KNOWLEDGE BASED SOFTWARE MODEL FOR THE MANAGEMENT AND TREATMENT OF MALARIA PATIENTS: A CASE OF RAKAI REFERRAL HOSPITAL

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A Project Report submitted to the School of Post-graduate Studies in the partial fulfillment of the requirement for the award of a degree of Master of Science in Software System's Engineering of Kampala International University

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DECLARATON

I *SSEGAWA E.JAMES KIGGUNDU* do hereby declare to the best of my knowledge, that this graduation Project is my original work, design and initiative and that it has never been presented to any other institution for any academic award. The literature and citations from other researchers and writers have been referenced and acknowledged in text foot notes and bibliography / reference.

Signed ..... Date 22/10/2009.....

APPROVAL

This dissertation / thesis has been submitted for examination with our approval as the University supervisors.

Signed .....

Date 22/10/2008

Mr. Bada Joseph Kizito

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Signed .....

Date 22/10/08

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Supervisor

DEDICATION

I dedicate this research to all those men and women, who have been so instrumental and resourceful in the release and realization of this important thesis of the developed system. Their exertion and input have been of real great facility to me and I regard them for the work successfully well done.

My sincere recapitulation goes to my supervisors and lectures, Mr. Bada Joseph Kizito and Madam Maureen Ouma P. Ndungwa, Professor Gonzalez Vicente. My dear wife Madona of Madosoft.jesk Enterprises, for the continued support always; you are commended so greatly, celestial rewards are abundant for you ever more, My children, brother and relatives, the struggle will never end, remain good as you have always been to me.

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ABSTRACT

Malaria is an infection or disease caused by bacteria parasites (Plasmodium Falciparum – causes severe Malaria, plasmodium Vivax, Plasmodium Ovale, and Plasmodium Malariae), transmitted by bites of infected anopheles (female) mosquitoes to humans. These vectors comprise of two types in Africa particularly in Uganda, i.e. *anopheles fenestus and Anopheles gambaie (example Anopheles arabiensis)*; feeds on man inside the house mainly at dusk, mid-night and dawn and rests indoors and makes them effective transmitters (vectors) of the disease. People in both urban and rural areas have consistently become prone to repetitive attacks of malaria, causing a lot of deaths and significantly increasing the poverty levels of the rural poor. Malaria is a national problem; it causes a lot of maternal pre-natal and antenatal disorders, anemia in pregnant mothers, low birth weights for the newly born, convulsions and epilepsy among the infants. Cumulatively, it kills about one million children every year in sub-Saharan Africa. It has been estimated to account for 25-35% of all outpatient visits, 20-45% of acute hospital admissions and 15-35% of hospital deaths. Uganda is the leading victim country, for which Rakai and Masaka districts are the most affected. So it is not clear whether these abhorrent situations and episodes of recurrences and failure to cure from the disease are a result of poor diagnosis, prescription and dosaging, treatment habits and compliance of the patient's to the drugs or the ethical domain of the stake holders in relation to the main stream methodology of malaria management.

The research is aimed at offering an alternative approach to manage and deal absolutely with problem by using a knowledge based software model of Artificial Intelligence (AI) that is capable of performing common-sense and cognitive reasoning, so as to take decisions like the human brain would do to provide instantaneous expert solutions so as to avoid speculative simulation of the problem during differential diagnosis in the most accurate and literal inferential aspect. This system will assist physicians in many kinds of medical diagnosis, prescribing treatments and doses, and in monitoring patient responses, basing on the body weight and age group of the patient it will be able to provide instantaneous and timely information options, alternative ways and approaches to influence decision making during case analysis. The computerized system approach, a new model technique in Uganda termed as "Software Aided Treatment" (SAT) will try to change the moral and ethical approach and influence conduct so as to improve the skills, experience and values (social and ethical) in the administration and management of the disease and drugs (combination therapy and generics) by both the patient and the health worker.

The main objectives of this research / study include; to clearly simulate the causes of the recurrences and failure to cure from Malaria, establish whether the shortcomings are a result of poor diagnosis, prescription and dosaging, to provide a platform for the health workers to improve their ethical and social computing abilities that furnish good health practices to improve the health conditions of the people in those communities, to help the health worker project a true perspective (view) of the disease evaluation and assessment in terms of diagnosis, treatment and cost to avoid speculative approach and eventually raise hope and encouragement of the patients while recognizing that they are being treated with the help of an intelligent machine, this enriches their psychiatry for quick recovery.

The methodology of development and implementation was based on the System Development Life Cycle (SDLC) which proceeded through investigation and analysis, review of the existed systems, questionnaires and guided interviews was done, designing and modeling, using VB.Net 2005 and UML based on object oriented paradigm while implementation was done using PHP and SQL server version 2005. This system / software has embedded controls and procedures that the health worker requires to project the synthesis (analysis) of the diseases pathology including the relevant views required to expedite the advantage for furnishing disease management.

The findings about this software are that, inputting the observable symptoms of clinical diagnosis, after narrowing it down to the nearest assumed signs is easy and by using the search and similar algorithms or knowledge based system abstractions and heuristic rule paradigm, the system generate / output the appropriate solution, the treatment and dosage patient must administer, a report for the health worker who handled the case. This reduces analysis with assumptions that cause inconsistencies in decision making for the known and the unknown disease characteristics towards the right solution to manage and treat the problem.

A LIST OF CRONYMS AND ABBREVIATIONS

AI	Artificial Intelligence
SAT	Software Aided Treatment
ES	Expert System
MIT.	Massachusetts Institute of Technology
LAB	Laboratory
WHO	World Health Organization
DFID	Department For International Development
UML.....	Unified Modeling Language
VB.....	Visual Basic
PHP.....	Hypertext preprocessor
SQL.....	Structured Query Language
ANN.....	Artificial Neural Networks
ECG.....	Electro Cardio Gram
MLP.....	Multi Layer Perceptron
MDSS.....	Medical Decision Support System
CESA.....	Computational Engineering in Systems Applications
DSS.....	Decision Support System
MoH	Ministry of Health
DFD	Data Flow Diagram
UPS	Uninterrupted Power Supply
GB	Giga Byte
MB	Mega Byte
USB	Universal Serial Bus
RAM	Random Access Memory
DVD	Digital Video Display
XP	Extended Programming
NTFS	New Technology File System
DDL	Data Definition Language

DML	Data Manipulation Language
OS	Operating System
ER	Entity Relation
KB	Knowledge Base
ORM	Object Role Modeling
IV	Intra venous infusions
MPs	Malaria Parasites
CQ	Chloroquine
SP	Sulfadoxine Pyrimethamine
MDI	Multiple Document Interface
ITNs	Insect Treated Nets
PB	Progression Bar
PK	Primary Key
PK	Foreign Key

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CHAPTER ONE

INTRODUCTION

The knowledge based software is an expert system of Artificial Intelligent (AI), knowledge based computer system that has the ability to perform common-sense and cognitive reasoning, so as to take decisions like the human brain would do. It is built basing on creating a knowledge base and an inference motor that are used in knowledge engineering; these two form the heart of the ES, whose main function is to store the expert's knowledge dependably, to recover it and to infer new knowledge whenever it is required. The systems that diagnose and treat problems, like illnesses in people or problems in computer hardware and software, natural language, games, perceptions, character recognition, Design, finite elements and financial analysis, are now in widespread use in all sectors of life. Some other diagnostic systems based on AI technology are being built into photocopiers, computer operating systems, and office automation tools, like Microsoft's Office Assistant, an integral part of every Microsoft-Office application, provides users with customized help by means of decision-theoretic reasoning. Stand alone units are being used to monitor and control operations in factories and office buildings i.e. use of robots and rifts respectively. On the other hand, in the field of medicine, AI -based systems assist physicians in many kinds of medical diagnosis, prescription of treatments, and monitoring patient's responses.

The system therefore under design is a medical Expert System (ES) that will explore and simulate remedies for the professional gaps and deficiencies that do exist in the hospitals and other health infrastructures during the management and treatment of malaria, in the bid to providence of quality service to the people against this most prevalent infection / disease. It will exhibit how the application of computer interactive intelligent systems (software) can help to improve the performance of the health workers by providing instantaneous and timely information options, alternative ways and other approaches to influence decision making during diagnosis, prescription of treatment, dosaging, and prognostic approaches to this disease.

The continuous use of such computerized system approach, a new model technique in Uganda, Software Aided Treatment (SAT) will try to change the moral and ethical approach and influence the conduct and improve the skills, experience and values (social and ethical) in the administration and management of the disease and drugs (combination therapy and generics) by both the patient and the health worker. Inspite of the efforts and interests endeavoured to reduce the magnitude of this disease

in society, its infection has continued to show and prove prevalence and recurrence to most people in both Urban, semi-urban and rural areas, it seemingly doesn't emerge to be effectively curable even from after a short period of treatment, and therefore people have consistently become prone to attacks of malaria, causing a lot of deaths and increasing the poverty levels of the rural poor.

Malaria is caused by bacteria parasites (Plasmodium Falciparum – causes severe Malaria, plasmodium Vivax, Plasmodium Ovale, and Plasmodium Malariae), transmitted by bites of infected anopheles (female) mosquitoes to humans. These vectors comprise of two types in Africa particularly in Uganda, i.e. *anopheles fenestus and Anopheles gambaie (example Anopheles arabiensis)*; feeds on man inside the house mainly at dusk, mid-night and dawn and rests indoors and this is what makes them effective transmitters (vectors) of malaria; The most affected / vulnerable groups of people by malaria are the children under five (5) years of age and the pregnant women because it reduces their immunology very quickly.

1.0 Back ground of the study

The origins of the concept knowledge based software of Artificial Intelligence (AI) can be traced way back decades in popular science fiction, but as a true scientific pursuit, it is a very young area of study. Most scientists agree that, its beginning resides with *Alan Turing*, in 1950, Turing, who also helped develop the Automatic Computing Engine, one of the first digital computer attempts, wrote a landmark paper now referred to as the "Turing Test." The test called for human to use a computer terminal to interact in conversations with several different people, as well as with the machine. If the human could not determine which of its conversations were with a person and which were with the machine, the test had been passed and the machine would be considered intelligent-now known as "artificial intelligence," a phrase later coined by John McCarthy, co-founder of the MIT AI Lab in 1956.

In 1958 prominent researchers H.A. Simon and A. Newell predicted that computers would be able to compose classical music, play chess at a grandmaster level and translate spoken language by 1970. They split AI research projects into two categories, strong AI and weak AI. Strong AI is the development of software that will some day think and reason at, or above the level of a human being. Weak AI, which has already been implemented in everything from automotive systems to video games, chess playing computer programs which was developed in 1979), is the development of minute individual intelligent features that enhance a current technology. Stanford, 1974 MYCIN expert system, a computer program that contains knowledge used for a specified purpose, was developed and it diagnosed blood bacterial infections better than practicing doctors could, however provided that its limitations were observed, thus at the present day expert and intelligence systems are used in

manufacturing industry to provide services like Robots, in transport to moderate temperatures and oil consumption, in medicine and health and so on. Other expert systems that preceded these types of innovations included: Macsyma 1965 authored by MIT to carry out complex numerical and mathematical analysis, Teiresias 1972 by Stanford, ushered in the platform of knowledge transformation.

1.1 Problem Statement

Inspite of the efforts endeavoured to reduce the extent (magnitude) of many diseases in Rakai and Masaka communities, people in both urban and rural areas have consistently become prone to repetitive attacks of malaria, causing a lot of deaths and significantly increasing the poverty levels of the rural poor. Malaria is recognized as a national problem by the Ministry of Health, World Health Organization (WHO) and Department for International Development (DFID) among others, it causes a lot of maternal pre-natal and antenatal disorders and anemia in pregnant mothers, low birth weights, convulsions and epilepsy among the infants and cumulatively kills about one million children every year in sub-Saharan Africa. It has been estimated to account for 25-35% of all outpatient visits, 20-45% of acute hospital admissions and 15-35% of hospital deaths. Uganda is the leading victim country, for which Rakai and Masaka districts are the most affected. So it is not clear whether these abhorrent situations and episodes of recurrences and failure to cure from the disease are a result of poor diagnosis, prescription & dosaging, treatment habits and compliance of the patient's to the drugs or the ethical domain of the stake holders. So this research is aimed at offering an alternative approach to manage and deal absolutely with problem by providing instantaneous expert solutions so as to avoiding speculative simulation of the problem during differential / inferential diagnosis.

1.2 Objectives of the Study

The main objectives of this research / study are:

1.2.1 General objective:

To investigate and clearly simulate whether the causes of the recurrences and failure for patients to cure from Malaria is a result of poor diagnosis, prescription and dosaging. Establish whether the system can help health workers physicians to project a true perspective (view) of the disease evaluation and assessment to avoid speculative approach, and finally discover whether hope and encouragement of the patients can be revamped and repatriated while recognizing that they are being treated with the help of an intelligent machine

1.2.2 Specific objectives

1. To investigate whether the system can be modeled to clearly provide information for treatment and other options that can be used for management of malaria.
2. To design and create a platform (Software Aided Treatment) for the health workers to enhance and improve their ethical and social computing abilities that furnish good health practices to improve the health conditions of the people in those communities.
3. To implement a system that will be in position to provide alternative and heuristic solutions to the recurrent health problems in the management of malaria as a whole.
4. To test whether the designed system can provide instantaneous remedies and information options that can be used to treat malaria.

1.2.3 Research questions and hypothesis

1) Have you ever been attacked by malaria this year? How many times have you been got attacked by malaria in a year?

2) Do the health workers vary the medicine and give enough dosage for your treatment for the different times you get the infection?

3) Do the doctors tell you what you are suffering from after diagnosis? Do they talk about the cost before completing the treatment?

4) Do you complete the dose after the doctors have mentioned about the cost?

5) Do the health workers make any reference to a computer system while checking you or giving you treatment?

6) How do you feel when the doctors examine you along side with their computer systems next in use?

Hypothesis

i) $\mathbf{H_1}$ Quick recovery from malaria is enhanced by the patients' attitude towards the malaria drugs

$\mathbf{H_0}$ Quick recovery from malaria is not enhanced by the patients' attitude towards the malaria drugs

ii) $\mathbf{H_1}$ Completion of the drug doses by the malaria patients depends on how the patient feels about the drugs

$\mathbf{H_0}$ Completion of the drug doses by the malaria patients depends on how the patient feels about the drugs

iii) $\mathbf{H_1}$ The patients' recovery from malaria is directly proportional to the patient's compliance to drug doses as prescribed by the doctor.

iv) $\mathbf{H_0}$ The patients' recovery from malaria is not directly proportional to patient's compliance to drug doses as prescribed by the doctor.

1.3 Justifications of the Study

1. It will solve professionals' inability and the unpreparedness to deal effectively with the infection due to of lack instantaneous interactive systems (software) to provide information during symptom analysis (diagnosis) for the right prescription and dosaging.
2. It will minimize the difficulty to fully explain the cause of failure to manage malaria, probably due to mixing or confusing issues between the most known and the unknown symptoms.
3. It will enhance the ethical and moral domains of the health personnel that arise probably due to work load, specialization and deployment effect, attitude and other unstable working conditions.
4. It will provide expert solutions in cases where there is lack of specialist doctors reaching the very sick persons to handle the cases due with the real experience and skill for manipulation of the symptoms.
5. Medicine is a field in which SAT is critically needed, "the increasing expectations of the highest quality health care and the rapid growth of ever more detailed medical knowledge leave the physician without adequate time to devote to each case and struggling to keep up with the newest developments in his field. For lack of time, most medical decisions must be based on rapid judgments of the case relying on the physician's unaided memory. Only in rare situations can a literature search or other extended investigation be undertaken to assure the doctor (and the patient) that the latest knowledge is brought to bear on any particular case, so is the opportunity for new computer tools: to help organize, store, and retrieve appropriate medical knowledge needed by the practitioner in dealing with each difficult case, and to suggest appropriate diagnostic, prognostic and therapeutic decisions and decision making techniques", thus this tool will change the situation and mitigate the gaps.

1.4 Scope

The research / study was conducted around the districts of Rakai and Masaka with the main emphasis put on Rakai referral hospital.

The technical scope included the following areas:

1. The Disease model which shows the category and the characteristics that defines the attack on the patient.
2. Opportunistic diseases and their characteristics which take advantage of the existence of the main domain category (malaria).

3. It will also encompass the specific modules for the complementing approaches like treatment, prescriptions, dosaging, and diagnosis.
4. The personnel that handles the problem (diseases) that requires an immediate solution, that is the medical practioners and physicians.
5. The patients that are registered at the health facility every other time.

In this case, every time malaria symptoms are identified and fed into the system, the particular interfaces which contain all the attributes / information one requires to remedy the problem of the disease will be displayed.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter shows h ow the information and knowledge of the different writers and researchers contributed to the development of this expert system of artificial intelligence. The citations tend to give us the views and literature of other researchers and academicians in support / conformity with the existence of similar expert systems that can be used to deal with the problem in terms of treatment of the disease and the general approach its management. However medical expert systems based on artificial intelligence have been under wide spread use to manage different difficult medical situations that could not have been easy to manage in patients by the doctors' un aided wisdom, for example, cancer, gynecology, oncology, parasitology and microbiology. These writers tend to explore the areas of interest that can seize advantage of using expert systems to facilitate decision making by doctors during case management. The cited writers therefore enhance support to this system in the following areas:

2.1 Definition of AI

Simon H.,A. and Newell A. (1956) defined artificial Intelligence (AI) as a knowledge based system that has the ability to perform expert reasoning like a human brain would do so as to take decision of the existing problem. They continue to state that, they continue to carry out diagnostic functions and explain the domain of the problem depending on the created knowledge base using declarative or procedural rules to infer new knowledge.

Webster, Watson (2002), Hart, (1999) describes literature review as the literature that effectively creates a firm foundation for advancing knowledge by opening up areas where research should targeted. It is also looked at as a means of using ideas of the literature to justify a particular approach to an existent problem using selected methods so as to enhance or contribute new knowledge. This is also highlighted in Emetu, (2007)

2.2 How AI Systems work

Rubinoff, (1985), "The system Clear," Computing Explanation Automation from rules, says that, part of the input of an expert system is based on the rules that are designed to work with bases of rules developed independently as new knowledge to generate explanations for explanations i.e. meta knowledge processing, by means of automatic analysis of the existent bases of rules. It clarifies that concepts must and then automatically examine the bases of rules to identify other rules that are related

with the concept. The information contained in the selected rules is translated then in English's basic form as a natural language.

2.3 Areas of application of AI

According to David Waltz, Computer Science Research Division, NEC Research Institute, Princeton, NJ, Adjunct Professor Computer Science at Brandeis University in Waltham, MA. (1993 to 2003), Senior Scientist and Director of Advanced Information Systems at Thinking Machines Corporation in Cambridge, "The case study of Diagnosing and Treating Problems", highlight application area where AI technology is having a strong impact on health and everyday life, Systems that diagnose and treat problems; whether illnesses in people or problems in hardware and software natural language, games, perceptions, character recognition, Design, finite elements and financial analysis. AI - based systems that assist physicians in many kinds of tasks like medical diagnosis, prescription of the treatments and in monitoring patient responses are now in widespread use.

NJ, Adjunct Professor Computer Science at Brandeis University in Waltham, MA. (1984 -1993), Senior Scientist and Director, "Advanced Information Systems at Thinking Machines" Corporation in Cambridge, says that, Diagnostic systems based on AI technology are being built also in other systems like photocopiers, computer operating systems, and office automation tools to reduce service calls. Stand-alone units are being used to monitor and control operations in factories and office buildings, and also in hospitals for specialized functionalities.

Economou G., P., K, Lymberopoulos D., Goutis C., E. University of Patras, 261 10 Patras, Greece, VLSI Design Laboratory Department of Electrical Engineering states: Medical Decision Making System based on a robust configuration of Artificial Neural Networks (ANNs) is a whole category of human diseases, as can be proved by the already adapted systems that covered Pulmonogical and Haematological Cases. Moreover, an inside view is provided on one of the most crucial topics: ANNs' learning procedure. Since these cases are concerned with blood analysis and malaria parasites are carried in blood, thus AI system is most suitable and most appropriate for analyzing Laboratory findings to prescribe treatment for the problem.

2.4 Accuracy of AI systems

Simon, (1981) "Rules, classification, consultations of diagnostics", 1984 "Rules, semantic nets forward and back", suggests that an expert system looks for satisfactory knowledge to generate

sufficient solutions. Thus this tells us that the computer systems (ES) have been traditionally used for applications that demand high degree of accuracy, while the level of accuracy and precision that demands satisfactory solutions is ruled by the domain of the problem, hence creating a knowledge base using the expert's knowledge provides the highest level of credible inferences for accurate solutions for diagnosis and treatment of malaria.

According to Lars Eden Brandt (2004) Bo Heden, University Hospital, Lund, Sweden. Hans Ohlin, and Ralf Rittner, "Artificial neural networks", say, to the real hands on experience the computer-based method / algorithm was more accurate than the cardiologist in reading the electrocardiogram (ECG), a test used to diagnose heart attacks in patients seen for chest pain in hospital emergency departments. "The neural networks performed higher than an experienced cardiologist, indicating that they may be useful as decision support," says Eden Brandt, a consultant in the department of clinical physiology at the University Hospital. Neural networks are designed to "think" like humans, drawing knowledge and decision-making capabilities through experience. To teach a neural network how to recognize heart attacks, researchers exposed the computer memory to thousands of electrocardiogram readings, more than any cardiologist could possibly read in a lifetime, notes Eden Brandt. In the study researchers included 1,120 ECG records of people with heart attacks and 10,452 ECGs records that were normal. The neural networks were found to be 10% better at identifying abnormal ECG s than the most experienced cardiologists on staff. An estimated 25% of ECG readings are "misjudged or overlooked" by the physician, and a person may be sent home from the hospital without a correct diagnosis, according to the scientists, thus over looked symptoms of malaria by the inexperienced health workers can aggravate through inadequate diagnosis or treatment uncomplicated malaria to severe or complicated instance.

Medical journals published by the Dallas-based American Heart Association. Science Daily (DALLAS, Sept. 16. 2005) "Artificial Intelligence Improves Heart Attack Diagnosis" Drawing on artificial intelligence technology, researchers have for the first time found that machines show promises of improving on human's ability to diagnose heart attacks, according to a study in today's American Heart Association journal circulation.

2.5 Efficiency

Guillermo Callahan Olachea. Helsinki University of Technology 68534B, Recommends two applications, the implementation of a MLP (Multi Layer Perceptron) based MDSS (Medical Decision Support Systems) for heart disease diagnosis. Since heart diseases can be a quite extensive and

experience-required diagnosis, the implementation of a MDSS using soft computing is effective for the detection of various heart diseases. This proposal uses a Multilayer Perceptron with an improved back propagation algorithm, that is, WeAidU, a MDSS for myocardial perfusion images using ANN Artificial Neural Networks. WeAidU is a computer based DSS system for the automated interpretation of diagnostic heart images; the system is based on ANN, Image processing techniques and large well - validated medical databases. There are three major contributions: OncoDoc: Computer Based Guideline for Breast Cancer Treatment. OncoDoc is a - Knowledge system that is based on providing medical guidelines to Doctors to provide the best diagnosis. Research on selection for a MDSS for Breast Cancer Detection, its aim is to provide a physician controlled operation of guideline knowledge through hyper-textual reading of a knowledge encoded as a decision tree.

2.6 Design Models

Behrens, U., Frasinsk,M., Hagge, L. and Ohrenbergy, (1996), "Use of Object Oriented Software methodology for design of Expert / control systems, says that an Expert system knowledge based system is a combination of data structures (Entity Level knowledge) and interpretation procedures (problem solving knowledge). Therefore in this system / project the design is based on the object oriented and Entity Relational paradigm.

Ameen Abu-Hanna, (April 1998), University of Amsterdam, Peter Lucas, Netherlands Utrecht University, "Computational Engineering in Systems Applications (CESA 98)" talk about Intelligent Prognostic Methods in Medical Diagnosis and Treatment planning, that computational prognostic models are increasingly used in medicine to predict the natural course of disease, or the expected outcome after treatment. Prognosis forms an integral part of systems for treatment selection and treatment planning. Furthermore, prognostic models may play an important role in guiding diagnostic problem solving, e.g. by only requesting information concerning tests, of which the outcome affects knowledge of the prognosis (prediction). Several methods and techniques from the fields of artificial intelligence, decision theory and statistics have been introduced into models of the medical management of patients (diagnosis, treatment, follow-up). Typically, recent prognostic methods rely on explicit pathophysiological models, which may be combined with traditional models of life expectancy. Examples of such domain models are causal disease models and physiological models of regulatory mechanisms in the human body. Such model-based approaches have the potential to facilitate the development of knowledge-based systems, because the medical domain models can be (partially) obtained from the medical literature. Various methods have been suggested for the

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representations of such domain models ranging from quantitative and probabilistic approaches to symbolic and qualitative ones.

Szolovits Peter (1982), "Artificial Intelligence and Medicine.", "Knowledge-based Systems in Artificial Intelligence" Lenat D., B. McGraw-Hill, West view Press, Boulder, Colorado and Randall Davis, Department of Electrical Engineering and Computer Science, MIT. Specialist artificial intelligence (Al) on medical applications, are concerned with fundamental issues of knowledge representation and reasoning, including protocol analysis to discover how clinicians reason about probability and causality, and with programs which model human expert performance in some areas of medical diagnosis, they talk about a Knowledge-based systems, knowledge representation, problem solving methods, and use of artificial intelligence in medicine. These authors then describe five prototype computer programs that tackle difficult clinical problems in a manner similar to that of an expert physician, these programs include:
INTERNIST a diagnostic aid that combines a large database of disease/manifestation associations with techniques for problem formulation;

EXPERT and the Glaucoma Program which use physiological models for the diagnosis and treatment of eye disease.

MYCIN a rule-based program for diagnosis and therapy selection for bacterial diseases in blood.

DIGITALIS THERAPY ADVISOR, which aids the physician in prescribing the right dose of the drug digitalis and also explains its actions; ABEL a program that uses multi-level pathophysiologic models for diagnosis of acid-base and electrolyte disorders. In summary therefore the citations above show the impact AI can cause in the field of health in identifying diagnosing, and treatment of diseases.

It is clear in all the literature gathered about the different works done by the different researchers and writers that, the expert systems played fundamental roles in the diagnosis and analysis of most simple and severe disease occurrences (pathology) for the right treatment and management. In this case therefore, the way forward to fight and roll back malaria in Africa and particularly in Uganda, is to employ the application of expert systems like (SAT) in the process of explicit diagnosis, analysis and interpretation of symptoms for both uncomplicated and complicated malaria to provide the best solutions to the existing and escalated frequency and prevalence of malaria.

CHAPTER THREE

METHODOLOGY

3.0 System investigation and requirement analysis

In this chapter, we explore the methods and stored procedures that were used to generate information options and solutions to the pre-existed problems in malaria management and treatment. The system investigation was done using the research tools / instruments which included the questionnaire, observation and interviewing, were conducted in the ministry of health. These tools acted as the main fact finding methods, which assisted the researcher to come up with the most required expert information which was used to build the knowledge base. This knowledge was acquired from the practicing doctors and field personnel later initiated the creation of object models used in the system development hence object-oriented analysis.

3.1 Research instruments for data collection

The investigative techniques for data collection includes:

Interview: This technique involved interacting and making careful dialogue between the physicians at the MOH who are most charged with the operations of controlling malaria and carrying out diagnosis and treatment of the malaria patients. This prompted taking note of the very important information that reflected the methods they use to manage and treat people within the endemic areas. This gave the researcher real hands on and first hand information of how the problem can be dealt with including the basic control strategies used to minimize the occurrences of the disease.

Questionnaire: The questionnaires were designed and appropriated to the physicians and some of the people who became victims of malaria at some level. They were designed in such a way to guide the acquisition of the expert knowledge that was important in the provision of information of how the problem has previously been handled (the history of the problem) and the challenges encountered in the administration and management of the disease. They also helped in generation of extra information that showed other strategies to control and mitigate the existence of malaria in the endemic areas. The questions existed in precise closed end and short structured open questions outlined and given to the respondents.

Observation: This was employed during the review of the existent sample systems (prototypes) for some algorithms that simulated diagnostic ways to analyze and provided solutions for complicated problems that

didn't have known formal techniques to provide solutions, thus taking note of the important points that were used to deduce the required methods of implementing a new system.

Review: This involves re-examination of the prototype models which have similar roles in solving and handling problems of the same nature, for example Decision Support Systems (DSS). Interview and Questionnaires methods were the most effective in this process of knowledge acquisition. Interview method generated instant reactions and brain storming for the possible and most appropriate solutions. The Questionnaires presented well thought of and practical answers that could be referenced later on for comparison of alternative solutions to the problem. It also helped to guide the dialogue between the researcher and the patients in the bid to getting information from them.

3.2 Data processing and analysis

The corrected data was processed and analyzed to ensure that it provides a high level of reliability and validity in creating and measuring the degree of relationships between the independent and dependent variables that physicians need to use to explicitly manage malaria and the patients to achieve compliance to the drugs. The analysis was done through establishment of Bivariant correlations of Pearson's coefficient using Epi-Info (SPSS) software. The reasons for choosing this software were as seen below:

1. It portrays a linear relationship between the variables.
2. It uses the paradigm of independent and dependent variables which exhibit causal relationship
3. It enhances or produces a normal distribution between variables

3.3 Area of research

This research was carried out in Rakai and Masaka districts, and it focused on the following aspects: Diagnosis of malaria patients, this will help to identify the right symptoms and signs that effective management of the domain disease will be based. Dosage and treatment of the disease, after the clinical pathology has been made by the health work, the information concerning the age and body weights of the patient will be required so that the system can provide the real dose of the treatment to be administered. A thorough investigation was conducted about the efficiency of the system in comparison to the traditional methodology of diagnosis and treatment for the right decision to take about how to manage the problem.

3.4 Research / System design

This system was designed for development using the following software tools (methods); UML (Unified Modeling Language), VB.Net for designing and development of application interfaces. The real system implementation through coding and installation was done using VB.Net, PHP (Hypertext Preprocessor) and SQL (Structured Query Language) server 2005; these were basically for creating dynamic web based database system on a web server technology. This software has embedded controls and procedures that the health worker requires to project the synthesis (analysis) of the diseases pathology including the relevant views required to expedite the advantages of affordability. The method of using this software will include; input the observable symptoms of diagnosis, after narrowing them down to the nearest assumed signs, using the search or similar algorithms or knowledge based system abstractions and heuristic rule paradigm, the system will generate appropriate type of infection/s, the dosage and treatment reports for the patient. This will reduce analysis with speculations that cause inconsistencies in decision making for the known and the unknown towards the right solution to manage and treat malaria.

The most interesting aspect of this software is that it provides instantaneous expert information or solutions to the existing problem. It will be easy to apply, and affordable to the health personnel. This software will be prone to updates depending on the attributes' database reviews, discoveries and definitions, automatically refreshed through online connectivity. It will also provide for stand alone (work stations) which are the most targeted category of platforms because there are few networked information systems in the rural areas.

3.5 System Modeling

Among the several modeling techniques like Object Role Modeling (ORM), ER modeling, the researcher identified and posted for a modeling method that use Object Oriented paradigm / technology to model and implementing the design of the system. UML (Unified Modeling Language) as a language was used to model and create the class object and components. Object modeling was so vital in a sense that the technique helped the researcher to identify objects within the system environment and possible links and relationship that exist between them. The models in a structured system analysis were made of the following; the process, the data used by the process and the system functions, entities that interact with the system, and the use case to construct, manage and assemble them into useful computer applications, it was necessary to use the design tools which include DFD and other UML diagrams to represent data and information about objects like patients, physicians an the knowledge base for symptoms, doses of treatment and so on.

Advantages of UML

1. It is a standardized specification language specific to objects modeling and uses formal language i.e. information about a specific mode of expression is more precise in syntax and semantics.
2. It is an evolutionary general purpose modeling language that includes graphical notation used to create an abstract model of the system (UML model), these typical behavioural diagrams represent the graphical overviews of the functionality provided by the system in terms of Actors and Use Case and any dependencies between those use cases.
3. The object oriented concepts of encapsulation and abstraction provide by UML allow the system to be implemented in heterogeneous environments in terms of computer architecture, programming languages and operating systems.
4. The technology view is described in plain English language, so this furnishes understandability to the user.

3.6 Population of the study

The preferred target categories of people in this case are the Doctors, Nurses, laboratory assistants and Clinicians. The basic reason for choosing these people is that they have always interfaced with the patients of malaria and malaria it's self, so they have the basic ideas about the disease; they also have basic knowledge and skills, that is to say, can easily acquire the skills of using the expert system. Some more consideration was put on the local people during the investigation session so as to get information about the conduct exhibited by the doctors and Nurses when handling malaria patients, so as to deduce the impact the system can cause in the management of this endemic disease.

3.7 Requirement analysis

This helped in examination of the needs in general that are required to implement the system. They can also be regarded as the pedagogical components that must be in place so that the system can be built in order to fulfill the requirements of the domain of the problem.

3.7.1 System and requirement analysis

For the successful implementation of the system and running on the required platforms, these requirements summarized all the components that were uniquely required to be in place and these included the following denominations.

Hardware Requirements

Hardware for the information system environment means the physical components that make up a computerized information system infrastructure. These are important in a sense that resources can readily be accessed as required in the shareable environment by the computer systems themselves or the users. For that the system under implementation is a heavier one, and is to carry out cognitive reasoning, it required reasonable hardware resources to make it a dependable one.

1. The computer machine with a duo core processor of clocking speed of 2.0 GHz and above. This would support mult-tasking because the system will be put to a lot of interrupt requests that demand quick responses out of the heavy repository conditions, rules and knowledge base to infer new knowledge. It will work properly with the operating system that will implement the security measures required while using windows 2003 server.
2. RAM of 512 MB and above is recommended, this will help the machine to be much faster during the process of program execution sufficiently enough during the buffering, to provide just enough virtual memory (cache) to facilitate multitasking, multiprocessing and multiprogramming activities during a situation while using of the Expert system
3. Hard disk of at least 80 GB and above is required due to the fact that a knowledge base will be created, whereas also new inferred knowledge will keep on being added to the knowledge base thus expanding database. This space will also include the space for the operating system that will manage the resources.
4. A printer with a reasonable speed per minute out put and a USB facility.

5. A UPS is highly required to store power (power back-ups) for the machine in case unexpected power failure exists. This will hold and store the power until all the users have successfully saved their work and shut down the machines normally to avoid the file fragmentation and being corrupted.
6. DVD drive that operates atleast at a speed of 24X. This is used to install or burn the software designing or developed in this case. It is also used to install other softwares that are required during the development time, creating of backups of data and information.

Software Requirements

Software simply refers to programs that are basically required for the proper implementation of the system. It will include the software that will manage hardware as described in the hardware requirements analysis above, thus using windows 2003 server as the O.S and Hypertext Pre-processor (PHP) and MY SQL as the platforms for the development of the expert system. MySQL provides the knowledge schema, DML and DDL for manipulation and definition facility of knowledge. Windows 2003 server is the operating system that will manage the network facility more especially when new knowledge has been inferred or updated so that it can be shared on line. It also provides the NTFS file system that will be used to manage and enforce the required level of security and storage and avoiding such situations of limiting the amount of knowledge to be stored and accessed from the system. 2003 server operating system has many advantages among others, its robustness to provide of lots of features and capabilities like, data recovery in case of power outages, fault torelence, power management facility, active directory which helps in classifying and managing users of the system, reliability, compatibility and scalability and others.

Visual Basic (VB).NET

This is an object orientated programming language which was used to create various controls that users will apply to favourably execute the tasks they want to accomplish for example, modify / update records, cancel tasks, generation of views of knowledge and, creation of forms and interfaces / applications for the users for the different activities and operations on the data and knowledge.

3.7.2 Operational security requirements

Security is about the protection (prevention, detection and reaction) of system assets from loss or damage. It is also looked at as the mechanisms that protect the system against intentional or accidental threats that can lead to loss of confidentiality, integrity and availability of data. This also involves the protection of data within a database system against unauthorized disclosure, modification or destruction using software or hardware techniques. Security mechanisms are largely implemented with the facilitation of particular data dictionary information such as users and privileges stored in the knowledge base (KB). The systems components such as authorization control, integrity checker, transaction manager, scheduler, buffer manager, recovery manager, will focus on Principles and mechanisms of protecting data that is stored and controlling users' access to the stored data. The basic security standards must ensure; Confidentiality to allow individuals to view only the data which they are supposed to access, Integrity that is data remains unchanged in its form and has not been accidentally or maliciously modified, altered, or destroyed.

Referential integrity is highly to be ensured i.e. the ability to maintain valid relationships between values in the database, according to rules that have been defined. An Antivirus should be installed on every computer where this system will run to shield against viruses designed to corrupt the data and knowledge. Backup and recovery procedures must be used to restore correct states of the database in events of clashes. Accountability: if any one tries to enforce change on the database is suspected, a database audit is performed. Database system keeps track of all the operations that a user performs during a log-in session. When an illegal or unauthorized operation is found, it will be easy to determine the account number that performed such an operation. Availability: A secure system makes data available to authorized users, without delay. All this will be achieved on the software specification that has been described in the software requirements analysis.

3.7.3 Cost requirement analysis

This explores the cost incurred to actualize the system at an operational level. This is as shown in the appendix I

CHAPTER FOUR

SYSTEM MODELING AND DESIGN

4.0 Introduction

This chapter deals with the identification of the different object types required to instigate the implementation of the models using a known modeling technique l ike UML modeling paradigm that emphasizes object oriented modeling. These models are used in the creation of Entity Relational models (E-R model) for the system. This type of model describes the entities, attributes, relationsh ips an d their behaviour for the system.

4.1 The conceptual frame work

The expert system for the problem domain i.e. management of malaria, is simulated to function in the same way decision support system carry out logical decisions based on the rules and procedures embedded in the knowledge base. The whole idea is conceived in the conceptual frame work shown in the diagram Fig 4.1. The system object prototype, that includes the users and other entities show how they interact to achieve an objective by providing an instantaneous solution to the problem or question that may have been subjected to the system at a particular instance of time. The technical aspects of finding a solution to a problem, by the system, involve several organization levels; Database Management System (DBMS) level, Expert System (ES) constituting the main system level, the User Interface level that interacts with the Diagnosis and the Prescription subsystems to transfer the request to the main system. All those levels coordinate / cooperate through User Interface (UI). At another level are implemented the following analysis agents; Treatment, Dosage and other options (Recommendation options / preventive or control), through Decision Support System (DSS) Agent.

These agents can have access directly to the UI Agent. The Repository Agent is an agent taking the place of a DBMS as a collection of stored operational data used by the application systems. We shall consider DBMS to be a relational or an object-oriented one, designed to efficiently acquire, store, manipulate, retrieve, analyze, display and report all forms of pathologically referenced information geared towards a particular set of purposes. Then ES Agent is a rule-based system and contains in its knowledge base some of the following rules like it may be got in other options / analysis agent of the model:

1) If surroundings and habitat are not planned then mosquito breeding is favorable.
2) If zone is urban and habitat is planned then mosquito breeding is unfavorable.
3) If water is stagnant and temperature is high then mosquito breeding is favorable.

4) If mosquito breeding is favorable, plasmodium parasites are in human population, then malaria transmission is active.

5) If rainfall is weak / low and mosquito breeding is favorable then there is a season of abundance.

6) If soil is clay and altitude is low then mosquito breeding is favorable.

7) If soil is sandy and rainfall is low / weak then water is not stagnant.

8) If water is not stagnant and temperature is high then mosquito breeding is unfavorable.

9) If rainfall is heavy and mosquito breeding is unfavorable then there is no season of abundance.

10) If temperature is low and duration of parasite development in mosquitoes is long then malaria transmission is limited

11) If habitat is traditional and mosquito breeding is favorable then mosquito biting rate is high.

12) If habitat is modern and mosquito breeding is unfavorable then mosquito biting rate is low.

Option / Analysis Agent will be seen as a sub-system of PHP and My SQL scripts which is a collection of machine search algorithms for data mining tasks. The algorithms can be applied to a dataset or called from My SQL Objects, which contains tools for data processing, classification, regression, clustering, association rules, and visualization. - The Decision Support System (DSS) Agent contains a set of rules as the ES Agent. It can make and deliver decisions according to the information produced by the environment

4.2 System Modeling

A model is generally a representation of the real world, i.e. objects and events as well as their associations. The integrated collection of concepts / objects for describing data is intended to make the understandable using UML modeling method. This is therefore a description of the system's functional requirement in specifying how the program can be understood both by the user and the designers. Model management diagrams are the ones or elements that when organized make up a system through their relationships.

The modeling mechanism is realized through making use of the conceptual frame work, identifying how the concepts are relating to each other, and at the end determining the DFD, information flow and workability including the model management diagrams

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THE CONCEPTUAL FRAME WORK

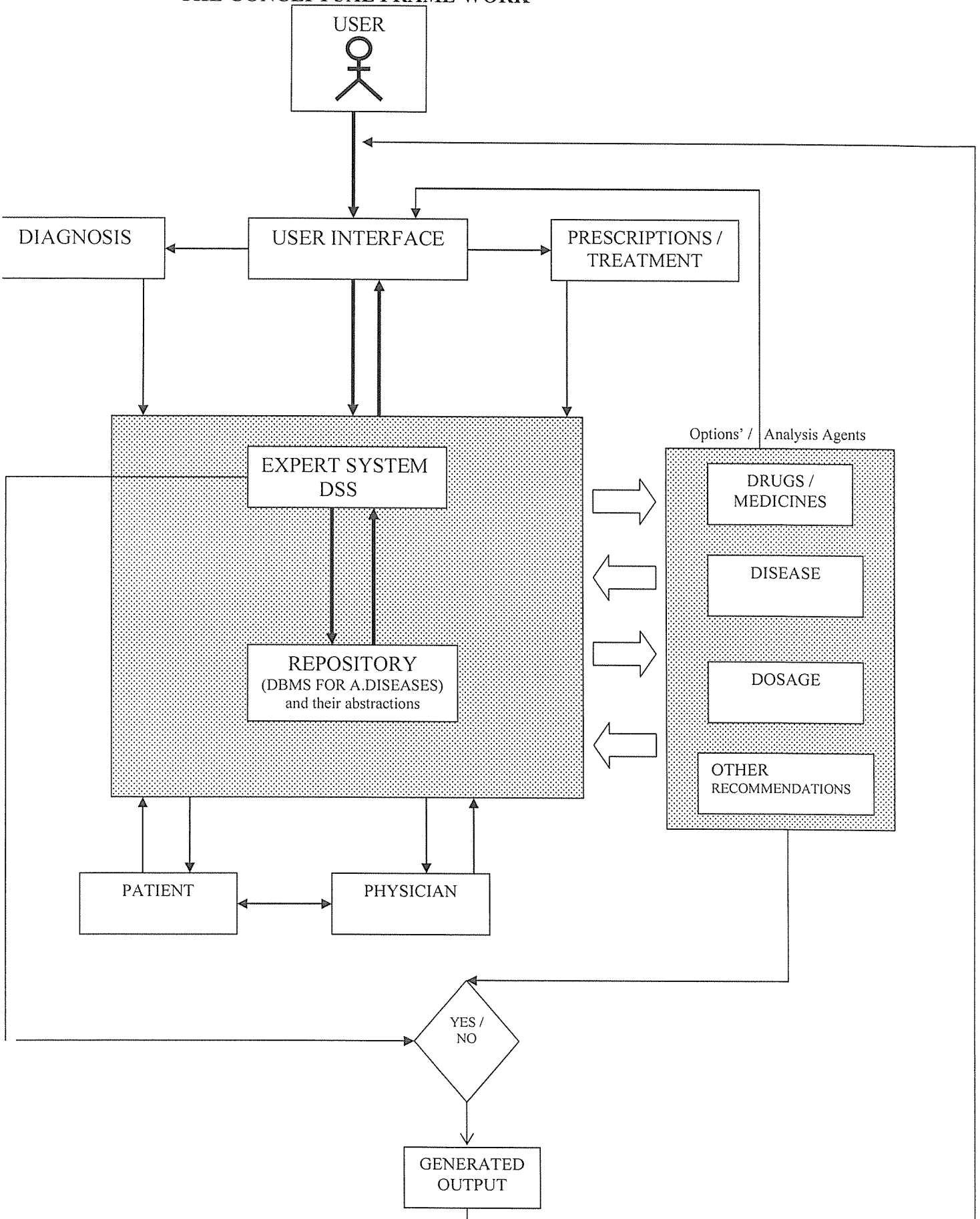


Fig.4.1

The conceptual frame work provides therefore for the way how these objects / entities within the classes interact to provide a means of how the system generates a solution to the problem when a query has been put up by the user. This is implemented through the use of entity relational models where different classes interact and how the operations are done in each case to help the system update, keep truck or add new data to the knowledge base or repository. Different classes can have / exhibit the same operations and methods on the database or knowledge base, therefore such methods can be applied by one or more classes, this process is called inheritance and once they occur in more than one class, therefore the process is called polymorphism

4.2.1 Entity relational analysis and modeling

This state of structured analysis led to the Data Flow Diagrams (DFD). It constitutes the processes (what the system does; one or more data inputs for specific outputs), data, entities and their behaviour, which are assembled up to make the system applications.

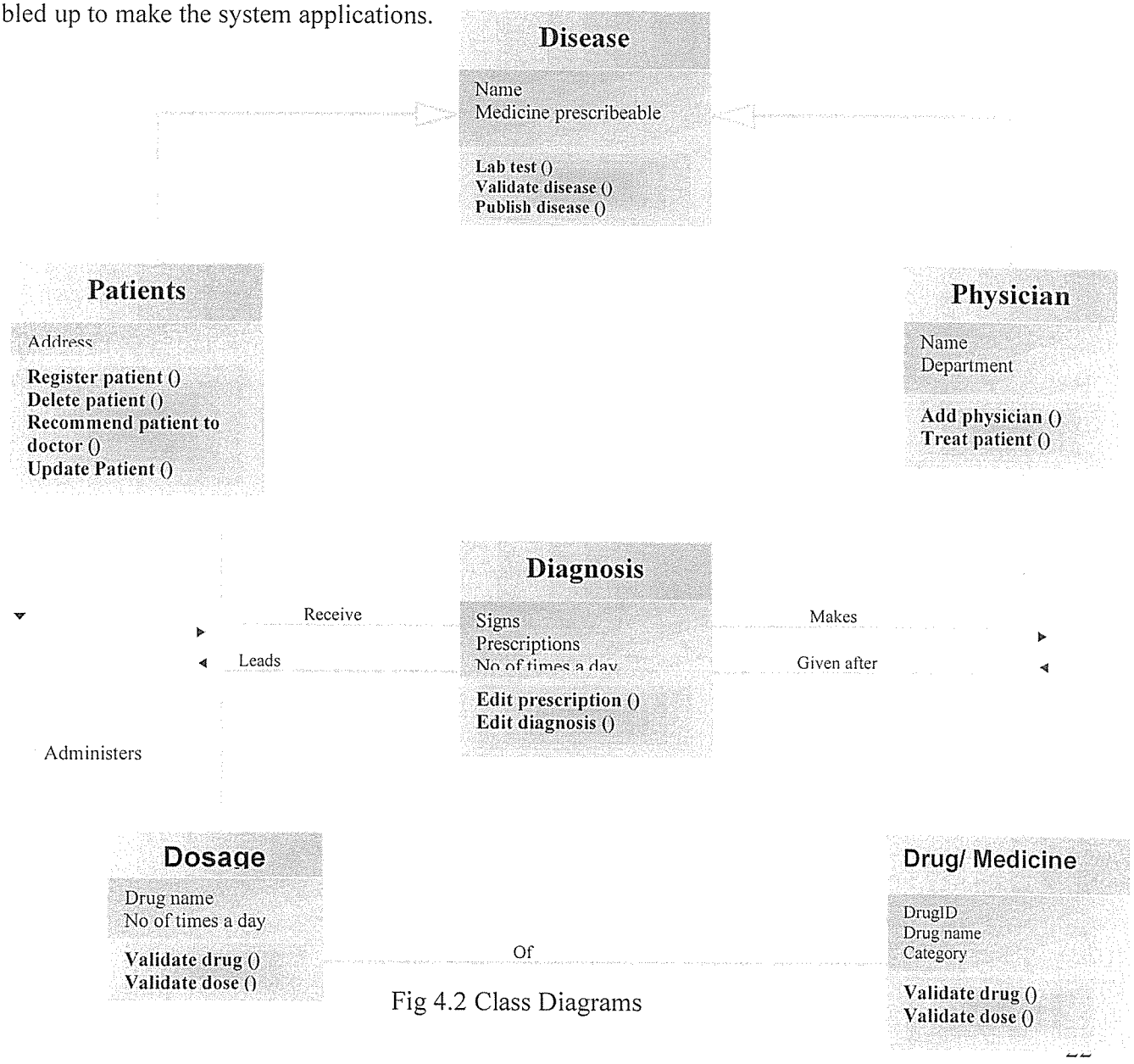


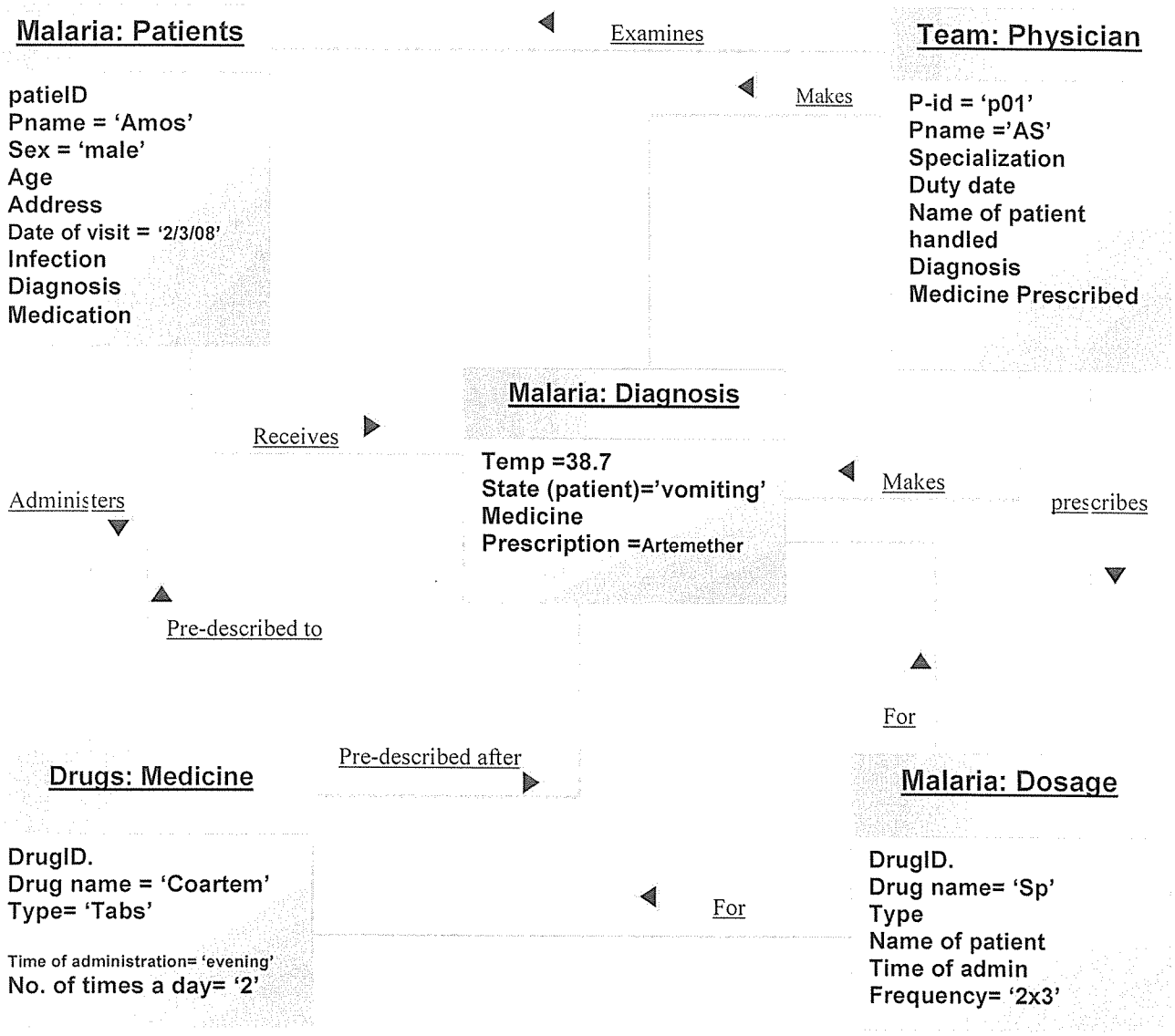
Fig 4.2 Class Diagrams

Attributes and relationships

The attributes of the entities can be regarded / referred to as characteristics that are used to describe them. They are the actual properties used to distinguish one entity instance from another. Attributes are represented as ellipses connected to their owning entity sets by lines, whereas relationships are the association that exists between two or more entities showing how those entities are related between one another. They are represented the solid lines and the thick arrows that show the link's name and direction of the association between objects (entities) in the relationship. These relationships can be represented as: one - to – one (1:1), one – to – many

(1: M), many – to – many (M: N)

Fig 4.3 Object Diagram



The system is handled on a model level to represent its abstractions towards the problem. This is therefore achieved through model management diagrams which include; Package and subsystems diagrams, structural diagrams and behavioural diagrams

4.2.2 Model Management Diagrams

A model is an abstraction of the underlying problem. This means that it is a description of the system's functional requirement in terms of use case specifying that the program can be understood both by the user and the designers. Model management diagrams are the ones or elements that when organized make up a system through their relationships. These elements can be built or purchased so that they can be re-used or not. These models diagrams that can address this issue are called packages and sub-systems.

Package Diagram

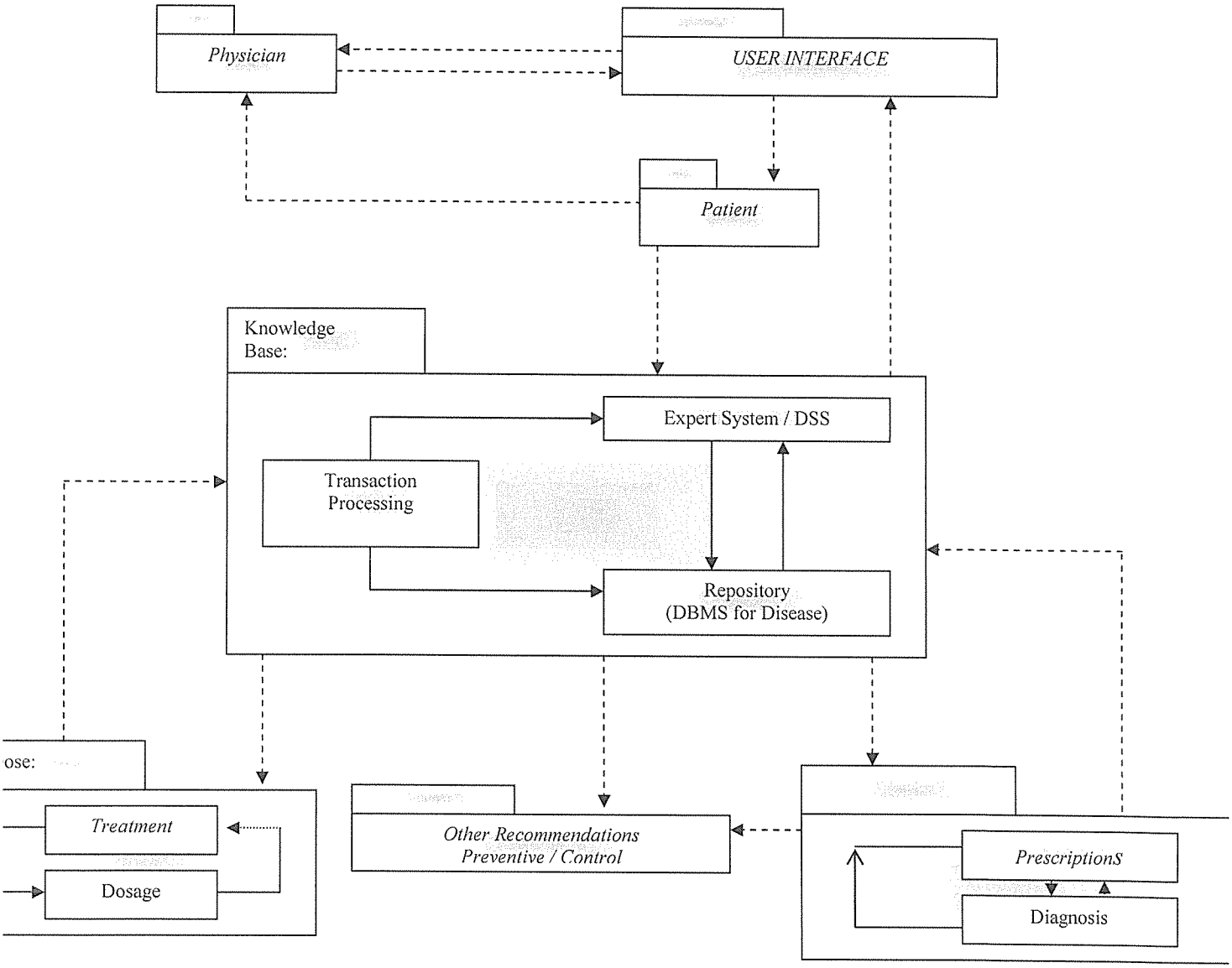
A package is a group or organized element in which other elements are situated or reside. It must have a unique name, for example, directories and folders in an operating system and group files. In this case, system development using UML allows grouping and organizing objects to form classes, which classes are arranged into modules that make the system. It becomes easier in this way to work with a package than with a particular element within its relationships, the examples such package include:

User interface, allows logging into the system using both user name and password, or guest accounts. The classes include the following aspects:

Patients:	This keeps track of the patient's records
Dosage:	Shows the Dose a patient must administer depending to the diagnosis and prescriptions by the doctor.
Physicians:	The personnel that handles the treatment or episode (patient)
Drugs-Medicine/ Prescription:	The treatment that is given to the patients
Diagnosis:	The directive given and the physical examination of the patient.
Data base (Repository) and the Knowledge base:	Where decisions can be effected after cognitive reasoning by the expert system.

The most common use for package diagrams is to organize use case diagrams and class diagrams, although the use of package diagrams is not limited to these UML elements. Elements contained in a package share the same namespace, and have unique names.

Fig 4.4 Package diagram for Software Aided Treatment (SAT) of Malaria

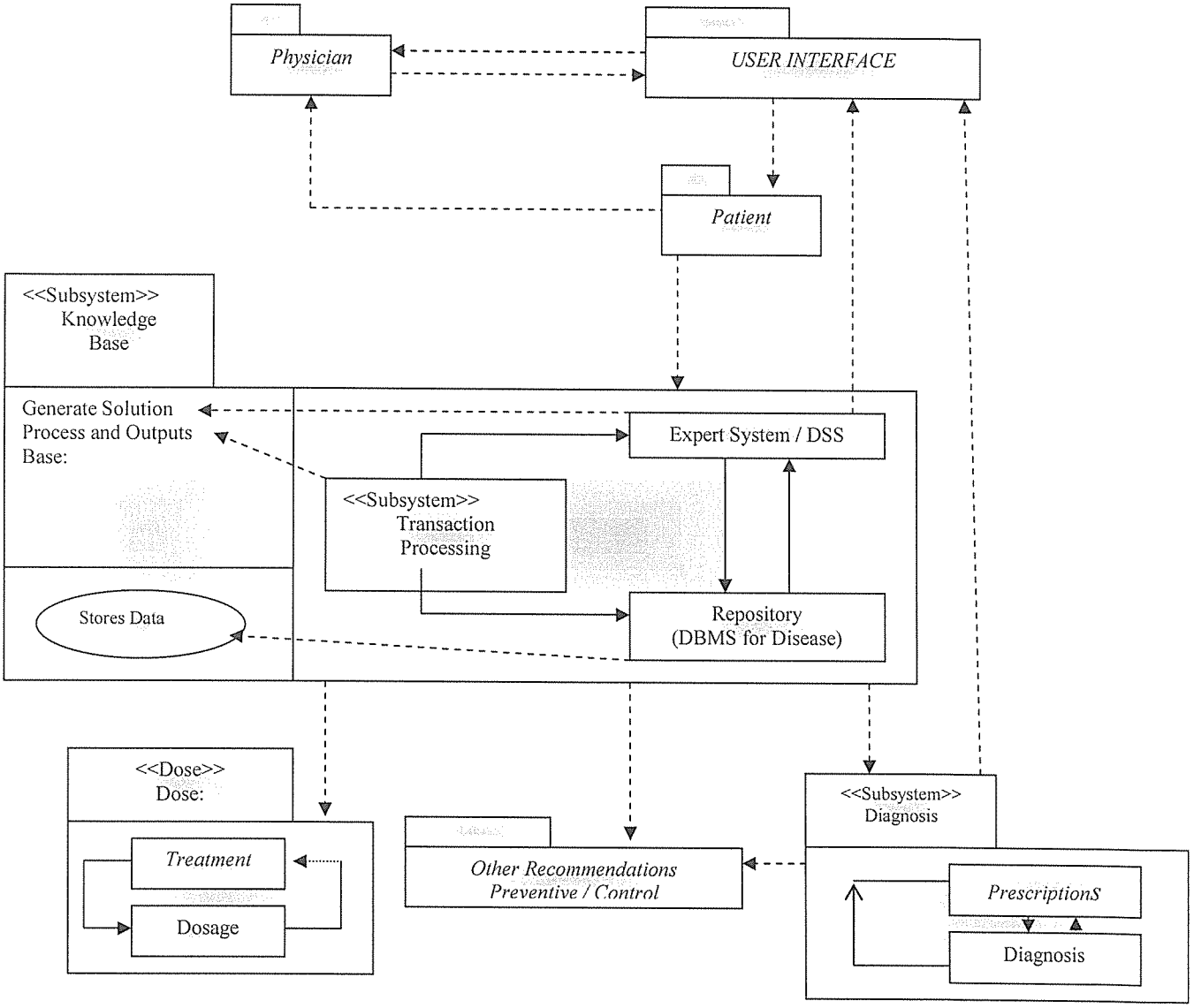


Sub-Systems Diagram

Subsystems are the recursively decomposed small groups of the objects or elements that are arranged to unit together in order to form the main big system. They consist of primitive elements which would also be either objects or classes that can not be decomposed any more to provide a service. Subsystems are represented as packages and marked with a key word <<*subsystem*>> and appear on an element or object. Use of subsystems helps to focus on the services the subsystem offers other than the service the package is providing because it may not be clear to identify the operations the package and the subsystem conduct at the same time in as some can't be accessed outside the subsystem while those provided by the packages can be shared by all.

This also makes testing of the system easier because each sub-system is tested independently for a particular function it is operating. This generates the accuracy and efficiency of the system.

The Fig 4.5 Subsystems of SAT prototype for malaria management



4.2.3 Structural diagrams

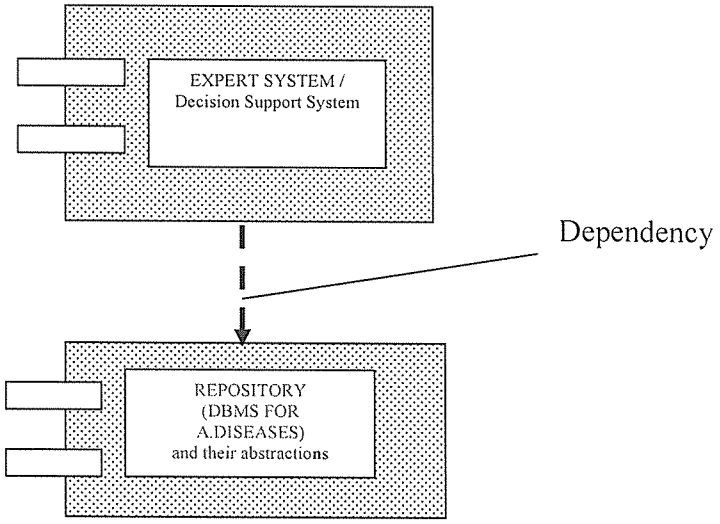
These diagrams are also called implementation diagrams because they are used for structural modeling directed towards the implementation of a particular system. Structural modeling is a technique that helps to prototype the conceptualized structure of either the subsystem or the whole system. This is done using two important diagrams namely; component diagrams and deployment diagrams

Component diagram

These are diagrams that depict or makeup the system for implementation. Component diagrams illustrate the pieces of software, embedded controllers, and so on that will make up a system. A component diagram has a higher level of abstraction than a Class Diagram usually a component is implemented by one or more classes (or objects) at runtime. They are the building blocks so that components can eventually encompass a large portion of a system.

Components are similar in practice to package diagrams, as they define boundaries and are used to group elements into logical structures. The difference between package diagrams and component diagrams is that Component Diagrams offer a more semantically rich grouping mechanism. With component diagrams all of the model elements are private, whereas package diagrams only display public items. The components are shown as rectangle with two small rectangles protruding from its sides which represents a part of the system that exists while the system is executing. It also exhibits dependency relationships shown by a dashed arrow from a client component to a supplier component for which it depends.

The Fig 4.6 Component diagram for a knowledge based system for malaria management

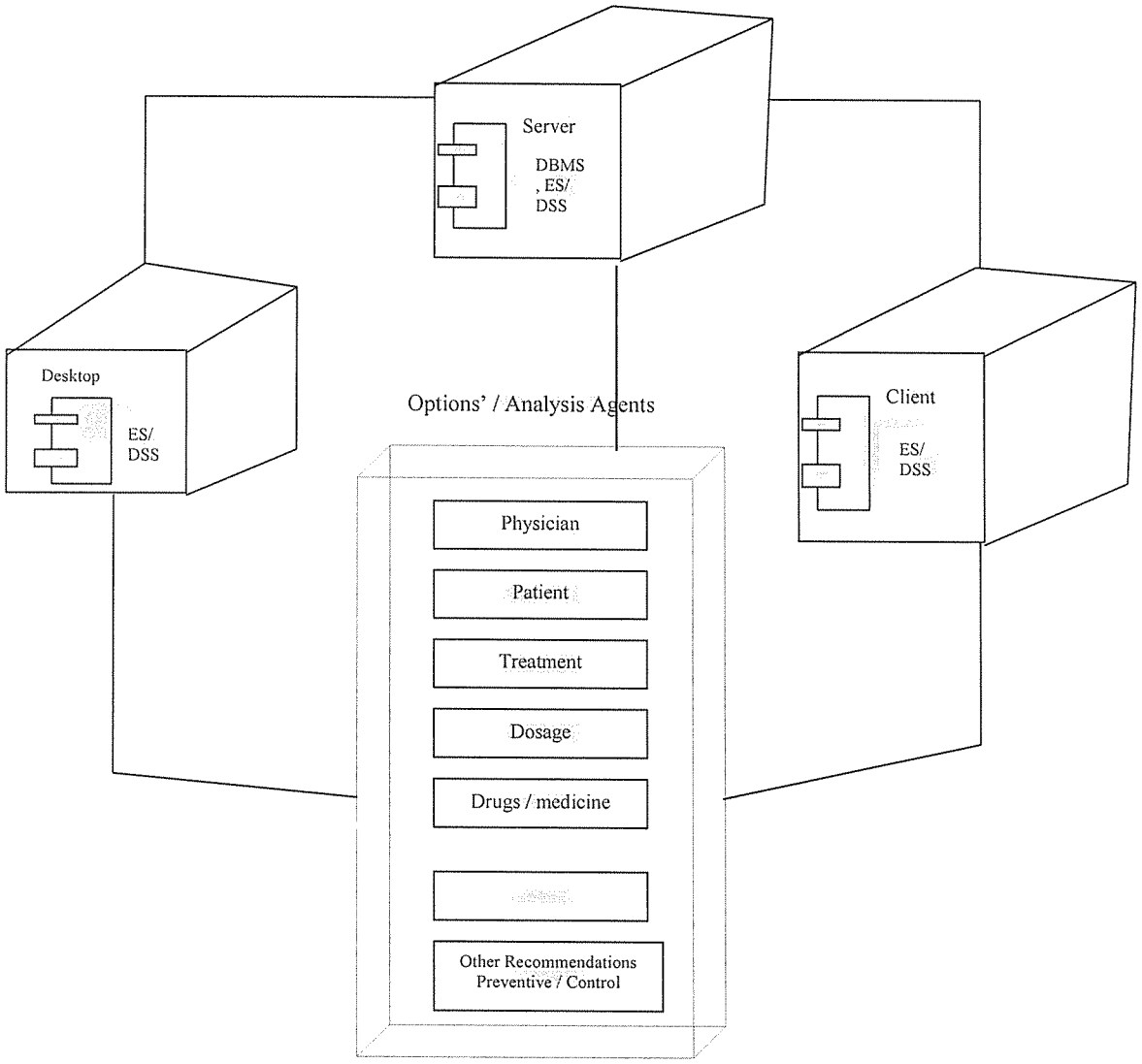


Deployment diagram

A deployment diagram or models or depict the run-time architecture of a system. It shows the configuration of the hardware elements and also shows how software elements and artifacts (products of the software development process) are mapped onto those nodes i.e. how the elements or components interact (an association represents a communication path between nodes) to implement a system in a particular

environment. A Node is either a hardware or software element. Requirements management in this case is an essential part of controlling complexity, risk, project scope and in un-ambiguously defining the goals and criteria for a successful software or business project. With UML and Enterprise Architect, you can model complex requirements and provide full traceability from each requirement right through to the final deliverables and system behaviour

Fig 4.7 Deployment diagram / the run-time architecture of the SAT system



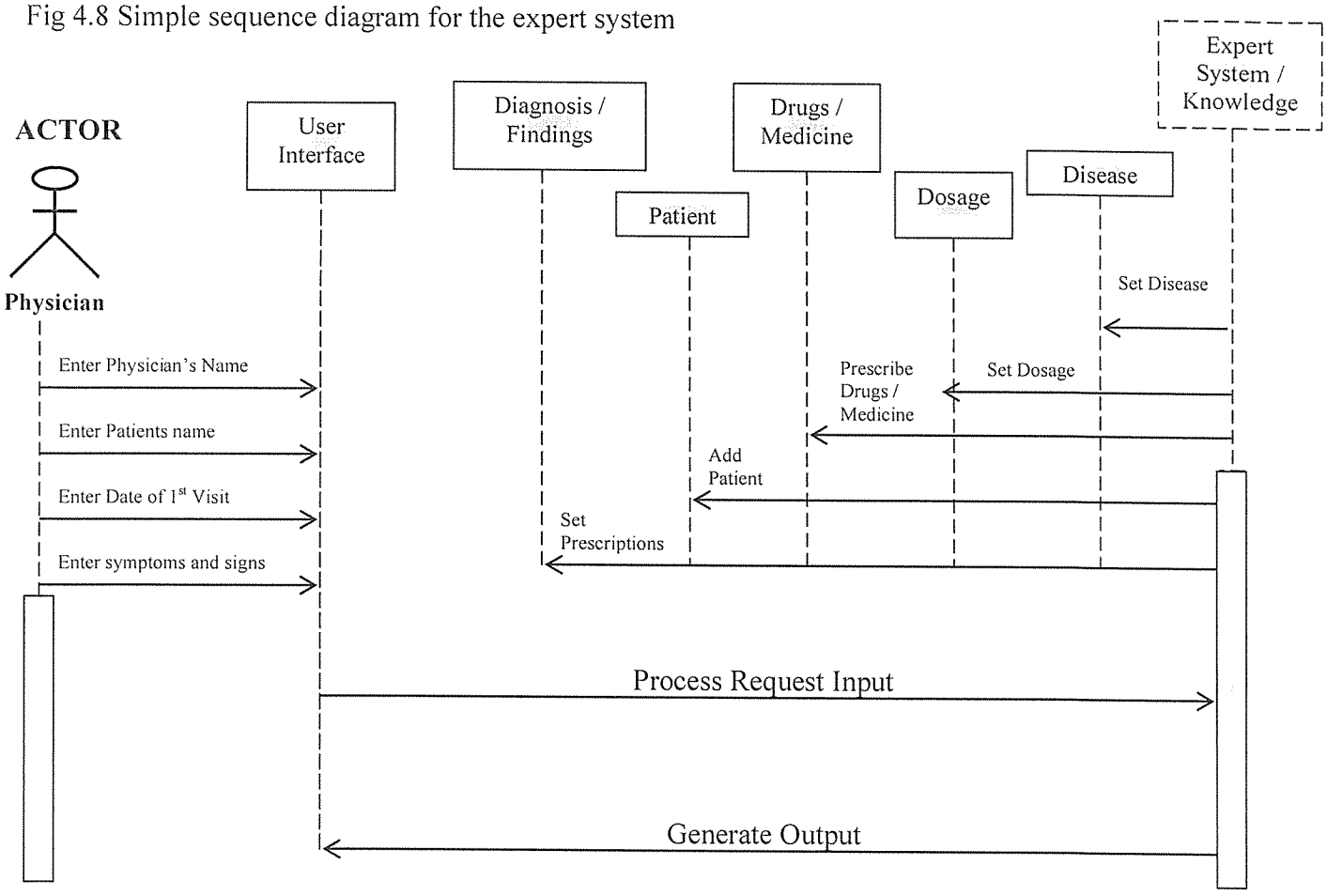
4.2.4 Behavioural diagram

These are the diagrams which are used to understand and communicating the way elements interact and collaborate with the purpose to provide a functionality of this required system. This explains the behavioral modeling in UML and it involves use of the following:

Sequence Diagrams

Sequence diagrams are also known as the interaction diagrams, used to depict or display the interaction between users, screens, objects and entities within the system. It provides a sequential map of message passing between objects over time. Frequently, these diagrams are placed under Use Cases in the model to illustrate the use case scenario, how a user interact with the system and what happens internally to get the work done. They have the following elements, Classes and Objects, vertical lines from the elements showing the existence of the element over time called life line, a horizontal solid arrow form the life line of the sender to the life line of the receiver labeled with a name of the operation to take place. This is called a communication. The collaboration diagram has the format below, which generates output according to the existing problem.

Fig 4.8 Simple sequence diagram for the expert system



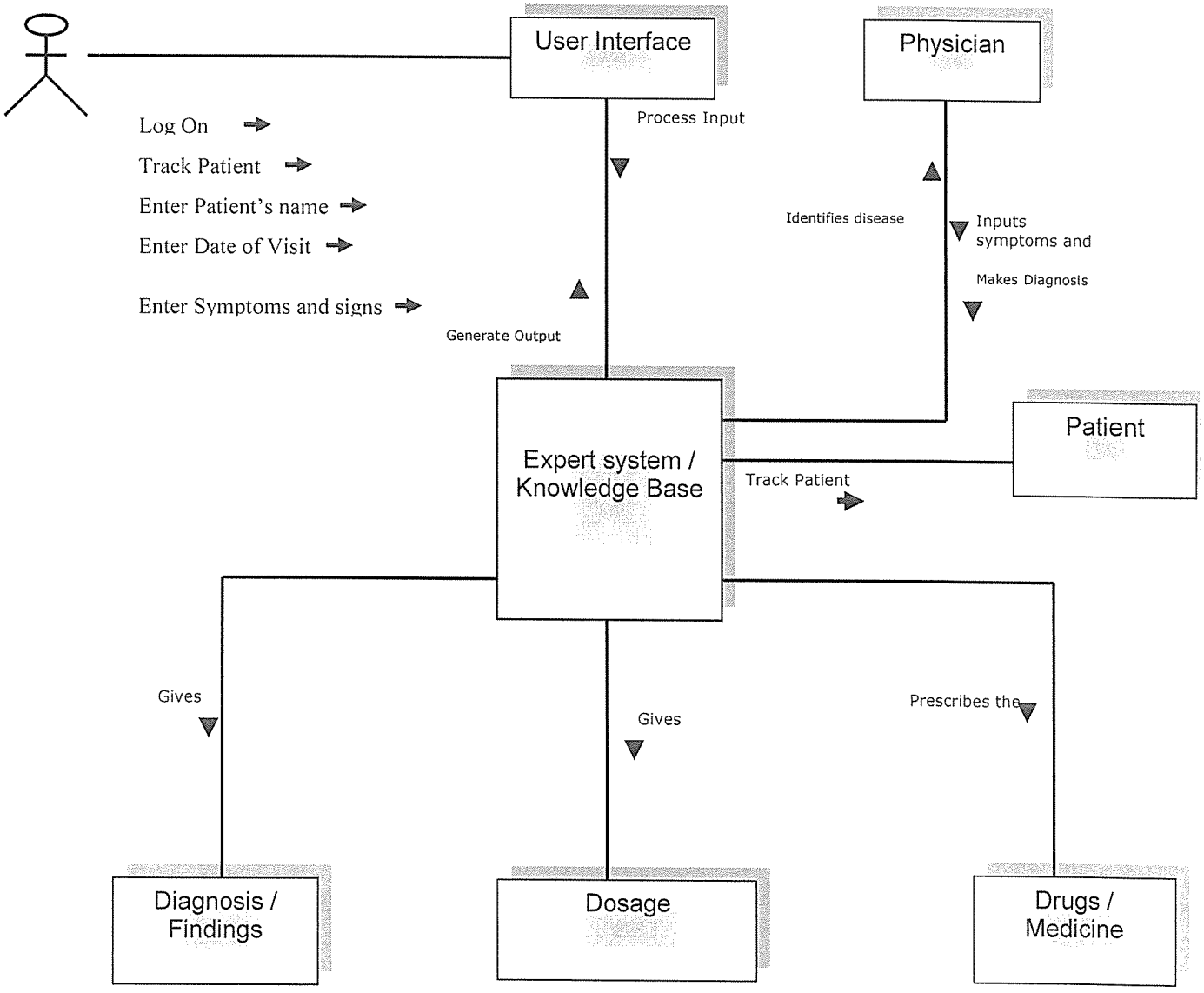
Sequence diagrams are good at showing which objects communicate with the other and what messages trigger off those communications. These sequence diagrams are not intended for showing complex procedural logic. Sometimes a sequence diagram will have a lifeline with an actor element symbol at its

head. This will usually be the case if the sequence diagram is owned by a use case. Messages are displayed as arrows. Messages can be complete, lost or found, synchronous or asynchronous, call or signal.

Collaboration

Collaboration defines a set of co-operating or interaction roles used collectively to illustrate a specific functionality. Collaboration should only show the roles and attributes required to accomplish its defined task or function. Isolating the primary roles is an exercise in simplifying the structure and clarifying the behavior, and also provides for re-use. Collaboration often implements a pattern and element is shown as an ellipse. Collaborations are shown by lines between objects, messages are shown as labeled arrows.
Collaboration also shows the relationship between objects and the order of messages passed between them

The Fig 4.9 Collaboration diagram for the expert system



4.3 System Design

This system was designed basing on two important components and these included, the Database system schema for keeping truck of important information, for example, about the patients, the physicians who handle them and the medicine used for treatment. This is very crucial in taking the history of the disease if it happens to reoccur in the future for a better management. The other component is the knowledge base, this is created to facilitate the inference of solution or new knowledge which can be used to take appropriate decisions during diagnosis, Dosaging, treatment and taking considerations of other preventive / control or case management mechanisms that can be employed in case treatment is overwhelmed by extremes of episodes. It included both the logical and physical designs of the system.

4.3.1 Logical Design

This includes the identification of the database tables, columns, keys, indexes and so on, that will store the required data sets and applications like forms, reports, menus that will operate on the database. Therefore the Agents that will constitute the system include the following objects:

1. Physicians
2. Patients
3. Drugs-Medicine for Treatment
4. Diagnosis
5. Dosage
6. Symptoms
7. Preventive / control method.

The interactions for these objects / Entities through their established relationships was reflected in the relational model during physical design as will be seen the subsequent chapters. The designs below reflect the fields to be considered, the data types and size for the data structures to be created. The designs for the Entities / Objects that will constitute the database system component agent in the expert system include the following:

Table 4. 1. 1 The physician

PHYSICIANS		
FIELDS	**DATA TYPE**	**SIZE**
Physician_ID	Char	3
Physician_Name	Char	20

Date	Date/Time	10
Location	Char	15
Department	Char	15
Specialization	Char	15
Category of case handled	Char	30
Comment / Remarks on the patient	VarChar	100

Table 4.1.2 The Patients

PATIENTS		
Date of visit	Date / Time	10
Patient_ID	Char	3
Patient's_Name	Char	20
Sex	Char	1
Age	Number	2
Physician / Doctor	Char	20
Body weight	Number	3
Complaint / Infection	Char	20
Diagnosis / Findings	VarChar	150
Prescriptions / Medication	VarChar	150
Dosage	Char	100
Comment / Remarks	VarChar	100

Table 4.1.3 Drugs-Medicine

Drugs_Medicine		
Medicine _ID	Number	3
Drug_Name	Char	20
Category	Char	15

MFD	Date / Time	20
EXPR	Date / Time	20
State	Char	20
Ingredients / Components	Char	100
Qty / Mgs	Char	10
Recommendations for use / Dose	Char	100

b) For the knowledge base, the following tabulation provided the contents that are required for the rules and procedures for the expert system to take decision during the process of providing solutions to the domain problem.

4.3.2 Symptoms

a) Uncomplicated Malaria

i) Clinical assessment

Fever

Headache

Backache

Joint pains

Rigors for 8-12 hrs with cold, hot stages and sweating

Table 4.1.4 Symptoms of Un complicated malaria

Un Complicated Malaria		
Children **< 5 yrs**	**Children** **5 – 12 yrs**	**Adults** **> 18 yrs**
• Fever • Refusing to feed • Crying a lot / irritable • Vomiting after feeding • Loose stool (diarrhoea like) • Convulsions	• Fever • Headache • General weakness of the body • Nausea / Vomiting • Sleepy appearance	• Fever for several hours • Headache • Joint pains • General body weakness • Bitter taste • Loss of appetite

• Drowsiness	• Convulsions	• Labour like abdominal pains • Dizziness • Backache • Shivering

ii) Laboratory findings

Malaria Parasites (MPs) asexual forms in blood film

b) Complicated Malaria

i) Clinical assessment

Table 4.1.5 Symptoms of Complicated / Severe Malaria

	Complicated / Severe Malaria
01	• Change of behaviour, confusion or Drowsiness
02	• Altered conscious or coma (unconsciousness)
03	• Convulsion
04	• Hyperglycemia (impaired release of glucose from the liver while tissues have a high demand of it.
05	• Acidosis (shortage of oxygen in the tissues occupied by the parasites
06	• Fits
07	• Difficult in breathing (pulmonary oedema or respiratory distress syndrome
08	• Acute renal failure
09	• Severe anaemia (haematocrit <20% Hb<6g/l, Dizziness tiredness, pollar (pale)
10	• Cerebral malaria
12	• Shock
13	• Dark reduced urine (Coca cola or coffee like colour)
14	• Jaundice
15	• Bleeding tendencies (PV bleeding in pregnant mothers)
16	• Prostulation (unable to sit up or stand without support)
17	• Severe vomiting

18	• Hyperprexia >39.5°C
19	• Threatening abortion (Uterine contractions, viginal bleeding)

Laboratory findings

Parastaemia >= 100,000 parasites / μL, MPs blood slides +, ++, +++, ++++ malaria parasite density

4.3.4 Diagnosis

- Consider all the Laboratory tests and examinations of the blood samples, like thick blood film for detecting the quantity of parasites and thin blood film for detecting the species specification
- All patients with fever
- Confirm the clinical diagnosis with Lab examinations
- Carry out differential diagnosis i.e. other causes of fever and causes of similar symptoms like Typhoid, Meningitis and Septicemia
- Carry out clinical investigation using the physical and the history examination of malaria.

4.3.5 Treatment

The treatment design model was destined to handle both the uncomplicated and complicated malaria. This is scheduled and named as first line drugs to handle the management of uncomplicated malaria and second line drugs to handle the complicated episodes.

First line drugs form malaria includes

i) Coartem, a combination of Artemerther and Lumerfantrine

ii) alternative, Artesunate and Amodiaquine

iii) Chloroquine (CQ) and Sulfadoxine Pyrimethamine (SP)

Second line for handling complicated or severe malaria

i) Quinine

The treatment of malaria using the drugs mentioned above is based entirely on the body weights which are seemingly dependent on the age (number of year) of the patient. Each day a dose is multiplied by 2 due the fact that it's taken in the morning and evening

Supportive or enhancements

- Paracetamol – 1g every 6 hrs for 3 days ⟶ 10 mg / Kg per dose
  Adults only 600 mg every 4 – 6 hrs
- Increased fluid intake

4.4 Physical Design

This phase of designed concentrated on the real object showing how they would be implemented to form the database system. It displayed the actual derivative of the Entity Relational model into what is termed as the Relational Model (RM) that defines the physical data files as represented in the constructs or the relational database schema below:

PHYSICIANS (**Physician ID**, **Physician Name**, Date, Location, Department, Specialization, Category of case handled, Comment / Remarks on the patient).

PATIENTS (Date of visit, **Patient ID**, Patient's_ Name, Sex, Age, **Physician / Doctor Name**, Body weight, Complaint / Infection, Diagnosis / Findings, Prescriptions / Medication, Dosage, Comment / Remarks).

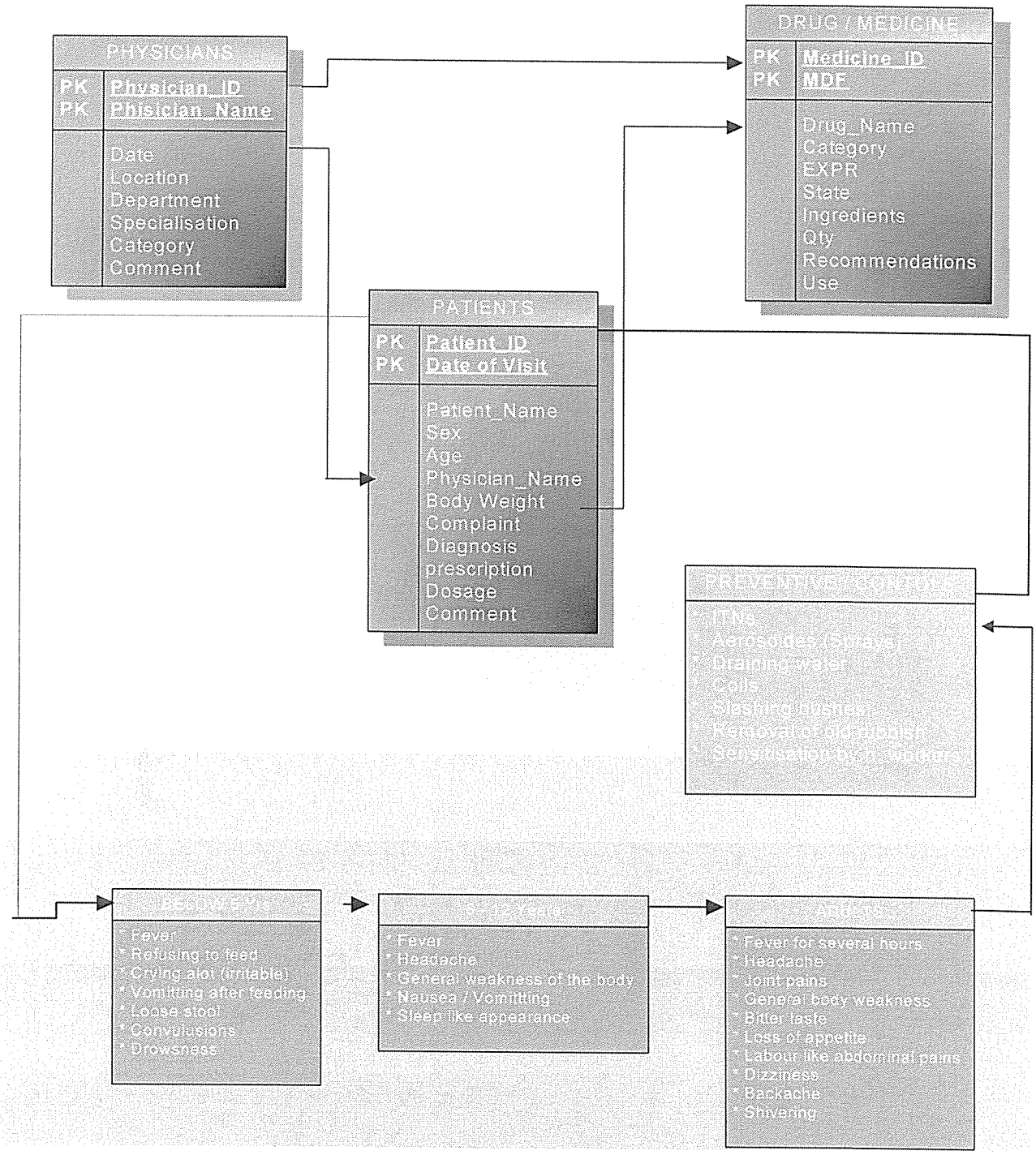
DRUGS-MEDICINE (**Medicine ID**, Drug_Name, Category, MFD, EXPR, State, Ingredients / Components, Qty / Mgs, Recommendations for use / Dose).

These objects have attributes that describe them and also fitted with relational keys the uniquely identify the respective records within those relations. These identifiers are known as *Primary Keys* (PK) and on the other case; they appear in other objects as *Foreign Keys (FK)*. These keys enforce relationships between them which could be described as either one – to – one, one – to – many, or many – to – many. Thus using the SQL statements and commands a number of operations can be administered on this database, they may include; updating, deletion, insertion, displaying values (retrieval) and so many others.

4.4.1Relational Model

This is a model that organizes and represents data in form of tables called relations. The relations are 2-Dimensional tables represented by tuples (rows) and attributes (c olumns). The descriptive way of the interaction is identified by the relationships that are defined by identifiers in form of Primary Keys (PK) and Foreign Keys (FK).

Fig 4.10 Relational Database Schema



The relational schema helps to enhance data normalization within the table. Normalization is a method of making relations fall into one or more categories or classes called Normal Forms which are class of relations free from certain set of modification anomalies. This reduces data redundancy caused by duplication or repeating values, which cause a reduction in the storage space hence affecting the proper operation of the

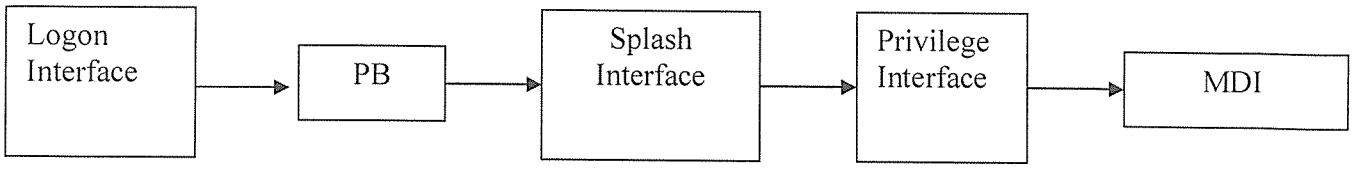
system. The database that trucks information about the patients, physicians, and treatment is connected to the knowledge base which make the inference for the new knowledge required in the management of the case including the preventive or control mechanisms that may be employed in case the frequency of the cases (episodes) escalated.

4.5 Interface Design

The interfaces in this case are the application interfaces commonly referred to Graphics User Interfaces (GUI). They interface the user and the system at the back end for every input and output data generated respectively. The users penetrate the system through using the predefined menus and controls developed onto the available applications designed to view or link other GUIs.

4.5.1 Security mechanism of the system.

Information security of this system covered a wide array of aspects which includes access controls that highlight the concerns of the system its self (software) and the processes (stored procedures and operations) intended to prevent un-authorized access, modification of instructions, deletion of the data structures, and the stored knowledge, other system resources or any disruptions that may compromise the efficiency (performance) of the system, or the platforms where the software is hosted, by exploiting the available vulnerabilities which can pause potential risks. This is implemented in the way that when the data stores are called for opening, sends a message that shows denial of access. This provides a reasonable reduction in the vulnerability and weaknesses that would have been exploited by the motivated agents of misuse and data loss thus minimizing interferences of the threats. This security is implemented looking at two important areas of primary focus and these include; *Physical security* that deals with considerations of securing the computer systems and also making sure that accidental and intentional acts are reasonably minimized in that environment. This is done by installing security system like Anti-viruses, d ata recovery and backups. Another mechanism is the *operations security* a means of controlling access to specific objects and resources of the system by particular subjects (users) including use of computers to procure control of other computer system where the software is installed. This was done through creating profiles that prompt username schemas or accounts and passwords so that the system can grant permission. In this case when the user logs onto the system or tries to access the object (database), the system checks and compares the rights and roles against the sets of authorizations before the access permissions are granted otherwise the denial of access will be realized. This process is called privilege authentication which acts as a key aspect in determining the actions a user can perform to the data structures.

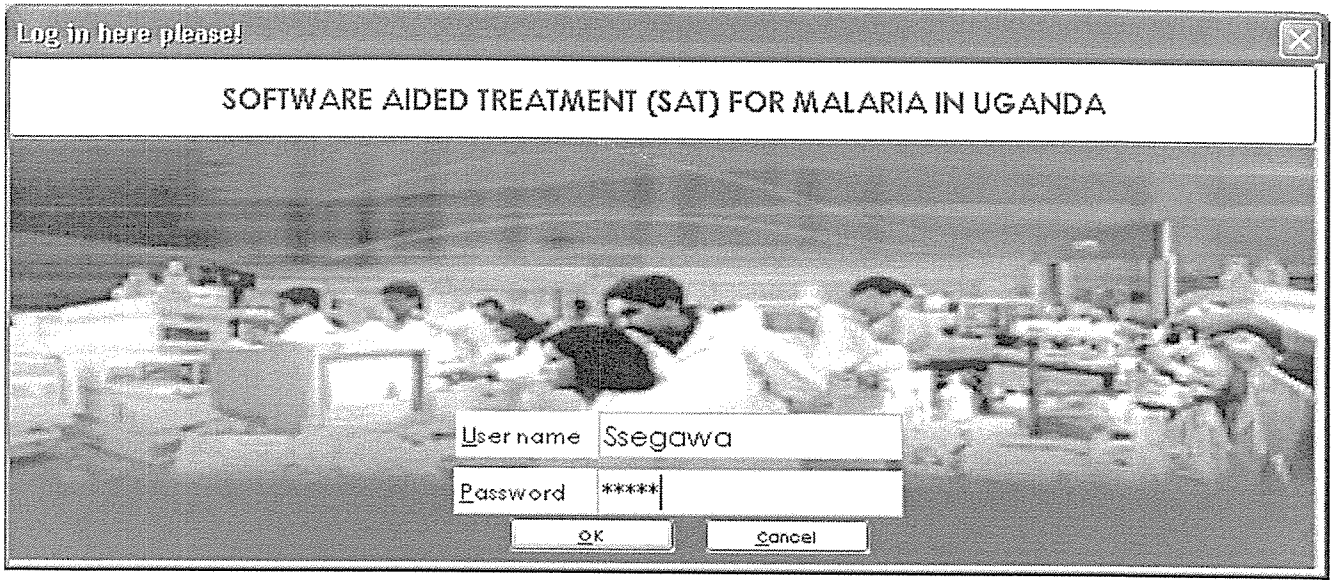


The whole security aspects was inspired to ensure that the system follows what is commonly known as the CIA paradigm, i.e. confidentiality in the essence of privacy, in that information and data can only be accessed by the bonafide users, Integrity of the data and knowledge base depends on the accuracy of the information provided on each subsequent time it is accessed so that it is not altered, remains the same for the particular domain of reasons for which it was retrieved and Available to the authorized users each time they try to create a view of it.

4.5.2 Log in Interface

This interface logs on the user into the system so as to start interacting with the different modules developed to provide the required output to satisfy the user's interests. This will be prompted through the use of user names and passwords enhanced through creating profiles for different users groups. Different users of this system are granted privileges and access right that helps them to optimize the advantages of using the system. When one logs on, the system first authenticates the users by finding out whether is a pre-defined user by auditing the user's personal settings, and then authorizes access to the data sets when authority is granted to the modules for which the privilege is defined. This is due to the fact that each specified user will have own privileges to interact with the system as a means and method of controlling user access. This is implemented as category privileges on a levels basis that take place at object, system and roles levels.

Fig 4.11 User with assigned privilege logging onto the system



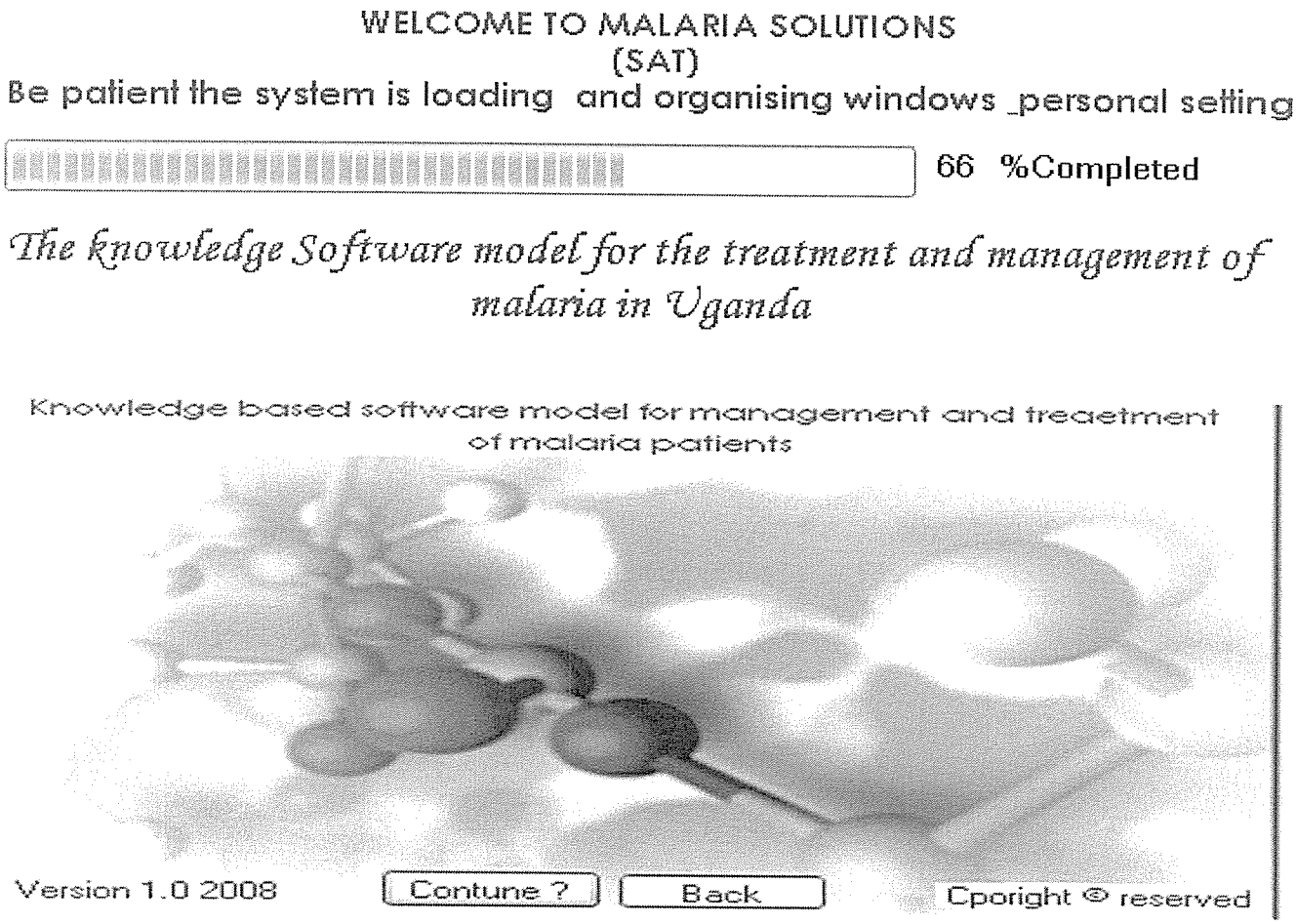
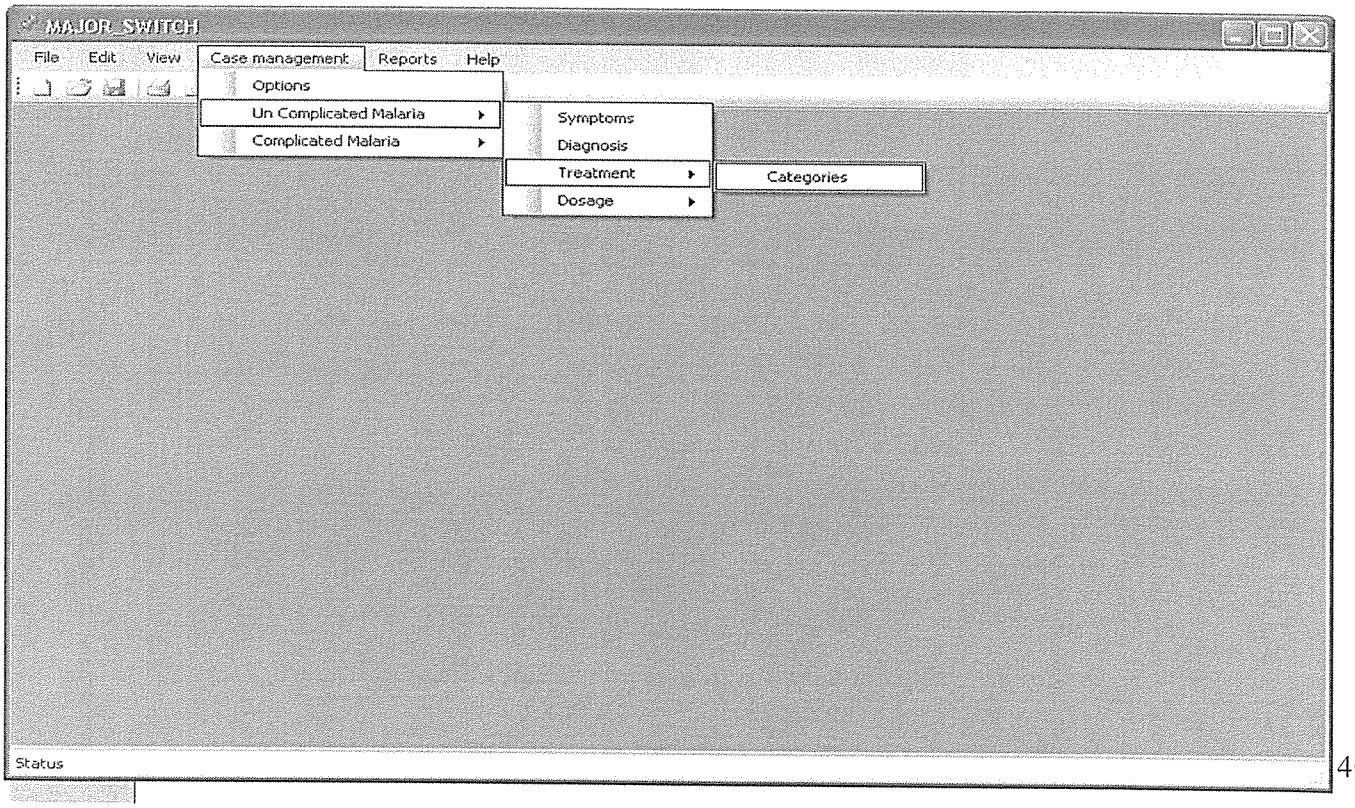


Fig 4.12 Main Document Interface (MDI) the acts as the main switch board for the system.



If the Treatment menu is clicked, it prompts an interface that guides the user to take options in order to achieve the desired goal information option for the management of the case.

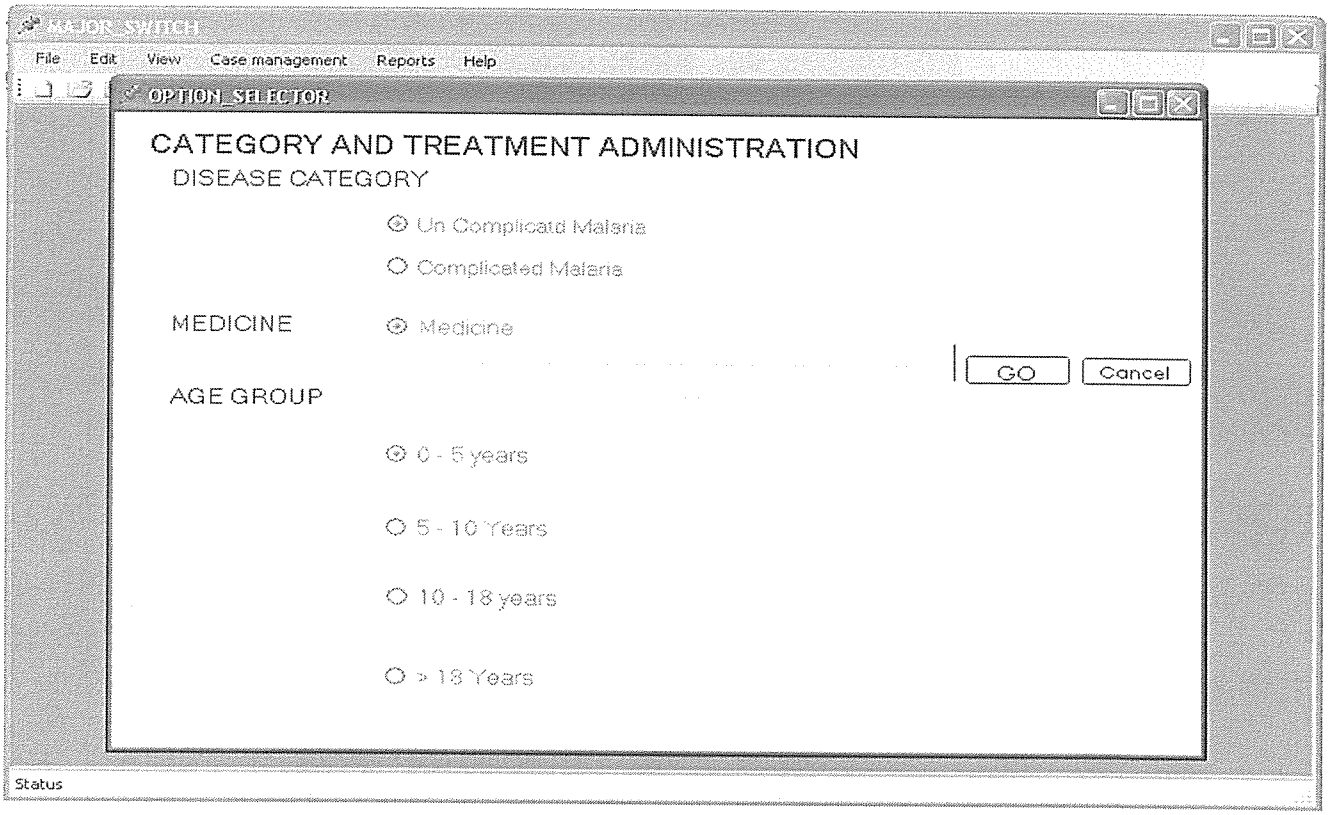
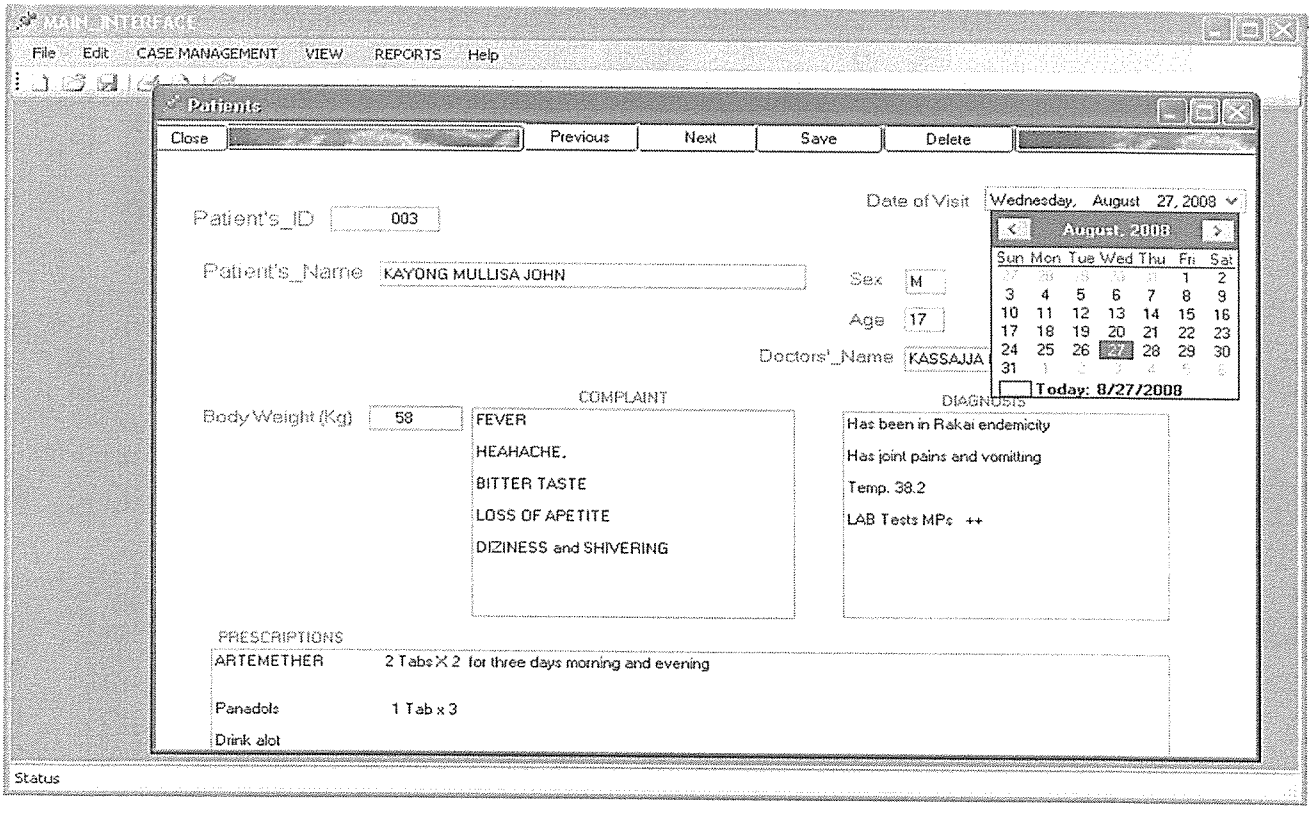
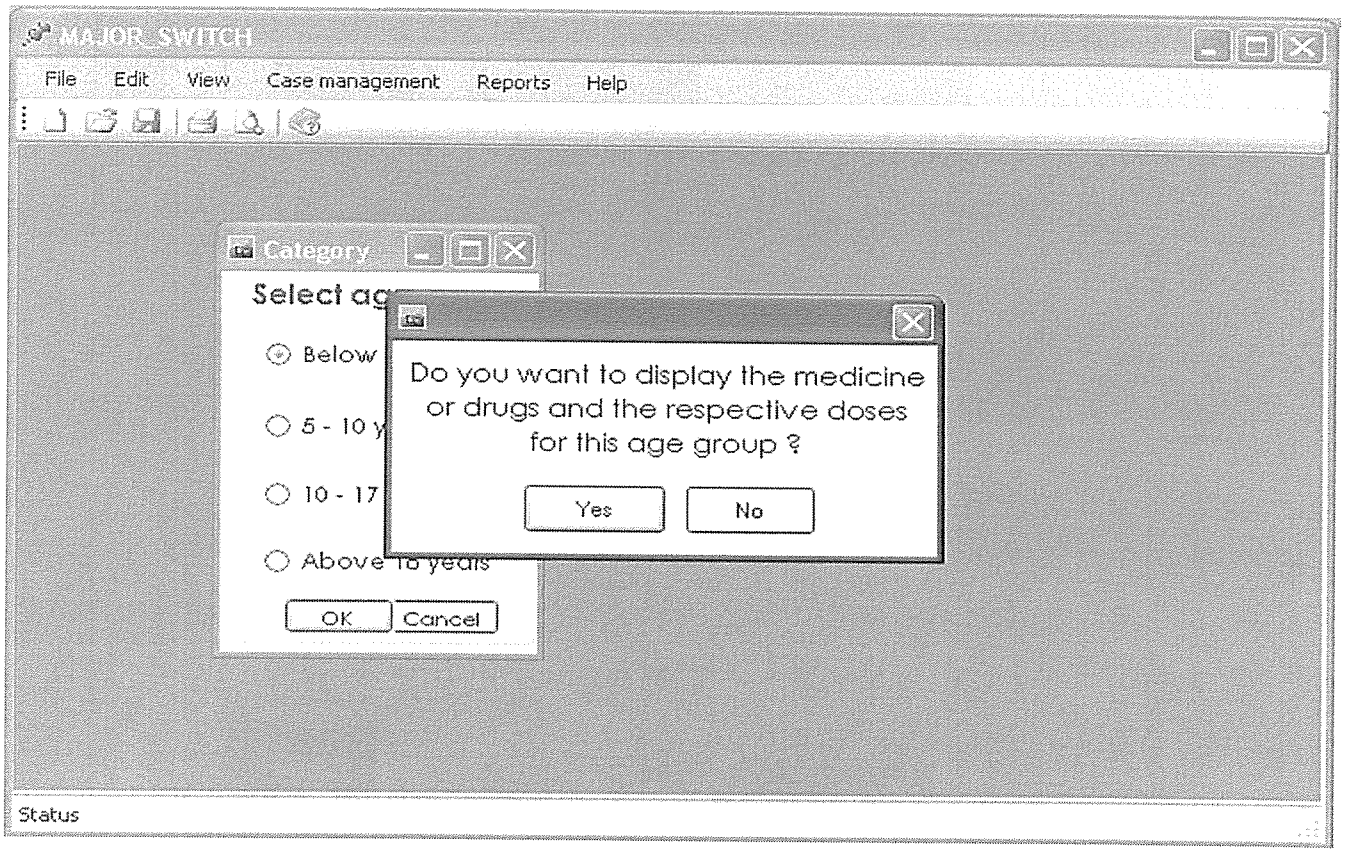
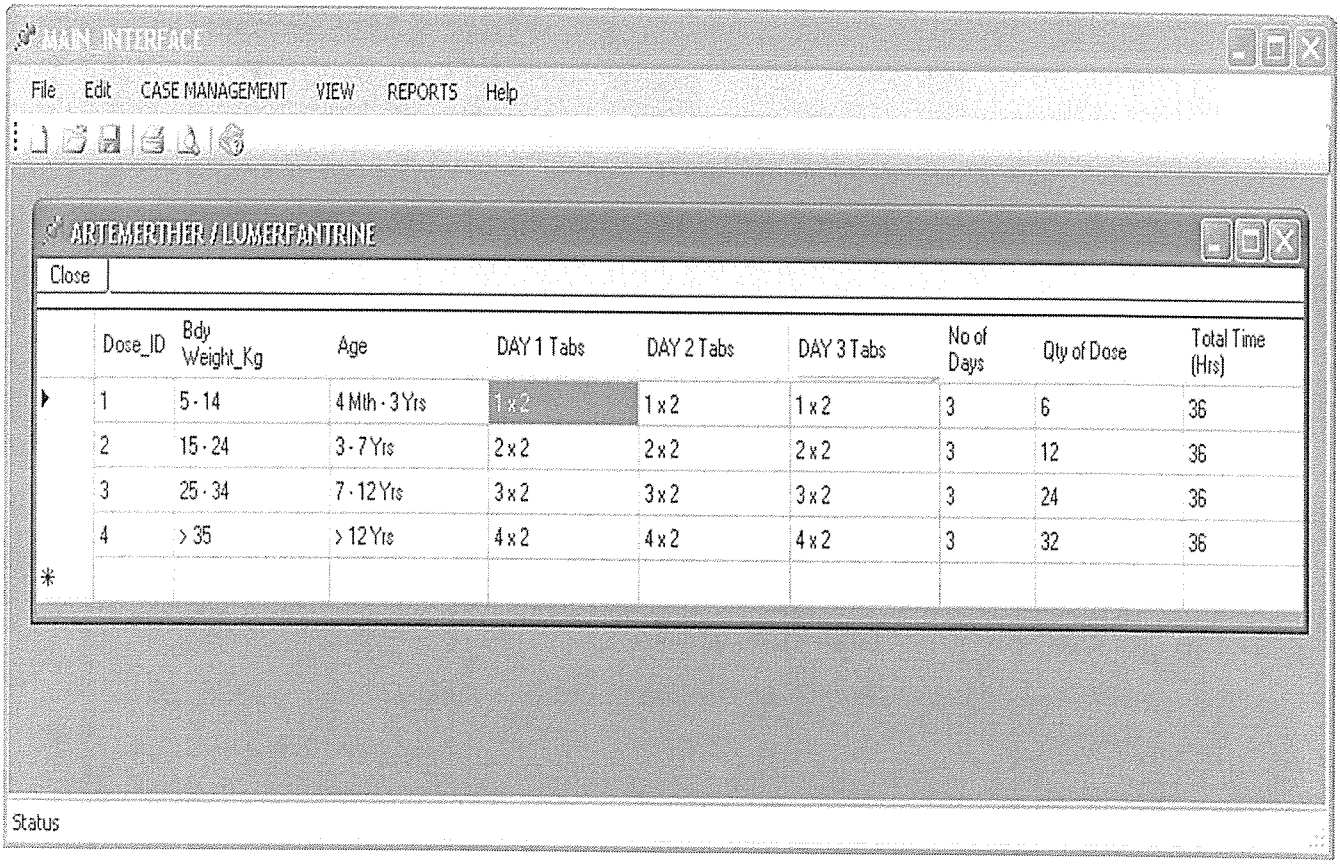


Fig 4.13 Input form for the Patients information.





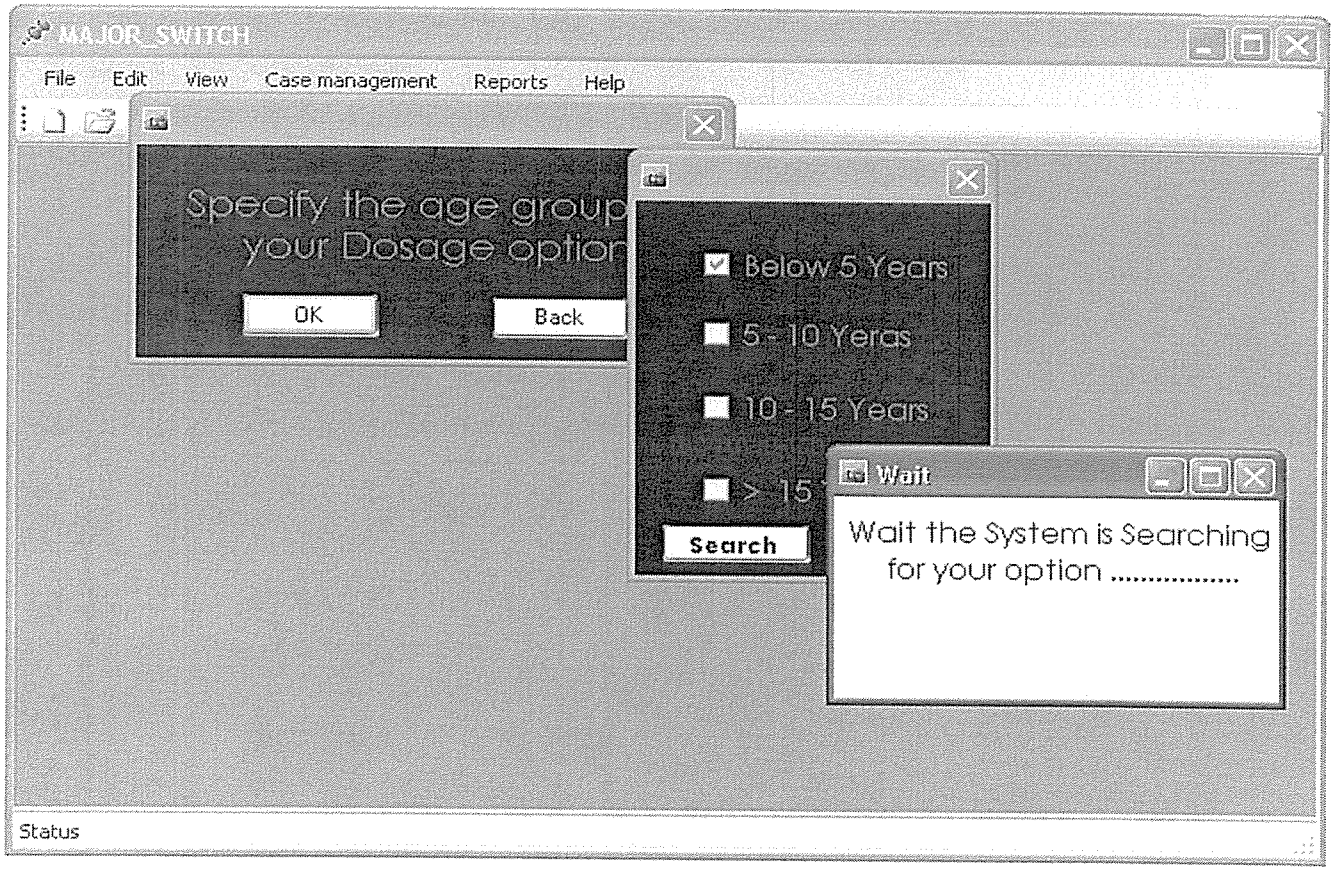
The general treatment information for the different age groups against the body weights of the patients is displayed in the table below

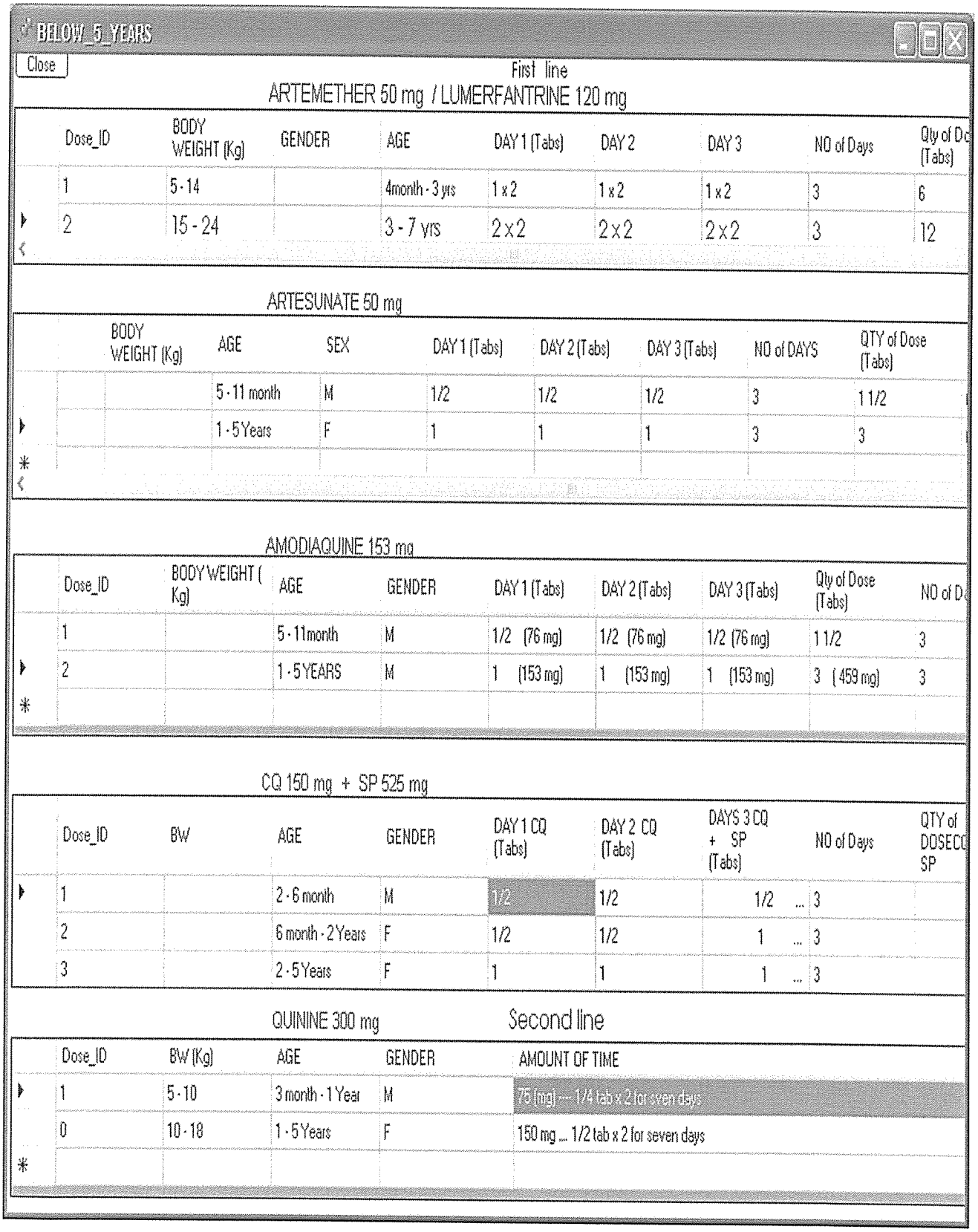


Dose_ID	Bdy Weight_Kg	Age	DAY 1 Tabs	DAY 2 Tabs	DAY 3 Tabs	No of Days	Qty of Dose	Total Time (Hrs)
1	5 - 14	4 Mth - 3 Yrs	1 x 2	1 x 2	1 x 2	3	6	36
2	15 - 24	3 - 7 Yrs	2 x 2	2 x 2	2 x 2	3	12	36
3	25 - 34	7 - 12 Yrs	3 x 2	3 x 2	3 x 2	3	24	36
4	> 35	> 12 Yrs	4 x 2	4 x 2	4 x 2	3	32	36

The same method is used to retrieve the dosage for the children or patients below five years of age. After the dose sub menu for uncomplicated malaria is clicked, the selection of the age group is also done to guide the user to take the right option. The relevant doses for the treatment of uncomplicated episodes in the patients below five years are displayed.

Fig 4.14 Drugs and the doses for treating malaria patients below 5 years of age





BELOW_5_YEARS

Close

First line

ARTEMETHER 50 mg / LUMERFANTRINE 120 mg

Dose_ID	BODY WEIGHT (Kg)	GENDER	AGE	DAY 1 (Tabs)	DAY 2	DAY 3	NO of Days	Qty of Do (Tabs)
1	5 - 14		4month - 3 yrs	1 x 2	1 x 2	1 x 2	3	6
2	15 - 24		3 - 7 yrs	2 x 2	2 x 2	2 x 2	3	12

ARTESUNATE 50 mg

	BODY WEIGHT (Kg)	AGE	SEX	DAY 1 (Tabs)	DAY 2 (Tabs)	DAY 3 (Tabs)	NO of DAYS	QTY of Dose (Tabs)
		5 - 11 month	M	1/2	1/2	1/2	3	1 1/2
		1 - 5 Years	F	1	1	1	3	3

AMODIAQUINE 153 mg

Dose_ID	BODY WEIGHT (Kg)	AGE	GENDER	DAY 1 (Tabs)	DAY 2 (Tabs)	DAY 3 (Tabs)	Qty of Dose (Tabs)	NO of D
1		5 - 11month	M	1/2 (76 mg)	1/2 (76 mg)	1/2 (76 mg)	1 1/2	3
2		1 - 5 YEARS	M	1 (153 mg)	1 (153 mg)	1 (153 mg)	3 (459 mg)	3

CQ 150 mg + SP 525 mg

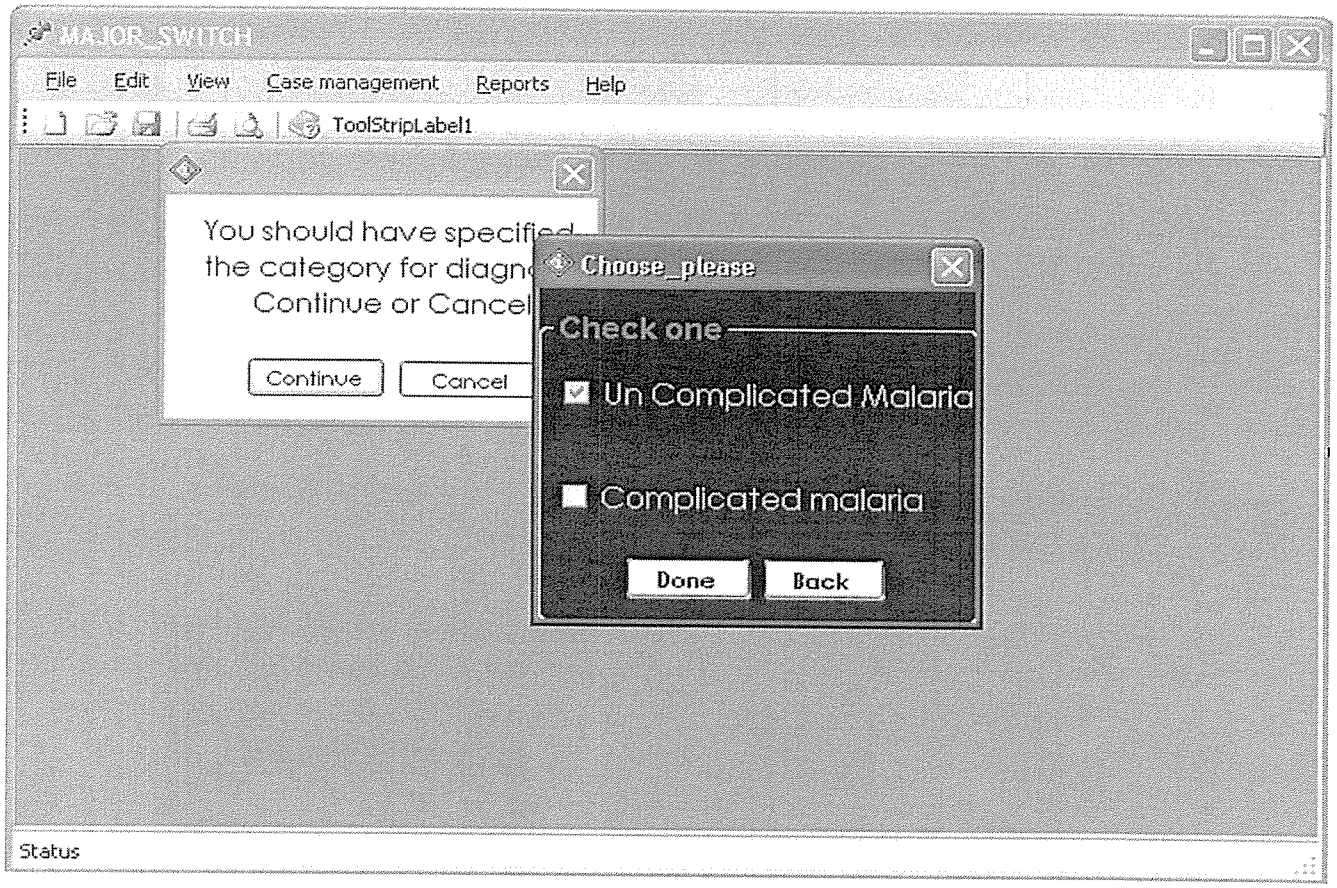
Dose_ID	BW	AGE	GENDER	DAY 1 CQ (Tabs)	DAY 2 CQ (Tabs)	DAYS 3 CQ + SP (Tabs)	NO of Days	QTY of DOSECQ SP
1		2 - 6 month	M	1/2	1/2	1/2 ...	3	
2		6 month - 2 Years	F	1/2	1/2	1 ...	3	
3		2 - 5 Years	F	1	1	1 ...	3	

QUININE 300 mg

Second line

Dose_ID	BW (Kg)	AGE	GENDER	AMOUNT OF TIME
1	5 - 10	3 month - 1 Year	M	75 (mg) --- 1/4 tab x 2 for seven days
0	10 - 18	1 - 5 Years	F	150 mg ... 1/2 tab x 2 for seven days

Fig 4.15 how symptoms are searched by the system



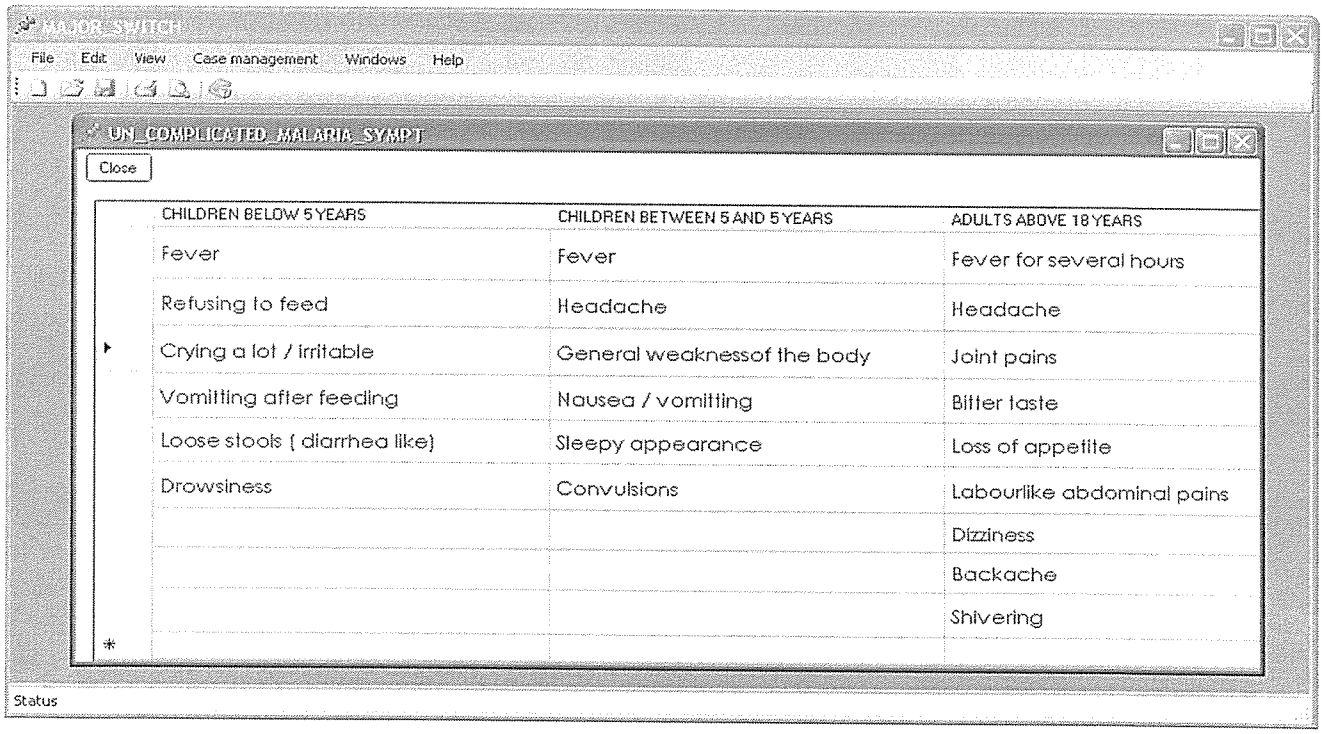
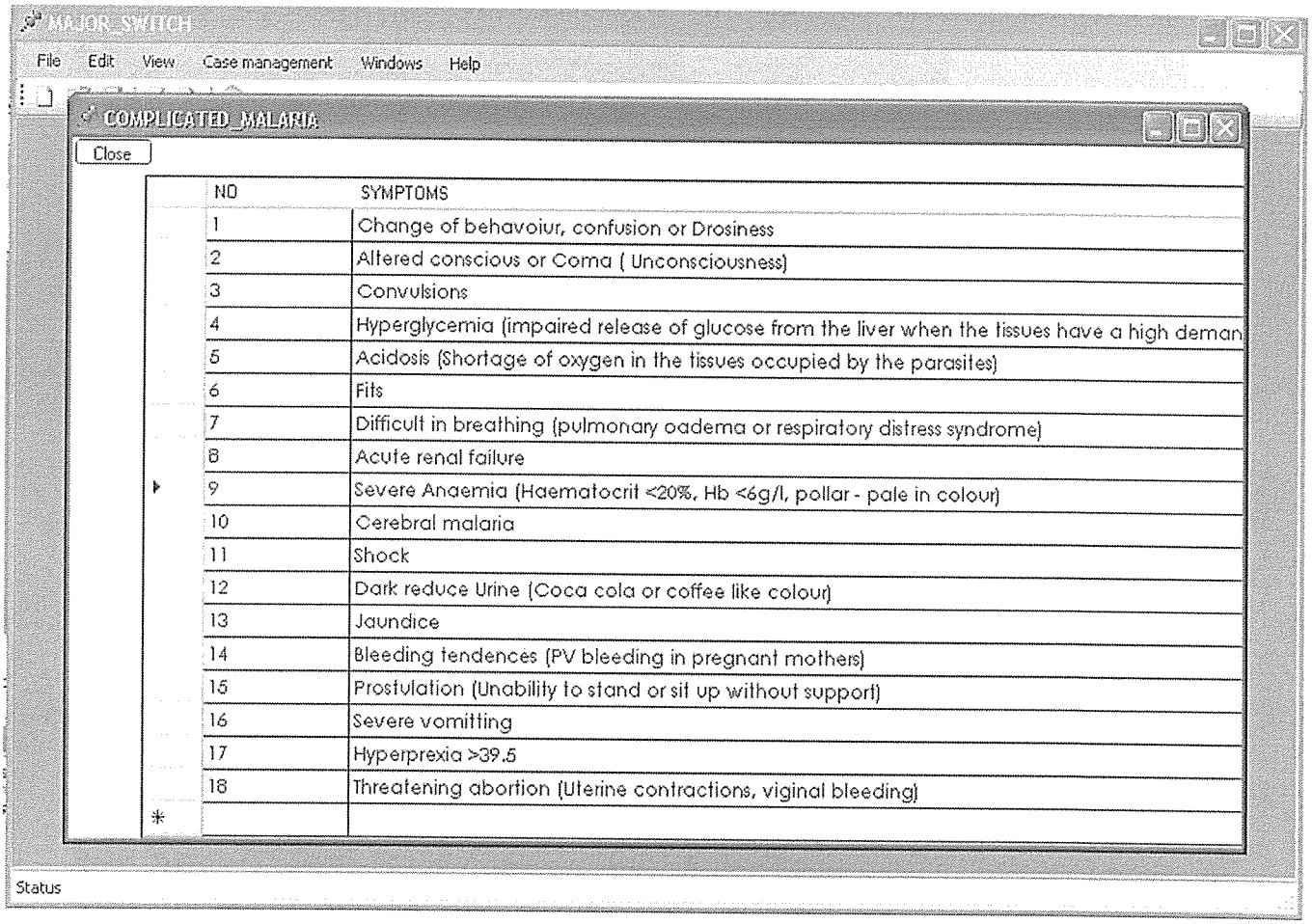


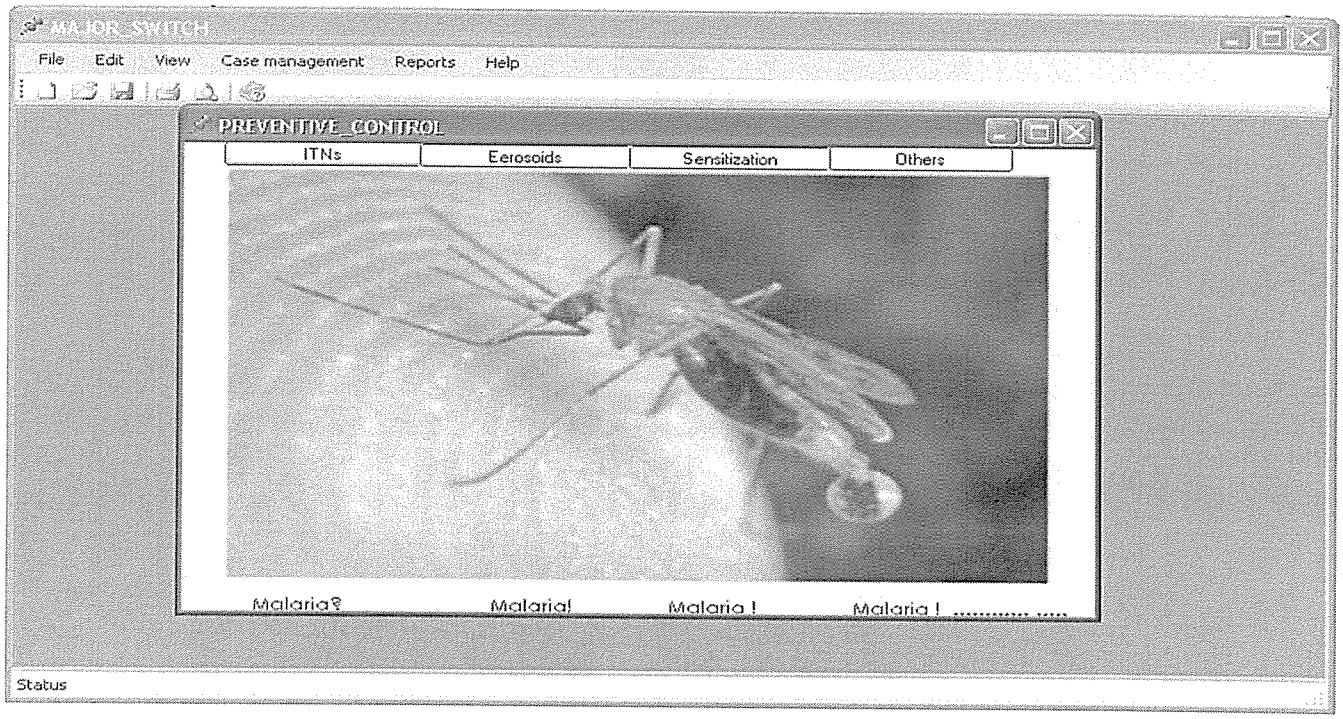
Fig 4.16 Symptoms of severe malaria

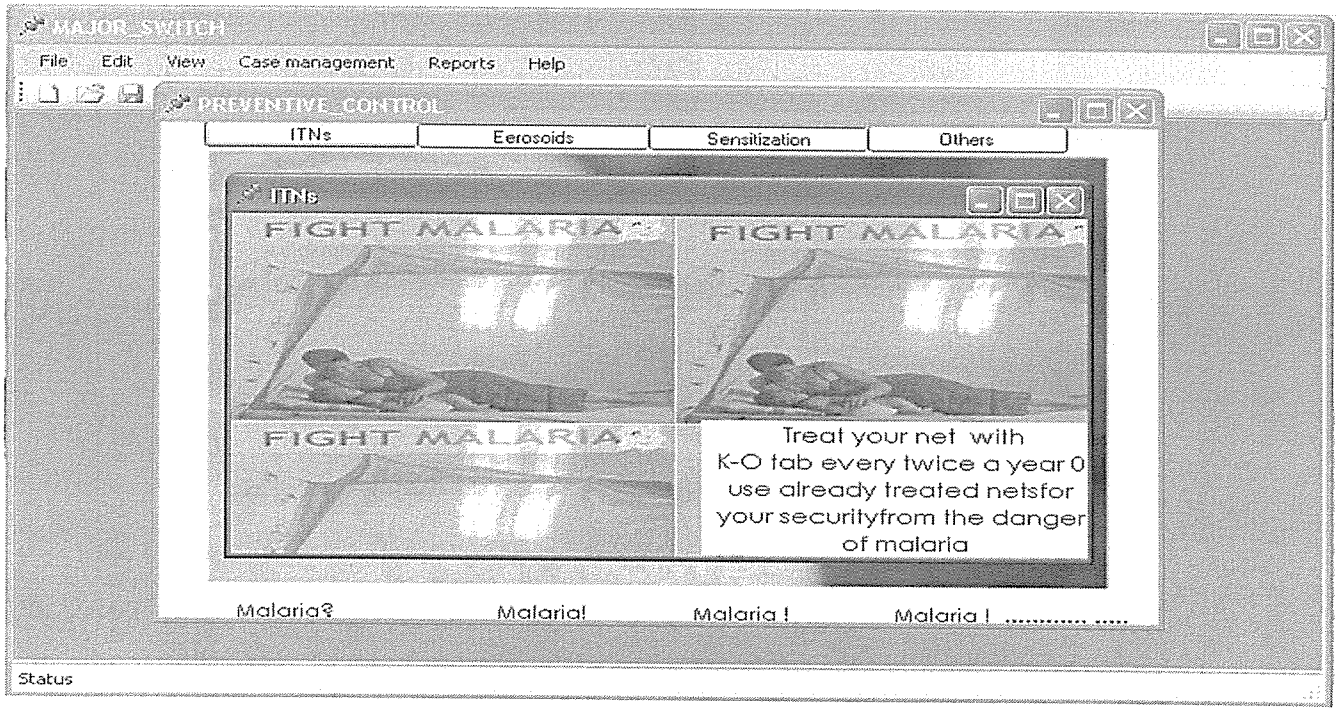


NO	SYMPTOMS
1	Change of behavoiur, confusion or Drosiness
2	Altered conscious or Coma (Unconsciousness)
3	Convulsions
4	Hyperglycemia (impaired release of glucose from the liver when the tissues have a high deman
5	Acidosis (Shortage of oxygen in the tissues occupied by the parasites)
6	Fits
7	Difficult in breathing (pulmonary oadema or respiratory distress syndrome)
8	Acute renal failure
9	Severe Anaemia (Haematocrit <20%, Hb <6g/l, pollar - pale in colour)
10	Cerebral malaria
11	Shock
12	Dark reduce Urine (Coca cola or coffee like colour)
13	Jaundice
14	Bleeding tendences (PV bleeding in pregnant mothers)
15	Prostulation (Unability to stand or sit up without support)
16	Severe vomitting
17	Hyperprexia >39.5
18	Threatening abortion (Uterine contractions, viginal bleeding)

The preventive / control methods of malaria can also be provided by the system if the user wanted to find out the what can be done so as to reduce the impact and the occurrences of malaria in the society of communities where treatment appears to be expensive, for example using ITNs, aerosols (spraying), draining stagnant water, using coils, slashing bushes around homes, removal of old cups and tyres and sensitization of the communities about the methods of control and prevention.

Fig 4.17 Preventive / control methods





CHAPTER FIVE

SYSTEM IMPLEMENTATION AND TESTING

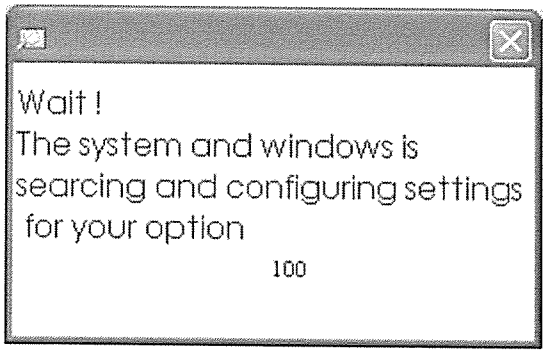
5.0 Introduction

System implementation is a normal technical mechanism of execute or putting the system in place in order to satisfy its cause using the embedded functionalities. It involves identifying the platform or site where it is going to be deployed so that it can work properly. System implementation takes place after the processes of design and modeling, coding and documentation, installation, testing, system change over process, training and maintenance.

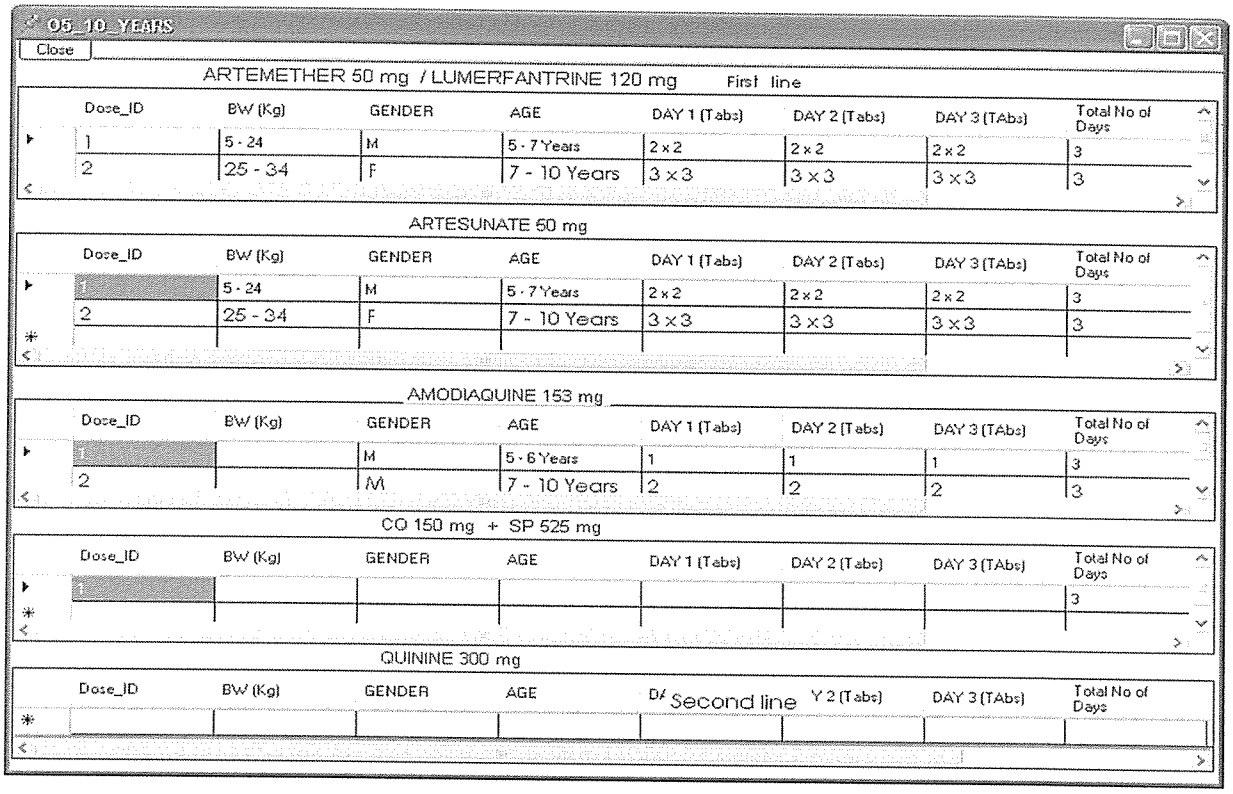
5.1 Implementation

This involves the processes like the actual construction of the modules and subsystems through coding using a known programming language. This helps to actualize the components that make up the whole system. Thus the design was done using Visual Basic (VB).Net to create the interfaces for both input and output forms and connected to the database and the knowledge base at the back end using Microsoft SQL server 2005.

Fig 5.0 Treatment and dose information for the patients below five years



When the system is prompted to generate the treatment and dose for the diagnosis made for the patients between 5-10 years, it searches, picks and displays the treatment information from the knowledge base or database. This is displayed in the form below and the code that implements the process is portrayed.



5.1.1 Coding and documentation

The codes show how the precedures and controls are effected and the expalnations made to show what the codes do to satisfy the need.

```
Public Class Wait

    Private Sub Timer1_Disposed(ByVal sender As Object, ByVal e As System.EventArgs)
Handles Timer1.Disposed

    End Sub

    Private Sub Timer1_Tick(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Timer1.Tick
        ProgressBar1.Value += 2
        If ProgressBar1.Value >= 100 Then
            If ProgressBar1.Value = 100 Then
                Timer1.Enabled = False
            End If
        End If
        pl.Text = pl.Text + 2
        If ProgressBar1.Value = 100 Then
            Me.Hide()
            SPLSCRE.Show()
        End If
    End Sub
Private Sub frmProgress_Load(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.Load
        ProgressBar1.Minimum = 0
```

```
        ProgressBar1.Maximum = 100
        ProgressBar1.Value = 0
    End Sub
End Class

Public Class UN_COMPLICATED_MALARIA_SYMPT

    Private Sub UN_COMPLICATED_MALARIA_SYMPT_Load(ByVal sender As System.Object, ByVal
e As System.EventArgs) Handles MyBase.Load

 //'TODO: This line of code loads data into the
'SATMALDataSet13.SYMPTOMS_UN_COMPLICATED_MALARIA' table. You can move, or remove it,
as needed.

Me.SYMPTOMS_UN_COMPLICATED_MALARIATableAdapter1.Fill(Me.SATMALDataSet13.SYMPTOMS_UN_CO
MPLICATED_MALARIA)

 //'TODO: This line of code loads data into the
'SATMALDataSet7.SYMPTOMS_UN_COMPLICATED_MALARIA' table. You can move, or remove it, as
needed.

Me.SYMPTOMS_UN_COMPLICATED_MALARIATableAdapter.Fill(Me.SATMALDataSet7.SYMPTOMS_UN_COMP
LICATED_MALARIA)

    End Sub

// This code helps to display the form that has does for all the drugs and hides the
one which has command button that prompts it as a child form

    Private Sub Button2_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button2.Click
        DOSES__FOR_ALL__DRUGS.Show()
        Me.Hide()
    End Sub

// The code below closes or exits the form

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button1.Click
        Me.Close()
    End Sub
End Class

// This code tries to set the data from the present to the previous record using the
prescribed data set. It can also be customized for the next, last or first recode in
that class.

    Private Sub BtnPrevious_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles BtnPrevious.Click
        Me.BindingContext(SatmalDataSet1, "Drug_Medicine").Position =
(Me.BindingContext(SatmalDataSet1, "Drug_Medicine").Position - 1)

    End Sub

    Private Sub Button4_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles Button4.Click
        Try
 // 'Clear out the current edits

            Me.BindingContext(SatmalDataSet1,"Drug_Medicine").EndCurrentEdit()
            Me.BindingContext(SatmalDataSet1, "Drug_Medicine").AddNew()
```

```
        Catch eEndEdit As System.Exception
            System.Windows.Forms.MessageBox.Show(eEndEdit.Message)
        End Try
    End Sub


// Using the data adapter and data set, the code helps to clear and the fill the form
with data when the form loads

    Private Sub DRUGS_Load(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles MyBase.Load
        SatmalDataSet1.Clear()
        OleDbDataAdapter1.Fill(SatmalDataSet1)
        BtnSave.Enabled = False
        BtnDelete.Enabled = False

    End Sub
End Class
```

Programming languages used is visual basic when combined with SQL statements made using SQL server DML procedures and controls. This is possible because the language is structured to do the manipulation of the database to provide the required data elements or sets according to the questions / queries a user makes. Further documentations is done in order to prepare user manuals for which the users can base on to do different activities on the system, like installation instructions and methods, trouble shooting, and maintainability of the system. On completion the coding process, system installation proceeds to make sure that it is used as required. Considerations and attention were mostly paid on hardware and software requirement and recommendations as was the case in the system requirement analysis

5.1.2 Installation

This involves the way how the system will be put to use using a computer system. The installation procedures are generated when the setup is run. The whole process of loading the software on the default drive is determined by the sufficiency of the disk space and RAM. Double click the setup as the executable driver, it will auto run initialize the system and then starts installing the software in the computer system, and during the installations, several requirement options are prompted by the user as required like choosing the default drive. The progress of the installation is guided by the wizard to completion.

5.1.3 Testing

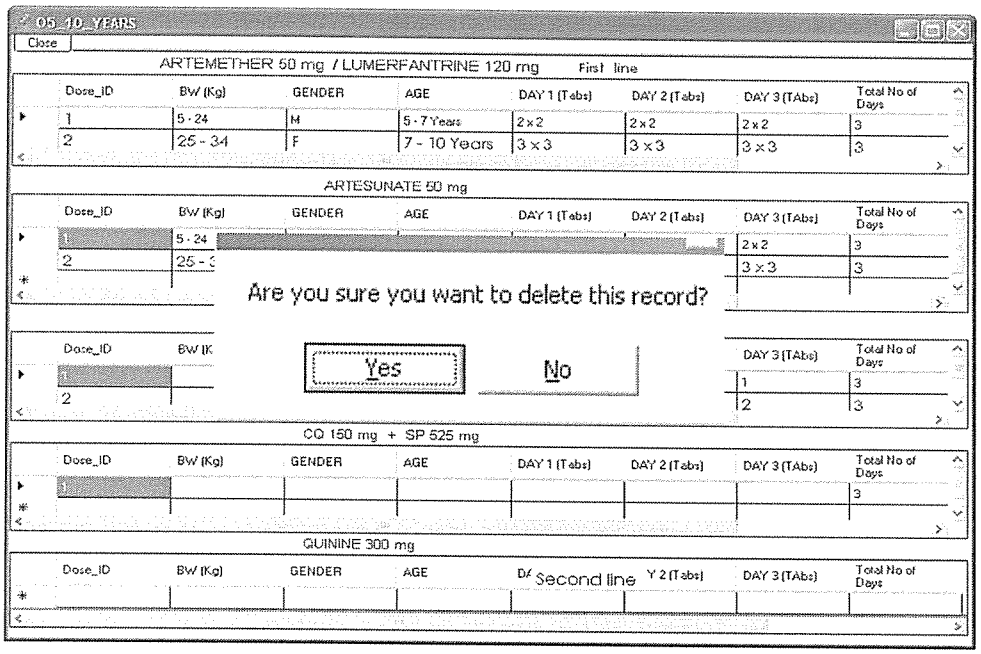
This process involves the mechanisms of finding out whether the system meets the requirement specifications for the users' needs by which it was developed. If its functionalities satisfy the users' requirements as was stated in the system requirement specification document (SRS), therefore, the system is regarded to be working properly.

Unit testing

A unit is the smallest testable part of an application. Testing was done on the subsystems that constitute the main system by applying actual data that corresponds to the data types in the design upon the modules of the database and knowledge base. The modules and the whole system accepted this data; the abstract data (False data) was rejected since it exhibited invalid data types. This is a method of testing verifies that the individual components of source code are working properly, correctly and efficiently. The application was tested at each stage of module development. Each module was tested individually to ensure quality and compatibility and to establish whether each module performed the required function.

In the same way when data was to be deleted, the system would send message boxes to confirm the action to be undertaken by the user. This process helps therefore to validate the compliance of the system to the cause for which the system was developed.

Fig 5.1 Confirmation of action from the user



System testing

After unit testing, the units are then integrated into one system and then tested as one entire component. System testing is performed on the entire system in the context of a Functional Requirement Specifications (FRS) and or a System Requirement Specification (SRS). During testing, both correct and junk data is used to provide input to the system and the behavior of the system is monitored in relation to the kind of input that was provided. It was also during this testing that the system was subjected for acceptance by users, and after this stage, the system is finally passed and commissioned for use.

5.1.4 Maintenance

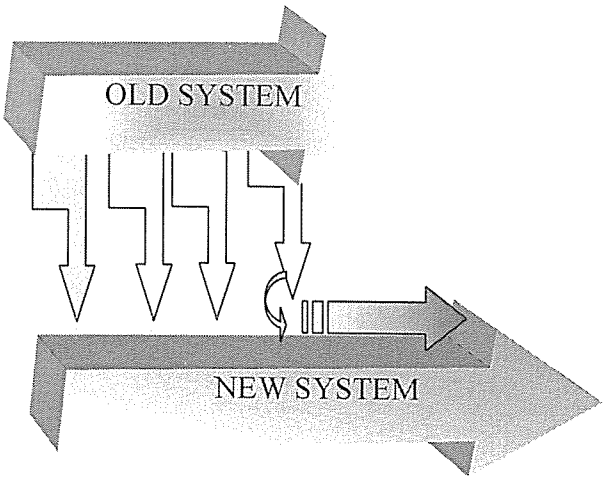
Acceptance testing and commissioning of the system, makes it become operational and thus because of the undiscovered errors during testing and coding, the system is to be maintained through out its life by debugging all the identified mistakes. This is because the system is dynamic, it keeps on expanding and growing due to the fact that new knowledge is being inferred and also user requirements change over time, this calls for functionalities and source codes be adjusted and maintained in line with user requirements and the systems is expected to perform more and have much more capability in the future. Change in technology for both the hardware and software, the system will have to be modified to fit in with the new technology. Maintenance is an endless process, it continues until the system is discarded or obsolete.

5.2 System change over method / conversion

This is the system used by organizations or business enterprises to change ways and means of operation in a particular field of work, for example changing from an old system and adopting a new one. This process is called system conversion. System change over are demanded by changes in the methods of operation that are intended to satisfy the business needs and rules, for example, changes in technology (hardware and software), new system requirements and users needs, bulk of work and service demands, the future projected business strategies and so many others.

There are different ways of how this can be made, they include; Parallel conversion, direct cross over and other similar ones among others. The recommendation the researcher made for this system was a parallel conversion method, this is because it was identified most of the personnel that handles diagnosis and treatment of the malaria patients have little knowledge and skills of using computer systems, thus require training so as to efficiently exploit the advantage and potential of the expert system in decision making to manage malaria cases.

Fig 5.2 Parallel conversion / system change over



The arrows show how the system assimilation takes place

The advantage of this method is that it allows the user to gradually develop a thorough understanding of the new system in terms of its functionalities against the old method. It also helps the user to integrate the both methods of assessment of the disease pathology to a better interpretation of the case, because the clinical assessment guides the use of the expert system to manage the case.

CHAPTER SIX

RESULTS, DISCUSSION, SUMMARY, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter deals with the general over view of the study and tries to summarize it. It tries also to point out the general limitations and challenges encountered during the process of carrying out this study. It views the recommendations to the system and administration in especially the areas where different disparities and shortcomings have been glossily perversed.

6.1 Results

a) Attitude of the patient towards the drugs

Correlations

		CAWARENE	DCOMPLET	FEELING
CAWARENE	Pearson Correlation	1.000	.216*	-.120
	Sig. (1-tailed)	.	.016	.119
	N	99	99	99
DCOMPLET	Pearson Correlation	.216*	1.000	-.261**
	Sig. (1-tailed)	.016	.	.004
	N	99	99	99
FEELING	Pearson Correlation	-.120	-.261**	1.000
	Sig. (1-tailed)	.119	.004	.
	N	99	99	99

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

Fig 3.0

b) Completion of dose by the patient

Correlations

		DVARIANC	CAWARENE	DCOMPLET	FEELING
DVARIANC	Pearson Correlation	1.000	.219*	-.096	.004
	Sig. (1-tailed)	.	.015	.172	.483
	N	99	99	99	99
CAWARENE	Pearson Correlation	.219*	1.000	.216*	-.120
	Sig. (1-tailed)	.015	.	.016	.119
	N	99	99	99	99
DCOMPLET	Pearson Correlation	-.096	.216*	1.000	-.261**
	Sig. (1-tailed)	.172	.016	.	.004
	N	99	99	99	99
FEELING	Pearson Correlation	.004	-.120	-.261**	1.000
	Sig. (1-tailed)	.483	.119	.004	.
	N	99	99	99	99

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

Fig 3.1

c) Recovery and compliance to drugs

Correlations

		DVARIANC	DCOMPLET	FEELING
DVARIANC	Pearson Correlation	1.000	-.096	.004
	Sig. (1-tailed)	.	.172	.483
	N	99	99	99
DCOMPLET	Pearson Correlation	-.096	1.000	-.261**
	Sig. (1-tailed)	.172	.	.004
	N	99	99	99
FEELING	Pearson Correlation	.004	-.261**	1.000
	Sig. (1-tailed)	.483	.004	.
	N	99	99	99

**. Correlation is significant at the 0.01 level (1-tailed).

Key
CAWARENE = Cost awareness
DCOMPLET = Dose completion
FEELING = Patients attitude
DVARIANC = dosage variance

Fig 3.2

Interpretation

At each level of the variables in each case as above, the correlation between the variables is evaluated significant as indicated in the foot notes. This means that there is an actual relationship one variable to another thus one influences another whereas the one side lined by a negation shows uncompliance or incompatibility between the variables.

6.4 Discussion

The attitude and feeling displayed by the patients towards the drugs, originates from the cost awareness that affect completion of the doses prescribed by the physicians, hence affecting the patient's recovery from malaria, this was significant at 0.216 (Fig 3.0) for dose completion and cost awareness. This is true in the sense that once the patients are told about the cost they have to incur for the treatment of malaria, they usually don't complete the doses because they can not afford to pay due to poverty.

Recovery and compliance to drugs by the patients is also associated with the attitude. When the physicians treat the patients and malaria doesn't cure, this means that the methods of drug administration play an important part in determining the level of recovery of the patient. The correlation is significant at the 0.01 Fig.3.3

6.1 Summary

This software tries to respond to the management requirements of the user in the bid to finding an appropriate information option and solution to manage malaria cases in the malaria patients (population) through diagnosis and treatment. The SAT system for the management of malaria cases in the subsequent environments is built on the basis of expert system and artificial intelligence paradigm to provide instantaneous information options based on comprehensive cognitive reasoning to provide physicians with

an enhancement to rationally and completely deal with the malaria problem from the very beginning of the decision making process to the time of termination of the case or the patient. This approach will help to precisely deal with malaria and avert its associated effects, like high costs of treatment caused by speculative estimation for diagnosis and treatment, premature abortions, absenteeism from work, general poverty and bankruptcy, retarded growth in children, poor academic performance in especially lower secondary and primary schools, and so many others. The implementation of this system will add value to the health and enhance / improve standards of living of the vulnerable groups of people especially in the rural areas and those places endemic and prone to malaria due to the favourable conditions of breeding habits of the mosquitoes, thus improving service delivery in the health sector in the bid to roll back malaria not only in Uganda but also in Africa as a whole and the world as a whole.

6.2 Assumptions for the system

1. All the information collected during the requirement specification is stated unambiguously and no omissions have been made, the software will meet and conform to the established standards.
2. The scope of the software (product) was adequately well understood and all the tasks well distributed to produce realistic and appropriate responses to the user.
3. System was based on the fact that, the assumed changes of scope by addition of skipped information will not grossly affect the execution and resources i.e. memory and cost.
4. The system will respond to the queries of the user according to the corporate and business standards.
5. Effort was distributed to make best use of the resources and providing the ultimate user friendliness qualifications so that even medium health workers can take advantage of interaction and exploitations of the options to generate the required solutions

6.3 Simplifications

1. The requirements / data objects symptoms, treatment, diagnosis, prescriptions and opportunistic diseases are described in a medical literature; there will be no opportunity for ambiguity thus easy to use.
2. The menu on the interfaces link directly to the attributes of the respective data objects / controls, thus enhancement, editing, modification and adjustments can easily be done by the authenticated user.
3. The interfaces have tools to help carry out the requirement changes without interfering with the database and design.

6.5 Conclusion

The tested parameters of this system have proved therefore complaint to the needs and projections of the requirements for which the system was developed. In contrast to the traditional methods of approach to case management of malaria i.e. diagnosis and treatment, the physicians had based on the interpolation of experience and thinking guided by the wisdom to hypothesize concepts, this system therefore provides a physical expert knowledge and definitions of medicine to guide the diagnosis, treatment and preventive / good control practices in a more suitable and informed perception of the cases. The system can empower also the less experienced health workers and practioners to manage mild and non- referral episodes. In the context of the patients, compliance to the physician's prescriptions and recommendations are a key pre-requists to quick recovery from malaria attacks and curing from the disease.

6.6 Limitations, Challenges and Constraints

These are the challenges that to some extent affected the performance of the researcher for his works to become more successfully although to a greater percentage the research / study achieved its destined objectives.

i) Resentment to the introduction of the topic of computerizing medical knowledge was registered in the first phases of data collection but later accepted, but it is not clear whether their acceptance will generate the curiosity of adoption of the system by the high management of the health ministry.

ii) The impetus for some of the health worker to adjust to the use of new approaches based on knowledge engineering i.e. to use the software, interest and attitude to change the technology that is being used by the health practitioners currently looked demoralizing, as they thought the system is going to complicate their work.

iii) The development of this system called for use of the integration of many languages (softwares) in order to come up with something, there was no independent language that could handle the development and implementation, thus it required that the researcher had to have mastered all the functionalities of the engaged softwares thus making the work more tedious.

iv) The process involved high costs for the development of this system than the projected budget thus making it more expensive under the fixed financial constraints the researcher had. So it wasn't possible to accomplish every thing as planned.

v) Some of the respondents had negative attitude to the process of using a computerized system in the enhancement of the traditional diagnosis and treatment methodology of managing malaria cases, therefore they were not cooperative and free to give much of the information that was required to develop the system due to the prevalent professional and medical ethics.

vi) The researcher found it had to compare the functionalities of the system towards the targeted efficiency and completeness because there was no existing samples or similar expert system prototypes or models built basing on artificial intelligence rationale, so the development depended entirely on the researcher's point of view and perception of the system.

6.7 Recommendations

i) For the system to work efficiently and correctly is advisable to use the quoted hardware and software requirement identified in the system investigation and requirement specification, else better hardware as may be recognized in the duo core systems will provide the best performance and quick responses to the request or queries made to it.

ii) For the good service delivery and stringent involvement in the fight to roll back malaria in Uganda and Africa as a whole, it recommended that every referral health unit (center) throughout the country benefits from this software so that atleast guided treatment and diagnosis against malaria is evidenced since most health centers country wide are privately owned and it is not easy to access specialist doctor to deal with problem there.

iii) The ability of the medium health workers to use the system to achieve the objective for which it was designed requires training, so for proper adoption and appreciation of the roles this system can play, training of how to use it should be done first in order to appraise the interest and technical efficiency during its use for good and effective services

iv) It is identified that fighting malaria in agent environments envisaged with endemicity is not easy without the help different stake holders; therefore government should come up with very clear supportive policies on the automation of knowledge, inv olvement and usage, to mandate the doctors, nurses, Lab assistants, involved in the clinical diagnosis and treatment to have basic knowledge in the application of ICT facilities.

v) The University should introduce courses like Bio-Health Informatics as course domains to equip the researchers in software system engineering have basic knowledge in the language and literature as their

aspiration are targeted towards diversifying the engineering processes to the medical field which is the way forward for improving the lives of the people for a better country.

vi) The University should introduce a research fund for the selected projects that reflect a national interest to help the researchers broaden the scope of their project implementations because of the high costs involved to avoid narrowing down the scope due to lack of funds. This dictates the level of efficiency and quality of work for the products of the research.

vii) The school of postgraduate should always try to monitor the progress of research programs against the teaching of course modules that had not been completed in accordance with the schedules. This will avoid conflict between the two compared to the deadlines set for submission the VIVA thesis, project reports and softwares and enhance qualitative productivity and working out sides pressure.

6.8 Area of future research

Future research is targeted towards the way how opportunistic diseases that take the guise of the presence of malaria to escalate its impact in the children below five years of age and pregnant mothers. Opportunistic diseases take advantage of the presence of malaria and cause adverse effects in the victim like cough and flue, they cause fever and almost evokes some how similar symptoms, thus increasing the magnitude of vulnerability

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15. Reccieved on January 6, 2007; Accepted July 2, 2007. *http://creativecommons.org/licenses/by/2* Open Access article distributed under the terms of the Creative Commons Attribution License.

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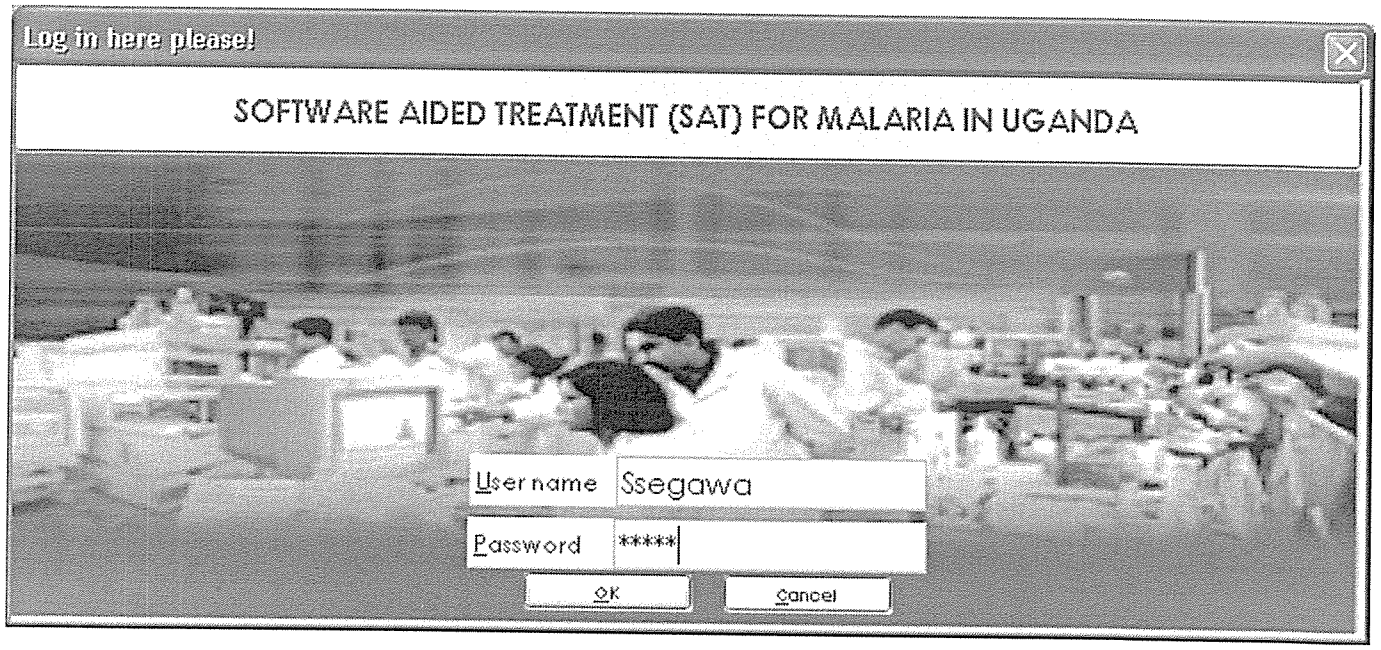
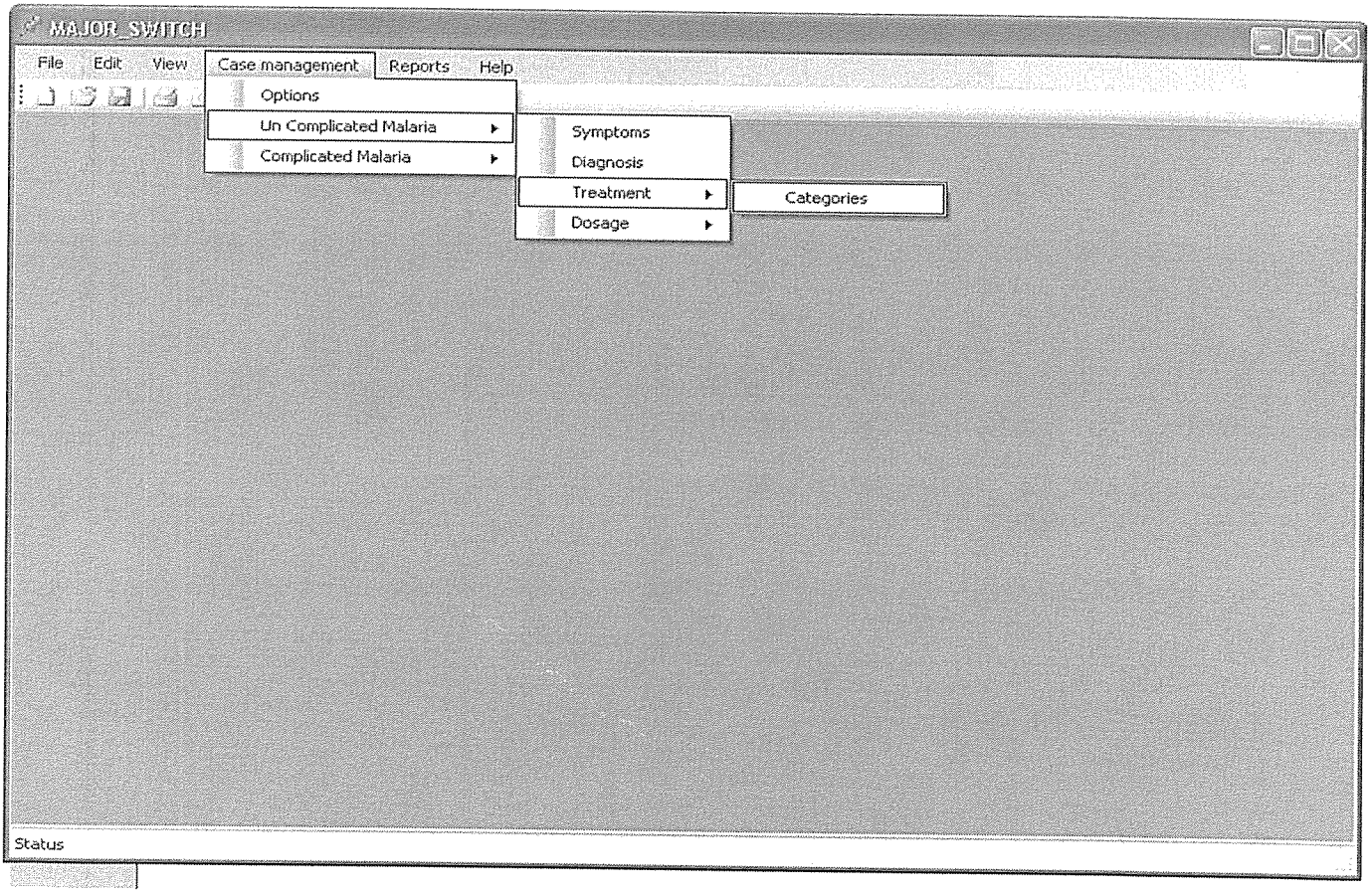
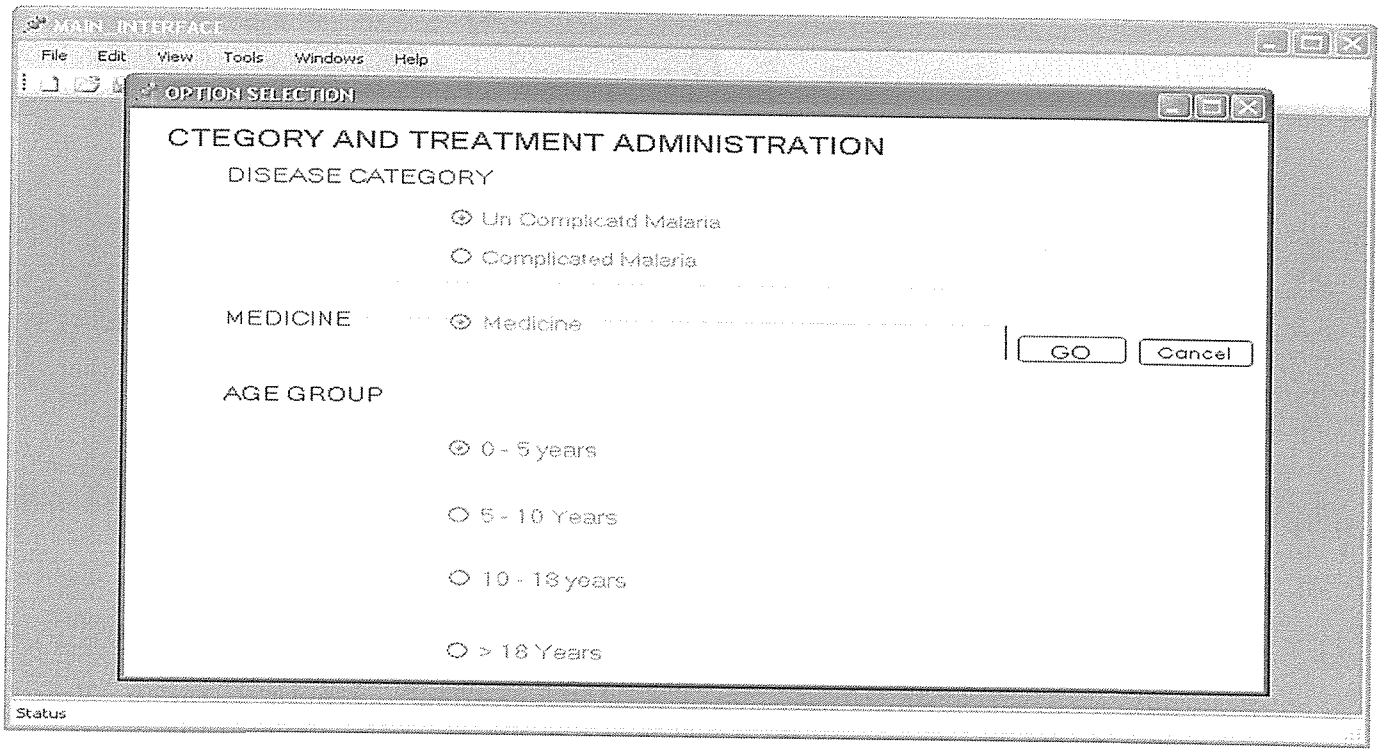
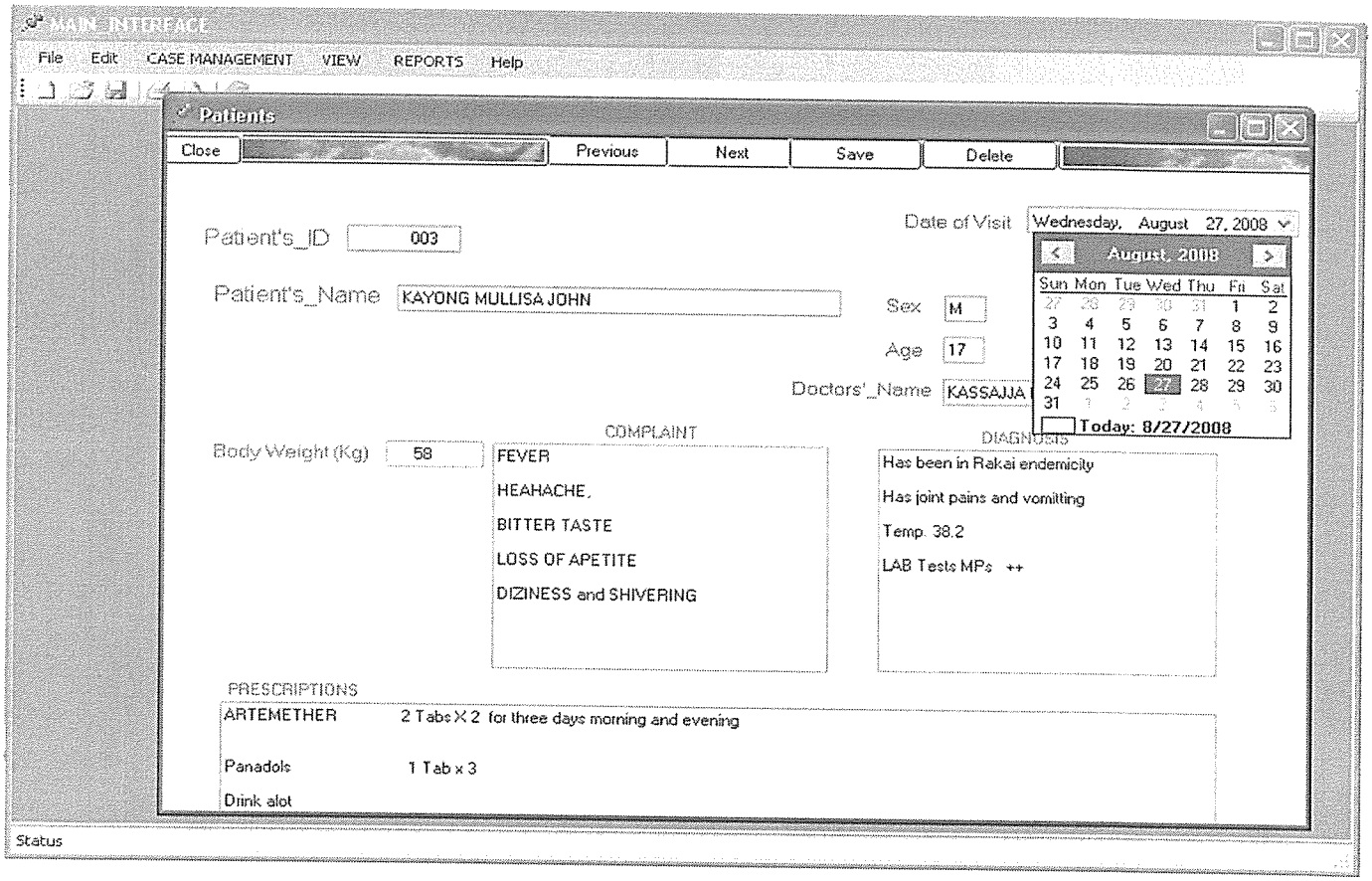
APPENDIX I Interfaces






MAIN_INTERFACE
File
Edit
View
Tools
Windows
Help
OPTION SELECTION
CTEGORY AND TREATMENT ADMINISTRATION
DISEASE CATEGORY
Un Complicatd Malaria
Complicated Maleria
MEDICINE
Medicine
GO
Cancel
AGE GROUP
0 - 5 years
5 - 10 Years
10 - 18 years
> 18 Years
Status


MAIN_INTERFACE
File
Edit
CASE MANAGEMENT
VIEW
REPORTS
Help
Patients
Close
Previous
Next
Save
Delete
Patient's_ID
003
Date of Visit
Wednesday, August 27, 2008
August, 2008
Sun Mon Tue Wed Thu Fri Sat
Today: 8/27/2008
Patient's_Name
KAYONG MULLISA JOHN
Sex
M
Age
17
Doctors'_Name
KASSAJJA
Body Weight (Kg)
58
COMPLAINT
FEVER
HEAHACHE,
BITTER TASTE
LOSS OF APETITE
DIZINESS and SHIVERING
DIAGNOSIS
Has been in Rakai endemicity
Has joint pains and vomitting
Temp. 38.2
LAB Tests MPs ++
PRESCRIPTIONS
ARTEMETHER
2 Tabs X 2 for three days morning and evening
Panadols
1 Tab x 3
Drink alot
Status

APPENDIX II

Cost analysis

ITEM	AMOUNT / COST (Shs)
Computer System	2,100,000.00
Customized softwares	250,000.00
Operational Costs	500,000.00
Development and other Costs	1,000,000.00
TOTAL COST	**3,850,000.00**

Tables that show medicine and doses for the specific age limits and body weights

ARTEMETHER 20mg + LUMERFANTRINE 120mg

Dose-ID	Body Weight Kgs	Age	DAY I Tabs	DAY 2 Tabs	DAY 3 Tabs	No. of Days	Qty of Dose	Total Time (Hrs)
001	5 - 14	4mnth to 3 yrs	1 x 2	1 x 2	1 x 2	3	6 Tabs	36
002	15 – 24	3 to 7yrs	2 x 2	2 x 2	2 x 2	3	12 Tabs	36
003	25 – 34	7 – 12 yrs	3 x 2	3 x 2	3 x 2	3	24 Tabs	36
004	> 35	> 12 yrs	4 x 2	4 x 2	4 x 2	3	32 Tabs	36

ARTESUNATE 50mg

Dose_ID	BW	Age	Day 1	Day 2	Day 3	Qty of Dose	No. of days
001		5 – 11 Month	½ tab	½ 25mg	3½ tab25mg	1½ tabs	3
002		1 – 6 yrs	1 tab	1 tab	1 tab 50mg	3 tab	3
003		7 – 13 yrs	2 tabs	2 tabs	2 tabs	6 tabs	3
004		> 13 yrs	4 tabs	4 tabs	4 tabs	12 tabs	3

AMODIAQUINE 153mg

DOSEID	BW	Age	Day1	Day 2	Day3	No of days	Qty of Dose
001		5 – 11 month	½ tab	½ tab	½ tab	3	1½
002		1 – 6 yrs	1 tab	1 tab	1 tab	3	3
003		7 – 13 yrs	2 tabs	2 tabs	2 tabs	3	6
004		> 14 yrs	4 tabs	4 tabs	4 tabs	3	12

CQ 150mg + SP 525mg

Dose_ID	BW	Age	Day1 CQ	Day 2 CQ	Day 3 QC + SP	Qty of Dose	No of days	Total time
001		2 – 6 month	½ tab	½ tab	½ 1/4	1½ 1/4		
002		6 month-2 yrs	½ tab	½ tab	½ ½	1½ ½		
003		2 yrs – 5 yrs	1	1	1 1	3 1		
004		6 – 10 yrs	2	2	1 1½	5 1½		
005		10 – 15 yrs	3	3	2 2	8 2		
006		> 15 yrs	4	4	2 3	10 3		

Quinine 300mg

Dose_ID	Body Weight Kg	Age	Dose every 8 hrs for 7 days		
001	5 - 10	3 month – 1yrs	75mg	¼ tab	X 2
002	10 – 18	1 – 5 yrs	150 mg	½	X 2
003	18 – 24	5 – 7 yrs	225 mg	¾	X 2
004	24 – 30	7 – 10 yrs	300mg	1	X 2
005	30 – 40	10 – 13 yrs	375 mg	1¼	X 2
006	40 – 50	13 – 15 yrs	450 mg	1½	X 2
007	>50	>15 yrs	600mg	2	X 2

APPENDIX II

b)

QUESTIONNAIRE TO THE MALARIA OFFICIALS

(MoH)

PREAMBLE

My name is *SSEGAWA E JAMES KIGGUNDU* a student in the graduate school of Kampala International University, pursuing a Master of Science in Software Systems Engineering. I'm carrying out research on how prevalent malaria in Uganda can be reduced by using software Aided Approach which gives instantaneous information options to furnish decision making during its management and treatment. So Iam requesting you to provide the available information by responding to the questions below. These questions are intended to gather the necessary information that can be used to build the system's knowledge base which will be used by the system to infer new knowledge that can be used to manage the problem of malaria.

Statement of Confidentiality

The information you have provided will be treated with the most appreciable and utmost confidentiality.

1.0 Personal information.

a) What is your title? Tick (√) where applicable.

Mr.	☐
Nurse	☐
Ms	☐
Lab assistant	☐
Dr.	☐
Professor	☐

b) What is your place of work?

.....

c) Area of specialty

.....

2.0 Have you ever attended to malaria patients? Tick (√) where necessary.

Yes ☐

No ☐

If Yes, what is the most vulnerable group of people?

i) Children below

Below 5 years ☐

5 -10 years ☐

10 -16 years ☐

ii) Pregnant Mothers ☐

iii) Youth ☐

iv) Elderly ☐

✓ Tick the option / s

c) What are the observable clinical features / symptoms of malaria?

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2.0 What are the most striking clinical manifestations of malaria that distinguish it from manifestations other diseases?

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3.0 Are there types / categories of malaria?

	Tick ✓
Yes	☐
No	☐

b) If yes, what are they?

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c) What are the differences between those types of malaria, if they do exist?

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4.0 What treatment do you prescribe in each case, for the patients with those types of malaria?

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c) Any additional information that can enhance the treatment / management of malaria?

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.....

.....

.....

.....

.....

.....

Thank you very much for taking part in the campaign to roll back malaria in Uganda.

End

QUESTIONNAIRE TO THE PATIENTS

Rakai and Masaka hospitals

PREAMBLE

My name is *SSEGAWA E JAMES KIGGUNDU* a student in the graduate school of Kampala International University, pursuing a Master of Science in Software Systems Engineering. I'm carrying out research on how prevalent malaria in Uganda can be reduced by using software aided approach which gives instantaneous information options to furnish decision making during its management and treatment. So Iam requesting you to provide the available information by responding to the questions below. These questions are intended to gather the necessary information that can be used to build the system's knowledge base which will be used by the system to infer new knowledge that can be used to manage the problem of malaria.

Statement of Confidentiality

The information you have provided will be treated with the most appreciable and utmost confidentiality.

3.0 Personal information.

What is your sex? Tick (✓) where applicable.

Male ☐

Female ☐

4.0 a) Have you ever been attacked by malaria this year? Tick (✓)

Yes ☐

No ☐

b) How many times have you been got attacked by malaria in a year?

One ☐

Twice ☐

Thrice ☐

Many ☐

5.0 i) Do the health workers vary the medicine and give enough dosage for your treatment for the different times you get the infection?

1. I don't know ☐

☐

☐

2. Yes ☐

3. No ☐

ii) Do the doctors tell you what you are suffering from after diagnosis?

a) Yes ☐

b) No ☐

iii) Do they talk about the cost before completing the treatment?

a) Yes ☐

b) No ☐

4.0 Do you complete the dose after the doctors have mentioned about the cost

a) Yes ☐

b) No ☐

5.0 Do the health workers make any reference to a computer system while checking you or giving you treatment?

a) Yes ☐

b) No ☐

6.0How do you feel when the doctors examine you along side with their computer systems next in use?

a) Happy ☐

b) Nothing ☐

c) Annoyed ☐

d) Time wasting ☐

Thank you very much for taking part in the campaign to roll back malaria in Uganda.

End

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GENDER–BASED STRESS AND EMPLOYEES PERFORMANCE,

IN THE MINISTRY OF HEALTH GOVERNMENT

OF SOUTHERN SUDAN,

JUBA

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DECLARATION A

"I, Suzan Gire Emmanuel Baya declare that this Thesis is my original work and has not been presented for a Degree or any other academic award in any University or Institution of Learning"

Suzan Gire Emmanuel Baya

02/11/2011

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