

# EHEALTH ADVISORY EXPERT SYSTEM FOR HIV/AIDS PATIENTS IN SOUTH AFRICA

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## Abstract

Human immunodeficiency virus (HIV) / Acquired immune deficiency syndrome (AIDS) is a major global health problem. It is the greatest threat to the reconstruction and development of South Africa. Advances in Information and Communication Technology (ICT) have facilitated development of medical expert systems. They have proved their usefulness by providing precise, quick and inexpensive consultation. Advisory expert system is seen as an enhancement tool in providing home-base care to people living with HIV/AIDS. In this paper we discuss our research motives, related work and the design of the web-based advisory expert system that allows HIV patients to manage the HIV-related symptoms.

## 1 Introduction

HIV/AIDS is a major global health problem in South Africa [2]. In 2011, the prevalence rate for HIV was estimated to be 10.6 percent and the total number of people living with HIV/AIDS rising from 4.2 million in 2001 to an estimate of 5.4 million in 2011 [1]. It has been estimated that up to 90 percent of nursing care is provided at home by the untrained family and associates [9]. Up to 80 percent of HIV/AIDS related deaths occur at home [9]. The patients and their care givers do not always have contact with professional help, thus support is inadequate.

This research is being conducted in Gugulethu, a township in Cape Town. This area represents community that have high prevalence rate of HIV/AIDS in Western Cape province [11]. People living with HIV/AIDS (PLWHA) receive medical care from Gugulethu community health clinic which is a public health facility. Counselors (trained health workers linked to the hospitals) have been enrolled to help the patients. Counselors' role is to maintain regular contact with the patients, train existing primary family on how to safely perform day-to-day task, provide clinical task such as administering pain relief or medication to patients and providing PLWHA with nutritional care and support information. The counselors toil on many fronts to meet the enormous demand for

the HIV/AIDS services. Despite their effort, they are not able to meet all the patients' needs.

Information and Communication Technology (ICT) solution has shown potential in medicine practice [5]. The powerful functionality of available technologies such as network communication, artificial intelligence, medical informatics allows health information to be effectively disseminated to patients [6]. Advance in internet and mobile computing has also become a vital source of information technology in health care [6].

This paper presents the development and partial testing of web-based advisory expert systems that will potentially help HIV/AIDS patients to self-manage the HIV-related symptoms. Our approach is to involve the expert (health care workers) in every step of the development process which includes collecting system requirements, designing interfaces and testing. In section 2 we present the use of home remedies to manage HIV-related symptoms and related work, section 3 covers our system design and test. In section 4 we have our conclusion.

## 2 Background

In this section we first present how home remedies can be used to manage HIV-related symptoms and then review existing advisory expert system that have been used to manage HIV/AIDS disease.

### 2.1 Use of Home Remedies to Manage HIV Related Illnesses

Literature reveals that home remedies which are readily available at home can extend and improve the quality of life for PLWHA [8, 9, 13]. Home remedies treatment involves eating healthy food, avoiding certain types of foods, psychological and emotional support and practicing hygiene to avoid skin infections [13]. According to report written on nutritional management of HIV/AIDS related symptoms, the specific objectives of home remedies are [8]:

- To reduce discomfort
- To alleviate symptoms
- To ensure adequate food intake using locally available foods

Health care workers at Gugulethu train patients on nutritional management of HIV-related symptoms. This should help the patients to cope with HIV/AIDS symptoms they experience. During counseling sessions, health-care workers and counselors always assess how patients are managing HIV/AIDS symptoms and, when needed, help identify alternative options.

To assist the counselors at Gugulethu health care to disseminate medical information to the HIV/AIDS patients, we developed web-based expert system. The system is feed with common HIV-related symptoms and the appropriate home remedies that are used to manage the symptoms. The system allows HIV patients to request for the appropriate home remedy for the HIV/AIDS-related symptoms they are experiencing. The medical information would be accessed using the mobile phone technology

## **2.2 Advisory Expert System in Medicine Practice**

Medical expert systems can play a major role by providing support in common clinical problems like prediction of diseases, prevention of diseases, diagnosis of diseases, providing patients with medical information etc. These systems rely heavily upon knowledge-based techniques in which decision making rules are derived through consultation with experts [10]. Different expert systems have been developed to provide medical information to PLWHA.

A customized treatment strategy for HIV (CTSHIV) is a rule-based expert system that was developed to recommend an individualized treatment for HIV patients [4]. CTSHIV provide the HIV patients with treatment strategy that avoid the antiretroviral agents for which a resistance has developed. It contains a knowledge base that encodes information from the medical literature on drugs resistant mutation. It also contains rules that rank and weight combination of antiretroviral agents. CTSHIV uses its knowledge base to find the level of resistance of each drug and find the weighting of each combination of drugs. The initial results of CTSHIV clinical trials were promising. However, the system showed some limitation by not understanding the relationship between genomic mutations conferring drugs resistance and clinical and surrogate marker outcomes.

E-Medical Diagnosis Expert System (EMDES) is an interactive expert system that is used to diagnose the HIV disease [7]. EMDES uses RMPJ2-RSA cryptosystem and signature schemes to ensure secure communication among the users. Patient login securely to the EMDES server and register personal data and clinical data (level of immune system, viral load and the opportunistic infection they are experiencing). The patient's

symptoms are accepted by the inference engine of the system as user input queries and response sent to the patient. To arrive to the appropriate diagnosis, the system performs CD4 lymphocyte count test [7]. The knowledge base is used to derive about the situation presented by the patient. The system evaluates the clinical data to confirm whether the patient is infected with the HIV or not. If confirmed, the system identifies whether the patient is in early stage/Intermediate Stage/Advanced stage.

In January 2005, the department of computer science, University of Botswana developed an online expert system to provide the general public with information related to HIV and AIDS [3]. The system would be queried by users using mobile phones technology. The system accepts frequently asked questions (FAQ) as inputs from the users and provides the appropriate answer to the question posed. It consists of user interface, inference engine and knowledge base. The user interacts with interface which consists of graphical screen. A question is typed on the screen and a response is displayed from the system. The inference engine uses the problem-solving logic to emulate the decision-making of a domain expert. The knowledge base is built from mainly the FAQs and answers manual of a local HIV/AIDS information call center [3]. The system was found to be a good system to disseminate HIV/AIDS information. More than 90 percent of the participant found it easy to use the system. They found the system useful in their own HIV/AIDS health care support. However the knowledge base showed some uncertainties. There was a possibility that the knowledge base could not provide the expected response to the users in some cases.

HIV-related symptoms can be managed through self-care practices. With availability of internet and mobile telephone technology this information can be disseminated to the patients and they can access it from any location. We developed a mobile and web-based advisory expert system which ensures faster feedback and greater accuracy.

## **3 System Design and Implementation**

Iterative design approach was used to develop the system. We choose the approach because it involves the domain experts (health care workers) and it allows correction of the system to be made early in the process. The following steps were followed:

### 3.1 Knowledge Acquisition

The process of extracting knowledge from domain experts in the field of concern is referred to as Knowledge acquisition [1]. We visited Gugulethu community health center and interviewed health care workers. The aim of the interviews was to find out the feasibility of the system. We also gathered knowledge on the common symptoms that are related to HIV/AIDS disease and appropriate remedies for some of the symptoms. The rest of the remedies were acquired from medical journals that were recommended to us by the health care workers. The interview was recorded and later transcribed.

### 3.2 Knowledge representation

The acquired knowledge was feed into the working memory of the system. Knowledge was encoded into rules. Forward chaining method was used. The condition part of the rule is checked whether it matches the working memory element. If it does, the action on the right hand side of the rule is taken.

### 3.3 System Development

We used JAVA programming language to develop the functions of the system. JAVA Expert System Shell (JESS) was used to encode the rules. MYSQL connector for JAVA was used to manage the interaction with the database through JAVA program that uses the connector facilities. JAVA program creates a RETE instance and passes the database details as facts. Springs framework was used to create easily testable and reusable java code. Maven was used to enable easy building of the JAVA project. Upon completion of the system coding, we hosted the system. The diagram below shows the system's overview.

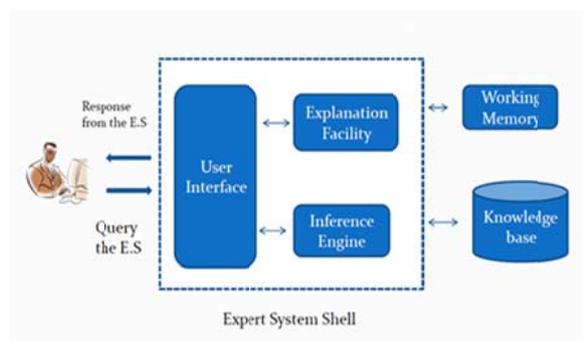


Figure 1: System Overview

### 3.4 System Testing

The initial step we took in testing the system was to train the health care workers on how to use the system. The health care workers were also trained on how to add/edit/delete symptoms and remedies from the systems. Usability tests are yet to be carried out. The health care workers will act as the

intermediates and train the patients on how to use the system.

## 4 Conclusion

This paper discussed ongoing research into the provision of medical information to HIV/AIDS patients via the web-based advisory expert system. The first result that was obtained is that it is possible to design and implement an accurate advisory system. This was shown through the usability testing that was carried out in the presence of the experts (health care workers). Successful completion of this research will hopefully empower PLWHA to manage the common HIV-related symptoms they experience. Future work aims at developing a mobile application that would provide medical advice in the same manner.

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