ninety-one countries and regions had continuing malaria spread. Sub-Saharan Africa continued to be

the frontline continent with an excessively high percentage of the worldwide malaria problem.

In 2015, the area identified with 90% of malaria cases and 92% of deaths cases associated with malaria. Around 13 countries mostly in sub-Saharan Africa accounted for about seventy-six percent of malaria cases and seventy-five percent deaths cases related to malaria globally. Base on the recent research made by WHO in December 2016, around 212 million malaria cases occurred in the year 2015 and 429000 deaths cases (WHO, 2016).

1.5. Problem Statement

In the sub-Saharan region, especially in Nigeria, the occurrence level of malaria disease is on rising. This is due to several causes such as bad shelter, an absence of physical activity, lack of drainage systems, lack of health education and the rapid spread of the ailment. The motivation behind this dissertation was due to the inadequate malaria control procedures in existence.

Likewise, malaria and its complications enforce significant financial consequences on individuals, families, health sectors, and countries. The public will continue suffering from health and an economic problem if the public remains to ignore malaria and its problems. Hence early technological diagnosis system and assessment tool are highly needed to serve people in our society. The early development of this Artificial intelligence system the more it will reduce the economic cost of the government, international donors, and families.

A Malaria Diagnosis system is proposed using VP-expert system software for malaria patient. The developed system will assist the medical specialists in diagnosing malaria patient as soon as they obtained Peripheral Blood Smear (PBS) Test. If properly sustained the system will makes the diagnosis of this fatal disease much easier, faster, and more accurate.

1.6 Objectives of Dissertation Work

Nearly 50% of persons with malaria live in the hospital, usually under the supervision of a doctor. The outstanding ratio of persons with malaria lives in their individual houses under the observation of spouse or family member. (An estimated survey shows that Malaria was accountable for approximately twenty to thirty percent of hospital admissions, and also around thirty to fifty percent of outpatient consultations).

This Dissertation looks at different Medical Artificial Intelligence (MAI) related work and software's that can help make diagnosis easier for people with malaria and their physicians in certain situations. We will present some development of an Expert systems for decision making in diagnosis and treatment in medicine. The system will offer decision support to malaria researchers, organisations and other healthcare experts in malaria endemic areas of the world.

Malaria is a deadly disease, which can lead to various other hazardous diseases such as Acute renal failure, hypertension, bleeding, respiratory complications, and infection. Hence, designing a consulting system proficient in assisting prevention or lessens of these patients' difficulties and malaria side effects is valuable. The key purpose of this research was to design an expert system (knowledge-based expert system), which will support the malaria specialist in diagnosis with precise and faster diagnosis and more accurate advice.

1.7 Organization of Dissertation Work

This thesis report consists of six chapters. Chapter one gave a brief overview of Artificial intelligent, Expert system, malaria, malaria demography, objectives and organization of the thesis. Chapter two reviewed about the researches that have been done related to the medical expert system for diagnosis. Meanwhile, chapter three discuss Expert system and VP Expert Shell. Chapter four explain the system knowledge acquisition and Representation, development and processes of the malaria diagnosis system. Testing and Validation of this system are deliberated in chapter five. Finally, chapter six gives conclusion and discusses the future scope of the thesis work.

CHAPTER 2

RELATED WORK

2.1 Overview

Medical ES's are very effective and useful in the area of diagnosis, and medicine. Various ESs were presented and still in use in hospitals and health centre. The subsequent section presents those medical ES and their interrelated researchers.

Concerning expert systems in the medical arena, we notice that there are a lot that focuses on different areas in the medical arena. Though, it is infrequent to find 2 expert systems concentrating on the same medical field. Hence, the correlated work will differ to include several representation types to uncertainty and reasoning for different medical expert systems.

2.2 Bacteraemia and Meningitis Treatment Expert System (MYCIN)

MYCIN was designed in the mid-late 1970's and it is a rule-based system by Shortliffe as a PhD thesis at Stanford University. The system was intended to assist doctors in guiding them on the treatment of patients with severe infections, specifically bacteraemia (bacteria in the blood), and meningitis (bacteria in the cerebrospinal fluid, the fluid that bathes the brain and spinal cord) (Shortliffe and Buchanan, 1984).

MYCIN was an initial backwards chaining expert system that utilised artificial intelligence to detect bacteria that caused severe infections, such as bacteraemia and meningitis, and to endorse antibiotics, with the prescription adjusted for patient's body weight, the term derived from the antibiotics themselves, as many antibiotics have the suffix MYCIN. In 1974 5 jury committee of experts approve 72% of Mycin's commendations for 15 patients and in 1976 eight experts made drug commendations for ten patients, MYCIN had the best match (52%) with authentic drug commendations used by attending specialist.

MYCIN would try to diagnose patients based on testified symptoms and medical test results. The program could demand more information regarding the patient, as well as recommend extra laboratory tests, to arrive at a possible diagnosis, subsequently, it would recommend a sequence of treatment. If demanded, MYCIN would describe the reasoning that yields to its diagnosis and commendation. Using approximately 500 production rules and a thousand facts about medicine, typically about meningitis infections. MYCIN worked at the roughly similar level of capability as a human expert in blood infections and relatively better than general physicians (Shortliffe and Buchanan, 1984).

MYCIN reasons about information related to a patient. It considers, for instance, laboratory results of body fluid analyses, signs that the patient is presenting, and overall features of the patient, such as gender and age. MYCIN acquires this data by questioning the doctor. MYCIN consultation proceeds in 2 stages. First, a diagnosis is made to detect the greatest expected infectious bacteria. Then 1 or more drugs are given that should control for all of the likely bacteria.

To have sufficient space for ambiguity, all data given to MYCIN may be competent by a certainty factor, a number amid - 1 and + 1, that specifies the doctor's degree of confidence in the response to a question. Therefore, if a physician is only ascetically certain that a specific symptom is existing, she or he can reply to a query by typing YES to specify a partial confidence in the answer. Operators can inquire WHY? when MYCIN is enquiring for facts, and MYCIN will describe what theories it is considering and how the current question will provide information that will improve support or assist to rule out that theory. Subsequently, diagnosis and treatment are complete, the doctor can if wanted, trace MYCIN's whole diagnostic trail (Harmon and David, 1988).

MYCIN Structure encompasses 3 main sub programs. The Consultation Database is critical of the system; it interrelates with the doctor to obtain info about the patient, creating diagnoses and treatment commendations. The Explanation Database offers descriptions and reasonings for the program’s actions. The Knowledge Acquisition Database is used by experts to update the system’s knowledge base (Shortliffe and Buchanan, 1984).

2.3 Diabetics Diagnosis Expert System (DDeX)

DDeX is a knowledge-based expert system developed to support the diabetics with systematic treatment advice and it contains the basic module of the expert system which are a knowledge base, an inference engine, and a user interface. The designed expert system is applied in diagnosis, treatment and establishment of advice to the doctors and patients (Sayedah and Tawfik, 2013).

The knowledge acquisition step in the development of this system was completed through direct questioning with the medical experts and nurses in the arena of diabetes and reviewing the correlated scientific materials. The developed system is a rule-based expert system, thus, for knowledge representation, if-then rules were used, where IF identifies the condition and THEN offers the recommendation.

The system was assessed by the internists and diabetes experts of Hasheminezhad Teaching Hospital, and the applicable remarks and commendations were used in the concluding development phase. The ultimate system was confirmed on 30 diabetics of several types, and the outcomes were equated with the specialists' diagnosis and advice. The reliability of the 2 methods was approved by the correlated internists.

This diabetes expert system wasn't meant only for diabetic persons but also for the public those alleged of being diabetic. With this persistence, the authors designed a diabetes valuation module by using Prolog server pages (PSP) as a web-based artificial intelligence language (Sayedah and Tawfik, 2013).

2.4 Sleeping Disorders Diagnosis Expert System (PSGEx)

PSGEx is an assisting diagnosis system for sleep disorders based on polysomnographic facts, which objects at supporting the medical specialist in his diagnosis duty by providing programmed examination of polysomnographic facts, summarising the outcomes of this examination in terms of a report of key results and probable diagnosis reliable with the polysomnographic facts (Paiva and Fred, 2000).

The designed software tool is a discourse from 2 points of view: first, as a combined environment for the design of diagnosis adapted expert systems and second as an assisting diagnosis instrument in the specific field of sleep disorders. This software tool encompasses one of the greatest prevalent shells called CLIPS (C Language Integrated Production System) with the subsequent structures: backwards chaining engine; graph-based description facilities; knowledge editor with a fuzzy fact editor and a rules editor, with facts-rules honesty inspection; belief modification plus mechanism; built-in case generator and an authentication component. It, therefore, offers graphical backing for knowledge acquisition, edition, explanation and validation.

The Key features of this system are perusing on patients' information records, organized navigation on Sleep Disorders explanations, internet links to connect pages, diagnosis reliable with polysomnographic information, graphical user-interface with graph-based descriptive facilities, ambiguity demonstrating and belief review, the creation of reports, linking to remote modules**.**

2.5 Dental Screening and Tracking Expert System (TxDENT)

TxDENT is a dental diagnostic screening and tracking expert system, TxDENT was designed at the University of British Columbia (U. B. C.) in the Faculty of Dentistry in the year 1997. The system was designed for a decision-support to expand the procedure of screening, choosing and tracing dental patients (MacEntee, 1999).

TxDENT is an expert system which works on individual computers to direct clinicians without radiographs or extra diagnostic helps through a methodical verbal scrutiny to record a folder of clinical discoveries and to endorse treatment and related fees. It suggests direction over a systematic clinical assessment of 5 main parts: jaw movement, dentures, oral mucosa, teeth, and periodontium, using strategic dichotomous choices based on IF-THEN rules comparable to those used by dentists in training. The rationality of each quantity has evolved from the agreement of experts in much the same way as agreement offers the foundation for most conclusions in clinical dental training today. TxDENT has been used in a university-based undergraduate dental hospital to direct medical

practitioners and students over a systematic verbal enquiry of each patient and to endorse instantly a treatment plan with related levies for the patient.

The program is built on an expert system in which a standardised technique assists dental specialists to make conversant and quick decisions through a decision-tree model. The choice rules for treatment are built on experimental understanding gained in various great epidemiological studies of older adults. TxDENT is also built on systematic inspection and experimental measures, but it endorses treatment and related payments by the rule-based system without reference to the ideas of the screening dentist (MacEntee, 1999).

2.6 Mobile Fuzzy Expert System (MFES)

MFES is a designed mobile built fuzzy expert system which is active in diagnosing malaria by the way that is likely to be done by an expert in the field of malaria control and similarly protested at assisting to equalise the percentage of patients to medical experts. This research considers designing a mobile-based fuzzy expert system that can support in analysing malaria. The fuzzification of hard inputs by the system was done using an inter treasured and trilateral involvement purposes while the defuzzification of the inference engine outputs was done by the weighted average technique. Root sum square technique of sketching inferences has been hired while the entire design was realized with the support of Java 2 Micro Edition of Java. This expert system performs on the readily obtainable mobile devices of the patients (Alaba and Isaac, 2016).

The design of MFES has hired the use of some hardware and software tools. The hardware tools comprise a Compaq Mini Computer System and X2 Nokia Cell Phone. The software tools contain ClamshellCldcPhone1 Emulator, Net beans 7.0.1 as the IDE (Integrated Development Environment), JDK 1.6 and Windows 7 Ultimate Operating System. The process of Human-Computer communication used by this system is based on Graphic User Interface that employed the use of graphic elements. The revolution of scalar inputs into fuzzy inputs in the research has hired both interval-valued relationship function. While the knowledge represented in the knowledge base is in the method of fuzzy rules by means of the generalised modus ponens. The sketching of inferences from the fuzzy rules practices

the root sum square technique and the defuzzification of inference engine outputs by the designed system employed the use of a weighted middling (Alaba and Isaac, 2016).

2.7 Other Potential Medical Expert Systems

Mohammed developed a fuzzy expert system for judgment of back pain diseases built on the experimental check up signs by means of fuzzy rules. The operator has to key in parameters such as body weight index, age, sex and experimental check up signs for this fuzzy expert system. On the foundation of these parameters, this fuzzy expert system makes a right judgment of back pain diseases and recommend some medical recommendation to the patient. The precision achieved from this fuzzy expert system was 90% (Mohammed et al., 2011).

Eugene and George enlarged an expert system which is used to identify main kidney diseases. The diagnosis is made by means of the analyses gotten from the experimental test and the para- experimental test. This system assists the medical specialist in producing the appropriate examination of a patient. A portion of common signs repeatedly happen in kidney diseases and numerous of them are similar, and that makes it hard even for a kidney specialist to place a precise diagnosis. This expert system eradicates this distress. This expert system has a very well assembled knowledge base. It has knowledge of 27 diseases from 9 different classes (Eugena and George, 2009).

Ali and others introduced an automatic Delivery System for Clinical Guidelines (DSCG) that assist physicians in diagnosing and treating patients having chest pain in the emergency section. Policies are adaptively carefully chosen from a knowledge base server that has a collection of clinically clear, graphical guiding principle. The system obtains patient information, like sickness and valuation results, and relates this information to suitability standards. It endorses utmost favourable treatment strategies and investigates based on the greatest practicable diagnosis. Clinicians may also use the commendations as a recommendation or prompt a choice to check the patient’s situation during the treatment by means of an intelligent agent (Ali et al., 1999).

Singla designed an expert system to detect the utmost significant lung diseases amongst the patients. The decision is made by means of the sign and symptoms that can be fingered by the patient. This medical expert system helps the specialist or doctor in building the appropriate diagnosis of the patient. The lung diseases have various consistent symptoms and some of them are actually identical. This produces much difficulty for the doctor to reach a right decision. This expert system may take away this difficulty and it is taking the acquaintance of 32 lung diseases. Its accuracy is 70% (Jimmy, 2013).

Samy and others designed an expert system that urges the patient with conditions for appropriate analysis of some of the eye diseases. The eye has constantly been regarded as a shaft to the inner mechanisms of the body. The disease states often generate indications from the eye. CLIPS language is used as a tool for sketching the expert system. An initial assessment of the expert system was approved out and a positive response was accredited from the users (Samy et al., 2008).

Ahmad and Al-Hajji introduced a Rule-Based Expert System for Neurological Disorders. This system diagnoses and treats more than ten forms of neurological diseases. It supports the patients to obtain the essential commendation about the uncommon disorders attack to them due to their nervous system disorders. The expert rules were constructed based on the symptoms of each kind of neurological disease, and they were presented using decision tree and inferred using backwards chaining procedure. The knowledge base comprises data, collected from volumes and physicians about neurology and its disorders (Ahmad and Al-Hajji, 2012).

Dasylva and others designed an expert system that urges the patient with conditions for appropriate analysis of some of the eye diseases. The eye has constantly been regarded as a shaft to the inner mechanisms of the body. The disease states often generate indications from the eye. C-Language Integrated Production System is used as a tool for sketching the expert system. An initial assessment of the expert system was approved out and a positive response was accredited from the users (Dasylva et al, 2013).

Falaki and others presented a web-based diagnosis and treatment system that employs the use of machine learning method. Based on the research, a machine learning method rough

conventional was employed to use on characterized groups of malaria disease symptoms gathered to produce understandable rules for each identical of harshness. The designed system characterized module was categorised into 5 problems issue of malaria and the organization precision on exercise dataset was labelled to be hundred percent whereas that of testing data set was ninety four percent. However, the research sued to have designed a web-based diagnosis and treatment system that can be retrieved anytime and everywhere, it must not outflow the minds of people that weren't all the proposed clients of the system might have practiced it due to the circumstance that the common of the clients can be uneducated of the use of the internet and likewise the price stipulated for retrieving the designed system since it remained a web-based system.

They also introduced an automatic Delivery System for Clinical Guidelines that assist physicians in diagnosing and treating patients having chest pain in the emergency section. Policies are adaptively carefully chosen from a knowledge base server that has a collection of clinically clear, graphical guiding principle. The system obtains patient information, like sickness and valuation results, and relates this information to suitability standards. It endorses utmost favourable treatment strategies and investigates based on the greatest practicable diagnosis. Clinicians may also use the commendations as a recommendation or prompt a choice to check the patient's situation during the treatment by means of an intelligent agent (Falaki et al., 2012).

Analysis of the above previous researches displayed that many team dissertations on the design of malaria diagnosis expert system have hired its implementation on impartial systems or the internet. These research that are within this category might not be retrieved without restrictions by malaria affected persons that are in underdeveloped and developing area of endemic nations due to the charge of accessing the internet, purchasing smartphones and also the necessity for technical know-how. Thus, thought of an application being standalone or web-based and that it is available anytime everywhere is only applicable to some and not all.

CHAPTER 3

EXPERT SYSTEM AND VP-EXPERT SHELL

3.1 Overview

An expert is a somebody who through his training and knowledge is able to do things in a better way, while the rest cannot. Expert System is a Computer Program designed to act as an expert to provide a solution to a problem in a specific domain**.**

The individuals involved in an expert system development are the domain expert, knowledge Engineer and User. The domain expert presents the knowledge about a specific domain, through his knowledge and training. The knowledge Engineer represents them in an appropriate manner, through a suitable tool and makes an Expert System. The last user uses the system and solves his/her problem. The main task completely depends on the knowledge engineer, who has to abstract the knowledge from the expert and present them to the user in a simple understandable manner. In this chapter, the various components of expert systems and VP-Expert System Shell are briefly explained.

3.2 Expert System

Expert systems are artificial intelligence applications which exemplify approximate non-algorithmic expertise for answering confident forms of problems. For instance, expert systems are employed in diagnostic applications inspecting both people and machinery. They also play chess, make monetary preparation decisions, topologize computers, monitor real-time systems, guarantee insurance policies, and accomplish countless other services which earlier need human expertise (Dennis, 1989).

In the universe of Artificial intelligence, an “Expert system” is a computer system with the capacity to copycat or replicate the tasks of human’s intelligence by making decisions just the way a skilled human expert does. Expert systems are developed to solves difficult problems by cognitive thinking about knowledge, expressed mainly as if-then rules quite than through predictable procedural code.

AI programs that attain competency at expert level in providing solutions to a problem in some task areas by conveying to endure a frame of information about exact tasks are termed expert systems or knowledge-based. Frequently, the word Expert systems are earmarked for a program whose knowledge base has the knowledge which is utilized by human experts, in comparison to the knowledge acquired by non-expert and textbooks. The synonymous used the 2 entities, “Expert systems” (often called ES) and knowledge-based systems (often called KBS), are utilized frequently. Considering the two terms, expert systems and knowledge-based systems represent the greatest common types of AI application. In an expert system, the area which human intellectual endeavor to apprehend is identified as the task domain. Task means some goal-oriented, problem-solving activity and Domain means the exact area in which the task is being accomplished (Mishkoff, 1985).

3.3 The Architecture of an Expert System

An expert system is termed as a system, not a program because the building of an expert system is a mixture of many elements that drive into the decision making viz. goals, facts, rules, inference engine, etc (Dennis, 1989). The basic Architecture of Knowledge Based Expert System (KBES) is shown in Figure 3.1.

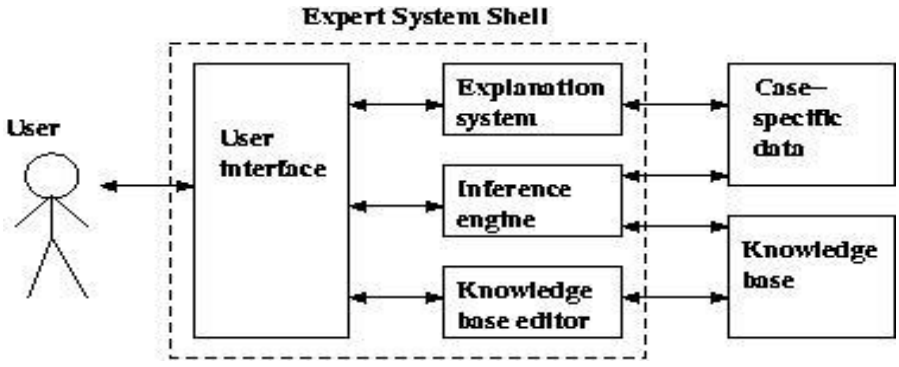

Figure 3.1: Expert System Architecture

3.3.1 Knowledge base

The heart of the expert system is the knowledge base. Engineering problem solving uses heuristic knowledge as well as recognized scientific ideologies and computational

algorithms. A heuristic knowledge is a “rule-of-thumb” that aids one to limit how to proceed. The domain knowledge of an expert system is organised in the knowledge base and this module is so critical that the successful practice of the system relies on the excellence and dependability of the knowledge confined in it (Sayedah and Tawfik, 2013).

A knowledge base comprises both stationary or declarative knowledge (facts about objects, events and situation) and dynamic or procedural knowledge that deals with the info about the sequence of action. There are various methods of representation and organisation of knowledge and knowledge base. The knowledge is denoted in the method of production rules, (if-then rules), which are very influential and frequently used method for representing knowledge.

3.3.2 Inference engine

Assembling of the Expert knowledge in the knowledge base is not enough and there must be an extra component that guides the execution of the knowledge. This component of the expert system is recognized as the control structure, the rule translator or the inference engine. The inference engine chooses the kind of search to be used to solve the problem. In fact, the inference engine runs the expert system, defining which rule is to be useful, executing the rules and defining when a suitable solution is attained. The kind of inference mechanism relies on equally the nature of the problem domain and the technique in which knowledge is represented in the knowledge base.

3.3.2.1 Forward chaining

In an expert system someone may starts with a preliminary state and tries to reach the goal state for the specific problem. The method of shifting over different solutions to proceed from the preliminary state to goal state is termed search and the realm of all probable paths of search is the search space. There are 2 search methods broadly used in rule based systems are “forward chaining and backward chaining”.

In “forward chaining” the search proceeds in the forward direction. The forward chaining is a data driven search. The forward chaining is advantageous when goal conditions are

minor in number when related to the initial state. Antecedent part is checked first and then goes to consequent part.

3.3.2.2 Backward chaining

A system supposed to perform backward chaining if it attempts to back a goal state or suggestion by examining known information's in the framework. It searches in the state space working from goal state to the preliminary state by the application of inverse operators. When there are rare goal states and many preliminary states, it may be better to start with the goal to work back towards the controller state. Backward chaining is a Goal driven or ambitious search.

3.3.2.3 Hybrid chaining

Hybrid chaining always starts with forwarding chaining and anywhere a fact is required from the operator, go into contrary to the leaf node of the knowledge and have it to proceed with forwarding chaining mechanism.

3.3.3 Working memory

The working memory aims at the gathering of symbols or reliable information that mirrors the present condition of the problem which comprises of the data gathered during problem implementation.

3.3.4 Knowledge acquisition

Knowledge acquisition is a method of extracting, constructing and organising knowledge from a sole source, typically human specialists or expert, so it might be used in software such as an expert system. Accomplishments of any expert system mainly rely upon the superiority, comprehensiveness, and accurateness of the data stored in the knowledge base. This permits one to obtain more knowledge about the problem realm from the expert (Patel, 2013).

3.3.5 User interface

User interface is a vital component and it creates communiqué amid the expert system and the user or operator.

3.3.6 Explanation facility

The Expert System has the capability to describe to the user how a conclusion has arrived and this is one of the key benefits of the expert system.

3.4 Development of Expert Systems

Generally, there are essential phases involved in designing any expert systems. These phases have been explained below and illustrated in figure 3.2 thereafter (Nilsson, 1998).

- Detect the problem: Similar to several compiler programs the expert systems are in a wisdom an answer viewing for a crucial problem. To validate the design of an expert system there must be an actual problem in demand to solve. For this specific purpose, the initial stage in the design of an expert system must be to study the condition and then obviously choose what the problem is and how much the system might be supportive.
- Study the alternatives: Though the problems may be suitable to the criteria for an expert system we would be cautious with simpler or similarly suitable alternate solutions. For instance, positive kind of employee's performance might be linked to training. Nevertheless, the solution could be to make available the employees with the information they want in a printed manual. A solution couldn’t be the best but then it should be at least the humblest and least exclusive.
- Feasibility: The subsequent phase is to regulate whether the design system is practicable or not. The system would be practicable from all aspect that is procedural, economically and so on.
- Selection of design tools: An expert system design tool is a software set that permits us to key in the expert's knowledge inside the computer without having to program. Most of the expert system design tools are rule based. Still, some tools

allow the execution of the frames and semantic network but they are slightly expensive.

- Execute the knowledge acquisition: At this stage in the design procedure, we are finally prepared to execute some actual creative work. The design of an expert system essentially starts with the knowledge acquisition that is obtaining the knowledge which comes from diverse areas like an ordinary textbook, journals or other references.
- Design and complete the ES: As we have chosen the proper tools that are needed using the knowledge we may now start to develop the expert system. First, we desire to generate a plan for a hierarchical flowchart, matrix decision tree or other plans that will assist us in establishing and understanding the knowledge. By means of these assistances, we will be able to translate the knowledge into the "if-then" rule. Once the elementary design is achieved we can start to create a sample of one of the sections of the system. Once we are contented that the system is going to perform correctly we can start to increase the sample into the final system.
- Testing and correcting: After the expert system has been designed we want to spend extra period for the testing purpose. There won't be any such expert system which is faultless for the initial time and a significant amount of effort will be needed to validate it. The responses of the users will display the places to make the corrections so that we may realize the best execution.
- Maintenance: The vital part of the expert system design is the constant maintenance, updating the system with innovative knowledge and eliminating the knowledge that is no longer related.

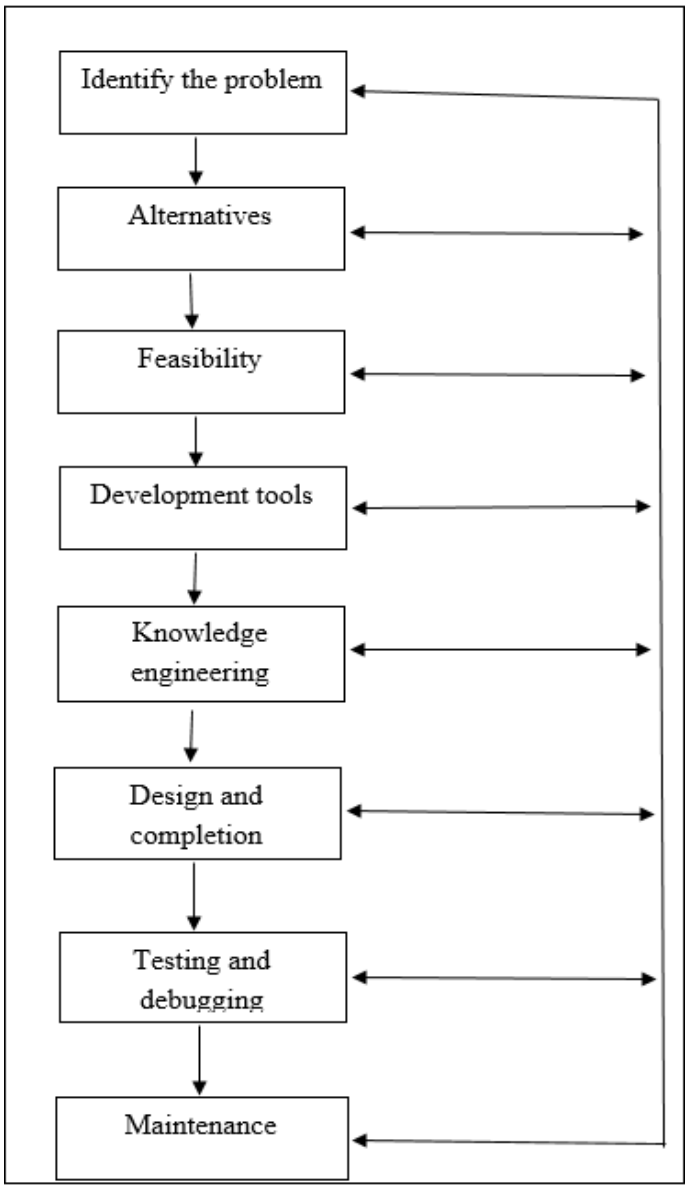

Figure 3.2: Expert System Development Cycle

3.5 Expert System Features

- Goal driven reasoning or backwards chaining: An inference method that practices if-then rules too frequently and breaks down the goal into minor sub-goals that are easier to verify.
- Handling uncertainty: The capability of the system to think with rules and facts that are not surely identified.

- Data-driven reasoning or “forward chaining”: An inference method that practices if-then rules to infer a problem solution from original facts.
- Data representation: Is the technique in which the problem precise data inside the system are kept and accessed.
- User interface: Is the menu of the code that generates an easy to practice the system.
- Explanations: Capacity of the system to describe the cognitive procedure that was employed to reach a commendation.

3.6 Some Expert System Tools

- PROLOG: A logic programming language that practices backwards chaining.
- CLIPS: A common domain software tool for constructing expert systems (C-Language Integrated Production System).
- OPS5: First AI language used for Production System (XCON used for configuring VAX computers).
- EMYCIN: Is an expert shell for knowledge representation, reasoning, and description
- MOLE: A knowledge acquisition tools for obtaining and sustaining domain knowledge
- ESPLAN: Is based on fuzzy explanation of antecedents and consequents in production rule.
- LIPS: Is used for answering linear programming problems (Linear program solver).
- VP-Expert: Is a Rule Based Expert System Shell

To executes the required implementation efficiently, a cautious choice of an ES shell for the precise domain purpose is very vital. VP-Expert was finally selected as the development shell for executing MALX (Malaria Diagnosis Expert system), considering the virtuous performance of the interface and command menu of the shell.

3.7 Advantages of Knowledge Based Expert System

The Key advantages of KBE's encompass the subsequent vital points.

- Knowledge is supplementary obvious, available and expandable. The human cognizance absorbs new info without troubling the knowledge already kept in the mind or disturbing the mode in which it processes the info. In the similar way the knowledge in KBES can be prolonged without disturbing and affecting the current knowledge.
- The knowledge base can be slowly and incrementally established over a lengthy period of time. The modularity of the system permits unceasing development and modification of the knowledge base.
- A Knowledge Based Expert System might describe the characteristic via an explanation facility.
- A Knowledge Based Expert System is not partial and does not make quick or illogical decisions. It uses a methodical style for discovering the solution to the problem.

3.8 Application of Expert System

Some of the applications of the expert system are Knowledge Domain which is used in Finding out faults in vehicles and computers. It also applied in Finance and Commerce for Discovery of possible fraud, doubtful transactions, stock market trading, Airline scheduling and cargo schedules. Another application is a Design Domain where the Camera lens is designed and automobile design. It also used in Monitoring Systems for Equating data continuously with the experimental system or with prescribed behaviour such as outflow monitoring in long petroleum pipeline. Another potential application is Medical Domain for Diagnosis Systems to reduce the cause of disease from experimental data and conduction medical operations on humans.

3.9 Why Used Expert System

An expert system has turn out to be vital in our day to day happenings that contribute vastly, Human experts are not at all times accessible. An expert system can be practiced anywhere, anytime. However, Human experts are not 100% dependable or reliable, human experts may not be worthy of explaining choices and it Cost effective.

3.10 Limitations of Expert System

The subsequent are the limitations or boundaries of Knowledge Based Expert System

1. They do not study
2. They lack common intellectual and sensitivity
3. They can't apprehend infrequent knowledge
4. They are more appropriate for problems concerning inference.

3.11 VP-Expert

VP-Expert is a Rule-Based Expert System Shell. VP-Expert offers the inference engine, the user interface, and everything required to make a working expert system. A shell is an expert system comprising empty knowledge base. If someone designs a knowledge base for a specific domain then it becomes an expert system in that specific domain. By means of a shell, someone can design an Expert System in several domains. VP-Expert assists only Rule-Base Knowledge illustration or representation, which is easy English similar to rule building (Sayedah and Tawfik, 2013).

VP-Expert works based on the backward reasoning for inference. The tool has an inference engine for navigating the knowledge base to response questions, an editor for writing rules of the knowledge base, and a client's interfaces for supervising the questions, inquiring queries from the clients, and giving recommendations and clarifications, where desired. It also comprises restricted graphical proficiencies. Be informed this is a student type of VP-

Expert, this acknowledges that some options or selections won't be accessible and that the magnitude of your knowledge bases will be restricted.

3.12 Reason for Selecting VP-Expert

There are several numbers of expert system tools accessible in the market, but VP- Expert provides a strong combination. It has an input command that robotically produces a knowledge by the table confined in a text, database or worksheet, an inference engine which practices Backward Chaining and Ideal design windows that makes it probable to detect what is going on behind the screen as the inference engine navigates the knowledge base. VP expert posse's a Confidence factor that allows one to justify for uncertain info in knowledge base, an easier English like rule creation, a Commands that permits the VP-Expert to clarify its actions throughout the consultation and it also has a Knowledge Base Chaining which permits one to construct knowledge bases and chain, else it would be too big to fit in memory. Finally, it creates question Robotically and has the capacity to perform Peripheral DOS programs.

3.13 Knowledge Base in VP-Expert

Construction of Expert System with VP Expert is essentially an enquiry of inducing a knowledge base that comprises 3 stages:

1. ACTIONS
2. RULES
3. QUERY STATEMENTS

At the middle of the procedure are variables, that replace of intentions in VP-Expert. The key objectives of the inference engine are regularly the discovery of a value for some goal variables, employing backwards chaining to search for rules that can input a value to that variable as a portion of its consequent.

3.13.1 ACTIONS block

The ACTIONS block includes of declarations that regulate the activities of the shell. These declarations are performed inside the command in where they appear. In conclusion, the actions block is the code that regulates the implementation of the inference engine.

The key DISPLAY explanation guides the client on what to do. The FIND statement speaks the framework's aims. The final declaration presented the results. Info to each of these declaration kinds is discussed below.

3.13.2 FIND statement

The elementary type of this statement is FIND variable. This statement initiates the inference engine, making it access the knowledge base of rules till a value is achieved for the variable. This trail the backwards chaining explained in sequence:

- It looks for the initial rule that might insert the variable a value (as part of the THEN section of the rule) and tries to locate values for variables in the IF section of the rule.
- It pauses where any value is located for the variable (except it is a plural variable).
- If there weren't rules located which comprise the variable in its THEN section, the shell in its place query the client for its value.
- If there were rules that comprise the variable in its THEN section, but no single of them can be verified, then the variable is assumed to possess an unknown value.

Though, it's likely to have multiple FIND statement in the ACTIONS block yet it's infrequent we really do that. It is mostly more effective to have a sole FIND to initiate the consulting procedure and to make use of the rules to initiate certain that additional values are solitary located when wanted.

3.13.3 DISPLAY statement

The chosen text might be presented on the screen by means of a DISPLAY statement then enfolding the text in dual quotation marks. By means of confirming that the client has time

to recite a message before it goes up or goes from the screen, key in dual quotation marks as the end character in the message. This will hang all processing till the client presses some button on the control panel. The dual quotation marks itself wasn't shown. The value of any variable might be comprised in a shown message merely by unfolding the variable term in twisted brackets. Still, you can similarly place DISPLAY statements in the THEN or ELSE section of a rule. This might be specifically convenient for making clarifications available or aimed at showing info solitary if a positive situation holds (VP-Expert Primer, 2017).

3.14 Query Statements

Variables that don't seem as the consequent of some rule in the knowledge base are referred possible queries for the client. Uncertainty, the inference engine tries to locate such a variable, the client will be driven by its value. This would be complete with ASK and CHOICES statements.

3.14.1 The ASK statement

The method of the prompt for a variable is explained by an ASK statement. As with any further program, these prompts must be useful. It contains the subsequent procedure:

ASK variable: "prompt";

For instance:

ASK BP: "Please take the patient's BP, and enter it into the system?"

3.14.2 The CHOICES statement

If there exist a limited quantity of probable replies towards a query they might be presented in a menu well-defined by a CHOICES statement. It contains the subsequent method:

CHOICES variable: list of values;

For instance:

CHOICES BP: Normal, High, Very_High;

This menu is published out once the query is enquired. Be informed that if there wasn't any CHOICES statement for a variable, the client must key in the value on the cursor later the prompt.

3.15 Production Rules in VP-Expert

The production rules of an expert system comprise its domain knowledge, stated as IF-THEN form rules. Dissimilar to the statements in the ACTIONS part, they aren't executed in the directive enumerated; as an alternative, they are accessed as desired through the course of backwards chaining. The directive of rules is vital only when there are multiple rules that might be utilised to give a variable a value, as the inference engine try to verify the rules in the directive specification.

3.15.1 Basic form of rules

The elementary procedure of a rule is as follows in the subsequent order:

- RULE rule name
- IF antecedent
- THEN consequent;

Every single rule required an exceptional tag up to forty letters in extent next the word RULE. Similar to any supplementary tag you apply in programming, it must be expressive of what the rule means. Let's look at very modest sample rule:

RULE Diagnosis_of_malaria

IF Diagnosis = malaria

THEN Treatment = Chloroquine;

In this condition, Diagnosis and Treatment are variables, and malaria and Chloroquine are possible values for those variables. Additionally, this rule conditions that if Diagnosis takes the value malaria, we might then input Treatment the value Chloroquine. If the inference

engine is now attempting to apply this rule to locate a value for the variable Treatment, it would:

- Crisscross to see if Diagnosis was previously being inputted a value.
- If there wasn't any, it would apply the rules to attempt to FIND a value for Diagnosis, inveterate to this rule after it has finished, therefore.
- If the value of Diagnosis is malaria, then Treatment is inputted the value Chloroquine. By that stage, the inference engine doesn't work anymore and locating a value for Treatment.
- If Diagnosis acquired some additional value, then the rule fails, and the inference engine required to search for the nearly extra rule to insert Treatment a value.

3.16 VP-Expert's Consultation Screen

The method of applying VP-Expert to answer a particular problem, based on the rules in its knowledge base, is termed a "consultation". In general, the client doesn't input questions straight to the system this happened through the actions part of the knowledge base but does pass in responses to queries related to the question. To initiate a consultation, select Consult over the main menu, and then select Go.

In VP-Expert consultation screen there are 3 windows; Communication window, Rule Window and Values Window. The communication window is where data or Information is inputted by the user, and results are revealed here. The Rules Window permits one to see the action of the VP-Expert's inference engine, as it interrelates with the knowledge base throughout the consultation. The values window records the middle and last resultant values throughout the path of the consultation. The values are shown as variable = value CNF.

3.17 Certainty Factors

Clients might also offer confidences in the information they enter in answer to queries. This might be complete with the subsequent stages; Move to key in the value, Press HOME, key in a value between 0 and 100 then Press ENTER and END.

You can apply the DISPLAY statement to display equally the values allocated to a variable and the confidence in that task. This is accomplished through by introduction a # before the variable in the DISPLAY:

DISPLAY "I recommend {#treatment} for your symptoms."

For instance, if VP-Expert needed to input Panadol to treatment with a confidence of 90, this may print: I recommend Panadol CNF 90 for your symptoms. Since it wasn't probable to show the confidence in an extra useful method, your system would possibly create obvious to the clients precisely what the CNF 90 is all about (Jose, 2011).

The acronym CNF 100, which appears at the side of each variables task in the values windows, denotes the confidence factor. This is a number that shows the degree of certainty that a decision is valid. A confidence factor of 0 shows no confidence while a factor of 100 shows total confidence. Confidence factor can be inputted by the end user when responding queries throughout the consultation. Confidence is a personal method to give variable levels of certainty to declarations. If there is no confidence factor been stated explicitly, then 100 is assumed.

3.18 Logical Operators

The IF section of a rule might be construct of up to twenty easy premises linked by the logical operators OR or AND. For instance:

RULE Malaria

IF temperature = very_high

AND convulsion= yes

AND injected<> yes

THEN Diagnosis = Malaria;

If VP-Expert is trying to apply this rule to locate a value for Diagnosis, it initially resolves to crisscross whether the temperature is very_high (locating a value for temperature if compulsory), then whether convulsion is yes accordingly.

3.19 VP-Expert Main Menu

Choices in any menu can be carefully chosen by means of the navigation keys, pressing a function key, a number, or by means of the initial character of the option term. The line under the menu likewise displays the submenu of the choice presently highlighted. Vital choices in the main menu were revealed on the subsequent table below:

Table 3.1: Important Options of a VP-Expert Main Menu

Edit	For creating and modifying a knowledge base
Consult	For Executing the expert system on the present knowledge base
File name	Choose extra knowledge base for erasure or consulting
Path	Change the current drive
Quit	Quit VP-Expert

The Escape button might at all times be applied to backspace, in precise, to escape a choice that was already selected. A consultation can be terminated by tabbing Ctrl-C.

If there weren't file been preselected by means of the Filename option equally the edit and Consult will swift for the file name. The client can then key in a file name or choose a folder from the presented menu. For Edit, the folder name might be new, if a new folder is to be formed VP-Expert will prompt you to input the new folder name (VP-Expert Primer, 2017).

3.20 VP-Expert Editor

VP-Expert comprises a precise, but enough text editor that can be cited from the Main and Consult Menu. It is likewise cited robotically where ever a grammar blunder is noticed in the knowledge base. If cited from the Main Menu, the client will be prompted to the folder

name to be corrected. The client can also input a name or choose from the presented menu. A new folder might be itemized by keying a new folder name.

Since the editor is relatively non-intuitive to use, hence it's frequently for you to select whatsoever editor you desire by confirming that the file you produce ends in the extension K.bs.

3.21 Editor Command Menu

Once in edit style, the base of the screen shows items of editor commands (Sample is given on figure 3.3) that might be cited by applying the function keys. However, the selections in the items alter wherever the Alt or Ctrl buttons are scrolls down. This displays the commands that can be cited by merging one amongst these buttons with the proper function key.

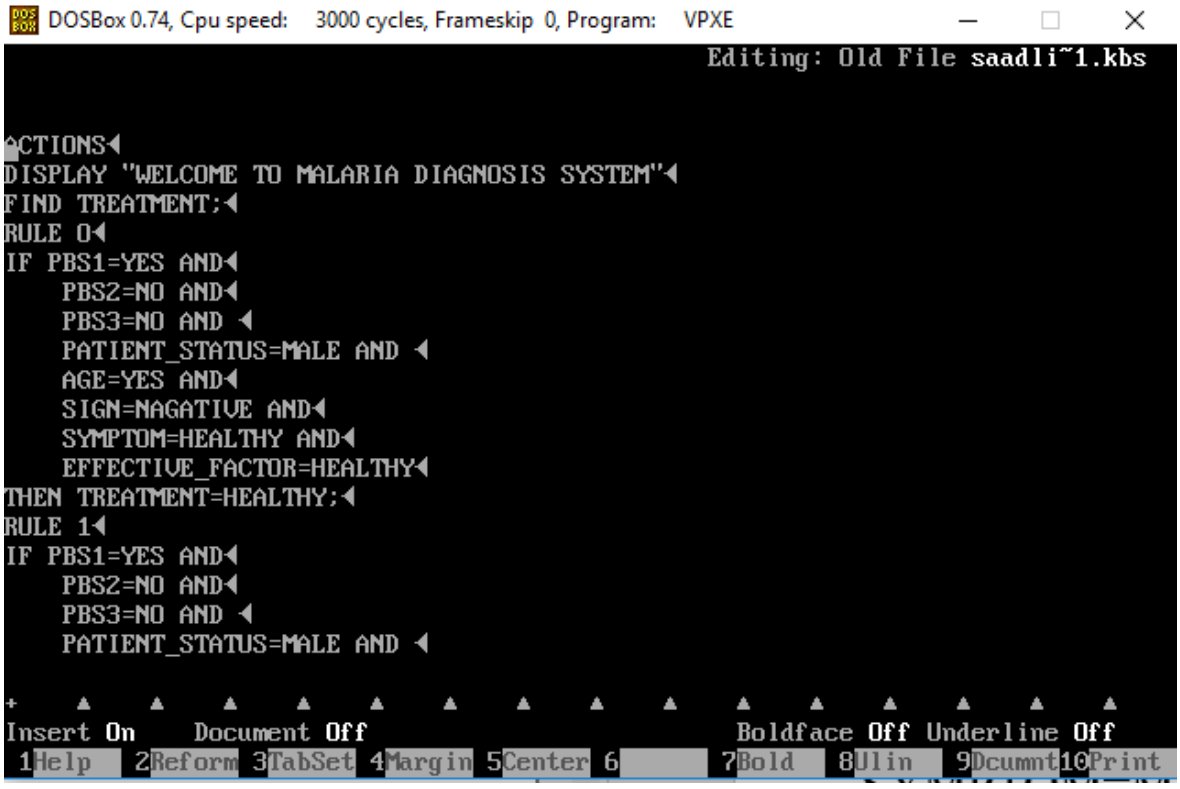

Figure 3.3: Sample of Editor Command Menu in editing mode

3.22 Editor Commands

The subsequent table itemized (Table 3.2) the popular generally used editor commands

Table 3.2: Editor Commands for VP-Expert System

F1	Invokes the help facility
F10	Print the file
ALT-F5	Save the current file without exiting
ALT-F6	Save the current file and exit the editor
ALT-F8	Quit the editor without saving
Control-Enter	Input a new line
Delete	Delete the letter at the pointer location
Backspace	Delete the letter to the left of the pointer location
Control-T	Delete from pointer to end of word
Control-Y	Erase this line
Page Up	Up one screen
Page Down	Down one screen
Home	Shift to beginning of line
End	Shift to end of line

CHAPTER 4

DEVELOPMENT OF MALARIA DIAGNOSIS EXPERT SYSTEM

4.1 Brief History of Malaria

Malaria pest was discovered by “Charles Louis Alphonse Laveran” in 1880, a French army surgeon based in Constantine, Algeria and he is the first to observe the pests in the blood of a patient having malaria, this event happened on the 6th of November 1880. Nobel Prize was awarded to Laveran in the year 1907 for his kind discovery (WHO, 2016).

Malaria surfaces when a feminine Anopheles mosquito bites human, which then poisons the body with the organism or parasite Plasmodium. This is the only class of mosquito that has the possibility of causing malaria. There are 4 common species of these parasites Plasmodium falciparum which causes the complicated type of malaria, and Plasmodium Vivax, Ovale and Malariae which cause less severe symptoms.

Malaria symptoms or signs can be characterized into two simple (uncomplicated) and severe (complicated) malaria. The symptoms of malaria typically grow in Ten to 28 days resulting in the infection. In many people, symptoms may not grow for several months. Some of the malaria pests can pass into the body but will be inactive for long periods (WHO, 2010).

4.2 Simple Malaria

Simple or uncomplicated malaria is the kind of malaria which is diagnosed only when there are present of signs and symptoms. There are a fever and a positive blood smear to the ratio of 1-10% per high power fields. There wasn’t any sign of altered consciousness, hypoglycaemia, severe anaemia, jaundice or respiratory complications.

4.3 Severe Malaria

Severe or complicated malaria by definition is the demo of asexual forms of the malaria pests in the blood in a patient with a possibly mortal indication or difficulty of malaria in whom further diagnoses have been excepted. There are a fatal fever and a positive blood smear to the ratio of 11-100% per high power fields.

The core problems of severe malaria comprise “cerebral malaria, acute renal failure”, severe anemia or bleeding. “Acidosis and hypoglycemia” are the two most popular metabolic difficulties. Any of this kind of difficulties might grow quickly and growth to death in an hours or days.

4.4 Malaria Diagnosis

Physical examination will be conducted by a satisfied doctor and a through laboratory test which will testify whether the patients are healthy or not. If the patients have symptoms of malaria, the doctor may order them for blood tests to ascertain their diagnosis. If the “peripheral blood smear” test is to the ratio of 1-10% per high power fields then the patients have Simple malaria and if is to the ratio of 11-100% per high power fields then it is Severe malaria. Patients having >100% per high power fields “peripheral blood smear” test are likely to be admitted. Patients with absent symptoms, signs and <1% PBS result are considered to be Healthy. Patients who are at higher risk for developing complications of “Plasmodium falciparum malaria” are extremes of age, pregnancy, and Patients who seem sick and prostrated. The designed MALX has over 360 rules and these rules are obliged for the diagnosis to be made. The working principle of this expert system is totally depended on it rules which match the corresponding result for the final patients diagnosed.

4.5 Methodology

The developed system employs the collection of data from an expert precisely a doctor via direct interview and other relevant sources to produce the rules using expert system methodology for the actualization of VP-Expert system for diagnosing malaria patients. The designed system development procedure is divided into two categories; Knowledge Acquisitions and Knowledge Representation. Knowledge Acquisitions it includes the

acquisition of data from an expert, papers, books and other relevant sources. Knowledge Representation explains how the knowledge is being Represented and it includes coding in terms of IF-THEN statement. Running the system on VP expert software and finally loading the program for consultations.

4.5.1 Knowledge acquisitions

The knowledge acquisition steps in the development of this system were done through direct interviewing with the medical specialists in the field of malaria, medical textbooks, master's thesis, papers and studying the related scientific materials. Also initiating elementary enquiries, adopting essential modifications in each stage and then the developed expert system is designed based on preceding phases.

4.5.2 Knowledge representations

The developed system was a rule-based expert system, for the knowledge representation the IF…THEN rules have been used, where IF demonstrate the condition and THEN provides the solutions. For converting experts' knowledge to these rules, 3 common phases must be handled which are "Block Diagram, Mockler Charts, and Decision Tables". For diagnosing malaria, the knowledge was presented in a Block diagram as shown in Figure 4.1.

The diagnosis has five phases: 1) Healthy, 2) Simple Malaria, 3) Severe Malaria, 4) At-Risk and 5) Admission. The diagnosing section consists of 6 attributes, which the diverse mixtures of these attributes would lead to several diagnoses.

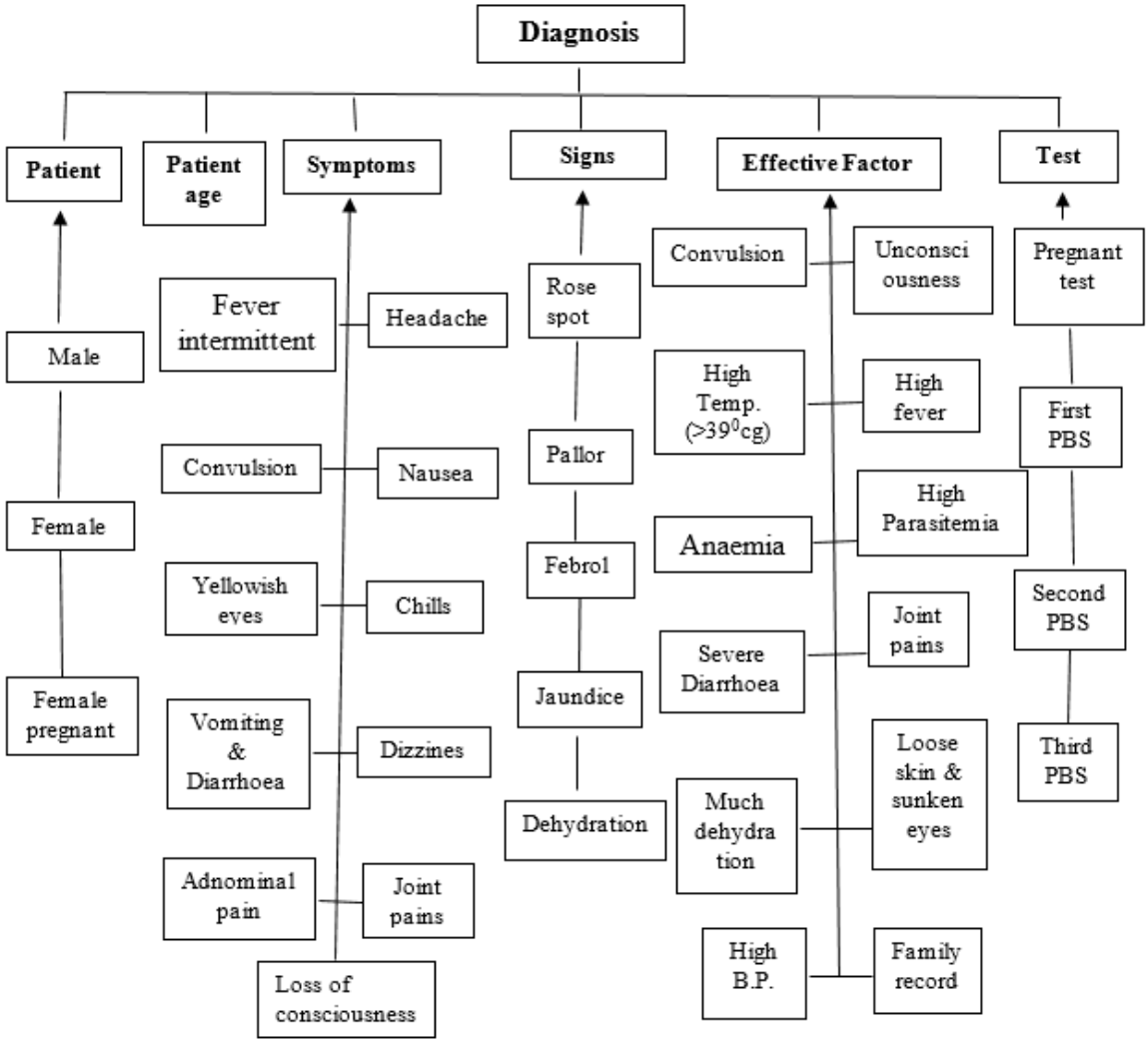

Figure 4.1: The Block Diagram of Diagnosis

The next step is developing the relevant Mockler Chart in accordance with the previous block diagram, where the queries that the client is oblige to response and the selections that he has to choose would be deliberated. This developed system required 4 Mockler Chart comprises of Diagnosis, Signs and Symptoms, Effective factors and Assessments as shown below:

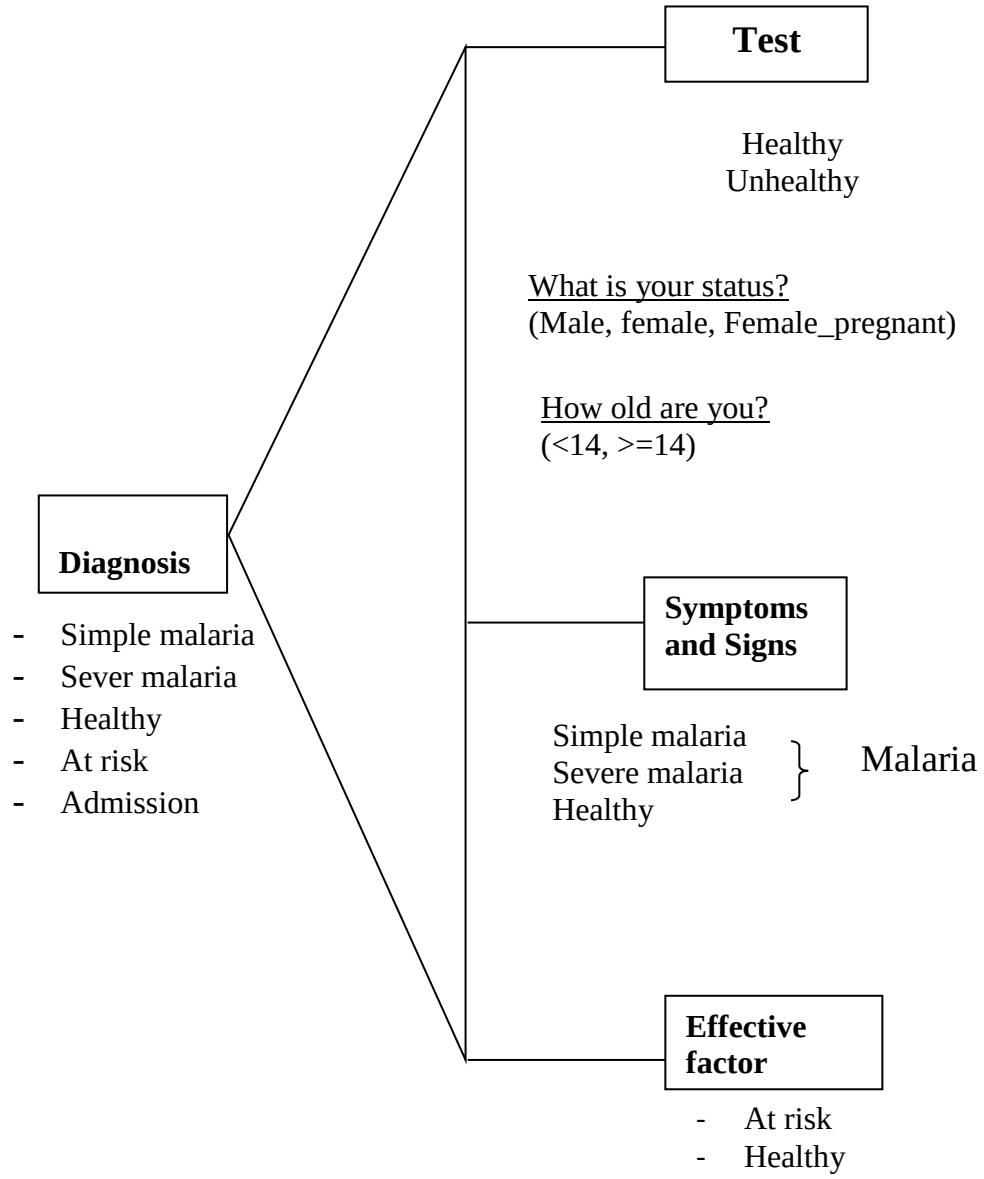

Figure 4.2: The Mockler Chart of Diagnosis Expert System

The above "Mockler Chart" of Diagnosis was designed to display the interrelation of tests, patient's status, patients age, sign, and symptoms and effective factor. The "Mockler Chart" of sign and symptoms, the queries and choices are the determinant factor determining the sign and symptoms of the patient's which will confirm whether the patients are Healthy or Malaria victims. Also, the Mockler Chart of the Effective factor, the queries, and choices analyze whether the patients are Healthy or At-risk. The final

Mockler Chart is the Diagnosis tests of the malaria patients which regulate the status of the patients. After designing the Mockler Chart, it will be ideal to introduce the interrelated decision tables relevant to the Mockler Chart.

Table 4.1: The Decision Table of Signs and Symptoms

Symptoms / Signs Table	**Healthy**	**Malaria**
Dehydration	No	Yes
Anaemia	No	Yes
Fever (intermittent)	No	Yes
Vomiting and diarrhoea	No	Yes
Chills and Rigors	No	Yes
Yellowish discoloration of eyes	No	Yes
Loss of consciousness	No	Yes
Headache	No	Yes
Rose spot	No	Yes
Pallor and jaundice	No	Yes
Abdominal pains	No	Yes
Convulsion	No	Yes
Chest pain & running nose	No	Yes
Dizziness	No	Yes
Urine frequency	No	Yes

The “Signs and Symptoms” decision table above is constructed in line with the different “Signs and Symptoms” which the condition of the patient would be finalized. In every row of the table there exist a rule of signs and symptoms.

Table 4.2: The Decision Table of Effective Factors

Effective Factor / Diagnosis	**Healthy**	**At Risk**
High temp. $>39^0$ centigrade	No	Yes
High Parasitemia	No	Yes
Blood pressure	<140/90 mm Hg	>=140/90 mm Hg
Rate of red cells containing parasite between 10% & 100%	No	Yes
Pregnancy +PBS1	No	Yes
High fever	No	Yes
Passage of dark urine	No	Yes
Sever malaria	No	Yes
Convulsion	No	Yes
Loose skin and sunken eyes	No	Yes
Hypoglycaemia	No	Yes

The Decision Table of Effective Factors shows the relevant rules which analyze whether the patients are Healthy or At-risk. The decision Table of Tests include the compulsory tests report comprises pregnancy, first "Peripheral Blood Smear" (PBS1), Second "Peripheral Blood Smear" (PBS2), Third "Peripheral Blood Smear" (PBS3) and lastly the decision about the patient's condition has been demonstrated in the table below:

Table 4.3: The Decision Table of Tests

Pregnancy	**Pbs1**	**Pbs2**	**Pbs3**	**Test**
Female	=<10%	>10% or <100%	-	Unhealthy
Female pregnant	=<10%	>10% or <100%	>=100%	Unhealthy
Female pregnant	=<10%	>10% or <100%	>100%	Unhealthy
Female	<10%	<10% or <100%	<100%	Healthy
Female pregnant	=10%	>10%, <100%	>100%	Admission
Female pregnant	<10%	<10%, or 100%	<100%	Healthy
Female pregnant	=<10%	<100%	=100%	Admission
None	=<10%	>10% or <100%	-	Unhealthy
None	<10%	>10% or <100%	<100%	Healthy
None	=<10%	<10% or <100%	<100%	Healthy
-	<10%	>10% <100%	>100%	Unhealthy
-	<10%	<10% or <100%	<100%	Healthy
-	=<10%	<10% or <100%	>=100%	Unhealthy
-	<10%	<10% or <100%	>=100%	Admission

The last table is a decision table of diagnosis that indicates several mixtures of patient's status, patients age, signs, symptoms, effective factor and tests. From the table, each row shows a rule of diagnosing decision which by analysis provides the ultimate decision of the diagnosis.

Table 4.4: The Decision Table of Diagnosis

Test	Patient Status	Age	Signs	Symptoms	E. F	Diagnosis
Healthy	Female	Yes	Negative	Healthy	Healthy	Healthy
Healthy	Female	No	Negative	Healthy	At risk	At risk
Healthy	Female	No	Positive	Malaria	At risk	Admission
Healthy	Female	No	Negative	Malaria	Healthy	Simple malaria
Unhealthy	Male	No	Negative	Malaria	Healthy	Simple malaria
Unhealthy	Male	Yes	Positive	Malaria	At risk	Admission
Unhealthy	Female	No	Positive	Malaria	Healthy	Severe malaria
Unhealthy	Female pregnant	Yes	Positive	Malaria	Healthy	Admission
Unhealthy	Female	Yes	Negative	Malaria	Healthy	At risk

4.6 Coding

Malaria diagnosing Expert system was coded via the use of a VP-Expert shell, the shell is a precise tool for designing expert systems thus only expert's systems developers are acquainted with it. VP-Expert operates based on the backward reasoning for inference. The tool has an inference engine for checking the knowledge base to reply queries, an editor for coding rules of the knowledge base, and a user interfaces for handling the queries, asking questions from the client, and offering suggestions and clarifications, where desirable. It

likewise has restricted graphical proficiencies. The production rules of this expert system include 8 attribute question which serves as the input of this system.

1. PBS1 result equal or less_than 10 percent?
2. PBS2 result higher_than 10 or less_than 100 percent?
3. PBS3 result equal or higher_than 100 percent?
4. Please enter your patient status?
5. Your age equal or higher_than 14 years?
6. What is your sign result?
7. What is your symptom result?
8. What is your Effective factor result?

The sample of this expert system rules is being demonstrated below for proper explanation.

According to Rule 6;

IF PBS1 result equal or less_than 10 percent YES AND

PBS2 result higher_than 10 or less_than 100 percent NO AND

PBS3 result equal or higher_than 100 percent NO AND

Your patient status Female AND

Your age equal or higher_than 14 years YES AND

Your sign result Negative AND

Your symptom result Malaria AND

Your Effective factor results Healthy THEN

Treatment = Simple Malaria

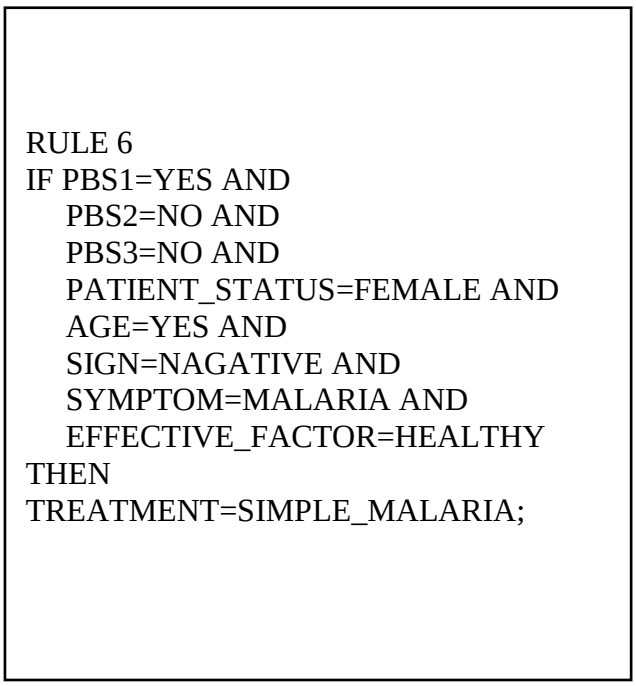

Figure 4.3: A Sample of the Malaria diagnosis expert system rule

CHAPTER 5

RESULTS, TESTING AND VALIDATION

5.1 Design Presentation

In the process of designing the system, all the rules, paths and the relationship amid the attributes has been tested with necessary modification. The VP expert software is used for the design of this system and finally, the designed system has been presented.

The developed system was evaluated by internist and Malaria Expert of "Gambo Sawaba Government General Hospital, kofan Gayan Zaria, Kaduna State of Nigeria" and all relevant notes and recommendations were used in the final development step. After the validation and endorsement of the system by the management, the final system was tested on 35 patients of various types, and the results were compared with the specialists' diagnosis and advice. The consistency of the 2 methods was approved by the related internists board.

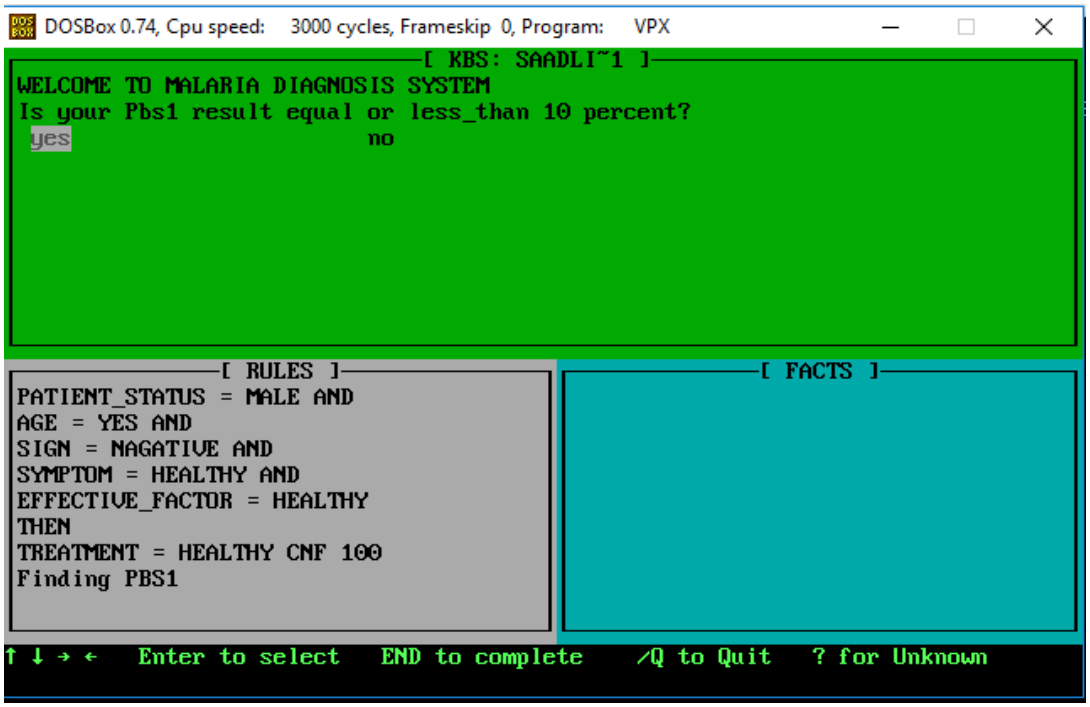

Figure 5.1: The designed system before consultation

5.2 Sample Running of the Expert System

It is essential to illustration the Use-case diagram for well understanding on how the system runs. The Use-case diagram as shown in Figure 5.2 demonstrates the interaction between the user and the expert system.

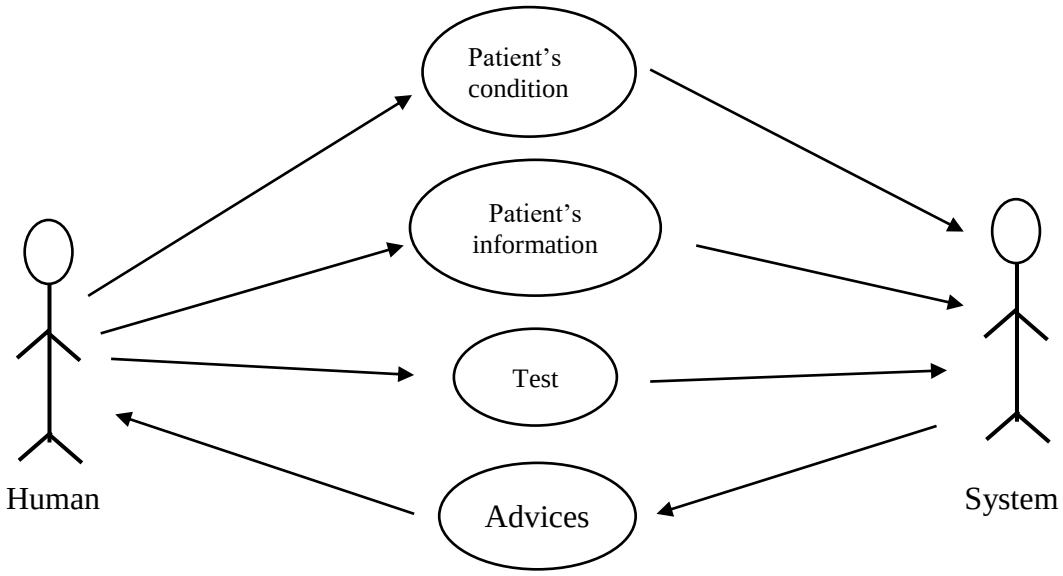

Figure 5.2: Diagnosis in Use-Case Diagram

5.3 Results and Discussion

At this point, all necessary data (as explained in chapter four) would have been inputted. The MALX user interface performs the necessary knowledge evaluation through the Rules and facts windows to determine what result would be giving out base on the questions answered.

The Figures 5.3 and 5.4 demonstrate the execution of the VP-Expert that is the User Interface. On the execution, the user interrelates with the system through the user interface. The "user interface" has 3 windows which are Questions Window, Rules Window and Facts Window. The questions window is where the questions system should be asked by the users, and their alternatives are illustrated. Rules window presents the rules by how the

users' answers. The Facts window displays the users' answers, which may determine the systems final decision. The main advantage of facts and rules windows is that the user can see vivid clarification for the system's decision-making. After the system has received the facts, the system presents the final answer or decision.

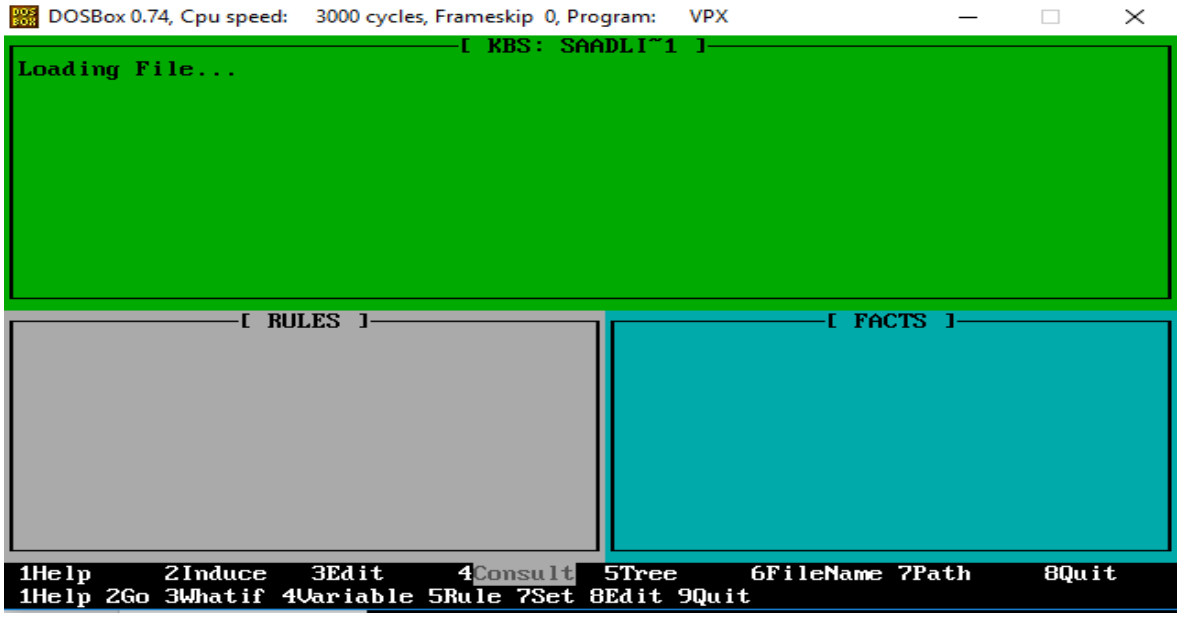

Figure 5.3: The System Consulting the KB

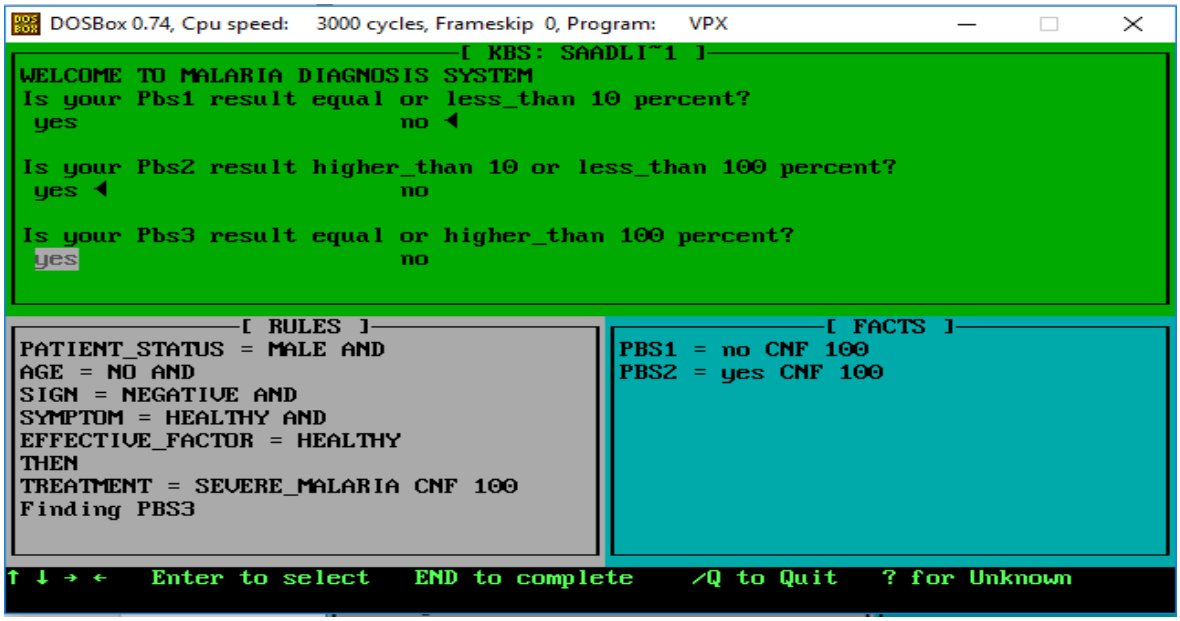

Figure 5.4: User begin answering questions after the system consult the KB

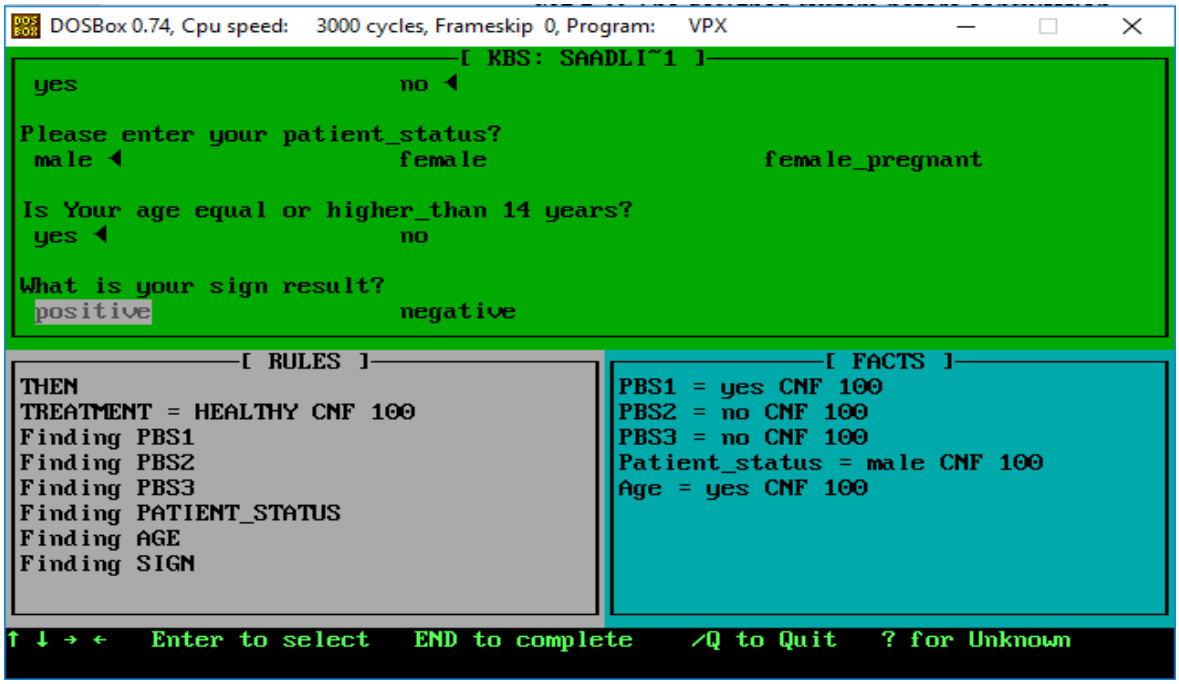

Figure 5.5: User answering questions about the blood test results

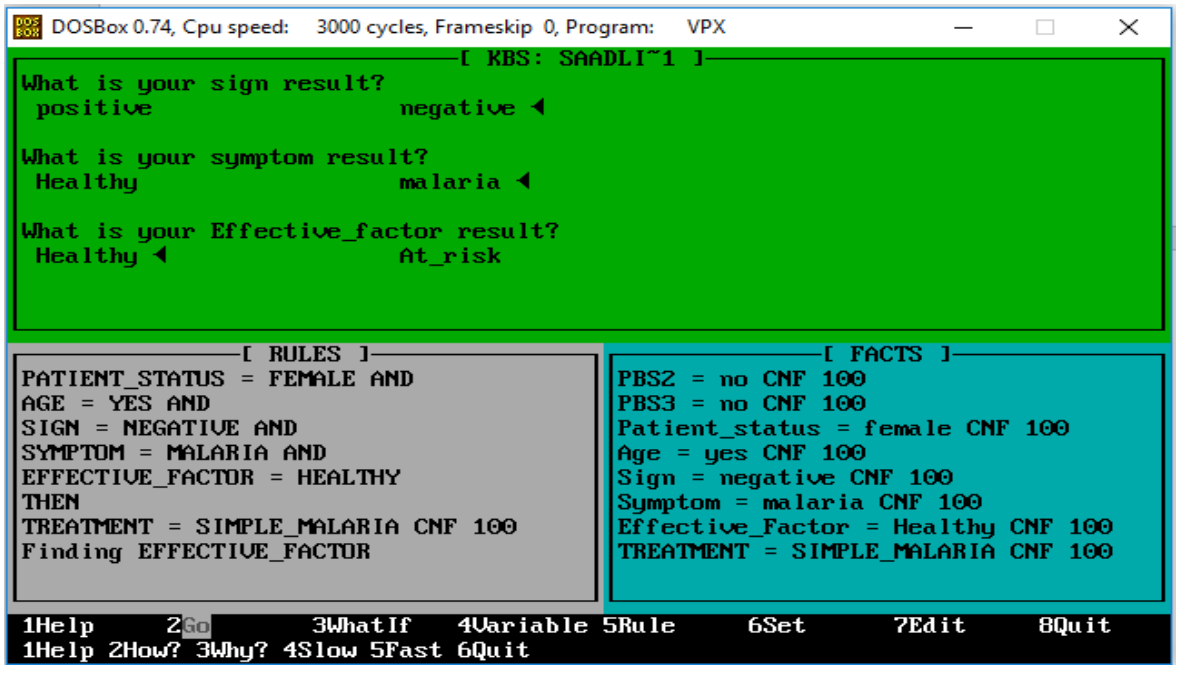

Figure 5.6: Result of a Diagnosis

The MALX system has demonstrated a good performance as validated by domain experts. The results illustrated in Figure 5.6 have shown the possible value and helpfulness of the system. It was confirmed by the experts that this system can be used by malaria experts

and it will assist in decreasing the workloads of these experts who work under pressure due to the high number of malaria patients that are in increased for every minute.

Nigeria bears the globe utmost malaria problem, with about fifty-one million cases and two hundred and seven thousand deaths testified yearly (roughly thirty percent of the whole malaria problem in Africa), whereas ninety seven percent of Nigeria's whole population (roughly 173 million out of 192 million people) is at danger of infection. Nearly 50% of these infected persons live in the hospital, usually, under the supervision of a doctor, this makes our hospitals congested. The inspiration behind this work was due to the inadequate malaria control measures in existence.

Early and accurate diagnosis of malaria systems are essential for effective and life-saving diagnosis, hence MALX is developed with the aim to be the nearest response to this call. If a doctor has the capacity of diagnosing 200 malaria patients per day manually, then MALX have the ability to diagnose 700 malaria patients per day, hence it makes the diagnosis of this deadly disease much easier, faster, and more accurate. This offers the expected accuracy of the system since the aims of an expert system is to make fast and accurate decision just the way an intelligent human or human expert does.

CHAPTER 6

CONCLUSION

6.1 Conclusion

The area expert systems are one of the largest areas of artificial intelligence which has realized the utmost marketable achievement. Currently, expert systems are applied in a huge number of different fields, starting from medical sector, military, law, politics, and economics. They are currently used in engineering and industries in the control of robot where they inter-relate with vision systems. Any field in which choices are to be constructed is a potential application of expert systems. AI programs that attain competency at expert level in creating solutions to problems in some task areas by conveying to endure a frame of knowledge about precise tasks are termed expert systems or knowledge-based.

The design of MALX has been presented and the Knowledge acquisition and representation stages are vividly described. For the ultimate decision in MALX, IF-THEN rules have been chosen. The knowledge of if-then rules data is collected from medical experts and based on the knowledge acquired 363 production rules have been created. The production rule comprises 8 input attributes and has 5 output number of diagnosis.

The Malaria Diagnosis Expert system was developed using VP expert system shell. The developed system has been tested on 35 patients with 93% accuracy at “Gambo Sawaba Government General Hospital, Kofan Gayan Zaria, Kaduna State of Nigeria”. All obtained results from the system were observed by a medical doctor’s handling Malaria cases and it satisfies the efficiency of malaria diagnosis Expert system. The result has been compared with the specialist’s diagnosis and the consistency of the 2 methods was approved by the specialist’s board.

In conclusion, Such Expert system can facilitate diagnosis of malaria patients by assisting experts in carrying out diagnoses. The doctors and nurses can make use of it as an assisting tool in the process of medicinal decision making.

6.2 Recommendations and future work

Effective medical diagnosis expert systems are possible if a proper selection of knowledge acquisition and representation methods are followed. MALX was developed to help the medical specialists with fast and accurate diagnosis and save time for both the doctors and patients as well. The authorities were pleased with MALX especially the knowledge it contains. The compactness and easiness of the system makes it a suitable device to be used as an interface for malaria diagnosis. During the testing many recommendations were made about enhancing the system, I therefore suggest that any person willing to carry out a further research on this dissertation should include:

- An additional input for drugs specification.
- An additional input for treatment advice.
- An additional input for previous PBS result.
- Creation of another knowledge base (KB) in same working memory for other common prevalent disease.

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APPENDIX

MALARIA DIAGNOSIS SYSTEM KB

```
ACTIONS
DISPLAY "WELCOME TO MALARIA DIAGNOSIS SYSTEM"
FIND TREATMENT;

RULE O
IF PBS1=YES AND
   PBS2=NO AND
   PBS3=NO AND
   PATIENT_STATUS=MALE AND
   AGE=YES AND
   SIGN=NAGATIVE AND
   SYMPTOM=HEALTHY AND
   EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 1
IF PBS1=YES AND
   PBS2=NO AND
   PBS3=NO AND
   PATIENT_STATUS=MALE AND
   AGE=YES AND
   SIGN=POSITIVE AND
   SYMPTOM=HEALTHY AND
   EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 2
IF PBS1=YES AND
   PBS2=NO AND
   PBS3=NO AND
   PATIENT_STATUS=MALE AND
   AGE=YES AND
   SIGN=NAGATIVE AND
   SYMPTOM=MALARIA AND
   EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 3
IF PBS1=YES AND
   PBS2=NO AND
   PBS3=NO AND
   PATIENT_STATUS=MALE AND
   AGE=YES AND
   SIGN=POSITIVE AND
   SYMPTOM=MALARIA AND
```

EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 4
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 5
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 6
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 7
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 8
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND

AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 9
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 10
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 11
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 12
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 13
IF PBS1=YES AND

PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 14
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 15
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 16
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 17
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK

THEN TREATMENT=ADMISSION;
RULE 18
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 19
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 20
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 21
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 22
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND

SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 23
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 24
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 25
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 26
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 27
IF PBS1=YES AND
PBS2=YES AND

PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 28
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 29
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 30
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 31
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;

RULE 32
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 33
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 34
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 35
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 36
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND

SIGN=NAGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 37
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 38
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NAGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 39
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 40
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 41
IF PBS1=YES AND
PBS2=NO AND

PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 42
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 43
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 44
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 45
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;

RULE 46
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 47
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 48
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 49
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 50
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND

SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 51
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 52
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 53
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 54
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 55
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND

PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 56
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 57
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 58
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 59
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 60

IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 61
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 62
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 63
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 64
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 65
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 66
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 67
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 68
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 69
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND

AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 70
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 71
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 72
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 73
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 74
IF PBS1=NO AND

PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 75
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 76
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 77
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 78
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK

THEN TREATMENT=SIMPLE_MALARIA;
RULE 79
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 80
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 81
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 82
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 83
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND

SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 84
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 85
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 86
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 87
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 88
IF PBS1=YES AND
PBS2=YES AND

PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 89
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 90
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 91
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 92
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;

RULE 93
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 94
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 95
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 96
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 97
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND

SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 98
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 99
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 100
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 101
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 102
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND

PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 103
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 104
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 105
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 106
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 107

IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 108
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 109
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 110
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 111
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 112
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 113
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 114
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 115
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 116
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND

AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 117
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 118
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 119
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 120
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 121
IF PBS1=NO AND

PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 122
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 123
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 124
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 125
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK

THEN TREATMENT=ADMISSION;
RULE 126
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 127
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 128
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 129
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 130
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND

SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 131
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 132
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 133
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 134
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 135
IF PBS1=NO AND
PBS2=YES AND

PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 136
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 137
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 138
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 139
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;

RULE 140
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 141
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 142
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 143
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 144
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND

SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 145
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 146
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 147
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 148
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 149
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND

PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 150
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 151
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 152
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 153
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 154

IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 155
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 156
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 157
IF PBS1=NO AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 158
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 159
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 160
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 161
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 162
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 163
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND

AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 164
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 165
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 166
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 167
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 168
IF PBS1=NO AND

PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 169
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 170
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 171
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 172
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK

THEN TREATMENT=ADMISSION;
RULE 173
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 174
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 175
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 176
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 177
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND

SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 178
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 179
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 180
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 181
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 182
IF PBS1=NO AND
PBS2=NO AND

PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 183
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 184
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 185
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 186
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;

RULE 187
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 188
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 189
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 190
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 191
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND

SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 192
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 193
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;

RULE 194
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 195
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 196
IF PBS1=NO AND
PBS2=NO AND

PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 197
IF PBS1=NO AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 198
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 199
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 200
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;

RULE 201
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 202
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 203
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 204
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 205
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND

SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 206
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 207
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 208
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 209
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 210
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND

PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 211
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 212
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 213
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 214
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 215

IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 216
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 217
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 218
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 219
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;

RULE 220
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 221
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 222
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 223
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 224
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND

PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 225
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 226
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 227
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 228
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 229

IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 230
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 231
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 232
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 233
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND

EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 234
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 235
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 236
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 237
IF PBS1=YES AND
PBS2=NO AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 238
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND

AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 239
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 240
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 241
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 242
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=HEALTHY;
RULE 243
IF PBS1=NO AND

PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK ;
RULE 244
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 245
IF PBS1=NO AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 246
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 247
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY

THEN TREATMENT=ADMISSION;
RULE 248
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 249
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 250
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 251
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 252
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND

SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 253
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 254
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 255
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 256
IF PBS1=YES AND
PBS2=YES AND
PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 257
IF PBS1=YES AND
PBS2=YES AND

PBS3=YES AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=ADMISSION;
RULE 258
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 259
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 260
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 261
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;

RULE 262
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 263
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 264
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 265
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 266
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND

SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 267
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 268
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 269
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 270
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 271
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND

PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 272
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 273
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 274
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 275
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 276

IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 277
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 278
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 278
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 279
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 280
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 281
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 282
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 283
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 284
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND

AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 285
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 286
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 287
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 288
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 289
IF PBS1=YES AND

PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 290
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 291
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 292
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 293
IF PBS1=YES AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK

THEN TREATMENT=SEVERE_MALARIA;
RULE 294
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 295
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 296
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 297
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 298
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND

SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 299
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 300
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 301
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 302
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 303
IF PBS1=YES AND
PBS2=NO AND

PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 304
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 305
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 306
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 307
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;

RULE 308
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 309
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 310
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 311
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 312
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND

SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 313
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 314
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 315
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 316
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 317
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND

PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SIMPLE_MALARIA;
RULE 318
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 319
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 320
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SIMPLE_MALARIA;
RULE 321
IF PBS1=YES AND
PBS2=NO AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 322

IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 323
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 324
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 325
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 326
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND

EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 327
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 328
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 329
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=NO AND
SIGN=PISITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;
RULE 330
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 331
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND

AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 332
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 333
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 334
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 335
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 336
IF PBS1=NO AND

PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 337
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=MALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 338
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 339
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 340
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY

THEN TREATMENT=SEVERE_MALARIA;
RULE 341
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 342
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 343
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 344
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 345
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=NO AND

SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 346
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 347
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 348
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 349
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 350
IF PBS1=NO AND
PBS2=YES AND

PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 351
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 352
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=AT_RISK;
RULE 353
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 354
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;

RULE 355
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 356
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=AT_RISK;
RULE 357
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND
SYMPTOM=HEALTHY AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 358
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=NEGATIVE AND
SYMPTOM=MALARIA AND
EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 359
IF PBS1=NO AND
PBS2=YES AND
PBS3=NO AND
PATIENT_STATUS=FEMALE_PREGNANT AND
AGE=YES AND
SIGN=POSITIVE AND

```
   SYMPTOM=MALARIA AND
   EFFECTIVE_FACTOR=HEALTHY
THEN TREATMENT=SEVERE_MALARIA;
RULE 360
IF PBS1=NO AND
   PBS2=YES AND
   PBS3=NO AND
   PATIENT_STATUS=FEMALE_PREGNANT AND
   AGE=YES AND
   SIGN=NEGATIVE AND
   SYMPTOM=HEALTHY AND
   EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 361
IF PBS1=NO AND
   PBS2=YES AND
   PBS3=NO AND
   PATIENT_STATUS=FEMALE_PREGNANT AND
   AGE=YES AND
   SIGN=POSITIVE AND
   SYMPTOM=HEALTHY AND
   EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 362
IF PBS1=NO AND
   PBS2=YES AND
   PBS3=NO AND
   PATIENT_STATUS=FEMALE_PREGNANT AND
   AGE=YES AND
   SIGN=NEGATIVE AND
   SYMPTOM=MALARIA AND
   EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=SEVERE_MALARIA;
RULE 363
IF PBS1=NO AND
   PBS2=YES AND
   PBS3=NO AND
   PATIENT_STATUS=FEMALE_PREGNANT AND
   AGE=YES AND
   SIGN=POSITIVE AND
   SYMPTOM=MALARIA AND
   EFFECTIVE_FACTOR=AT_RISK
THEN TREATMENT=ADMISSION;

ASK PBS1: "Is your Pbs1 result equal or less_than 10 percent?";
CHOICES PBS1: yes, no;
ASK PBS2: "Is your Pbs2 result higher_than 10 or less_than 100 percent?";
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CHOICES PBS2: yes, no;
ASK PBS3: "Is your Pbs3 result equal or higher_than 100 percent?";
CHOICES PBS3: yes, no;
ASK Patient_status: "Please enter your patient_status?";
CHOICES Patient_status: male, female, female_pregnant;
ASK Age: "Is Your age equal or higher_than 14 years?";
CHOICES Age: yes, no;
ASK Sign: "What is your sign result?";
CHOICES Sign: positive, negative;
ASK Symptom: "What is your symptom result?";
CHOICES Symptom: Healthy, malaria;
ASK Effective_Factor: "What is your Effective_factor result?";
CHOICES Effective_Factor: Healthy, At_risk;