Enhancing Home Base Care provided for HIV patients using an Advisory Expert System in Gugulethu Township

Mburu, Christine Wanjiru, Dr. Le, Hanh

Department of Computer Science

University of Cape Town, Private Bag X3, Cape Town 7701

Tel: +27 216502663, Fax: +27 216503551

Email: chrissyshiru@gmail.com, hanh@cs.uct.ac.za

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 (ICTs) have facilitated development of medical expert systems. They have proved their usefulness since they can provide; precise, quick and inexpensive consultation. Advisory expert system is seen as enhancement tool in providing home-base care to people living with HIV/AIDS. In this paper we describe the development of advisory expert system used by HIV-patients in Gugulethu to self-manage the HIV-related symptoms they experienced. We also present the results obtained at the end of the research.**

Keywords: Expert system, HIV, AIDS, ICT, HCWs.

I. Introduction

Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) is a major global health problem. It is a threat to the reconstruction and development of South Africa [3]. 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. Up to 80 percent of HIV/AIDS related deaths occur at home [5]. The patients and their care givers do not always have contact with adequate professional help. This is as a result of health clinics being far, lack of transportation means in the region, lack of funds to pay for transportation and poor infrastructure [4]. The South African government is providing clinical support to handle the complexity and incurability of HIV/AIDS. In addition to this, more funds have been allocated to facilitate in developing more computer based systems to help manage the HIV/AIDS pandemic.

a. Gugulethu Township (Case Study)

In our research we worked with people from Gugulethu Township in Cape Town. The area has high prevalence of HIV in Western Cape Province. Most of the HIV-patients in this area access medical information by walking long distance to the clinic. Most of these patients are poor and they sometimes can't afford to visit the clinic regularly for medical advice. In this township there is scarcity of health care workers (HCWs). The HCW toil on many fronts to meet the enormous demand for the HIV/AIDS services but they are not able to meet all the patients' needs. We interviewed the HCWs and the patients and acquired requirements that would enable us to develop an appropriate system that would solve the mentioned problems.

II. Proposed System

We proposed to develop a web-based advisory expert system. These systems are suitable for disseminating medical information because they can be accessed by large number of patients. We visited Gugulethu community health center and interviewed HCWs. 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 the symptoms. Other remedies were acquired from medical journals that were recommended to us by the HCWs. The interview was recorded and later transcribed.

We used both the iterative design model and user-centered design in this project. User centered design allowed us to continually consult the HCWs when making design decisions throughout the development process. HCWs conceptual model was used to arrange the task of the advisory expert system. A list of all activities carried out to query the system and how the system provides the appropriate remedy for the specific symptom was created. We also created a list of activities that the HCWs would follow to add, edit and delete the symptoms and remedies to/from the system. We used activity modelling which is a tool intended to capture and succinctly represent information

regarding activities that are most relevant to interaction design.

a. System Development

Iterative design was used to ensure that the system met all the user requirements. The system was tested, analyzed and refined to improve the quality and functionality of the design.

In first iteration we used low fidelity prototype using pencil and paper. The prototype helped us to validate the requirement of the HCWs. We used the prototype to elicit corrections from the HCWs. This interactive prototype allowed us to run offline experiments studying the effects of the corrections provided by the users. Taking into account all of the feedback from the first iteration we were ready to develop a second prototype of the system which would take the suggested improvements into consideration.

The second iteration involved creating a fully functioning system. We first designed the back-end (server and database). A knowledge base was developed. The acquired knowledge was encoded into rules. 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. MySQL server was chosen to implement the database. Java programming language was used to derive the system functions which were embedded to jess. The system web-pages were arranged in a manner that allowed the user to complete the querying task at ease. Tabs were used for easy navigation through the system. All the desired design features were implemented and the system was ready for test to ensure that it met all the users' requirements.

b. System Evaluation

After the design and development process, we had our second prototype ready for evaluation. The main aim was to test the functionalities of the system. We presented the system to students at University of Cape Town to evaluate the functionalities of the system. Some problem surfaced during the evaluation. We fixed the problems identified to ensure that the system was working perfectly. After all testing were complete, we were satisfied that the system was fully functional and it worked as expected.

The next stage involved usability testing. This was done to test the ease of use, practicality and information accuracy of the system. We visited the clinic and trained the HCWs and patients how to use the system. Four HCWs were appointed as the administrators of the system. A user name and unique password was given to them. This gave them the privilege to access the system knowledge base. With this privilege they could add/edit/delete the system's knowledge. We used observation, constructive interaction and artifact walkthroughs techniques to carry out the test. After the training, we handed the laptop to the HCWs for them to use the system on their own. We watched them closely to help them whenever they encountered difficulties. The HCWs were able to add, edit and delete information to/from the system. They could also conduct querying task at ease. After several attempts, the HCWs were able to perform all the tasks. They appreciated the simplicity of the system and confirmed that the system provide the correct information. They confirmed that they could keep the system up to date with the information they acquire during the weekly counseling session.

During the weekly training session, the HCWs trained the HIV-patients how to use the system. The training was conducted in two parts: a group training presentation and a hands-on training using the mobile phones. In the first part of the training session, the HCWs introduced the system to the group of patients. The patients were trained how to query the system. We took note of the main question that the patients were asking concerning the system. In the second part of the training session, the HCWs used the Nokia c200 mobile phone to walk-through the tasks involved in querying the system using a mobile phone. Each of the four HCWs has a phone and they engaged with the patients as the trained them how to use the system. The patients used their mobile phones to query the system. Some of the patients did not have internet-enabled phone but they were interested in learning. The training ended successfully

III. System Results

To answer the research question underlying this study, statistical analyses were conducted on the data obtained during the six month period the patients and HCWs were using the system. This data was analyzed from the system logs. We start by describing the participants demographic including age, gender and the level of education. We proceed by reporting the use of the system and how the data in the system was kept up to date. We acquired all the demographic data from the system log. The system ensured anonymity, we could only get the age, gender and level of education from the logs.

a. Age

From the pie chart below shows that the system was mostly (45 percent) used by participants who fell in the age group 16 to 25. This is because South African youth are the first adopters of mobile

technology [2]. Age group 26-35 was also actively using the system to access medical information.

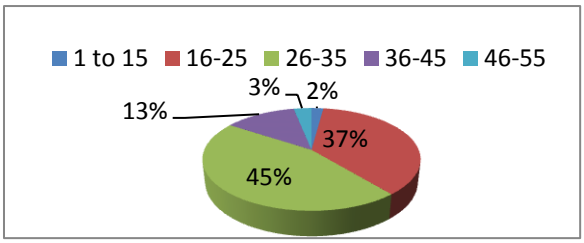


Figure 1: Pie chart showing the age-group of participants

b. Gender

Majority of the participants who accessed the system were female. During the training session the women were curious to use the system. They also involved in asking question concerning the system. Most women accessed the system so that they could use the information to help themselves and their young children whenever they experienced the HIV-related symptoms. The pie chart below shows that 68 percent of the participants were female.

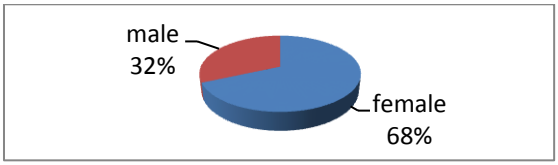


Figure 2: Gender participants.

c. Education Level

Majority (43 percent) of participants in this study had completed grade eight. 11 percent of the participants had undergone the tertiary education. From this statistic it clearly shows that most of the people in Gugulethu just have basic education level. Most of them are unemployed and rely on small businesses to run their families.

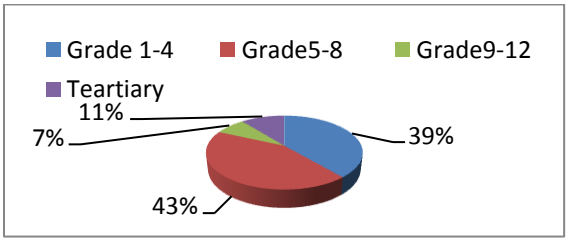
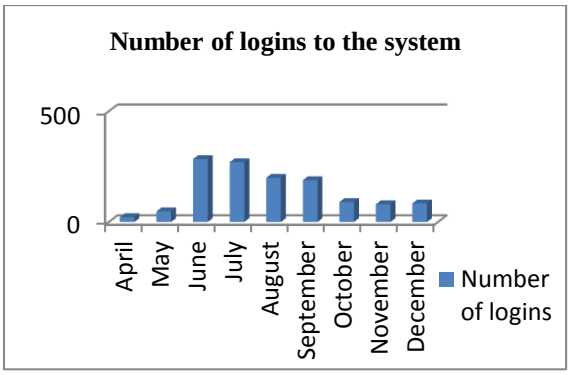


Figure 3: Pie chart showing the level of education

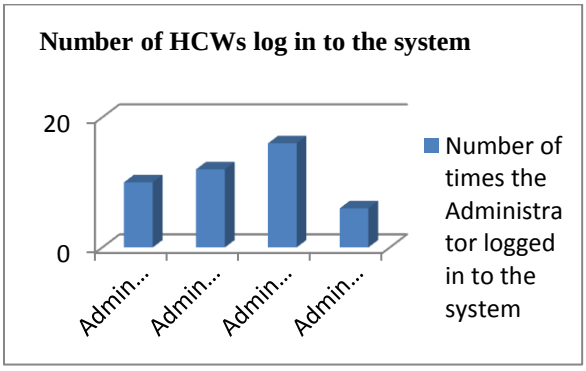
IV. Results from the System Logs

In this session we represent our result on the number of users who accessed the system, number of times the HCWs log in to the system to update the information in the system and the number of home remedies added/updated/deleted in the system over a period of six months. These results will be represented in a bar graph. Bar graph 1 show the number of time the patients logged into the system. The system was up and running by end March 2012. In April and May the few patients managed to use the system. At this point the HCWs were still training the patients on how to use the system. Also at this point there was little information in the system and the HCWs were trying to populate the system with more information. Later the number of log-in increased. The patients had fully learnt how to use the system. The graph also shows that the system has been fully utilized throughout the six months period. This indicates the usefulness of the system



Graph 1: Number of Log-ins

Graph 2 shows the number of time the administrator (HCWs) logged into the system. These HCWs had been trained how to update the data in the system. The HCWs accessed and used the system at ease. The system was helping them to disseminate information to their patients and they were active in adding vital information to the system.

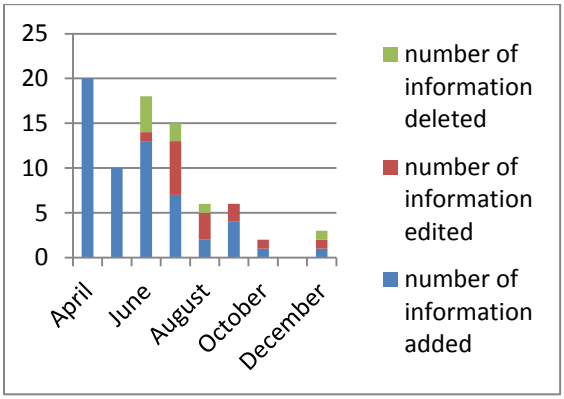


Graph 2: Number of log-ins by the HCWs

Graph 3 below shows the flow of data to and from the system. When we began this study the HCWs were active in adding home remedies to the system. The HCWs also edited the information in the system to ensure that the information was correct. The information was also edited to ensure that it was easy to understand the advice provided. Some

advice which involved the use of spices were edited to ensure that only the acceptable spices were included. Some home-remedies which included the use of herbal medicine were deleted from the system. According to the ministry of Health in South Africa, the HIV-patients are not supposed to use any herbal medicine.

Graph 3 shows that the HCWs managed to put the system data up-to-date. This was to ensure that the information provided by the system was correct. This also can indicate the simplicity of the system. The HCWs manage to access it through out the year. The system contained accurate information since the HCWs updated it frequently to ensure that the relevant information was maintained into the system.



Graph 3: Graph showing the flow of information to and from the system

This results show the system was practical, simple, usable and efficient.

V. System Significance

With this research, we managed to develop an advisory expert system that be used to disseminate nutritional and psychological support advice to PLWHA. The system can be accessed using a mobile phone from any geographical location. The system is easy to use and from the results demonstrated in graph 3, the HCWs managed to keep the system's information up-to-date.

Through interviews we discovered that the system helped the patients used the readily available home-remedies to self-manage the HIV-related symptoms they were experiencing. The system is simple to use and from our results, we show that patients with basic education can use it. The system is cost effective and it reduces the traveling cost to and from the clinic. The patients use minimal time to access the system. In conclusion the system demonstrated to be an effective and efficient means of disseminating medical information to HIV-patients.

VI. Conclusion and Future Work

This work sought to prove that ICT is a powerful tool that can be used to reach a large number of patients. ICT4D projects can be used to elevate patients' livelihood. The projects need to emphasis on empowering underprivileged people by allowing them to access professional help using tools such as mobile phone which penetration is increasing in developing countries.

An interesting avenue of future work would be to use Unstructured Supplementary Service Data (USSD) provided by the mobile service provider to query the expert system for information. This would allow users to use any type of phone to access the medical information. This will cut the high internet cost involved. Additional work which could also be done is providing an interface where patients can communicate with HCWs via the system. The patients can air their views without visiting the clinic. The online communication is recorded and later tackled when the patients attend the weekly meetings

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