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Ebinformatics: Ebola fuzzy informatics systems on the diagnosis, prediction and recommendation of appropriate treatments for Ebola virus disease (EVD)



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ABSTRACT

Ebola Virus Disease (EVD) also known as the Ebola hemorrhagic fever is a very deadly infectious disease to humankind. Therefore, a safer and complementary method of diagnosis is to employ the use of an expert system in order to initiate a platform for pre-clinical treatments, thus acting as a precursor to comprehensive medical diagnosis and treatments. This work presents a design and implementation of informatics software and a knowledge-based expert system for the diagnosis, and provision of recommendations on the appropriate type of recommended treatment to the Ebola Virus Disease (EVD).

In this research an Ebola fuzzy informatics system was developed for the purpose of diagnosing and providing useful recommendations to the management of the EVD in West Africa and other affected regions of the world. It also acts as a supplementary resource in providing medical advice to individuals in Ebola – ravaged countries. This aim was achieved through the following objectives: (i) gathering of facts through the conduct of a comprehensive continental survey to determine the knowledge and perception level of the public about factors responsible for the transmission of the Ebola Virus Disease (ii) develop an informatics software based on information collated from health institutions on basic diagnosis of the Ebola Virus Disease-related symptoms (iii) adopting and marrying the knowledge of fuzzy logic and expert systems in developing the informatics software. Necessary requirements were collated from the review of existing expert systems, consultation of journals and articles, and internet sources. Online survey was conducted to determine the level at which individuals are aware of the factors responsible for the transmission of the Ebola Virus Disease (EVD). The expert system developed, was designed to use fuzzy logic as its inference mechanism along with a set of rules. A knowledge base was created to help provide diagnosis on the Ebola Virus Disease (EVD). The Root Sum Square (RSS) was adopted as a fuzzy inference method. The degree of participation of each input parameter was shown using the triangular membership function and the defuzzification technique used is the Center of Gravity (CoG).

The resulting software produced a user-friendly desktop-based, Windows-based, application and the tools used were explained in the results section in three (3) separate phases. First, a comprehensive online survey was conducted over a period of about 3–9 months. 100 Participants participated in the survey on the perception and knowledge analysis of different individuals about Ebola Virus Disease (EVD) transmission factors. 31% of the participants didn't know that there is presently no cure for Ebola. 28% believed that there is presently a cure for Ebola. 43% agreed that Ebola is both air-borne and water-borne, while 33% disagreed, 24% do not know. 23% believed that insects and mosquitoes can help in transmitting the Ebola Virus Disease (EVD), while 30% were completely ignorant. We noticed that ignorance was a major limiting factor among some participants.

Second, a test was conducted among 45 people. Results from a comprehensive testing of the Ebinformatics software by allowing users to operate and use the software, revealed that 60% of them were satisfied, while 16% were not satisfied with the software, while 24% were indifferent. 69% of the users were in agreement that Ebinformatics was supportive, 20% disagreed, while 11% were indifferent. 67% found the software easy to use, 13% disagreed, while 20% were indifferent. Third, the output of the

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software, showing the various diagnosis and recommendations interfaces were presented. Recommendations were also given with respect to how the system can be extended, and further improved upon.

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1. Introduction

The deadly, scary spate and debilitating effects of the Ebola Virus Disease (EVD) in the West African sub-region, especially in 2014, left terrifying, untold hardships and discrimination mostly among the affected West African countries [1–3]. Many are yet to fully recover from the Ebola scare and the psychological trauma it generated. It is a known fact that the Ebola Virus Disease (*henceforth*, EVD), is a very contagious and deadly disease. Presently, there is no globally recognized or known cure for the disease. Other problems associated with the disease are lack of proper knowledge in diagnosing and managing the disease especially among countries in Sub-Sahara Africa. In some cases, lack of proper training for medical experts to effectively and efficiently manage the disease constitutes a problem. With these in view, there is need for a practical implementation of a complementary system that can diagnose and provide excellent recommendations to individuals in order to curb the spread of the disease. Such system will also act as a supporting tool for medical experts and resident doctors in training. The aim of this research is to develop an Ebola Fuzzy Informatics system for the purpose of diagnosing and providing useful recommendations for the management of the EVD in West Africa and other affected regions of the world. It will also help in providing medical and health advice to individuals in Ebola – ravaged countries. In order to

achieve the specified aim, the following objectives will be achieved. They are (i) Gather facts by conducting a comprehensive preliminary survey to determine the perception of the public about factors responsible for the spread of the Ebola virus (ii) develop a system based on modeled facts for the basic diagnosis and provision of recommendations on the Ebola Virus Disease (iii) adopt the knowledge of fuzzy logic and expert systems concept developing the proposed system. As a result of the recent pandemic and great epidemic of EVD in West Africa [1–3] in 2014, it is evident that there is an urgent need of an informatics system that can be made available to people irrespective of their geographical location or region. This will provide individuals with the necessary support in diagnosing and providing appropriate recommendations to users of the informatics software.

2. Materials and methods

2.1. Review of relevant literature

Many works have been conducted in times past with respect to developing diagnosis and predictive-related informatics applications for disease management. Eslami and colleagues [4] developed an expert system with the ability to appropriately and correctly

The screenshot shows the 'EbInformatics: Ebola Diagnosis and Health Management System' interface. At the top, there are navigation tabs: HOME, DIAGNOSE, NEWS, and ABOUT APPLICATION. Below the tabs, a heading reads 'FOLLOW THE STEPS BELOW TO DIAGNOSE YOURSELF FOR THE EBOLA VIRUS' with a note: '(NOTE THAT THIS TEST IS PURELY PREDICTIVE, YOU ARE ADVISED TO VISIT A HEALTH CENTRE)'. The interface is divided into three sections:

- STEP ONE: FILL OUT BASIC INFORMATION.** This section contains three dropdown menus: 'This Diagnosis is for:' (set to 'Someone else'), 'Gender:' (set to 'Male'), and 'Age:' (set to '19-24').
- STEP TWO: SELECT THE SYMPTOMS YOU ARE EXPERIENCING.** This section features a search box 'Search Symptoms Here...' and a list of symptoms on the left. The symptoms listed are: Breathing Difficulties, Chest Pain, Chills (Shivering), Cough, Cough (Bloody), Diarrhea, Fatigue, Fever, Headache, Hiccups, and Joint Pain. To the right of this list are three radio buttons for severity: 'MILD', 'MODERATE', and 'SEVERE'. The 'SEVERE' option is selected. There are 'ADD' and 'REMOVE' buttons. A box on the right contains the selected symptoms with their severity levels: Bleeding Eyes - Mild, Cough (Bloody) - Moderate, Bleeding Gums - Severe, Bleeding Mouth - Mild, Bleeding Nose - Moderate, Breathing Difficulties - Severe, Chest Pain - Severe, Fever - Mild, and Fatigue - Severe.
- STEP THREE: JUST OTHER FOLLOW UP QUESTIONS.** This section contains three dropdown menus: 'Current Region of Residence:' (set to 'Europe'), 'Country you've visited in the past week or month:' (set to 'NONE'), and 'Have you visited any Ebola stricken country in the last three(3) months?:' (set to 'No').

At the bottom of the interface, there are two buttons: 'Get Result' and 'Clear Data'. The footer of the window reads: 'By: Oluqbenga Oluwabemi, Folakemi Oluwabemi and Oluyemi Abimbola'.

Fig. 1a. EbInformatics Software depicting the symptoms of Patient 0002. The EbInformatics graphical user interface depicting the three different sections of the software. These are the basic information section, symptoms selection section and other follow-up question section. Here, some symptoms were selected for the diagnosis of patient 0002. Patient 0002 is a male patient, aged between 19 and 24; The symptoms selected for patient 0002 were: Bleeding Eyes – Mild; Cough (Bloody) – Moderate; Bleeding Gums – Severe; Bleeding Mouth – Mild; Bleeding Nose – Moderate; Breathing Difficulties – Severe; Chest Pain – Severe; Fever – Mild; Fatigue – Severe; Current region of residence was Europe. No country visited by the patient in the last 1 week or 1 month or in the last 3 months.

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