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EXPERT SYSTEM IN RURAL MEDICAL CARE

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ABSTRACT

This paper looks into how an expert system can be used to solve rural problem as it relates to medical care. An expert system is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. Rural medical care is a health care system found in the rural areas, whose operations are at its poorest state due to lack of sufficient medical practitioners. This research work looks into the areas of rural medical care that could be aided with the use of an expert system that would automate some of the processes and at the same time supplement the few medical officials available in the rural areas in order to improve on the healthcare system. This research considers the manual processes involved in the registration of patients in the rural medical centers, diagnosis and also the schedule of a follow-up appointment. Analysis of the current system was carefully carried out to determine where modification, changes and improvement should be made in the design of the proposed system. Finally, a computer system was designed; which would be used as prototype for further improvement.

KEYWORDS: expert systems, rural care, medical care, diagnosis, health workers.

I. INTRODUCTION

Rural areas are areas secluded from the towns and cities and are limited to urban development. Compared with urban residents, rural residents have higher poverty rates, a larger percentage of elderly, tend to be in poorer health, have fewer doctors, hospitals, and other health resources, and face more difficulty getting to health services [1]. Lack of all these expose them to sub-standard living and diseases.

Medical care is the delivery of modern medicine and facilities in the treatment of ailments to subdue the effects on the sick and also use of preventive medication for several other sicknesses.

The few doctors available in the rural areas can be assisted by the introduction of Expert systems which could be operated by attendants and nurses in the rural hospitals/clinics/dispensaries.

[2] distinguishes two approaches when defining an Expert system:

- The human/artificial intelligence oriented approach and
- The technology oriented approach.

Artificial Intelligence (AI) approach defines an expert system as a computer system that performs functions similar to those normally performed by a human expert.

In the technology approach, an expert system is a computer system that uses a representation of human expertise in a specialist domain in order to perform functions similar to those normally performed by a human expert in that domain.

Generally, an expert system is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. It operates as an interactive system that responds to questions, asks for clarification, makes recommendations and suggestions, and generally aids the decision-making process.

In order to accomplish feats of apparent intelligence, an expert system relies on two components: a knowledge base and an inference engine. A knowledge base is an organized collection of facts about the system's domain while an inference engine interprets and evaluates the facts in the knowledge base in order to provide an answer.

Expert system in medical care is now very common in the various areas of specialization of the medical domain. The expert systems developed before are designed to handle single problem, for example to deal with heart disorders, blood infections etc. But nowadays, expert systems are designed to cover a broad range of problems in

the medical domain ranging from diagnosing, responding to test results and also prescribing drugs for a number of ailments.

The issues are that doctors and other medical personnel are saddled with the responsibility of delivering good medical care and advices to patients and people; but there arises the question of the availability of these medical practitioners in rural areas, to adequately carter for the needs of the people in that area. Agency for Health Care Policy and Research [1] in its research for improving health care in rural populations reported that inadequate medical personnel in rural areas accounts for high mortality rate in the area, and also more patients are yet to be examined in the health centers.

To geometrically increase the number of patients examined daily, the primary health care centers (PHC) need to be introduced to the modern technology of expert system which will assist the doctors in the prognosis and diagnosis of simple ailments complained by patients as well as prescribing drugs.

The motivation was born out of considering persons residing in a rural area, it is grievous to see how conditions of patients get complicated just because they have to wait on a long queue for a doctor's attention. Some patients end up dying of a curable disease because they would have to wait (daily) for a very busy doctor who travels in from the nearby town/city to do his/her job of which in most cases, he/she takes it as a charity activity. The few nurses and attendants around battle and struggle to revive lives with little or no idea of what to actually do. Sometimes they luckily succeed but one can't but imagine how much more they will achieve with the aid of a medical care expert system.

It is necessary that expert system is designed in such a way that it can be easily accessed in order to save time. Also, the nurses need to be educated on computer operation and how to use the expert system.

II. REVIEW OF LITERATURE

Expert systems have been used in many health-related interventions to ease one process or the other in support practitioners in their day to day decision making tasks in health centres around the world. The first expert system was developed in 1965 by Edward Feigenbaum in collaboration with Stanford University Geneticist, Joshua Lederberg and the Chemist Carl Djerassi who invented the first commercial oral contraceptive [3]. DENDRAL (from the Greek word for "tree"), as their expert system was later known, was designed to analyse chemical compounds. The expert system was designed to aid chemists in determining the structure of organic molecules through the use of complex array of "IF - THEN" rules. The program was used in industry and in academia.

The experience with DENDRAL inspired the creation of Feigenbaum's next expert system, MYCIN at Stanford in the 1970s [4] which assisted physicians in diagnosing blood infections. Its job was to diagnose and recommend treatment for certain blood infections. MYCIN was developed partly in order to explore how human experts make these rough (but important) guesses based on partial information. MYCIN was never actually used in practice.

The later version called NEOMYCIN was compared to MYCIN as two approaches in rule based expert systems decision generation [5]. The work dealt with these by having an explicit disease taxonomy (represented as a frame system) to represent facts about different kinds of diseases. The basic problem-solving strategy was to go down the disease tree, from general classes of diseases to very specific ones, gathering information to differentiate two diseases subclasses (i.e., if disease1 has subtypes disease2 and disease3, and its known that the patient has disease1, and subtype disease2 has symptom1 but not disease3, then ask about symptom1).

The efficacy of expert system towards healthcare is demonstrated by discussing an on-going in-house Tele healthcare project: Tele-Healthcare Information and Diagnostic Environment (TIDE) [6]. TIDE aims to ensure a continuum of healthcare throughout the life-time of an individual. Technical realization of TIDE involves a confluence of information technologies- AI (expert systems, case-based and common-sense reasoning), medical informatics, multimedia, internet and database technologies.

In the work of [7], a rule based expert system called 'Trauma Advisor' was developed to help clinical staff in rural locations in the diagnosis and treatment of trauma patients with injuries to head. The work was also to aid emergency services in the studied area.

In another work of Ntalasha [8], a mobile phone based medical diagnostic system was designed to aid in the diagnosis and treatment of diseases remotely. The user exchanges SMS through the use of mobile phone with the application which in turn respond with necessary feedback for necessary action. This would work well if the rural area has a functional mobile telephone network coverage.

U-health [9] is a diagnostic expert system designed to measure blood pressure, pulses etc. in a networked environment. The expert system introduced in [10] was to support decision making using machine learning to aid in the prediction of bronchopulmonary dysplasia which is common to premature infants. This can be used within the first week of child birth.

Another instance was the development of expert system using ruled based in health care for the monitoring of heart failure [11]. The rule set was generated through a structured interview conducted with 10 heart failure

clinicians. The outcome from the trial showed that the used rules significantly increased self-care and improved clinical management of heart failure. They further advised validation for future use.

Another decision support expert system which help health workers in the evaluation of emergency patients with unknown chest pain who are at risk of heart attack was introduced [12]. The system used Bayesian model to give a correct diagnosis for patients which may be difficult to achieve using standard evaluation procedures.

A mobile based expert system for disease diagnosis was introduced in [13] with focus on Nigeria. The proposed system was to be accessed through mobile phone in the most areas where getting adequate health care is a challenge. Unfortunately, these areas may also lack the required data network to access the proposed system and or be able to afford smart phones to be used for same.

On the overall, expert systems have been designed to solve different problems as it relates to human health. The focus of this work is the design of expert system to aid diagnosis in health care to rural areas having in mind that rural areas may not have constant power supply, mobile phones or network coverage to use. The proposed system would be hosted on a computer locally in the medical centers in the rural areas. This expert system particularly looked into solving health problems commonly found in rural areas in Nigeria.

III. METHODOLOGY

System Analysis and Design

System analysis carried out by analyzing both current and proposed systems, these analyses are used to develop the user requirements. In constructing the logical model of the proposed system, unified modelling language (UML) notations would be used. The Unified Modelling Language is a standard language for specifying, visualizing, constructing, and documenting the artefacts of software systems. The UML notations would be used because it has a well-defined semantics, provides a spectrum of notations for presenting different aspects of a system, and has been accepted as a standard notation in the industry. The UML components used to carry out the analysis are the use case, class and sequence diagrams.

An algorithm is a sequence of steps that logically shows how a task could be solved; the start of an algorithm is the input, while the end shows the output. The processing of data takes place in between the ‘start’ and the ‘end’. There are several algorithm techniques that could be used (pseudo-codes, flowchart, decision-table etc.), but flowchart would be used for this research.

Flowcharts are graphical symbols used in developing the algorithm. They show steps in processes with symbols; where the flow of the process is indicated with arrows. The flowchart will show the abstract, module and unit levels of the proposed expert system.

The need for system analysis and design has become inevitable considering the complex nature of demand for technology in business places and at homes. Normally, users, who demand reliable and cost-effective systems to manage their businesses, may not be fully aware of the capabilities and limitations of contemporary computer technology. On the other hand, application developers/programmers may not also understand how to satisfy the users of their applications. In all, this brings about a communication gap (lapse or divide) between the users and the developers of systems. Thus, in order to bridge this gap, there is the need for system analysis and design.

User Interface

The interaction between end-users and the computer is said to take place at the “user interface”. A user interface is well-designed when the program behaves exactly how the user thought it would.

The new system’s user interface is designed using a graphical user interface to ease interaction between the operator and the system.

A graphical user interface (or GUI, often pronounced "gooey"), is a particular case of user interface for interacting with a computer which employs graphical images and widgets in addition to text to represent the information and actions available to the user. Usually the actions are performed through direct manipulation of the graphical elements.

Input Design

Input design specifies the manner in which data enter into the system for processing. Input design can ensure the reliability of the system and produce result from accurate data or it may result in the output of erroneous information.

The new system input interface is to be designed using checkboxes where by the operator of the system checks/ticks to make input into the system.

The design of the new system is to have two input windows/frames named the HISTORY and PHYSICAL EXAMINATION windows/frames. Each of these windows/frames is expected to display all the options (symptoms and signs respectively) required to make diagnosis. Another way to make input into the system is through the patient’s registration page.

The input is going to be through the keyboard and the mouse.

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Output Design

The term output is applied to any information produced by a system, whether printed, displayed or spoken.
The output of the new system would be displayed on the video display units and at the same time written to a file for record purposes.

Files Design

A file is a named collection of stored data. The file system of the new system is to be designed using a text file (notepad) to create patients' records. These files are read from and written to as the need arise.

Procedures and Programs

Procedures are the steps that unify the whole process, that link everything together to produce the desired output. These will involve both computer and clerical procedures. They will start with the origination of the source document and end with the output document being distributed. The design of the computer programs will constitute a major task in itself. These tasks include accepting input, processing and displaying output.

Hardware and Software Specifications

The proposed system is to be designed to run on any operating system that has Java2 Standard Development Kit Version 1.4.2_08 (J2SDK1.4.2_08) installed in it.
The following hardware would also make the proposed system run faster; this hardware includes:

- CPU with minimum speed of 466Mhz;
- Minimum of 256MB of RAM;
- Free space of at least 1GB on the hard disk drive.

With all these hardware and software specifications in place, the proposed system would be functional.

IV. SYSTEM ANALYSIS

The analysis of both the current system and the proposed system are as follows:

Overview of the Current System

The To fully understand how much time, energy and lives the expert system on rural medical care is supposed to save, it is appropriate that a mental picture of the process(es) of seeing a doctor is vividly drawn:

- Registration of Patient: - when an ill person checks into a clinic/hospital, the questions asked are: Is he/she reporting in that clinic/hospital for the first time? If the response to that is No, the patient gives his /her name and the number to his/her folder which contains his/her data and medical history. If the response is Yes, a new folder is opened for the person of which he/she will be asked name, age, sex, occupation, residential address. The folders of the patients (both old and new) are taken to the doctor while they (the patients) wait in line for their turn to see the doctor.
- Examination: - if it's an old folder, the doctor checks the patient's medical history, and then asks the patient what is wrong with him. If it is the reoccurrence of the same symptoms of the former ailment, it is most likely he (doctor) recommend a laboratory test (as the case may be). If it's the occurrence of new symptoms, the doctor prescribes drugs or recommends a laboratory test as the case may be. If the folder is a new one, the procedure is the same with an old folder except that the folder does not contain a medical history.
- The Laboratory: - In the case of patients that go for test is in the laboratory, they go through other processes of form filling, their sample(s) collected for the test and they are told when to come for the result.
- Medical Appointment: - The laboratory result is taken to the doctor who then diagnoses and prescribes drugs according to the findings of the laboratory result. The symptoms, the test, the diagnosis and the prescription, form the medical history of the patient which are contained in his/her folder. The doctor fixes a later date appointment in order to examine how the patient is responding to treatment. This process is carried out on each patient that comes into the clinic.

Users Requirements

The current system of rural clinic operations regarding the processes and procedures involved is adequate. However, the insufficiency of staff leaves so much to ask for; as such patients are left in large numbers, queuing to be attended to. In view of this, the users require: To be attended to as soon as possible; Reduced time spent on each of them (the users/patients); and Proper documentation and easy accessibility to their folders.

Overview of the Proposed System

To fill in the loop holes in the current rural medical care system attributed by insufficiency and inefficiency of staff and time wasting, the proposed system is intended to carry out registration of patients (both old and new), examination of patients, instructing the patients to go for laboratory test if need be (however, the expert system

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does not carry out the test) and diagnosing the disease of the patient. The proposed system also intends to prescribe drugs for the patient but refers the patient to a human doctor in the case of complex ailments.
In the process of system analysis, analysts often construct models to give an overview or stress on aspects of the whole system. This enables analyst to contact users in the best way, and when users' need is changed, it is possible to modify or construct a new model. Analysts use model to: Concentrate on important features of the system, pay less attention to less important ones; Be able to respond to changes or changes in user's requirements with low cost and risk; and Properly understand users' environment and write documents in the same way that designers and programmers construct the system.

- Use Case Diagram: are used during requirements elicitation and analysis to represent the functionality of the system. Use cases focus on the behaviour of the system from an external point of view. A use case describes a function provided by the system that yields a visible result for an actor. An actor describes any entity that interacts with the system (e.g., a user). This has been used to highlight and identify the various functions provided by the system.

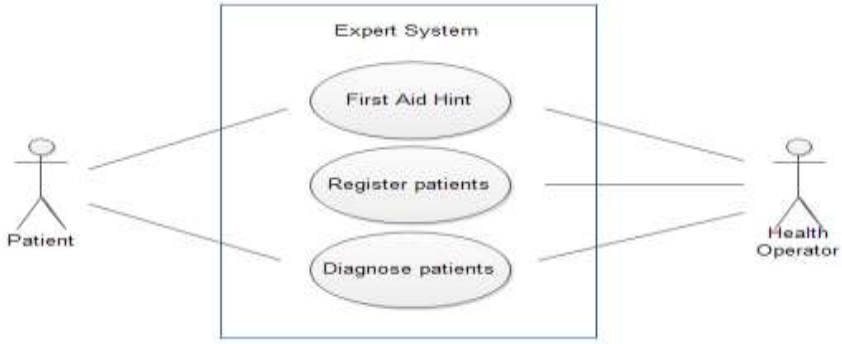

Figure 1: use case diagram

One of the use-case scenarios details:
Use case name: Register Patients
Participating Actors: Health Operator, patient.
Entry condition: new patient.
Flow of events: Input patient's bio-data.
Exit condition: Click save, to create patient's record and exit.

- Class Diagram: are used to describe the structure of the system. Classes are abstractions that specify the common structure and behaviour of a set of objects. This is used to describe the classes of the system and their relationships to each other.

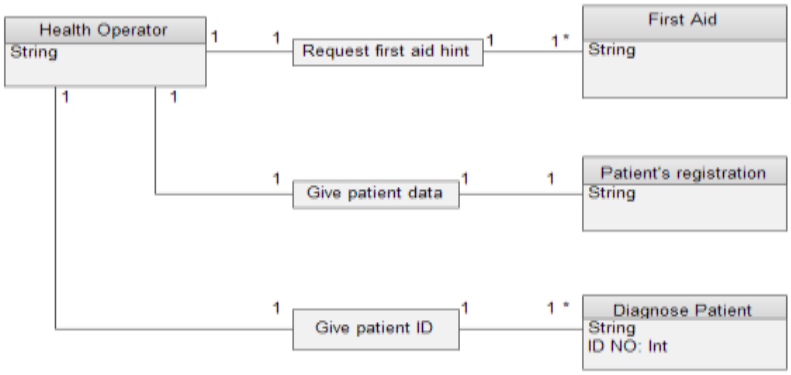

Figure 2: Class diagram

- Sequence Diagram: are used to formalize the behaviour of the system and to visualize the communication among objects. They are useful for identifying additional objects that participate in the use cases.

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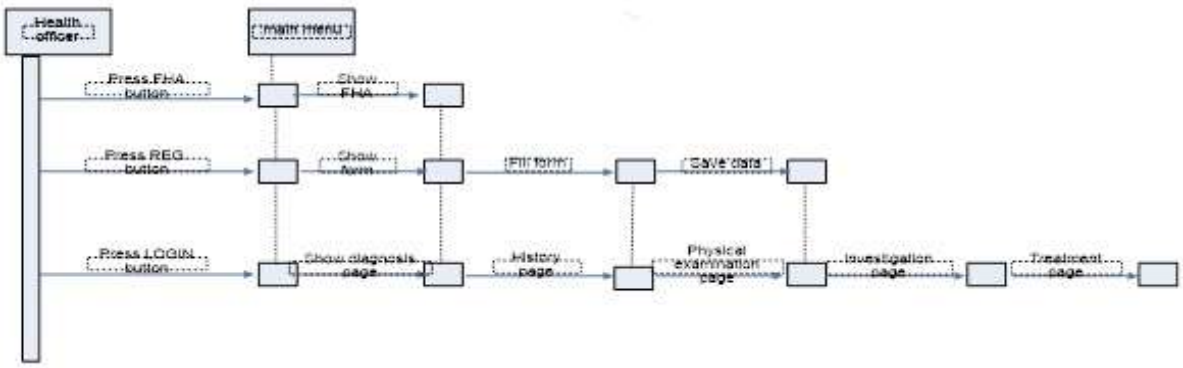

Figure. 3: Sequence diagram

Hardware and Software Specifications A. Algorithm
The proposed I. system is to be At this level, the flowchart shows how the various modules (classes) interact within the main module (super class). designed
Hardware and Software Specifications
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V. SYSTEM DESIGN

Algorithm
As stated previously in the methodology section, the flowchart is the algorithm adopted for the preliminary system design of the proposed expert system. The flowchart will show the abstract and two module levels of the proposed system.

- Abstract level

At this level, the flowchart shows how the various modules (classes) interact within the main module (super class).

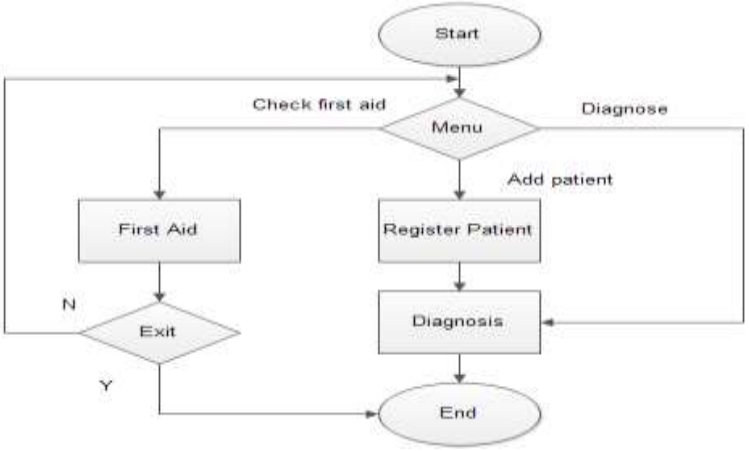

Figure 4: Abstract Level Flowchart

- Module level

The flowchart at this level shows how the various units (methods, subroutines, procedures) interact within a module.

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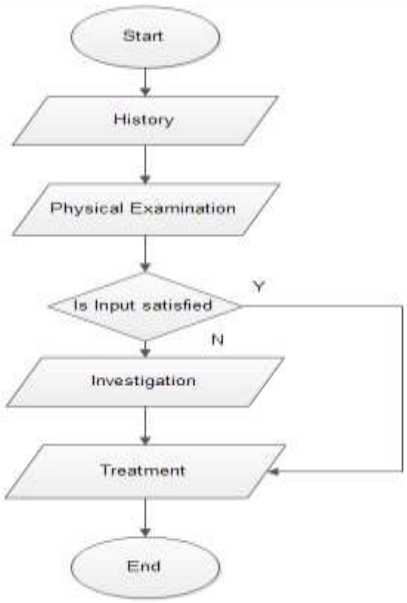

Figure 5: Diagnosis Module Flow Chart.

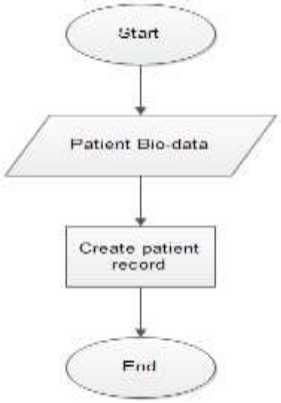

Figure 6: Registration Module Flow chart.

- Active program

This subsection shows the running program as screenshots from the respective pages within the program.

Figure 7: Main Menu

The First Aid: this is the part that assists health attendants by providing first aid hints to enhance their knowledge on some little emergency operations.

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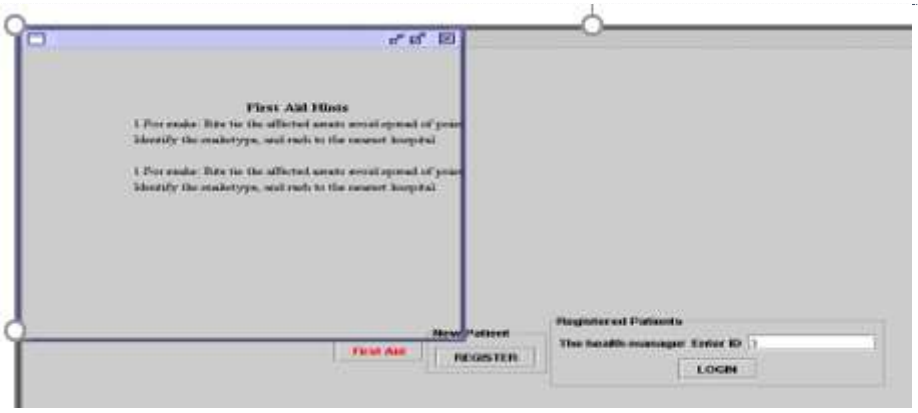

Figure 8: First Aid Screen

Patients Registration: this handles patient registration and the creation of patients' record files.

Figure 9: Registration Screen

Diagnosis: this accepts input into the system in order to make diagnosis and give treatments as appropriate.

Figure 10: Diagnosis Screen

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- **Output**

Structure of the patients' file system is as follows:

Table 1: File Structure

ID NO	Integer
NAME	String
SEX	String
ADDRESS	String
PHONE NUMBER	Integer
NEXT OF KIN	String
AGE	String

The other files that the system makes use of are those that serves as the knowledge base for the system.
The following patients' files were created for a total number of 2 patients that were registered.

Figure 11: Patient's 1 File

Figure 12: Patient's 2 File

After diagnosis and prescription of treatment, patient's 2 file is as shown below:

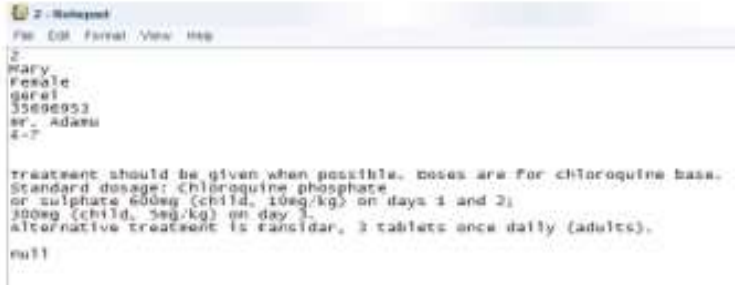

Figure 13: Patient 2's File after Treatment

VI. DISCUSSION

The limitation of the designed system prototype is that it cannot carry out tests, so it will have to refer patients to a laboratory for test(s) in cases of ailments that require test for confirmatory diagnosis. Also, there are some complicated conditions that the system cannot cover for example when patient is unconscious or when the ailment requires surgery.

In quest for massive wealth and greener pastures, doctors migrate from the rural dwellings to urban settlements. This leaves the habitants robbed of adequate medical care. The few doctors that decide to stay will have to work round the clock to attend to all patients. Due to the poor educational standard of the rural areas, people tend to make themselves vulnerable to simple ailments which they could ordinarily have avoided if they were educated on few health tips and their ignorance makes it hard for the health workers to cope with their high rate of visits to

the medical care units. The development of the system has significances to humans especially those in the rural areas, and the medical personnel. The system will automate the registration process of patients in hospitals/clinics and also keep a database for such. It will also diagnose patients based on input from them and prescribe drugs for them if need be.

VII. CONCLUSION

The expert system was experimented to try diagnosing common ailments for example malaria in the rural area in focus and it was found to be effective. This research looks into the areas of rural medical care that could be aided with the use of an expert system that would automate some of the processes and at the same time supplement the few medical officials available in the rural areas in order to improve on the healthcare system. This research considers the manual processes involved in the registration of patients in the rural medical centres, diagnosis and also the schedule of a follow-up appointment. Analysis of the current system was carefully carried out to determine where modification, changes and improvement should be made in the design of the proposed system. Finally, a computer system was designed; which would be used as prototype for further improvement.

Further work can still be done on the program written to improve on its performance in the areas that could not be covered. These include Improving on the program's user friendliness, scheduling of a follow-up appointment to be able to monitor patients' response to treatment.

VIII. ACKNOWLEDGEMENTS

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IX. REFERENCES

[1] Improving Health Care for Rural Populations. Research in Action Fact Sheet. AHCPR Publication No. 96-P040, March 1996. Agency for Health Care Policy and Research, Rockville, MD. http://www.ahrq.gov/research/rural.htm.

[2] Goodall, A. (1985). The guide to expert systems. Learned Information.

[3] Lindsay, R. K., Buchanan, B. G., Feigenbaum, E. A., & Lederberg, J. (1993). DENDRAL: A Case Study of the First Expert System for Scientific Hypothesis Formation. Lindsay, Robert K., Bruce G. Buchanan, E. A. Feigenbaum, and Joshua Lederberg. "DENDRAL: A Case Study of the First Expert System for Scientific Hypothesis Formation." Artificial Intelligence 61, 2 (1993): 209-261. Article. 53 Images.

[4] Negnevitsky, M. (2005). Artificial Intelligence: A guide to Artificial Intelligent Systems (2nd ed.). Essex, England: Pearson Education Limited. Retrieved from www.pearsoned.co.uk

[5] Sotos, J. G. (1990). MYCIN and NEOMYCIN: two approaches to generating explanations in rule-based expert systems. Aviation, Space, and Environmental Medicine, 61(10), 950–4. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2241738

[6] Abidi, S. S. (1999). TIDE: an intelligent home-based healthcare information & diagnostic environment. Studies in Health Technology and Informatics, 68, 720–5. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10724989.

[7] Fraser, R. B., Wolf, A., Dunham, C. M., Turney, S. Z., Cushing, B. M., Ramzy, A. I., & Eastham, J. N. (1991). An Expert System for the Diagnosis, Treatment, and Triage of Head Injuries in Remote Environments (pp. 275–279). Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-93503-9_49

[8] Ntalasha, D. (2012). Mobile Phone Based Medical Diagnostic System. US-China Education Review, 6, 619–626.

[9] Lee, J.-J., Song, B.-H., Kim, T.-Y., Seo, D.-W., Bae, S.-H., & Korea Jang-Jae Lee, S. (2008). A Design and Implementation of U-health Diagnosis System using Expert System and Neural Network. Internation Journal of Future Generation Communication and Networking, 1(1), 83–90.

[10] Ochab, M., & Wajs, W. (2016). Expert system supporting an early prediction of the bronchopulmonary dysplasia. Computers in Biology and Medicine, 69, 236–244. http://doi.org/10.1016/j.compbiomed.2015.08.016

[11] Seto, E., Leonard, K. J., Cafazzo, J. A., Barnsley, J., Masino, C., & Ross, H. J. (2012). Developing healthcare rule-based expert systems: Case study of a heart failure telemonitoring system. International Journal of Medical Informatics, 81(8), 556–565. http://doi.org/10.1016/j.ijmedinf.2012.03.001

[12] Vila-francés, J., Sanchís, J., Soria-olivas, E., José, A., Martínez-sober, M., Bonanad, C., & Ventura, S. (2013). Expert system for predicting unstable angina based on Bayesian networks. Expert Systems with Applic Ations, 40, 5004–5010. http://doi.org/10.1016/j.eswa.2013.03.029

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Impact Factor: 4.116
CODEN: IJESS7

[13] Oyelami, O. M., Abu-Naser, S. S., Kashkash, K. A., Fayyad, V., Al-Ahmar, M., Huang, M. J., … Li, Q. (2012). A Mobile Phone-Based Expert System for Disease Diagnosis. In E-Healthcare Systems and Wireless Communications: current and future challenges (Vol. 1, pp. 220–235). IGI Global. http://doi.org/10.4018/978-1-61350-123-8.ch011

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