A Framework for Patient Diagnosis System in Sub-Sahara African Primary Health Care Centers

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Abstract---- **Primary Health Care (PHC) is an essential health care that should be made universally accessible, affordable, and acceptable to individuals, communities, and countries, but there is shortage of medical expertise and good medical services for people in many primary healthcare centers of sub-Saharan Africa countries. Many of these countries spend a lot to overcome these challenges with little success. There is also a rural-urban migration problem, which leaves the rural areas with little or no medical expertise, and high response time for diagnosis and treatment of patients, to mention but few. The purpose of this work is to develop a framework for the diagnosis of common ailment in primary health care centers, with the aim of assisting in the diagnosis process that will be reliable.**
The framework uses Rule-Base approach to enhance accurate diagnosis and quick response. The proposed framework operation will be based on logic inference guided by the constituents of the database and the knowledge base of the system.

Keywords- component; Framework, Patient Diagnosis Sytem, Primary Health Care Centers, Sub-Sahara Africa.

I. INTRODUCTION

The dearth of medical expertise in medical science is a major crisis that the developing countries especially, Sub-Sahara African countries, are facing. The fact that health care service delivery in these countries is far from being compared with the minimum standards set by World Health Organization (WHO) cannot be disputed [1]. Some factors are responsible for the inadequacies. They include; unqualified medical personnel, insufficient hospitals, and particularly in less density areas without social amenities, equipment, to mention a few. As a result, the factors listed, particularly the lack of qualified or adequate medical personnel, have contributed to deaths that could be avoided [2].

Medical diagnosis is a phrase that identifies as nearly as possible the specific clinical problem that is causing illness. This involves both the process of attempting to determine or identify a possible disease or disorder affecting a patient. Diagnostic process is a complex process which usually begins with the patient's own illness history and graduates into a result that can be grouped from one point to another depending on the symptoms gathered. This particular step in medicine is very important and significant to the treatment of every patient; this is therefore taken very seriously in the development of intelligent systems in the medical field. [3]

The problem of disease diagnosis and management is complex due to the involvement of a lot of variables; such as: inability of the patients to express exactly how they feel, inability of the doctors and nurses to give a precise outcome of what is observed, while sometimes laboratories results are noted with some flaws caused either by the carelessness of technicians or malfunctioning of the instrument. Based on all these factors, amongst others; medical researchers cannot precisely characterize how diseases alter the normal functioning of the body. All these complexities in medical practice make traditional quantitative approaches of analysis not to be reliable.

Information Technology (IT) has evolved to be of great importance in the contemporary world of today, most businesses, government offices, schools and establishments are based on how well their Information System and IT capabilities are being structured and managed. One significant area in which IT has achieved tremendous success is in the health sector and part of it is the creation of patients' diagnostic systems for hospitals and health centres. This power of IT could be harnessed in arranging, storing and retrieving medical knowledge acquired by the practitioners in dealing with cases and suggesting appropriate diagnosis, prognosis, therapeutic decisions and

decision-making techniques. Hence, the need for a technological tool that can provide facilities for non-specialists and to ensure that reliable decisions could be taken in the absence of experts. [4].

The aim of this work is to propose a framework to diagnose and treat common ailments and diseases in primary health care centres.

II. LITERATURE REVIEW

Primary Health Care (PHC) is an essential health care that is made universally accessible, affordable, and acceptable to individuals, community, and country through full participation; and surely, the people have the right to participate in their healthcare delivery. PHC is an approach to health beyond the traditional health care system and it focuses on reducing the gap between the health status of developed and developing countries, and within countries. The main focus of primary health care is to provide better health for all. *Health, as defined by WHO (1948), is a state of complete physical, mental and social wellbeing, and not merely the absence of diseases or infirmity.* It is a fundamental human right of the people [5].

In order to sustain economic and social development, human welfare is paramount, and good health is essential to human welfare. WHO has identified some key elements to achieving this goal and part of these is organizing health services around people's needs and expectations, i.e. service delivery reforms; and reducing exclusion and social disparities in health [6].

Comprehensive healthcare is imperative and relies on adequate number and distribution of trained physicians, nurses, midwives, community health workers, and other related health professionals, working as a team and supported at the local and referral levels. But this is not so in many developing countries (e.g. Sub-Saharan Africa) where there is prevalence of inadequate number of health personnel or professionals which exposes patients to all manner of poor health service delivery by unqualified health personnel. These are places where access to quality health is inadequate, inaccessible and/or not affordable; and where the level of illiteracy and poverty is very high [3].

In the Alma-Ata (1978) declaration, it was proposed that by year 2000, all the people of the world should attain a level of health that will permit an economical productive life. [5]. Now in 2017, the target is yet to be fully achieved. In fact, according to the 2017 joint WHO/World Bank Group Report it shows that the 21st century has seen an increase in the number of people able to obtain some key health services. But, there are wide gaps in the availability of these services in Sub-Saharan Africa and Southern Asia [1]. The primary health care is the closest level of national health system to individuals, family and community, and it constitutes the starting point of a continuing health care process.

Therefore, the introduction and availability of this (system, framework, or technological tool) could go a long way to assist medical practitioners in delivering their health services as required, and to ensure that reliable decisions could be taken in the absence of experts in these geographical areas.

III. RELATED WORKS

In [3], the authors developed a health diagnostic and monitoring software for common diseases across all parts of the human body, targeted towards individuals and health personnel in remote areas where medical personnel are inadequate.

This software would provide advice to patients or users based on their blood pressure, body mass index and also offer assistance in administering common drugs. It will also have a system in place to remind users of medical review with their doctors. It would minimize drug abuse and improve quality of health delivery and reduce mortality in some situations. The unique feature of this software is its ability to diagnose multiple or several diseases across all parts of the human body depending on the expert's information and the correct symptoms presented to it by the patient or the user. After the ailment has been diagnosed, the BMI of the patient will be considered for the dispensing of the prescribed drug. In their work, the knowledge base is a declarative representation of expertise, in conditional statements like the IF-THEN rules, while the inference engine uses forward chaining, backward chaining and mixed chaining. Their work is not web-based.

According to [7], the authors developed a MDS using Fuzzy Logic so as to enhance the accuracy and precision of the medical diagnosis since it is one of the most efficient qualitative computational methods and because it has the ability to handle vagueness, ambiguity and imprecision that characterizes medical diagnosis. They used Visual Prolog Programming Language as their implementation language. Their proposed MDS is meant to diagnose various diseases. Their work was not targeted towards primary healthcare. Their aim is to reduce doctor's job during consultation. It does not give direction on the next step of action if diagnosis is not in line with malaria ailment.

The authors in [8], developed a multi-agent online medical diagnostic system that is composed of different agents that provide various medical services like location of medical centers, booking of appointments with doctor, and remote access to patient's medical records. The multi-agent system contain six different type of agents such as the main agent (MA), the user agent (UA), the medical store agent (MSA), a database wrapper (DW), some doctor agents (DA), and media and government agent (MGA). Each of this agents communicate and inter-operate through standard agent communication language (FIPA-ACL) and content language (SL) and formal ontologies is used to describe communication between different services at the application level.

Also in [4], the authors argue that the traditional expert systems utilize a static sets of questionnaires that does not intelligently ask pertinent questions. Also many traditional

expert system often utilize only one inference strategy. These limitations do not make expert system effective and efficient in addressing the issues of health monitoring and diagnosis in healthcare. The authors therefore developed Web Based Online Medical Diagnosis System which is useful where can only be useful online. However, our system is designed for Primary Health Care Centers where there may not be internet and absence of doctors is also inevitable.

The authors [9], in their work, reviewed and compared expert diagnostic systems for various diseases like tuberculosis, heart diseases, and kidney diseases using computational models such as fuzzy and neural network techniques. According to them, some researchers have evaluated their expert system in hospitals and obtained high accuracy and precision but none of them considered the primary health care in rural areas where human experts are not available which is the aim of our work.

IV. METHODOLOGY

The framework for the proposed diagnostic system is as shown below in Figure 1. The system is based on the rules in knowledge base and the patient symptoms, from which the output disease can be inferred.

A. The Database

The database is viewed as the memory of the framework in which important details about the medical center personnel, diseases, treatment and prescription, and patient can be stored for future use or referencing. Patient demography details will be collected and stored in the database coupled with all vital data on the patient's current state for diagnosis. In addition to the demography data, is the symptoms table and prescription table on which the record of symptoms for ailment and the recommended prescription are stored. The other table included in the database is the staff table which stores information about authorized staff.

B. The Knowledge Base

The general knowledge and extracted knowledge from experts can be represented with any of these representational format; frame-based representation, semantics network, and production rules [10-12]. Though, each of these approaches has their limitations and advantages, the production rule representational approach is adopted in the current work.

Expert's knowledge, facts about diseases, and symptoms are represented as a set of IF-THEN rules and stored in the knowledge base; these set of rules are reference to guide the reasoning process for the diagnosis [3]. The extract of these rules is shown in Table I.

C. The Inference Engine

Inference engine utilizes the contents of the database and the knowledge base to infer [13]. The rules contained in the knowledge base are like patterns which can be traced by the inference engine following the process of forward and backward chaining, to reach conclusion; in line with other contents of the database that has to do with the patient.

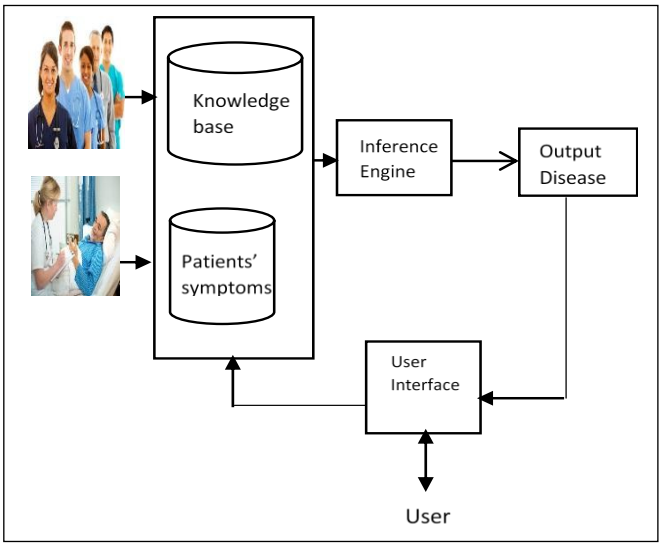

Figure 1. A framework for the PDS

D. User Interface

A user interface is the means through which a user interacts with the system. There are three users in our system: human experts which include medical doctors, pharmacist, nurses, medical students, medical laboratory scientist; the administrator and the patient. All the users interact with the diagnosis system through the user interface. The inputs from human expert constitute the knowledge base from which our if-then rules is obtained. Knowledge-based information and the inputs from the patients which generally consists of past records, symptoms and patients profiles serve as the inputs to the inference engine and the user can as well access the diagnosed disease, advice and prescriptions through the interface as shown in both Figures 2 and 3.

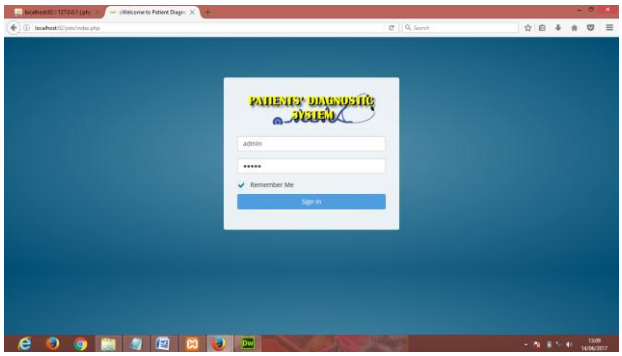

Figure 2. User Interface for Sign-in page

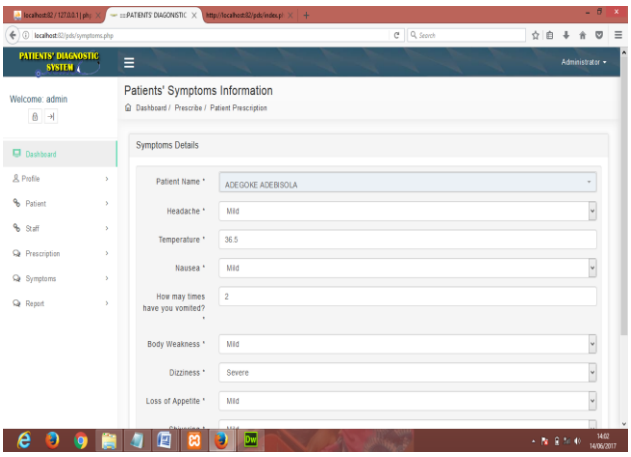

Figure 3. User Interface for Symptom page

V. CONCLUSION

For primary health center to achieve its goals, it must have been evaluated to be reliable in delivering quality health services in relation to its required (or expected) level of operation. The proposed framework for diagnosing diseases given the prior knowledge from human expert and symptoms from patient is an attempt to equip primary health centers and strengthen their service delivery where absence of medical doctor is inevitable. The proposed framework operation will be based on logic inference guided by the constituents of the database and the knowledge base of the system.

TABLE I. EXTRACT OF MALARIA RULE TABLE

Rule no	Headache	Temperature	Nausea	Vomiting	Body Weakness	Dizziness	Loss of Appetite	Shivering	Joint Pain	Conclusion
1	Mild	Mild	Mild	Mild	Mild	Severe	Mild	Mild	Mild	This may not be malaria. Contact the doctor
2	Mild	Moderate	Mild	Mild	Moderate	Severe	Severe	Moderate	Moderate	Moderate
3	Moderate	Severe	Mild	Mild	Severe	Severe	Severe	Severe	Mild	Severe
4	Mild	Very Severe	Mild	Mild	Severe	Mild	Mild	Moderate	Severe	Very Severe
5	Mild	Moderate	Mild	Moderate	Moderate	Moderate	Severe	Mild	Moderate	Moderate
6	Moderate	Mild	Moderate	Mild	Mild	Moderate	Mild	Mild	Mild	Mild
7	Mild	Severe	Moderate	Moderate	Severe	Moderate	Moderate	Moderate	Severe	Severe
8	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Mild	Moderate	Moderate
9	Mild	Moderate	Moderate	Moderate	Moderate	Severe	Moderate	Moderate	Moderate	Moderate
10	Mild	Mild	Moderate	Moderate	Mild	Mild	Mild	Mild	Mild	Mild

Some of the success factors of the framework are: sufficiency of the level of knowledge available in the knowledge base; the friendliness of the user interface; the skill of the developer; and the provision of management support for the framework.

As a future work, it is intended that, when the system is developed it will be useful in diagnosing patients, with (giving) quick and flawless prescription, referral or advice as the case may be, which will definitely reduce death rate in underdeveloped environment and aid in achieving one the goals of the WHO.

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