MATERNAL MORTALITY RATE MONITORING MODEL USING KNOWLEDGE DISCOVERY IN DATABASES (KDD)

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ABSTRACT

The state of maternal health is an important indicator of a nation's health care delivery system and the level of the society's development. Previous efforts to meet the Millennium Development Goals (MDGs) on the reduction of maternal mortality in Nigeria have shown only marginal reductions in the last five years, making the MDGs targets by 2020 clearly unachievable using current strategies alone (Mid-Point Assessment Overview, MDGs Nigeria, 2008), hence this study; The methodology adopted for this study is Object-oriented analysis and design methodology that starts with understanding the domain, locating proper data sources, preparing the raw data, applying advanced analysis techniques, and extracting and validating the resulting knowledge from a quality registry for maternal mortality. The results will be to develop an integrated IT solution that is suitable for Nigeria, focused on the maternity care conditions and control the rate of maternal mortality in Nigeria using knowledge discovery in database (KDD).

Keywords: knowledge discovery in database (KDD; Maternal, Mortality, Model

Introduction

Universally childbirth is an event that attracts celebration, but this is not so for many women who experience childbirth as suffering and tragedy that may end in death. The state of maternal health is an important indicator of a nation's health care delivery system and the level of the society's development. Previous efforts to meet the Millennium Development Goals (MDGs) on the reduction of maternal mortality in Nigeria have shown only marginal reductions in the last five years, making the MDGs targets by 2020 clearly unachievable using current strategies alone (Mid-Point Assessment Overview, MDGs Nigeria, 2008).

Nigeria has a population of 140 million people with women of child bearing age constituting about 31 million and children less than five years of age constituting 28 million (National Bureau of statistics, 2010). Women of child bearing age and children under five years of age therefore constitute a significant percentage of the nation's population. Nigeria, which constitutes just 1% of the world population, accounts for 10% of the world's maternal and under-five mortality rates. Nigeria ranks second in the world, after India, in the scale of maternal mortality with the rate of 800 deaths per 100000 live births (Pitterson, 2010). Annually, an estimated 52,900 Nigerian women die from pregnancy related complications out of a total of 529,000 global maternal deaths. A woman's chance of dying from pregnancy and childbirth in Nigeria is 1 in 13, compared with 1 in 35 in Ghana and 1 in 2800 in developed countries, and only about 40% of deliveries are attended to by skilled birth attendants. According to the World Health Organization (WHO)/United Nations Children Fund (UNICEF), in 1995, Nigeria had the third highest number of maternal deaths in the world (approximately 45000 deaths). By the year 2000, for every 100,000 live births, about 800 women died in the process of child birth. Out of the 27 million Nigerian women of reproductive age back then about 2 million did not survive either pregnancy or childbirth. In 2008, according to UN report, the figure stood at between 1000 and 1500 deaths per 100,000 live births. The State of the World Children Report 2009 stated that 1 out of 9 global maternal deaths occurred in Nigeria.

Till date, Nigeria is second on maternal mortality rate in the world with about 144 girls and women dying every day from complication of pregnancy and child birth. 1 in every 18 women die giving birth compared to 1 in 4800 in the US (Pitterson, 2010; Daily Independent, 2010). According to the survey conducted in February 2010, the record stands at between 165 per 100,000 live births in the South West and 1549 per 100,000 live births in the North East (Onumere, 2010).

Government can improve the health facilities to reduce maternal mortality if a control system is put in place to report mortality rate in the country. The neglect which results to a higher mortality rate may be attributed to the lack of information on the rate of death experienced in the country during child birth. More specifically rural areas are the ones lacking the high quality services needed to reduce maternal mortality in the whole region. According to a study, health services and human health resources (such as equipped hospitals and well trained personnel) are more valuable for rural communities (Jennett, Yeo, Scott, Hebert & Teo, 2015). Thus the delivery of these services remotely using accessible technology could help to level up the unequal access to health services. Electronic health records, risk assessment systems, and remote control are just some examples of how technology can be applied in the healthcare field.

The number and the size of databases recording medical data are increasing rapidly. Medical data, produced from measurements, examinations, prescriptions, etc., are stored in different databases on a continuous basis.

This enormous amount of data exceeds the ability of traditional methods to analyze and search for interesting patterns and information that is hidden in them. Therefore new techniques and tools for discovering useful information in these data depositories are becoming more demanding.

RELATED WORK

There are many studies which focused on an overview of maternal mortality monitoring model using knowledge discovery in databases (KDD) all of them concentrate on how to reduce mortality rate.

The rest of this paper is organized as following: the related work for this research area, Materials and Methods and Finally, conclusion

LITERATURE REVIEW

Health Informatics

Health care is a very research intensive field and the largest consumer of public funds in developed countries. With the emergence of computers and new algorithms, health care has seen an increase of computer tools and could no longer ignore these emerging tools. This resulted in the uniting of healthcare and computing to form health informatics. This is expected to create

more efficiency and effectiveness in the health care system, while at the same time, improve the quality of health care and lower cost.

Health informatics is an emerging field. It is especially important as it deals with collection, organization, storage of health related data. With the growing number of patient and health care requirements, having an automated system will be better in organizing, retrieving and classifying of medical data. Physicians can input the patient data through electronic health forms and can run a decision support system on the data input to have an opinion about the patient's health and the care required. An example of the advances in health informatics can be the diagnosis of a patient's health by a doctor practicing in another part of the world. Thus, healthcare organizations can share information regarding a patient which will cut costs for communication and at the same time be more efficient in providing care to the patient (George, 2014).

There are other issues like data security and privacy, which is equally important when considering health related data. Thus, health informatics deals with "biomedical information, data, and knowledge with their storage, retrieval, and optimal use for solving problem and decision making process" (George, 2014). This is a highly interdisciplinary subject where fields in medicine, engineering, statistics, computer science and many more come together to form a single field. With the help of smart algorithms and machine intelligence we can provide the quality of healthcare by having, problem solving and decision-making systems. Information systems can help in supporting clinical care in addition to helping administrative tasks. Thus, the physicians will have more time to spend with the patients rather than filling up manual forms (George, 2014).

The applications of information and communications technologies in medicine are commonly referred to as telemedicine and medical informatics. Although these terms are often used together and confused with each other, they are separate and have their own definitions. The Institute of Medicine defines telemedicine as the use of electronic information and communications technology to provide health care when distance separates the participants. It includes all forms of electronic communication between patients and providers and among providers, starting from telephone to interactive video and web-based communication. Medical informatics is defined by The National Library of Medicine as the field of information science concerned with the analysis

and dissemination of medical data through the application of computers to various aspects of health care and medicine. Medical informatics can also be referred to as the intersection of information science, computer science and health care. For example, medical informatics includes health care delivery processes that are supported by computers that help in analysing electronic data. (Christensen & Remler, 2007). Christensen & Remler (2007) have roughly categorized the different possible applications of ICT in chronic disease care in four group: technologies that support -

1) patient self-care and education,
2) communication between patients and providers or between providers,
3) electronic data storage and data sharing across providers, and
4) The technologies that combine all these three applications.

Successful management of chronic disease care is facilitated considerably by active involvement of the patient in his or her own treatment procedure. There is also increasing willingness from the patient side to be integrated in their own health care process, and health consumers are actively searching information independently (Detmer et al., 2013). The involvement is usually realized by patient education and information about his or her disease and information and communications technology can provide effective methods for patient participation.

This category includes medical devices for self-monitoring as well as interactive websites for education on the diseases. Moving towards more self-care and patient and health consumer inclusion is largely associated with new ICT technologies and has been noted by other commentators as well (Christensen, & Remler, 2007).

The ICT applications in electronic data storage and data sharing across providers - have probably received the most attention. It has been stated that shifting from paper based storing to electronic health records (HER), or electronic medical records (EMR) is associated with remarkable cost-savings (Hillestad et al., 2015) and faster access to information, which results in improved efficiency. Also unnecessary tests can be avoided, when information can be easily found from the data base by different users. Electronic process also enables storing bigger quantities of medical data (Haux, 2016). This is essential as the amount and complexity of health-related information and knowledge constantly increases and has already made information processing a

major component of any health organization. Health ICT facilitates moving from decentralized and institution-based storage towards more global data storing (Haux, 2016). Having national health records can improve health care processes as different providers can access the same information fast and for example the duplication of tests could be prevented. In the European Union the long term goal is to have a system where all the clinicians in Europe can access health records from all countries (Andersen, Frogner, John & Reinhardt, 2006). This would improve conditions for treatment as the patient as well as the health care professional mobility is expected to increase. Without electronic records and communication technologies having wide databases would practically be impossible.

For instance, software that integrates and analyzes provider and self-monitored patient data combined with communication technology makes it possible to do certain monitoring tests at home and send the data to health care professionals to be analyzed. When there is need for intervention, it can be done inexpensively and without delay. These kind of technical solutions have already been used in continuous remote clinical monitoring and have brought significant benefits to both patients and payers. For instance in care of hypertension patients, remote monitoring has helped to drop the blood pressure of the test groups and reduce the costs of the care (Christensen & Remler, 2007). There is also a steady increase of new technologies such as ubiquitous computing environments and sensor-based technology for health monitoring from distance (Haux, 2016).

The Electronic Medical Record comprises health-related information that is created by health care providers on behalf of a patient, such as diagnostic tests or prescriptions for medications. The main objective of an EMR is to improve the ability of a care provider to document observations and findings and to provide more information on treatment of persons in his or her care. EMR can also provide the underlying patient information for functions such as drug-drug interactions, recommended care practices or interpretation of data to support and improve clinical decisions (The National Alliance for Health Information Alliance Technology, 2008). However, these functions are limited by the extent of the information available in a provider-focused EMR within a single health care organization, hence the need to document how EMR is utilized and supports medical services in centers that use EMR system. The EMR is expected to replace paper-based medical records as the primary source of medical history for each person

seeking health care, while still complying with all clinical, legal and administrative requirements in developed countries (Janusz & Grzegorz, 2013).

To date, the digitization of health care typically has focused simply and solely on electronic records for patients. Most EMR systems are relational databases with a finite number of intra-enterprise applications and are limited to in-house use by health care facilities. Very few of these systems have realized fully functional, scalable, distribution capabilities, not to mention interoperability with external systems. This short-sighted tendency to build large-scale but restrictive automated systems that ignore the interactive nature of health care has resulted in limited operational success and acceptance (Wullianallur & Someswar, 2009). Electronic records have the potential to improve the quality of health care delivery and reduce costs (Hillestad et al., 2015). Accurate and up-to-date health information is critical. When an individual seeks health care, in order to provide effective and timely treatment, the provider needs to have information about the patient, including known allergies, chronic conditions, current medications and other pertinent health care data. However, such information is not always readily available. It may sometimes be available but incomplete or inaccurate, depending on whether the patient's records have been updated or not.

Though there have been challenges and failures in the implementation of EMR, their potential benefits are numerous. Some of the benefits are: complete and accurate information; universal and timely access to a patient's lifetime health information; knowledgeable sources to direct a patient to the appropriate care and substantially fewer medical errors. The EMR may exist in a distributed database, accessible from anywhere through a networked environment or a mobile smart card that a patient carries with him/her. If appropriate security measures are adopted, computerization also provides greater protection of confidential information via sophisticated keys and access controls. Additionally, the EMR system helps improve the quality of patient visit documentation and data, free up facility storage space, improve efficiency by eliminating time spent hunting down lost charts and provide immediate, simultaneous access to patient records (Janusz & Grzegorz, 2013).

Electronic Health Record Monitoring System

In the past 10 years Information technology (IT) has been used to improve the accuracy of patient records, and health monitoring. Benefits and challenging unsolved problems continue to

be the outcomes of such attempts (Bates & Gawade, 2013), such as electronic health records, remote monitoring, tele-health, health data collection and processing, and clinical decision support systems, to name a few. Groups interested in the IT-Healthcare efforts have gathered and exchanged opinions to identify technological areas with the highest benefits. These groups integrated by members of the public, health care provider and private sectors selected tele-health and electronic health records, in this order, as the most valuable IT approaches. The groups of interest also identified as a disadvantage the changes in the current practices and processes in the delivery of health services (Jennet et al. 2015).

The use of electronic health records (EHR) is one of the most successful examples of the application of IT to support health care services. Research efforts state that EHR is a solution with great potential as EHR strengthens the collaboration between public and primary care (Calman, Nauser, Lurio, Wu & Pichardo, 2012). Electronic health records offer additional benefits such as improving public health surveillance by documenting patient data, real-time guiding of the physician interventions using statistical data to generate clinical alerts, improving surveillance and management of a communicable disease, etc. (Calman, et al., 2012).

In Ghana, a software solution was designed in response to the rapid expansion of community health workers in Africa and Asia. This was made taking as an advantage the proliferation of mobile devices. The Mobile Technology for Community Health (MoTeCH) offers features such as calculating the schedule for each patient; and notifying both patient and community workers when care is due. The system automates the delivery of information for routine reports and integrates with existing software applications for mobile data collection. The presented project is the initial part of an iterative process and still requires advanced software development skills, attention to standards and configurable design to make it more readily available to groups of interest within the research (Macleod, Philip, Stone, Walji & Awoonor-Williams, 2012).

From Brazil and Peru, a Windows-based application called “TeleConsult” proposes to reduce the high mortality on rural areas in Latin America. TeleConsults proposes the establishment of a medical network that communicates using satellite. The system acquires images from ultrasound examinations, electrocardiogram and blood imaging and pretends to cover disciplines such as cardiology, gynecology pediatrics and infections from the region (Sachpazidis, Rizou & Menary, 2008).

An effort in the maternity and prenatal care is the 'Prenatal Risk Calculation (PRC)'. PCR is a software solution based on a previously introduced system known as JOY. PCR and JOY work using chromosome data information (aneuploidies), through this analysis prenatal risk could detect symptoms such as Down syndrome and potential cancer cells on the product. The test performance between PCR and JOY gave higher significant results while detecting aneuploidies in the first trimester trial; testing alone, the test performance results of JOY were better than the results of PRC. PRC demonstrated to be a good tool to detect prenatal risk but it still needs to be improved (Hörmansdörfer et al., 2008).

A clinical decision support system (CDSS) on maternal care field was created and implemented for rural health care centers in Africa. The QUALMAT CDSS provides guidance for antenatal, delivery and post-delivery care. This guidance is possible by incorporating features such as an orientation process based on set of routine actions, algorithms to detect situations of concern, and electronic tracking of perinatal and postnatal care. CDSS is a java based application that incorporates the World Health Organization (WHO) guidelines for pregnancy and childbirth care. The CDSS was first developed in English for the use in Ghana and consist of four parts: a user interface; an XML-database for patient data, a set of algorithms to screen entered values; and a set of training documents.

Decision support is implemented by offering guidance through routine action in maternal and perinatal care, detection of critical situations using clinical data and electronic pictograph for observation on the progress of delivery up to 24 hours. This system requires an equipped site with a laptop computer. Staff members in charge receive general software and QUALMAT training and are left in charge of user administration. The implementation presented limitations in complex medical environments leading to a different conclusion than expected. Another challenging issue was the implementation of the system in a resource-poor environment, leading to hardware insufficiencies and user frustration (Blank et al., 2013).

One example of applying mobile and wireless computing in health remote health assistance is our previous work called ERPHA. ERPHA (Emergency Remote Pre-Hospital Assistance) is an example of an IT solution based on mobile technologies to improve remote monitoring under

emergency situations like car accidents. ERPHA is an Information Technology solution that enables the continuous monitoring of a patient´s condition during the pre-hospital period.

ERPHA enhances the pre-hospital care quality by allowing early intervention of specialist physicians with key data such as video, audio and visualization of patient´s vital signs. ERPHA collects key health data form patient using body sensors that transfer their data to a mobile device (usually a smart phone) creating a body-sensor-network (BSN). The mobile device processes, displays and forwards the collected data to a hospital or medical center where a specialist physician can remotely assist paramedics in the diagnosis. Additionally, at the medical center the data sent by de mobile device is stored into a database for maintaining historical records of the patient. These records can be later used for identifying patterns for a more effective treatment or for classifying the severity of injuries. The mobile device can resend all collected data from the BSN plus video to a medical center where a physician can provide a better diagnostic of the patient being monitored. The BSN is built with Bluetooth-enabled sensors for vital signs such as ECG, stethoscope, pulse-oximeter, and blood glucose-meter. The mobile device has been implemented using smart phones running Windows Mobile and Android as operating systems. The mobile device currently transmits video, GPS location and data from the BSN to the hospital via Wi-Fi and 3G. Besides the smart phone a tablet can be used as alternate mobile device. At the hospital, the transmitted video, vital sign and patient information are stored and managed using dedicated database and video servers. The hospital front-end is implemented using Microsoft Visual Studio 2010 (ASP.NET) and Microsoft SQL Server 2008 R2. Further ERPHA details can be obtained at (Muñoz, Avila, Lavariega, Gonzolalez & Grote, 2012).

MATERIAL AND METHODS

Materials Required

Both secondary and primary data will be used to get facts on the subject where primary data will be collect from actual institutions and secondary data will be the data collect from literature review. Secondary data will also gathered information from a number of sources in order to carry out an investigation into the existing systems, its working procedures, and its mode of operation. Secondary data include: internet sources, journals, books and newspapers, manual auditing of maternal mortality rate monitoring.

Data Collection Tools

The researcher used the following methods during data collection: Observation and interviewing as our research methods. Through this the researcher was able to collect raw data on mother to child mortality rate at hospital where existing reports on the current system were obtained. Verbal interview techniques were used to interview employees in the hospital.

Observation

The researcher went to the hospital and observed their daily activities with regards to their current system and they were manually recording the mother to child mortality records. A follow up was made to determine the time it took to carry out the record management.

Interviewing

In this method, there was interaction between the researchers and the Staff. Interviews were conducted with the medical superintendent and some potential employees to find out what difficulties they encountered with the existing system. These interviews were held to verify the information collected since there was room to search for further information during the interview.

Methodology Adopted

Object-oriented analysis and design methodology (OOADM) which is adopted in this research work is a set of standards for system analysis and application design. It uses a formal methodical approach to the analysis and design of information system. Object-oriented design (OOD) elaborates the analysis models to produce implementation specifications. The main difference between object-oriented analysis and other forms of analysis is that by the object-oriented approach we organize requirements around objects, which integrate both behaviors (processes) and states (data) modeled after real world objects that the system interacts with. In other or traditional analysis methodologies, the two aspects: processes and data are considered separately. For example, data may be modeled by ER diagrams, and behaviors by flow charts or structure charts. The primary tasks in object-oriented analysis (OOA) are:

- Find the objects
- Organize the objects
- Describe how the objects interact
- Define the behavior of the objects
- Define the internals of the objects

Common models used in OOA are use cases and object models. Use cases describe scenarios for standard domain functions that the system must accomplish. Object models describe the names, class relations (e.g. Circle is a subclass of Shape), operations, and properties of the main objects. The OOADM presented the Data Flow Diagram (DFD), use case diagram, Interaction diagram, sequence diagram, activity diagram, collaboration diagram, package diagram for the proposed system.

CONCLUSION

The maternal mortality rate monitoring using KDD as developed in this paper is a work in progress that is expected to make a positive impact once it is implemented in any of the hospitals in Nigeria. Research demonstrates that the maternal mortality rate monitoring is a viable solution to the maternal-infant mortality problem that is currently present among the rural community areas in various states of Nigeria.

Also the use of electronic healthcare services makes possible to reduce attention issues associated with the main causes of death (hypertension, haemorrhages, and other complications of delivery) that are much higher in maternity-infant care. The mortality rate control system is a two-part system developed both for antenatal record assessment from any hospital terminal and maternal mortality rate monitoring reports.

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