A Web Based Numerical Model for Integrating HIV-AIDS Health Care Information Systems

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Abstract

The fight against the spread and effects of HIV- AIDS has recently been given high priority in Africa. However, an obstacle to the successful effort in fighting the pandemic remains the lack of an integrated and coordinated information sharing infrastructure to which all stakeholders have access. In Uganda, sharing of information on AIDS is further constrained by the diversity of information storage, processing, retrieval and dissemination interfaces adopted by the different healthcare providers. Integration of the Information systems of the various health care providers in the HIV-AIDS pandemic has not been attained as yet. This study describes a web based model for integration of the information systems of different organizations charged with the care of HIV-AIDS patients and information dissemination within the healthcare system. The results of the study demonstrate that integrated access to information about HIV-AIDS in Uganda is both possible and attainable. The approach used in this study is inexpensive given that it employed open source software.

Keywords: Web based, Numerical Model, Healthcare, Information systems, Integration, HIV, AIDS

1 Introduction

Although the fight against the Acquired Immunodeficiency Syndrome (AIDS) has recently enjoyed high priority, a major obstacle to a successful effort in fighting the pandemic remains a lack of an integrated and coordinated information structure to which every stakeholder has access [1]. Government and NGOs, research institutions and private companies collect data regarding the AIDS pandemic, its prevalence, behavioral risk factors, Anti Retro Viral (ARV) drug availability and distribution, development and testing. This information however, remains fragmented and so planning, decision and policy making the stakeholders is done with only part of the information available at any one time. The effectiveness and relevancy of the planning and decision making process is therefore made irrelevant. Coordinated information gathering and updating can be one of the most effective tools in fighting the pandemic. Systems that can make this possible on a national level, across all the various domains dealing with AIDS are therefore required.

In Uganda, organizations managing the AIDS pandemic have independent information systems. The result is a multiplicity of parallel information systems on the same population. Integrating these systems, so that specific and selected patient information can be shared is desired but has not been attained as yet. Health care managers, supporting staff and their patients alike continue to be denied quick access to information they require for the successful fight against AIDS.

This study aimed to create a web based model of a reusable design model that can help to integrate data in databases of different organizations, so it can easily be made available to health care workers handling the AIDS pandemic. Integrated Healthcare Information Systems have several benefits for AIDS care management. They provide on spot and timely access to huge medical archives required in health care [8]. However, most medical information systems currently in operation suffer from their centralized nature that fails to satisfy the distributed requirements of a regional or national health care system. Caring for an increasing and widely dispersed population of AIDS patients is costly, requires good coordination and real time flow of information. The treatment for AIDS is expensive and patient specific. Even when patients relocate from one place or change healthcare providers, the treatment needs to remain the same. Healthcare providers therefore require and would be greatly assisted by an information system with all data in place to which they can just refer, regardless of geographical location. A Web-based integrated information system as suggested by this study addresses this important need. Other benefits from such a system include better care and monitoring for AIDS patients, reduced treatment delivery costs and easier access to data by all the stakeholders.

By proposing model for information system integration, the study creates the potential for addressing the information sharing needs of AIDS Healthcare workers and

the public through promotion of appropriate data gathering, integration and information access.

2 Healthcare Information Systems

Healthcare Information Systems (HIS) are computer based systems designed to manage medical and administrative information that enables Healthcare professionals perform their jobs effectively and efficiently [11]. HIS have become an essential part of Healthcare information management and administration, focusing on the integration of all clinical, financial and administrative applications. Thus, they are also referred to as integrated healthcare information processing Systems (IHIPS). No HIS can be regarded as a success unless it has the full participation of its users. HIS receive medical data as input and produce timely information relevant to medical practice as output. They use various techniques to represent medical domain knowledge and associate that knowledge with medical data in order to alert medical practitioners about important patterns in the data. They range from simple systems operating on hand-held devices to large networks with integrated applications.

2.1 Benefits of Healthcare Information Systems

[5] have shown that the complexity of today's healthcare enterprises seems to grow exponentially, requiring new tools and new solutions to very complicated issues. The size of the databases is certainly an issue, but equally important is the ability to keep data current and synchronized with other databases. Integrated healthcare information systems offer benefits to both patients and the physicians. The patient is able to experience quick and efficient registration into the system and usually has increased mobility as to where he or she can be seen by a physician. The provider is also able to disregard location, and can view and access data from virtually anywhere. In addition, the data is current and complete, which is a benefit for all sides providing a higher quality of health care for less money.

Healthcare Information Systems offer physicians and other Healthcare providers full support of medical billing and records, tracking patient records, support compliance to regulatory mandates, reduce costs, improve workflow processes and distribute information more quickly, while still safeguarding medical information security [5]. They are an important bridge to a universal medical record and absolute patient portability.

[15] have identified critical information related issues affecting clinicians and shown that Healthcare information systems can assist physicians in the delivery of cost-effective, high-quality care. They also show that individual institutions can reap the benefits of medical information systems including optimal patient outcomes at the

lowest possible cost. This requires that they have quick and convenient access to comprehensive clinical information from different sources.

2.2 Issues with healthcare information Systems

Despite the benefits, HIS also present problems that prevent their universal use in hospitals. The initial high cost of acquisition of the basic infrastructure of HIS is too high for many healthcare organizations. Privacy and Security are still big concerns in the healthcare industry. There is also concern about the privacy of patient data on computer systems and how to keep such information secure. Medical practitioners are generally slow adapters to Information technology [5] [6].

2.3 Healthcare Information Systems Integration

[11] have defined medical information systems integration as the combination of diverse application entities into a relationship that functions as a whole. It enables applications from different vendors, fulfilling different roles in the provision of healthcare to communicate freely with each other, exchanging and sharing information to the benefit of all parties. To ensure continuity of the flow of information within and between organizations, a good integration environment for the different information systems has to be attained.

[7] have identified the levels of integration as technical integration, data integration, semantic integration and functional integration. Technical integration relates to the ability to interconnect databases using standard protocols and interfacing mechanisms. Data integration means the ability to interchange data elements. Semantic integration implies compatibility between concept and information models, whereby the meaning of the inter- changed data is preserved. Functional integration is the ability to provide and use functionality between systems.

Different architectures have been adopted for different places in attempts to integrate health care information systems. [7] have shown that integrated information flows between different hospitals required a common middleware, common data and business logic as in the distributed hospital environment (DHE) middleware platform. [8] Present a distributed architectural model for primary health care (PHC) centers in Athens whose architecture is designed to accommodate a specific PHC work flow model. The implementation was based on CORBA and web-based user interfaces. However, the conceptual architecture is generic and open to other middleware approaches like the distributed health environment (DHE) or HL7.

[13] have shown that with Internet technologies, the electronic medical records (EMR) allows patient data to be securely shared by multiple agencies, patients and families, creating the potential for new collaborative partnerships by supporting communication, consultation and cooperation. [[9] has demonstrated that records

can be accessed from multiple sites within networked systems, or geographically remote users can enter patient information into their local machines and send the data securely via the Internet to a centralized server, where the patient file is maintained. [4] have shown that it is possible to have a regional network providing health care professionals with the necessary infrastructure to collaborate with their peers, share opinions, exchange clinical data, and access regional information. In Brazil, [10] proposed an integrated access to health care information in the Brazilian Public health System using the common object request broker architecture (CORBA)/distributed common object model (DCOM) core communication mechanism for distributed object- oriented information retrieval and the health level seven (HL7) standards for medical data exchange.

The literature suggests that while web-based technology can be applied to improve links between health care information systems, there is still lack of a standard architecture for implementing information systems integration across all environments. These findings also contrast with the present situation in Uganda where there is no evidence of collaborative partnerships supporting EMR and web-based medical services are still limited to static web sites maintained by the Ministry of health, individual hospitals, [14] and the Uganda AIDS Commission. Integration of HIV/AIDS information systems has likewise not been attained in Uganda. Moreover, no attempts have been made to integrate the information systems used by organizations managing the AIDS pandemic in Uganda. The study therefore proposed a model and web based architecture to integrate information systems for AIDS healthcare organizations in Uganda so that information about patients can be shared in real time, regardless of geographical location or healthcare provider.

3 Aids Care Management

AIDS care Management reduces suffering and prolongs the life of AIDS patients. Approaches to AIDS care Management vary from region to region and from country to country. Both National and local organizations participate in this effort. It involves gathering epidemiological data about AIDS patients in the population, testing and identifying the sick, providing medication with ARV's and other drugs, counseling, giving medical and social care to the patients.

The approach to AIDS care differs from one country to another. In South Africa, a Spatial Information System has been demonstrated to be of use in the management of AIDS in South Africa [2]. The lack of physical infrastructure, reliable statistics and adequate resources hinder the efficient management of AIDS and collection of reliable data was a first step to assess the status AIDS in communities. The implementation of the AIDS database and the Spatial Information Management System can play a critical role in determining where and when to intervene, improving the quality of care for patients, increasing accessibility of service and

delivering a cost-effective mode of information.

In Uganda, the Ministry of health (2004) actively supports and coordinates the efforts of organizations that are involved in managing the pandemic. These include the Uganda AIDS commission (UAC), Center for disease control (CDC) and the Total AIDS Support Organization (TASO). [14] manages AIDS patients by providing such services as HIV testing, consoling, medical care, social support, capacity building and training, AIDS education and sensitization.

4 The Model

This section outlines the techniques applied to determine requirements for the model. A descriptive survey involving 56 doctors, 12 laboratory technicians and 17 AIDS patients affiliated to the Ugandan ministry of Health, CDC and TASO was conducted. Data collection was by use of structured interviews and questionnaires. Regression analysis of the data was used to determine requirements for the data model. figure 1 shows the model that was developed. The Entity-Relationship (ER) model as proposed by [3] as a way to unify the network and relational database views. It is a conceptual data model that views the real world as entities and relationships. A basic component of the model is the Entity-Relationship diagram which is used to visually represents data objects. The ERD creates a simple, easy to understand and conveniently presented data model consisting of entities and attributes. An ERD is here used as a graphical representation of the data storage requirements for an AIDS information system. It is used to identify the data that must be captured, stored and retrieved in order to support the AIDS patient care management activities performed by two organizations, CDC and TASO. The model was used to build a software prototype.

together use a common network, the internet. XML technology is proposed for use as middleware for structuring and transferring data between systems across the World Wide Web. The different information systems have separate databases. Users access the system from anywhere using the internet. The architecture enables a user to access patient records from any database connected to the system wherever there is an internet connection.

Figure 2. The Architectural Design

According to the architecture in Figure 2, different AIDS Healthcare Information Systems are linked together using a common network, the internet. XML technology is proposed for use as middleware for structuring and transferring data between systems across the World Wide Web. The different information systems each have a database. Users can interface with this system from anywhere using the internet. The architecture enables a user to access patient records from any database connected to the system wherever there is an internet connection.

5 Discussion and Conclusions

The software prototype developed is able to generate patient AIDS management reports about individual AIDS patient's, laboratory tests and results, AIDS defining symptoms, diagnosis, treatment, counseling and patient AIDS history reports. Integrating the databases of CDC and TASO provides both healthcare workers and patients with flexibility when accessing records. Doctors are also able to view

and access patient AIDS records from virtually anywhere, regardless of location. Patient AIDS data is kept current and complete. This enables provision of higher quality of AIDS care for less money. Integration of the CDC and TASO records provides a universal AIDS patient record and complete patient portability, as in [5]. The reports also provide doctors with quick and convenient access to comprehensive patient AIDS clinical information from different sources, as in [15].

Integrating AIDS care information systems as demonstrated by this study is useful for monitoring patients on ARV treatment nationally. ARV treatment for AIDS patients is expensive and patient [2]. By creating a universally accessible patient record, the model provides healthcare providers with a single reference point for the AIDS patient treatment history. The key advantages of such an integrated universal patient record for ARV treatment, monitoring and reporting system in the management of AIDS are:

1. AIDS Patients continue to get their specific ARV treatment regardless of location and organization providing the service.
2. Repeated and expensive laboratory tests for patients due to change of place and treatment center/organization are avoided.
3. It is easier to project demand for the ARV's and assist in planning and control the cost of providing the treatment for all patients at all times.

The results of this study therefore illustrate the benefits of having an integrated AIDS patient information system. They provide evidence that AIDS Information Systems integration has a role to play in prolonging the lives and suffering of AIDS patients via faster access to information while reducing on the costs of treatment, a key objective of AIDS care Management

5.1 Future Work

Many AIDS databases including legacy systems exist in Uganda. Further work is required to increase on the functionality of this system so that such databases can also be linked to it.

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