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A web based decision support system driven by fuzzy logic for the diagnosis of typhoid fever

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ABSTRACT

Research has identified Typhoid Fever (TF) as the major cause of morbidity and mortality in most developing countries. The diagnosis of TF involves several variables which usually makes it difficult to arrive at accurate and timely diagnosis. This research proposes a Web-Based Decision Support System (WBDSS) driven by Fuzzy Logic (FL) for the diagnosis of TF. The system comprises of a Knowledge Base (KB) and a Fuzzy Inference System (FIS).The FIS is composed of a Fuzzifier, Fuzzy Inference Engine (FIE), and a Defuzzifier. The FIE is the core of the FIS and it adopts the Root Sum Square (RSS) technique in drawing valid conclusion. The Fuzzifier uses a triangular membership function to determine the degree of contribution of each decision variable while the Defuzzifier adopts the Centroid of Area (CoA) defuzzification technique to generate a crisp output for a given diagnosis. An experimental study of the proposed system was conducted using medical records of TF patients obtained from the Federal Medical Center, Owo, Ondo State-Nigeria over a period of six months and the results of the study were found to be within the range of predefined limit as examined by medical experts. Standard statistical metrics were used to measure the efficiency of the proposed system and the results obtained show that the proposed system is 94% efficient in providing accurate diagnosis.

1. Introduction

Typhoid Fever (TF) remains a major public health problem in developing countries of the world even in the twenty first century (Lin et al., 2000; Otegbayo, Daramola, Onyegbutulem, Balogun, & Oguntoye, 2003). Unacceptable morbidity and mortality are still recorded in developing countries in spite of the availability of several drugs over the years for the treatment of TF (Otegbayo, 2005). The process of disease diagnosis and management is complex because of the numerous variables involved. It is further complicated by the imprecision and uncertainty associated with such variables (Djam, Wajiga, Kimbi, & Blama, 2011; Nguyen & Walker, 1997). Since the effectiveness of the therapy for a given disease is highly dependent on the level of accuracy of its diagnosis, these complexities in medical practice make the conventional quantitative diagnosis approaches inadequate and hence call for new technique.

Computer tools help to organize, store and retrieve appropriate medical knowledge needed by medical practitioners to deal with difficult cases and suggest appropriate diagnosis, prognosis, and therapeutic decisions (Szolovits, Patil, & Schwartz, 1988).

Expert System (ES) is an intelligent interactive computer based decision tool that uses facts and rules to solve difficult real life problems based on the knowledge acquired from one or more human expert(s) in a particular field. ESs have user friendly interfaces which make them highly interactive in nature and provide accurate and timely solutions to difficult real life problems (Durkin, 1994). In order to address the inadequacies of the conventional methods of medical diagnosis, medical expert systems were proposed.

Fuzzy Logic (FL) has been identified as a substantial soft computing tool that is used to represent the knowledge of an expert in a computer program such that the program can solve problems in a manner that is similar to human expert. That is, FL finds its strength in providing accurate solutions to problems that involve the manipulation of several variables (Ojokoh, Omisore, Samuel, & Ogunniyi, 2012). FL has been used extensively for the implementation of ESs in the field of medicine due to its ability in handling the imprecision and uncertainty inherent in medical records. Fuzzy expert system incorporates elements of FL which provides consistent, accurate, and timely results (Wainer & Sandri, 1999).

This research proposes a WBDSS driven by FL for the diagnosis and management of TF based on the principles and practices of medical diagnosis. The system was developed with the aim of providing a decision support platform for medical practitioners, TF researchers, and health care providers in developing countries of the world. The proposed system will assist medical personnel

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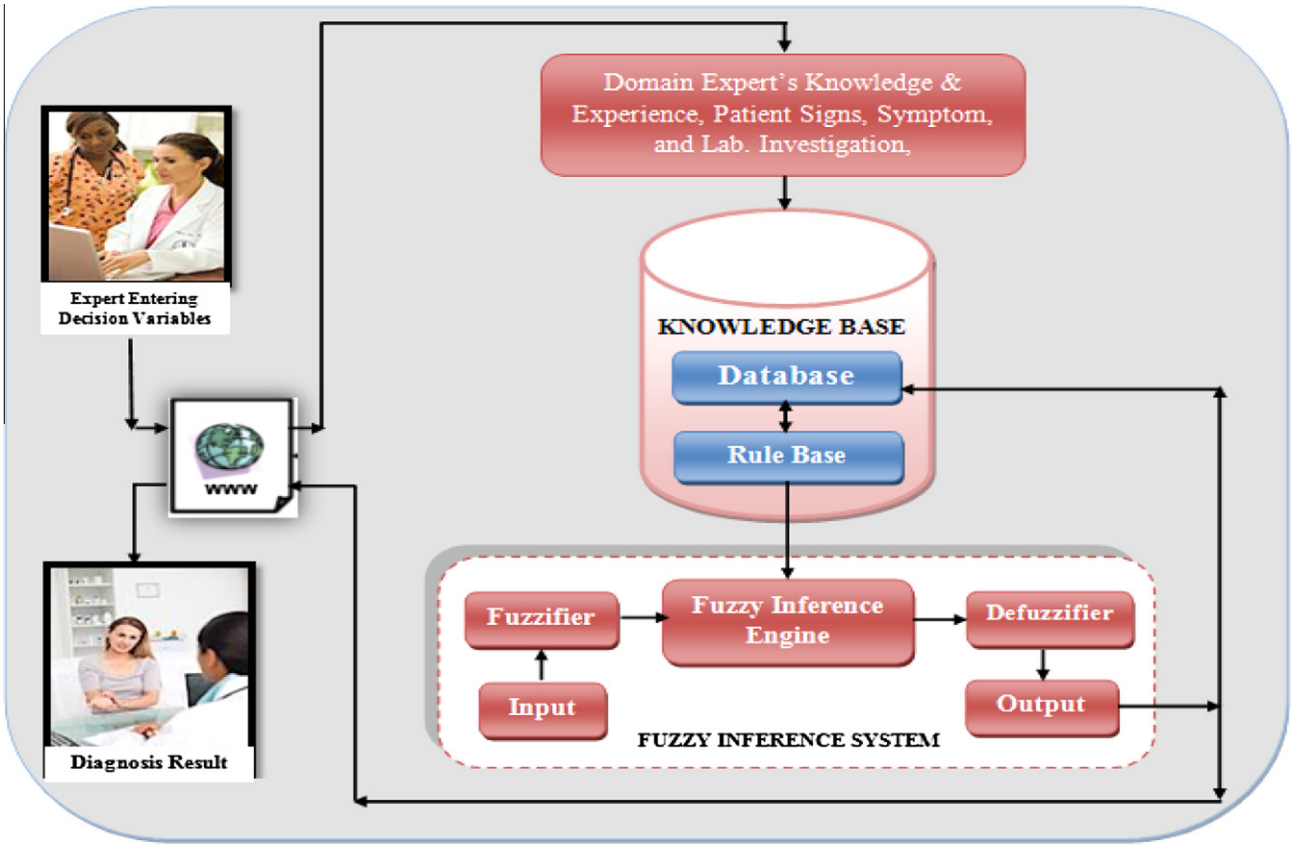

Fig. 1. Architecture of WBDSS for the diagnosis of TF.

especially in rural areas where there are shortage of doctors in providing quality health care services. The architecture of the proposed system as presented in Fig. 1 consists of a KB that houses the database and the rule base, a FIS that does the actual diagnosis, and a World Wide Web component which makes the proposed system accessible over the Internet.

The remainder of this paper is organized as follows: Section 2 presents review of related work; Section 3 presents the architecture of the proposed system, method and materials adopted by the research; Section 4 presents the experimental study and result of the proposed system. Section 5 presents the evaluation of the proposed system; Section 6 presents the conclusion and recommendations.

2. Related work

Salmonella enteric serotype typhi is the aetiological agent of TF, a multi systemic disease with protean manifestations and initial lesions in the bowel. The biggest challenge in the management of TF is perhaps the emergence and spread of multi drug resistance strains of the bacterial causing TF, and the complication with malaria co-infection leading to significant morbidity and mortality (Bhan, Bhal, & Bhatnagar, 2005; Bhutta, 1996; Gupta, 1994; Siddiquia, Rabbania, Hasanb, Nizamic, & Bhuttac, 2006). The above challenge of drug resistance has been attributed basically to the flows associated with the orthodox approach to TF diagnosis.

Computer technology can be used to reduce the number of mortality and minimize the waiting time to see a medical practitioner. Computer program developed by emulating human intelligence could be used to assist doctors in making timely and accurate decisions regarding patients' diagnosis. Such programs are known as medical decision support systems and they help health care professionals make timely clinical decisions (Shortliffe, 1987). Medical decision support systems operate on medical data using the knowledge of a medical expert in diagnosing patients' conditions as well as recommending effective treatments for patients (Wan & Fadzilah, 2006).

Many intelligent systems have been developed for the purpose of enhancing health care delivery, providing better care facilities, and reducing the cost of health care services. As expressed by some studies (Alexopoulos, Dounias, & Vemmos, 1999; Bourlas, Giakoumakis, & Papakonstantinou, 1999; Mahabala, Chandrasekhara, Baskar, Ramesh, & Somasundaram, 1992; Manickam & Abidi, 1999; Ruseckaite, 1999; Zelic, Lavrac, Najdenov, & Rener-Primec, 1999), intelligent systems were developed to assist users (doctors and patients) provide early diagnosis and prediction to prevent serious illness. Even when the system is equipped with "human" knowledge, it will never replace human expertise, since humans are required to frequently monitor and update the system's knowledge. Therefore, the roles of medical practitioners are important to ensure system's validity (Wan et al., 2006).

Early studies in intelligent medical systems such as CASNET, MYCIN, PIP, INTERNIST-I, have been shown to outperform manual practices of diagnosis in several domain (Shortliffe, 1987). CASNET (Causal Association NETworks) was developed in early 1960's as a general tool for building expert system for the diagnosis and treatment of diseases. CASNET major application was the diagnosis and recommendation of treatment for glaucoma. MYCIN was developed in the early 1970's to diagnose certain antimicrobial infections and recommend drug for treatment. It is made up of the following; explanation facility, knowledge acquisition facility, teaching facility, and system building facility. Personal Illness Program (PIP) was developed in 1970's to simulate the behavior of an expert nephrologist in taking the history of present illness of a