ISSN:2320-0790

An International Journal of Advanced Computer Technology

THE DESIGN AND CREATION OF A MALARIA DIAGNOSING EXPERT SYSTEM

Adewale O Adebayo*, Mayowa Fatunke, Uchechi Nwankwo, Oke G. Odiete
School of Computing and Engineering Sciences, Babcock University, P.M.B.21244 Ikeja, Lagos, Nigeria
*E-mail: adebayoa@babcock.edu.ng; wale_adebayo@yahoo.com

Abstract: Malaria kills about one million, two hundred thousand (1.2 million) people every year. Medical doctors are in limited supply, and provide somewhat expensive services. There is, therefore, the need to build computer-based systems that can assist doctors in diagnosing and recommending treatment for malaria to fill the supply gap and reduce the attendant costs, upon which this research is focused. The expert system would diagnose and recommend treatment of malaria from symptoms and blood test result provided by user patient. The expert system was created based on medical expert information collected through structured interviews, extensive literature review, and adopting the waterfall software development method. The system is towards reducing deaths associated with malaria and towards improved health care services, and is a guide to designing similar systems.

Keywords: Malaria Diagnosis, Malaria Treatment, Expert System, Diagnosing Expert System, Malaria Diagnosing System

I. INTRODUCTION

Malaria is a very common disease and a major health problem in the world today, mostly in Africa. Malaria kills twice as many people as previously thought; research has shown that malaria kills about one million, two hundred thousand (1.2 million) people every year which is nearly double the six hundred and fifty-five thousand (655,000) people estimated in 2009 (Guardian, 2012). Malaria is characterized by a fever which is caused by a parasite that is spread by malaria bearing anopheles mosquito, which has become resistant to certain treatments and many insecticides (Wikipedia, 2012).

Medical diagnostics is based on different methods of research and diseases determination, and their severity with the purpose to aid select and apply necessary treatment, and prevent the development of complications and recurring diseases. Diagnostic procedures involve interaction between the patient and the medical personnel in the form of "question and answer", good candidate for computerization.

Doctors that should treat malaria are expensive, limited in number, and not evenly spread across the globe. Nigeria, for instance, has twenty eight (28) doctors per ten thousand (10,000) individuals (Africapedia, 2012). In addition, the people that should access healthcare facilities are far removed from medical facilities.

In view of the foregoing, it is of great necessity to provide an expert system to assist doctors in diagnosing and treating malaria, which this research is focused on designing and creating. The aim of this research is, therefore, to build a web based expert system that will diagnose people of malaria, suggest treatment and provide necessary information on malaria, for hospitals and individuals. The software will diagnose malaria infection from information concerning the patient's symptoms and test results, and recommend a medication, have a database for storing information about drug prescription and other malaria related information, and be user-friendly.

The created system would retain the skill of an expert medical doctor relating to treatment of malaria in case of any eventuality. It would also be useful to people who need self-diagnosis before seeing medical consultants thereby reducing physician's workload during consultations and easing other problems associated with hospital consultations. In addition, it could act as a diagnosis tool, which can assist malaria researchers determine the intensity or concentration of malaria parasites in designated geographical locations and, in turn, help in developing effective control measures to limit the spread of malaria in such regions. It would also solve the problems encountered in areas where there are no medical experts or where medical experts are limited in number.

Extensive literature review was done on the subject matter. Design and creation research strategy (Oates, 2009) was employed. Necessary expert information was collected using structured interview and through the internet. The waterfall software development model was adopted primarily because this model is simple to understand, implement and it prescribes a systematic approach to software development (Hughes & Cotterell, 2009; Yogi, 2012). The software development environment includes Hypertext Pre-Processor (PHP - scripting language for connection to the database), Structured Query Language (SQL), Hypertext Mark-up Language (HTML - used for the user interface functionality) with Java Script (JS) and Cascading Style Sheet (CSS) to produce an interactive user interface that connects to a database. Unit and integrated system testing of the codes were done. Black box system testing was also performed.

II. THE PROPOSED SYSTEM

A. General Design

A model is a representation and description of the real world system. Models help users, administrators and system developers to better understand the system design. The user and administrative Use Case diagrams of the proposed malaria expert system are presented in Figure 1 and Figure 2. The system flow is depicted in Figure 3.

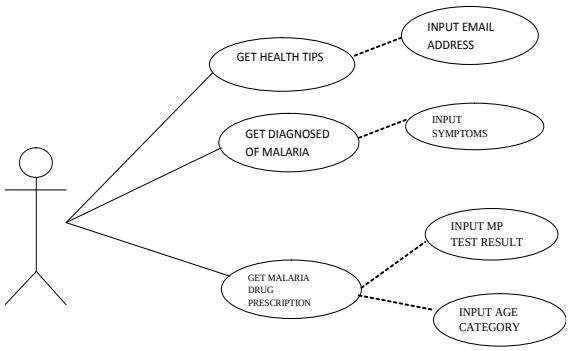

Figure 1: Use Case Diagram of a User

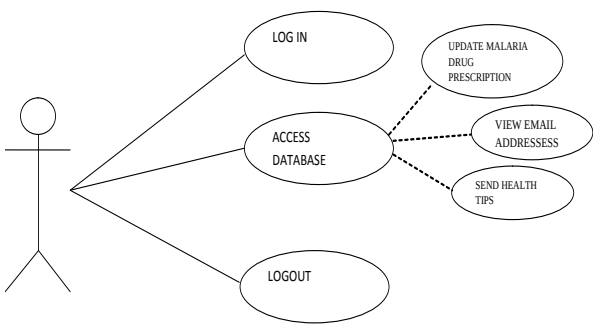

Figure 2: Use Case Diagram of Administrator

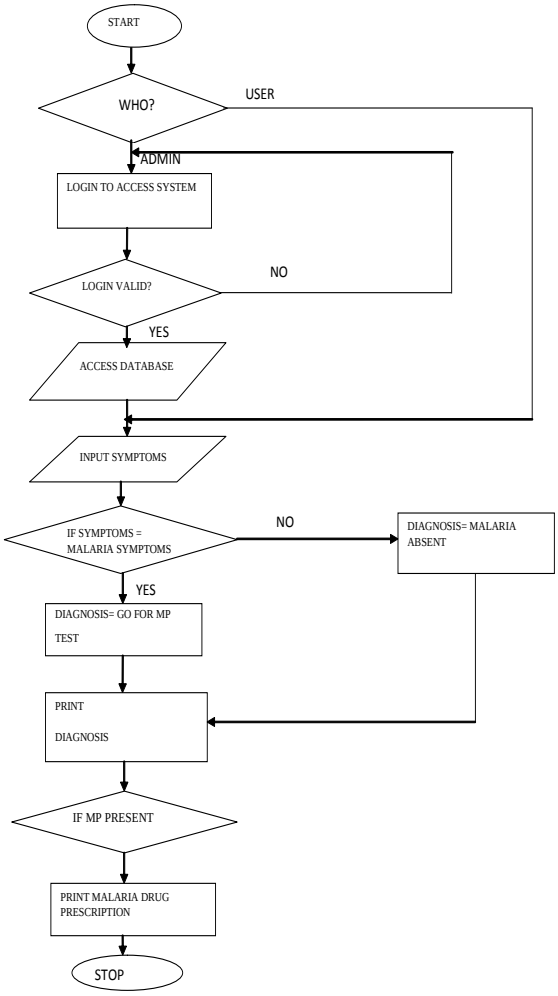

Figure 3: Flowchart of the Proposed System

The malaria expert system will have the components of a standard expert system depicted in Figure 4.

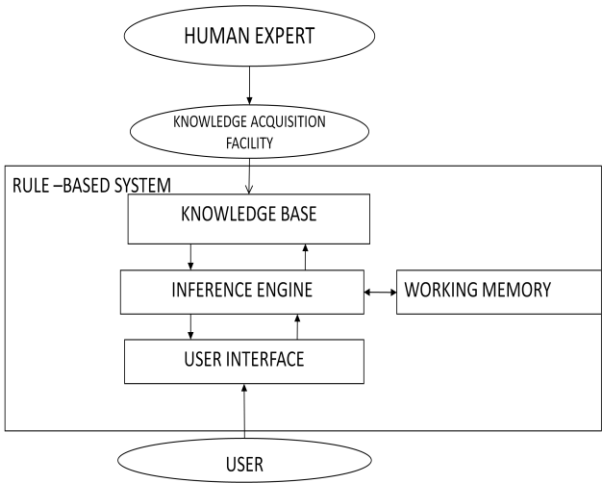

Figure 4: Main Components of Expert Systems [7].

Human experts, which in this case are doctors, solve problems by using a combination of factual knowledge and reasoning ability. In an expert system, these two essentials are contained in two separate but related components: a knowledge-base and an inference engine. The knowledge-base provides specific facts and rules about the subject, and the inference engine provides the reasoning ability that enables the intelligent system to form conclusions.

The knowledge acquisition facility is used to acquire necessary expert information about diagnosing and treatment of malaria. This information which serves as knowledge is stored in the knowledge base. This is the store in which knowledge of malaria acquired from doctors would be kept. This knowledge would be stored in a database using a relational database management system. The inference engine manipulates the knowledge stored in the database used as a knowledge base. The inference engine accepts query from the user, processes the query and sends required information back to the user through a user interface. It performs its function by using the working memory as temporal storage for facts generated during processing. A scripting language will serve as an inference engine for this malaria expert system. The Scripting language will be used to express rules and facts associated with the malaria expert system.

A user-friendly user interface for interacting with the system is defined. Users' queries would be sent to the online, web-based, expert system that would process it and return the result to the users. The online part of the system would be made up of the knowledge base, inference engine and the working memory Figure 5. A mark-up language would be used to develop the website.

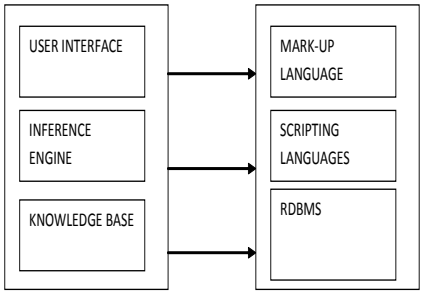

Figure 5: Summary Components of the Proposed System

B. Input Design

This web based expert system will have a user interface that receives user input and displays desired output. The user interface consists of different web pages. The homepage (Figure 6) of the application will have different links that a user can navigate through, and accepts administrator's user name and password. The malaria diagnosis (Mdiagnosis) link first page would have textboxes to fetch the name, password, email addresses and other necessary inputs, checkboxes that enable users tick their symptoms and activate processing as depicted in Figure 7.

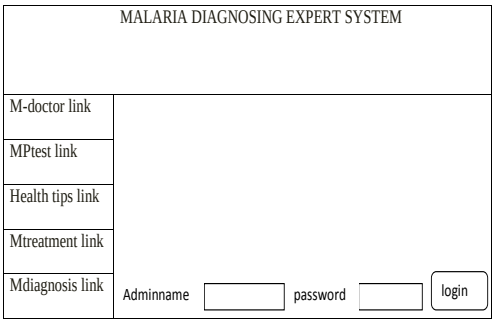

Figure 6: Proposed System Homepage

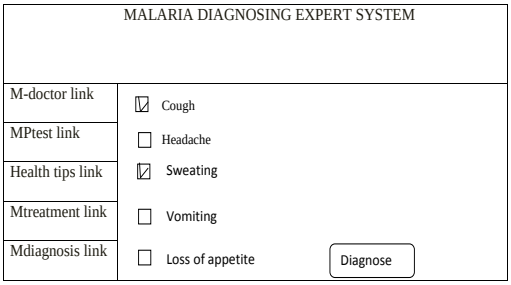

Figure 7: Mdiagnosis Link First Page

C. Output Design

This web based expert system will also use the user interface to display desired output to users. WebPages and java scripts alerts will display output to the user as depicted in Figure 8. List of outputs from the system include information on malaria, Email addresses, malaria diagnosis result, and malaria drug prescription.

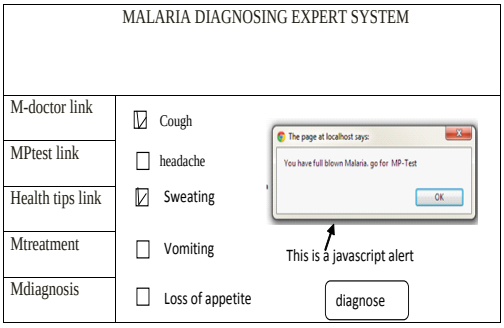

Figure 8: Webpage JavaScript Alert

D. Process Design

The two main actors of this expert system are the users and administrator. This expert system will have a database that stores needed information, created and maintained by relational database management software. Input from users would be manipulated with a scripting language (serves as inference engine). The scripting language and the relational database management software would store data in the database, fetch needed information from the database, and send required output back to the user. The administrator is able to access the database, after valid login, to update drug prescriptions, view malaria drug prescriptions and view email addresses in the database.

E. Database Design

The database for this application named malaria database, would consists of three main tables: Prescription table (Table I), Admin table (Table II), and User table (Table III). The Prescription table would store malaria drug prescriptions. The Admin table would store information about the system administrators. The User table would store basically the email addresses of users who want to receive health tips via email.

Table I: Prescription Table

Field	Type	Null	Key	Default	Extra
Id	Int(11)	No	Primary		Auto_increment
Testtype	Varchar(100)	Yes			
ACTcombination	Varchar(50)	Yes			
Age	Varchar(20)	Yes			
drugname1	Varchar(50)	Yes			
dosage1	Varchar(50)	Yes			
drugname2	Varchar(50)	Yes			
dosage2	Varchar(50)	Yes			

Table II: Admin Table

Field	Type	Null	Key	Default	Extra
Admin_id	Int(11)	No	Primary key		Auto_increment
Fname	Varchar(50)	No			
Lname	Varchar(50)	No			
email	Varchar(50)	No			
Password	Varchar(50)	No			

Table III: User Table

Field	Type	Null	Key	Default	Extra
User_id	Varchar(20)	No	Primary key		Auto_increment
User_emailadd	Varchar(20)	No			
User_name	Varchar(20)				

F. Platform Requirement

The minimum hardware required to ensure the proper running of the proposed application is: a standard processor, a RAM size of at least 128 MB, a hard disk capacity of at least 10 GB, and an SVGA color monitor. The software required to ensure the proper running of the expert system is: a Windows operating system, Java-script enabled web browser, Apache Server Version 2.0 or higher, MySQL database Version 5.0.51b or higher, PHP Version 5.2.6, and WAMP Package.

G. System Testing

In testing the database, it was ensured that the database captured the specified fields according to the respective attributes, and that the storage and retrieval functions of the database functioned properly. In process testing, it was ensured that every feature works satisfactorily. The application interface was properly tested to ensure that it queried the database as required and fetched required information for any particular page. The whole system was also tested to ensure that every part was well integrated and functional (black-box and white-box testing).

H. The Application

The Home page (Figure 9) is the index page available after the system has been implemented. The administrator is expected to provide a name and a password to access the system. This page has the electronic doctor module, M-DOCTOR link, which provides the basic functionalities of the system.

Figure 9: Homepage

The M-doctor page (Figure 10) lists all the available malaria symptoms. It allows a user to check symptoms and obtain diagnosis.

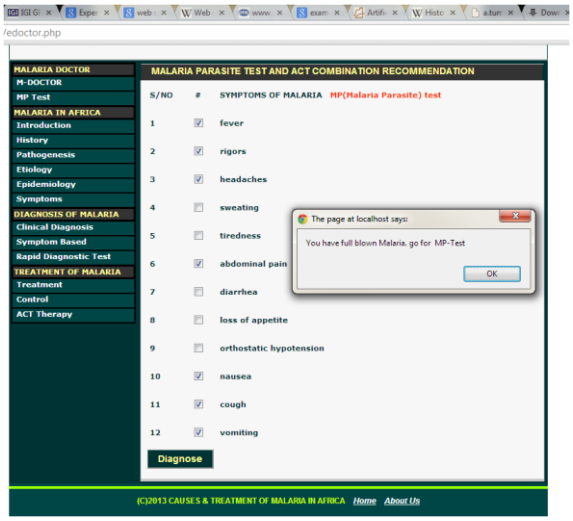

Figure 10: M-doctor page

The MP test page (Figure 11) enables the input of test result option and age, and provides malaria drug prescription button.

Figure 11: MP test page

The Prescription page (Figure 12) displays malaria drug prescription to the user after inputing malaria parasite result test result option and age cartegory, and on activating the Prescribe button.

Figure 12: Prescription page

The Admin page (Figure 13) enables administrator to access the database to update drug prescription, view the drug prescription in the database, view users' email addresses and send health tips via email.

Figure 13: Admin page

The Update drug prescription page (Figure 14) enables the administrator update drug prescription in the system database.

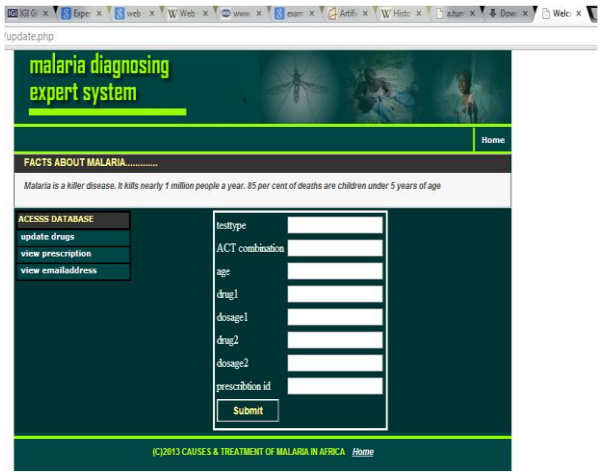

Figure 14: Update Drug Prescription Page

III. RELATED WORKS

Expert system is a branch of applied artificial intelligence (AI) that came to light in the mid 1960s. The basic idea of an expert system is to transfer the expertise of a human domain expert to a computing system, which makes inferences and arrives at specific conclusion [8] as would the human expert.

Medical artificial intelligence is primarily concerned with the construction of AI programs that perform diagnosis and make therapy recommendations. Expert systems today are more likely to be found used in clinical laboratories and educational settings, for clinical surveillance, or in data-rich areas like the intensive care setting. What is now being realized is that when they fill an appropriate role, intelligent programs do indeed offer significant benefits. One of the most important tasks now facing developers of AI-based systems is to characterize accurately those aspects of medical practice that are best suited to the introduction of artificial intelligence systems [9].

Searle's strong AI hypothesis states: "The appropriately programmed computer with the right inputs and outputs would thereby have a mind in exactly the same sense human beings have minds". Turing's "polite convention" states: "If a machine acts as intelligently as a human being, then it is as intelligent as a human being. Turing test can be used to describe systems that act like humans. This simple test has become an essential tool in the development and verification of Expert system [10].

General features of intelligent system include coping with uncertainty, data driven reasoning, data/knowledge representation, user interface, and ability of the system to explain the reasoning process that it used to reach a recommendation. General strength of intelligent system includes provision of consistent answers for repetitive decisions, processes and tasks, holding and maintenance of significant levels of information, encouraging organizations to clarify the logic of their decision-making, never "forgetting" to ask a question as a human might, all time availability, and multi-user expert system serving more users at a time. The weaknesses of intelligent transaction system include lack of common sense needed in some decision making and for fast, intuitive decisions, lack of capability for creative responses as human expert would in unusual circumstances, being clear about its logic and reasoning unlike human domain expert, susceptibility to knowledge base errors that would lead to wrong decisions, and rigidity to changing environments, unless knowledge base is changed [11].

The MYCIN Program for Infectious Diseases is one of the earliest medical expert systems to have been developed. It was designed to diagnose and prescribe treatment for infectious diseases particularly spinal meningitis and bacterial infections of the blood. It first decides what bacterium caused the disease and then suggests what antibiotic to give the patient. It is very helpful for physicians that lack expertise at certain diseases because it gives reason for suggesting diagnosis and recommending treatment [12]. The setback of MYCIN is that runs on large time shared systems (slow response), and it is not suitable for the treatment of malaria.

XDIS is an expert system that was designed to assist physicians in diagnosis. The system contains information of more than three hundred (300) internal diseases and pathologic syndromes most frequently encountered in general practice. For each set of symptoms entered for a case, the system gets the full list of possible diagnosis ranking from the most probable to the least probable. The time to work out a diagnosis is usually less than ten (10) minutes. XDIS helps make preliminary diagnosis on the

first visit of a patient to the physician and at the same time decides on the necessity of referring the patient to a specialist and to select medical tests to make a more exact diagnosis [3]. Its setback is that it gives probable list of diagnosis, not exact diagnosis.

Emerge is another example of a diagnosis rule-based expert system. It was designed to be used in an emergency room only. The system uses a form of production rules which incorporates weighing factors that are determined by a neural network. The neural network is composed of input and output blocks with a hidden layer block in between which communicates input to the output. The neural network learns from examples and then predicts an output based on this knowledge. This system also uses an IF-THEN-UNLESS statement instead of an IF THEN statement so that the decision process may be more precise, the results more accurate, and the explanations better understood [14]. Its setback is that it is difficult to maintain, manage and upgrade since it is not web-based, beside its restriction to emergency room usage.

Your Diagnosis is an online medical diagnosis and symptoms analysis system. It asks several questions about body system and symptoms. Allergies, medications and immunizations are recorded as well as family history and past medical problems. It also does a complex analysis of all information gathered about symptoms and produces a list of all possible and probable medical diagnoses. It is online and can be interacted with in stages. All provided information can be securely stored as confidential personal health record for future retrieval. It also gives a confidential medical report, which could be printed or have emailed for personal usage [15]. The setback of Your Diagnosis is its complexity in trying to diagnose and treat all the ailments in one sweep.

GIDEON was developed ten years ago by specialists in infectious diseases and biostatistics, and computer scientists at university-based medical schools in the United States and Israel. GIDEON is a computer program for diagnosis and reference in the fields of tropical and infectious diseases, epidemiology, microbiology and antimicrobial chemotherapy. It was designed to diagnose all the worlds' infectious diseases based on symptoms, laboratory testing and dermatological profile [16]. It helps in diagnosing infectious diseases, but difficult to maintain, manage and upgrade because it is not web-based. It also attempts to diagnose all infectious diseases which introduced certain complexities.

IV. CONCLUSION

The design and creation of the malaria diagnosing expert system should be seen as a contribution towards reducing deaths due to malaria. It would allow for more efficient diagnosis of malaria and aid in reducing the workload of scarce medical practitioners. In addition, its design would aid in design and creation of similar applications for other endemic diseases.

V. REFERENCES

[1] Guardian, (2012) Malaria deaths Research. Retrieved from: http://www.guardian.co.uk/society/2012/feb/03/malaria-deaths-research.

[2] Wikipedia, **(**2012**)** Malaria. Retrieved from: http://en.wikipedia.org/wiki/Malaria

[3] Africapedia (2012). Doctor to Patient Ratio in Africa. Retrieved from: http://www.africapedia.com/DOCTOR-TO-PATIENT-RATIO-IN-AFRICA

[4] Oates, B. J. (2009). Researching Information Systems and Computing. London: SAGE

[5] Hughes, B. and Cotterell, M. (2009). *Software Project Management*. London: McGraw-Hill Education

[6] Yogi, B. (2012). Software Development Life Cycle. Retrieved from: condor.depaul.edu/jpetlick/extra/394/Session2.ppt

[7] Stair, R. M., & Reynolds, G. W. (2007). Fundamentals of Information Systems. Boston: Course Technology

[8] Nammuni, K., Pickering, C., Modgil, S., Montgomery, A., Hammond, P., Wyatt, J.C., Altman, D.G., Dunlop, R., & Potts, H.W.W. (2004) Design-a-trial: a rule-based decision support system for clinical trial design. *Knowledge-Based Systems*, Vol. 17, Pages 121–129.

[9] OpenClinical (2012). Retrieved from: http://www.openclinical.org/aiinmedicine.html)

[10] Awodele, O. and Omotunde, A. (2011) *General Introduction to Artificial Intelligence.* Ibadan: Franco-Ola. Pp 5-50.

[11] WikiAnswers (2012). The advantages and disadvantages of expert system. Retrieved from: http://wiki.answers.com/Q/What_are_the_advantages_and_disadvantages_of_expert_system

[12] Buchanan, B.G., and Shortliffe, E.H. (1984). Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project. Retrieved from: http://www.amia.org/staff/eshortliffe/Buchanan-Shortliffe-1984/MYCIN%20Book.htm

[13] Rodionov, V. (1989). Diagnosis is made by XDIS. Retrieved from: http://mipt.soix.com/xdis.html

[14] Herzner, J. and Kubiska, M. (1992). Expert System Example. Retrieved from: http://www.rpi.edu/dept/chem-eng/Biotech-Environ/EXPERT/expmed.html

[15] YourDiagnosis (2012). Website. Retrieved from: http://yourdiagnosis.com

[16] Gideon (2012) Global Infectious Disease Epidemiology Network. Retrieved from: http://www.gideononline.com/.