Volume 10, Issue 1
April 2017
ISSN: 1946-1836

JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

In this issue:

The **Journal of Information Systems Applied Research** (JISAR) is a double-blind peer-reviewed academic journal published by **ISCAP,** Information Systems and Computing Academic Professionals. Publishing frequency is currently semi-annually. The first date of publication was December 1, 2008.

JISAR is published online (http://jisar.org) in connection with CONISAR, the Conference on Information Systems Applied Research, which is also double-blind peer reviewed. Our sister publication, the Proceedings of CONISAR, features all papers, panels, workshops, and presentations from the conference. (http://conisar.org)

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the JISAR journal. Currently the target acceptance rate for the journal is about 40%.

Questions should be addressed to the editor at editor@jisar.org or the publisher at publisher@jisar.org. Special thanks to members of AITP-EDSIG who perform the editorial and review processes for JISAR.

JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

Editors

2017 JISAR Editorial Board

Gateway to Clinical Intelligence and Operational Excellence through a Patient Healthcare Smart Card System

Sadath Hussain
hussains1@xavier.edu

Thilini Ariyachandra
ariyachandrat@xavier.edu

Mark Frolick
frolick@xavier.edu

Management Information Systems
Xavier University
Cincinnati, Ohio 45207

Abstract

The proliferation of technology in our daily lives has widely changed the way in which information is being captured, processed, stored and analyzed. Information systems have become an integral part of the healthcare system in the developed world. However, the patient journey through the numerous routes in the health care system can make the patient data integrity, profiling, reporting and analysis extremely challenging. It is imperative to design a model to capture the patient's medical records from various health care contexts (i.e. Family doctors, Free Clinics, Emergency room visits, Social Services routes, Senior care facilities and Hospital systems). This article proposes a distributed healthcare information system database which captures and synchronizes information for all patients routing throughout the various services in the US health care system that uses a Unified Medical Record Access and Analysis (UMRAA) card. The proposed system acts as an integrated data solution of a patient's medical history for use in daily operations and decision support analytics.

Keywords: medical record, healthcare analytics, data privacy, data security, unified access, multi-payer system

1. INTRODUCTION

The use of information technology in our daily lives has been on the rise, patient care information systems have now become an integral part of the patient care support in the developed world (Ash, Berg, & Coiera, 2014). In modern healthcare systems, "automation systems in hospitals and medical centers serve the purpose of providing an efficient working environment for healthcare professionals" (Kardas & Tunali, 2006). Some argue that the use of information technology is essential for keeping patients' records (Dick & Steen, 1991; Armony, Israelit, Mandelbaum, Marmor, Tseytlin, & Yom-Tov, 2015). The use of information technology is believed to have increased the quality of health care services, and decision support system for health care management, health education and research (Jones, Rudin, Perry, & Shekelle, 2014).

Information technology in healthcare has been greatly instrumental in enhancing the ability to apply the vast resources of information technology in complex and sustained health management situations. Healthcare providers that have seen great success in the area of

research and treatment have tremendously benefitted from the use of big data and analytics (Kayyali, Knott, & Van Kuiken, 2013). IT capabilities have empowered providers to be able to maneuver the medium to their advantage. The widespread adoption of IT has also led to a better grasp on handling unintended and unexpected issues when they arise (Bates, Saria, Ohno-Machado, Shah, & Escobar, 2014).). Additionally, IT capabilities encourage more abstract thinking about health care data; especially for research purposes. Yet this data is not fully integrated for access during regular patient visits or for decision support and research analytics (Jensen, Jensen, & Brunak 2012). The United States continues to have large integrated transactional and decision support databases but they are NOT integrated across the nation (Koebnick, Langer-Gould, Gould, Chao, Iyer, Smith, & Jacobsen, 2012).

This paper proposes the creation of a distributed healthcare information system that is grounded in past literature. It also lays out the process through which the adoption of an universal medical record access and analytics (UMRAA) system would be created. The implementation of such a system will involve a pilot study in a single US state. The potential success of the proposed plan in this particular state could be leveraged to help sell the idea to the rest of the nation. The paper first discusses the state of healthcare and IT as presented in past literature done in the field. The next part of the paper describes smart card use in healthcare, the proposed system, advantages and challenges as well as the plan for the development and implementation of the Unified Medical Record Access (UMRAA) card in detail. Finally the potential challenges that the proposal could face are discussed.

2. STATE OF HEALTHCARE AND IT

Keeping in mind the current state of the US healthcare system, it is very timely and paramount for a information systems and analytics to continue to be a major contributor to every decision-making process that goes on in the healthcare industry (Himss 2014). The growth of data collection and the inclusion of information technology in healthcare continues to grow at a rapid pace. It is expected to reach $31.3 billion by 2017 (Bernie Monegain, 2013). The current state of healthcare predominantly revolves around the following issues: (1) actual costs associated with getting quality care, (2) the accessibility and availability of healthcare across the continental US, and (3) the education provided to individuals about maintaining sound health and obtaining precautionary health check-ups in order to prevent major medical costs (Shi, & Singh, 2014). Another major issue with healthcare would be the potential inability to cater to the needs of the next wave of senior citizens (Ou, Shih, Chin, Kuan, Wang, & Shih 2013).

Additionally, the rise of medical errors and the potential for maltreatment due to lack of availability of complete patient health information is also one of the major issues in the healthcare industry (Agha 2014). The dissatisfaction with the healthcare system could increase over the next few years as a result of increased out-of-pocket expenses associated with the weakening economy and increasing prescription drug prices (Haren, McConnell, & Shinn, 2009). The gradual increase in uninsured individuals is only going to add to the increasing costs of health care in the future. Keeping these factors in mind, bolstering the US healthcare structure with the support of an integrated information technology solution for access and analysis would be the potential solution moving forward (IOM, 2009).

One such change in the past that has shown enormous success is switching from paper medical records to electronic medical records that provided a centralized location for storing patient information that in turn streamlined healthcare management (Frolick, 2005; Jacobus, Braun, & Cobb, 2014). The implementation of information system in health care practices is fraught with numerous risks. The stored data on multiple locations in health practices can be a challenge to report essential and strategic information for various stakeholders (AHRQ, 2006). The healthcare information management system in many developed countries like the US, Canada, and many European countries is not well integrated (Brown 2003). Due to various patient information flows and routes, there has been an inherent difficulty to integrate and report the data essential for the management, clinicians, policy makers and researchers (Poon, Jha, Christino, Honour, Fernandopulle, Middleton, & Kaushal, 2006).

.

3. SMART CARDS AND MEDICAL HEALTH RECORDS

The idea of having a complete medical record on a smart card based system has been considered for several years now (Smart Card Alliance 2012). Computer systems that could store medical histories on a smart card were invented more than a decade ago in countries such as Hungary, France, and Spain (Naszlady & Naszlady 1998). However, the US has yet to implement such a system at a national level. In 1998, a study involving an electronic chip card was carried out where 5000 chronically ill patients throughout Hungary received a smart

card that had entire patients' medical history stored in it (Naszlady & Naszlady 1998). The goal was to achieve complete patient information and also to support the growing need for an integrated healthcare delivery model.

Currently, there is no national health care smartcard system in place in the US. However, in some European countries such as Britain and France, pilot programs had been established over a decade ago. These pilot programs have proved to be highly useful and easily implementable (Neame, 1997; Marschollek & Demirbilek 2006; Liu, Yang, Yeh, & Wang. 2006). Today's, health smartcards in France have served the purpose of carrying information related to health insurance, and some ongoing health records and basic emergency health information. Furthermore, strengthening the evidence of their usefulness, the Exeter Care Card (ECC) pilot program that was funded by Britain's Department of Health and carried out by Exeter University (Hopkins, 1990), showed tremendous advantages of having such a smart card system in the health care industry. The advantages of the ECC pilot were the reduction in the cost of prescribing; reduced cost of carrying out investigations; reduction in risk of iatrogenic cases of illness; reduced times taken for data communication; ready access to necessary medical records (Neame, 1997). A valuable addition to the result of the study was that it also showed high patient satisfaction levels.

In 2006, another study illustrated to the US healthcare industry the possibility of solving one of the major hurdles to smartcard technology - which is interoperability (Marschollek & Demirbilek, 2006). Since healthcare organizations do not use the same health information system software, there are multiple sets of ways to code for the same information based on the type of software that is being used. These challenges can easily be overcome using standardized software and technologies in order to facilitate interoperability with multiple healthcare information systems, such as used in the German Health Card pilot program (Marschollek & Demirbilek, 2006).

Another study conducted by Wei Chen et al (2012), proposed to establish a portable electronic medical record system that applied streaming media technology to access medical images and transmit them via the Internet. This is an example of a distributed information management systems in healthcare. Figure one shows a graphical representation of the structure of the portable electronic medical record (EMR) system. The study proposed a system that is composed of the EMR query system, data exchanging, and the EMR streaming media system. The proposed architecture provided local hospital users the ability to acquire EMR text files from a previous hospital. It also helped access medical images as reference for clinical management. The proposed architecture shown in figure one provides a diagrammatic illustration of what a distributed information system could look like (Wei Chen, 2010). One major limitation to the system shown in the study is the system's dependency on the internet for its data transfer functionality. However, the concept proposed in this paper does not require the internet for its operability and functionality.

The factors that have been referenced from all the various studies described provides a compelling argument to implement a comprehensive, consolidated and secure model for healthcare information system that can be easily and quickly made available and accessible to healthcare providers. Adding portability to the electronic medical record system in the form of the UMRAA card maximizes efficiency and streamlines the whole patient-doctor experience at a national level.

4. UNIFIED MEDICAL RECORD ACCESS AND ANALYTICS (UMRAA) DISTRIBUTED INFORMATION SYSTEM

The work presented here proposes a theoretical approach to building a distributed information management system in the form of a Unified Medical Record Access and Analytics (UMRAA) card. The UMRAA system will not only store patient's entire medical history, but it will also update, synchronize and store all information at every point of a patient's encounter with healthcare (i.e. Hospital, Family Doctor, etc.). This system enables any doctor in the US to view a patient's entire medical history thereby increasing overall efficiency and reducing the possibility of potential medical errors or mall treatments.

Historically, smart cards have supported an impressive variety of applications, and this variety will expand as the cards have become smaller, cheaper, and more powerful (Shelfer & Procaccino, 2002). With this innovative outlook and compelling need for a comprehensive, consolidated and secure model for healthcare information system, this research describes a patient information system, where the data is captured on all the respective information systems redundantly. A key player in implementing the UMRAA Card system is the federal government.

The United States has one of the highest per capita health care spending among all the developed countries (Anderson, Frogner, Johns & Reinhardt, 2006), yet healthcare remains complicated and expensive. Highest per capita healthcare spending has not translated into more resources; the problem here is that the US health care system does not have the proper allocation of funds. The German Health Card (Marschollek & Demirbilek, 2006), the Taiwanese national health insurance card – which also had medical records (Liu, C et al., 2006) - and the Exeter Care Card (Hopkins, 1990) all have one thing in common. They have government funding. Out of the three aforementioned programs, the ECC and German Health Card were both well accepted by the patients and healthcare providers. These studies suggest that such a program can be implemented in the US and that the UMRAA card system will be well received by the general population.

However, it is worth mentioning that there are other proposals for integrating health care such as cloud based, block chain and personal health records. The characteristics of each of them are presented in table one.

5. INFORMATION TECHNOLOGY INNOVATION AND HEALTHCARE

Efforts to develop and optimize the integration of healthcare data have been continually evolving. To create a state of the art continuum of care there has been great demand for complete integration of the delivery of care and operational processes. The increased adoption of Electronic Health Records across the continuum has led to the accumulation of diverse healthcare data in silos. Given the growing opportunities and challenges with regard to achieving clinical and operational excellence, it is paramount to develop the ability to integrate all the diverse healthcare data in a meaningful way. This would enable healthcare organizations to utilize data in a more inclusive and innovative fashion. The acquisition of healthcare data that span various domains within the continuum of care must be captured and consolidated in a manner that is readily reusable for higher order functioning without the need for manual transformation of data. One major barrier to integrating data generated from diverse applications is its complexity which is inherent due to the nature of individual applications not being designed for synchrony (Lenz, R., Beyer, M., & Kuhn, K. A., 2007). The development of a comprehensive distributed information systems infrastructure would be the ideal solution for smooth information flow and knowledge generation. In spite of potential barriers, the demand for clinical and operational efficiency, and the adaptation of state of the art technology, has enabled a few organizations to succeed in garnering benefit from data integration. Healthcare decision makers would be forward thinking if they could predict and understand the extraordinary potential and value that UMRAA program could provide.

Data integration has led the way to the implementation of real-time business intelligence. Analyzing healthcare data to predict patient volumes, the cost of care and clinical outcomes in order to improve the quality, safety, and productivity of point of services has always been an integral part of running a competitive healthcare system (Mettler, T., & Vimarlund, V., 2009). In the past, organizations addressed this in the form of monthly and yearly data analysis and also often depending on market analysis and independent external resources. However, in recent years, this trend has changed due to the growing pace of delivery of care transition from volume based to value based care models. With ever-increasing healthcare market share competition and growing healthcare customer demands and changing needs, progressive decision makers are demanding dynamic data analytics reports and real-time business intelligence. Real-time business intelligence has become a great necessity in today's evolving healthcare environment in which organizations are operating in a constant state of evolution due to the continual change in the healthcare landscape (Raghupathi & Raghupathi 2014). Changing policies and customer demands are at their historic peak. Patients and stakeholders are more educated and technologically advanced, and therefore more demanding. Advances in technology along with growth in innovative mindfulness have also provided a favorable landscape for the growth of real-time business intelligence. Real-time business intelligence in the form of dynamic dashboards is becoming a common must-have for today's decision makers. Adaptation of revolutionary concepts such as UMRAA in healthcare are going to be the drivers of advanced future real-time business intelligence platforms (Azvine, B., Cui, Z., & Nauck, D. D., 2005). UMRAA has the capability to harness extraordinary diverse healthcare data and would, in turn, provide organizations with most current and state of the art information and knowledge that would allow them to make both business and clinical decisions in a more timely, efficiently manner and with a high degree of accuracy and success.

In addition to real-time business intelligence, big data in healthcare is another domain that has the potential to provide extraordinary advantages to the way we provide care to

healthcare customers (Raghupathi & Raghupathi 2014). With the advent of the widespread adaptation of electronic medical records, healthcare organizations are in possession of large volumes of complex and variable healthcare payer, provider and patient information. Today's advanced electronic health records have the ability to capture, store, manage and distribute healthcare big data in a timely and efficient manner. Existing analytical techniques have the capacity to derive deeper information and knowledge from this vast amount of health and business-related big data in terms of quality, safety, access and outcomes of providing care (Banerjee, A., Bandyopadhyay, T., & Acharya, P., 2013). With the introduction and implementation of UMRAA, benefits that arise from large volumes of organizational data can be factored exponentially to its potential applicability. One study states that big data has the potential to save more than $300 billion per year in US healthcare, which is predominantly coming from reductions of approximately eight percent in national healthcare spending. The two largest areas for savings with $165 billion and $108 billion in waste respectively are coming from Clinical Operations and Research Big data analytics (Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H., 2011).

Another promising avenue belonging to the data analytics realm that can influence healthcare is the system of interconnected applications that yield information from the environment through sensing and also interact with the surrounding physical world by using the internet to provide advanced services for applications, communication, and business intelligence (Atzori, L., Iera, A., & Morabito, G., 2010). Internet of Things has gradually transitioned into the mainstream by transforming the traditional Internet into a fully integrated Internet of tomorrow wherein lies the potential for not leaving any single digital device to work in solitude. The digital world of the future is poised to embark on a journey where each and every possible device on earth would communicate to the other in order to create an unmanned equilibrium of processes around us that would automatically sense the needs of the environment that they reside (Aggarwal, C. C., Ashish, N., & Sheth, A., 2013). Internet of Things has been vastly growing and successful in recent years due to the growth and development of devices that are generically embedded by open wireless technology such as Wi-Fi, radio frequency identification, and Bluetooth as well as actuator nodes and embedded sensor (Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M., 2013). UMRAA has the potential to take delivery of healthcare to a new dimension with the potential to transform into "Health Internet" as the Internet of Things for healthcare applications. As UMRAA is designed to work as an integrated data platform, it has the potential to interact and function to command necessary actions that may be warranted in given situations that presently require human intervention.

Finally, we discuss smart cities as the potential universal reality of tomorrow. Smart cities are geographic boundaries that are encapsulated in an integrated information and communication infrastructure that has multiple applications that are programmed to cooperate and coordinate with each other in order to understand and potentially predict our needs even before we realize them (Solanas, A., Patsakis, C., Conti, M., Vlachos, I. S., Ramos, V., Falcone, F., ... & Martínez-Ballesté, A., 2014). The widespread adaptation and implementation of UMRAA can provide a fundamental framework for future smart cities to replicate the structure and design of UMRAA to other required domains of human necessities in today's world such as banking, education, transportation, and communication.

6. PROPOSED SYSTEM

Although the use of information systems increased the quality of health care services, it still faces numerous challenges (Shekelle, Morton, & Keeler, 2006). The existence of multiple information systems in various healthcare facilities can make it a real challenge to compile and report the data for different purposes (Heathfield, Pitty, &Hanka, 1998). Historically, a number of data modeling techniques have evolved from recent research to improve reporting, analytics and quality of health care. In a recent study (McGregor, 2012), Patient Journey Modeling architecture (PaJMa) was used as a modelling technique for data representation. PaJMa was an approach used for process flow modeling that was designed specifically to understand the nuances of patient journeys during a patient-provider encounter.

UMRAA is a portable unified medical record system which is a part of a distributed healthcare information system. It maintains a continuously-growing list of data records that each patient encounters. Each encounter refers to a previous encounter on the smart card and is thus the patient data on the smart card is comprehensive and hardened against tampering and revision by unauthorized users.

The diagrammatic representation of the proposed system is represented in Figure 2

which shows the data flow in the proposed distributed information system. To phase in the system to the current US population, the first point of patient's data entry will be determined by the circumstances of each individual patient. Current patients can be given their UMRAA card on their next doctor or ER visit, while new-borns can be registered in conjunction with the issuance of their social security card and/or birth certificate. The proposed system could work very similarly to a CarFax (Barnett 1991) report that consumers can obtain for knowing the complete history of a car based on its vehicle identification number.

CarFax is a database search and reporting program where used car consumers enter a vehicle identification number (VIN). A CarFax application searches a database, and provides a report for a small fee. The business model for Carfax is as follows: used car consumers want to know if an automobile has a tarnished history, and CarFax provides an instant answer. CarFax is able to provide an answer because they have compiled a huge database of more than 1 billion vehicle registration records. By searching the database it can quickly provide detailed information on just about any vehicle sold in the US. The system proposed in the paper can be thought of as a "CarFax for patients."

Similar to a CarFax report, a healthcare provider such as a physician or nurse practitioner in any part of the United States may have access to a patient's entire medical history, regardless of which part of the country and what type of service the patient receives. For instance, a family doctor's reports from Anchorage, Alaska and free clinic reports from Atlanta, Georgia can all be accessible to a nurse practitioner in Amelia, Ohio). The UMRAA Card will synchronize (i.e. Download new data and upload previous data or even just allow access to the information stored) all information every time it is accessed at a healthcare facility.

Even after the Affordable Care Act (ACA), private healthcare organizations have the tendency to work in silos. Therefore the idea of having a Unified medical record would not be well accepted in the US. For the US healthcare system to adopt the proposed plan nationwide, it is important that the federal government push this agenda as an addition to the ACA which would help further the cause of moving from fee based performance to value based system. Individual health organizations would not be willing to adopt such a system as they fear that it would lead to patient poaching by their competitors. The data available in the smart card could be available to competitors if patients come in contact with competitors. Therefore, in order to implement and reap the benefits of the proposed plan, it needs to be adopted by the federal government which can make it a mandate as they did it in case of the ACA.

In addition, the adoption of the proposed plan would require the development of a common vocabulary. A champion from the highest echelon of government will be required to encourage adoption of such a system by healthcare providers, patients and insurance providers. High system adoption and system success through a strong champion from upper management is well recognized in large IT implementations in organizations (Cresswell, Bates, & Sheikh, 2013). Such a champion would encourage all stakeholders and consumers to adopt and share a common vocabulary/taxonomy. These stakeholders and consumers will be able to reap the benefits only if they are willing to talk the same language and if they are willing to do adopt a common taxonomy. In other words, a champion from the highest levels of government and the emergence and widespread adoption of a shared taxonomy is essential to implementing the proposed plan.

The implementation of the UMRAA Card system can be straight forward. Figure three shows the step by step illustration of the UMRAA process. Patient registration is triggered on the very first visit of a patient to any health care facilities or at birth. The proposed system requires patients to register at a point of interest in any possible routes such as primary care practice, hospital facility, social services or emergency room. In emergency cases, healthcare takes precedence over recording patient information and in some cases the formalities are relaxed in an emergency situation. The prioritization of registration and healthcare support is largely dependent upon the individual patient circumstance. Therefore, the patient registration can take place before or after the treatment for first-time visitors.

The UMRAA record for each patient is created in a database and stored on a portable electronic card. The next step of the process would be to encrypt the UMRAA card with a secure password. Now the UMRAA card is ready to be carried by the individual patient and presented at all health care facilities for data synchronization on each visit. After the essential clinical and health care activities, the patient data is recorded in the information system and transferred over to the health care card. If the patient paid a visit to another health care facility and the card is holding new data, it is transferred over to the primary care information system. This will ensure

completeness of patient data in all health care facilities. The process is visually presented in Figure 4.

However, the patient may also choose only to have new reports downloaded and have their previous history be only viewable to the healthcare provider they are seeing. This method will prevent possible privacy leaks and also prevent a littering of data in healthcare databases throughout the country where the patient was only visiting and had needed unplanned emergency care.

7. POTENTIAL BENEFITS

The UMRAA card would have a number of potential benefits with regards to many different stakeholders in the continuum of care. From a patient's perspective, the patient has complete and comprehensive information about his/her health status. This would immensely help in terms of patient compliance and satisfaction. Furthermore, most of the benefits that have been outlined for other stakeholders seem also to apply to individual patients as well.

From the providers' perspective, the healthcare provider will have complete knowledge and information that would be required to deliver a complete management plan. This vital information would also help in avoiding duplication of health services and at the same time avoid redundancies. The major benefit from the UMRAA card would be in the event of an emergency at a healthcare facility that never had any prior encounter with the patient seeking emergency medical care. The information on the card would be critical in making life and death decisions that would impact the health of the patient. Another significant benefit would be the reduction in readmission rates with the help of the data available from UMRAA to the first clinical point of contact which would potentially help the healthcare provider to take necessary steps to avoid readmission while planning the management.

Looking from a payer's perspective, UMRAA could lead to care coordination and reduction in over utilization leading to cost savings. Lesser administrative burden to process claims. Customization of health plans to determine the best combination of benefits for covered lives.

To put things in perspective, US healthcare system is one of the biggest spenders in comparison to its other developed counterparts worldwide. In spite of having extraordinary expenditure geared towards healthcare, outcomes do not match the expenditure or are less than some of the countries that spend far less than the US on healthcare. In view of these unfavorable trends in US healthcare, politicians and law maker have systematically steered healthcare from volume to value based service with the aid of various policies and reforms over the years (Mayes, R. 2011). Moving forward, having such new unexplored territories in the area of population health and value based care, would be detrimental for organizations with limited access to needed data. Having access to information that would help them control cost as well as provide quality care in order to be in alignment with the policies and reforms, is crucial for success. The kind of timely analytical information that can be derived from the data on UMRAA can be the paramount factor providing competitive edge to healthcare providers seeking growth in business and increased market share.

UMRAA can provide instant predictive information to healthcare personnel with regards to impending acute health episode based on the trend in the chronic condition of a patient. It can potentially reduce the emergency department visits as well as the thirty day readmission post discharge from a healthcare facility (Amarasingham, R., et al, 2010). As the US healthcare system is pacing towards a shift from volume to value based care as well as reimbursement; much of the financial gains are going to come from keeping patients out of emergency departments as well as preventing 30 day readmissions. Integrated systems like UMRAA are going to greatly impact such areas with reliable and accurate predictive information. This will enable payers and providers to act in time and steer towards desirable health outcomes that are in line with the requirements of the centers for Medicare and Medicaid services (CMS).

Healthcare organizations having access, disease, outcomes and analytics data, derived from UMRAA, can be tremendously instrumental to organizations. They can better align with the requirements of the CMS, as a result. CMS is the largest healthcare payer in the US., An organization's ability to align with CMS's requirements with the help of predictive analytics coming from UMRAA can greatly impact the financial viability of organizations. With enhanced reimbursements, organizations can gain growth and sustainability. Furthermore, with regards to BI benefits from UMRAA, avoiding duplication and reduction in redundancies can potentially give rise to economies of scale in relation to the use of supplies and cost of care. Additionally, having mass quantities of information coming from patient encounters across the continuum of care can facilitate the development of benchmark and best practices.

In addition to the above, CMS and healthcare in general are slowly steering towards population health and bundled payments. Historically, healthcare organizations, and the different entities within have worked in silos. This kind of operational silos in terms of providing and managing care will make predicting risk for bundled payments very difficult. UMRAA can be helpful in assessing time and costs in terms of episodes of care. This will help organizations be more cost effective in terms of predicting costs based on historical expenditures. Having the advantage of data and information in terms of cost of the care during the continuum can help them predict ball park risk. This will help us better negotiate payer contracts as well as deliver efficient and timely care leading to increased financial returns.

The vast amount of information and data that would be gathered from a complete and comprehensive healthcare history of patients' would help in running clinical and non-clinical healthcare analytics that would greatly help in research and development of clinical as well as healthcare management protocols. The vast amount of data and knowledge that would be generated from the advanced analytics of patient data will improve the efficiency of healthcare management and reduce healthcare costs, both, to the individual patient as well as the US healthcare system in general (Raghupathi, Raghupathi 2014). This kind of business and clinical intelligence framework can lead to a major breakthrough in healthcare and can give rise to a completely new approach to the way the US delivers healthcare in the future (Foshay, & Kuziemsky, 2014).

8. CHALLENGES

While there are a number of advantages of UMRAA, there are some challenges to the proposed approach. The UMRAA card system will incur costs of hardware, portable electronic health care cards, and software. In addition to the numerous costs associated with healthcare, the added costs of this system will be a burden that can be felt across the board, ranging from increasing insurance premiums to increasing tax rates.

The costs associated with the initiation, implementation, and maintenance of this system will have to be shared between the governments (i.e. City, State & Federal), insurance companies and local healthcare systems. As mentioned earlier, the costs associated with the initiation of this program will have to be funded via a federal stimulus package. However, to accelerate the implementation, the program can be started state wise, with the least economically weak states implementing the program first. Furthermore, the maintenance costs of this program will have to be shared in some proportion by all parties responsible for the healthcare needs of a US resident, namely, the governments at all levels, insurance companies, and even the individual hospital system or primary practice at a local level. This ensures that there are checks and balances across the board, and everyone is held accountable.

The system requires a compatible system at each patient healthcare touch point. Words on any online material can be recognized by software as text that can be editable. Similarly, the UMRAA database will have to be able to recognize all the data associated with medical records across various health care check points and be able to store that data in an effective way for daily access as well as decision support analytics.

The damaged, lost or stolen cards can occur and bring about additional costs. Such cards may also raise privacy and security concerns. These costs will, to a certain extent, be the responsibility of the patients. Just as social security cards and expensive jewellery are protected, the UMRAA card will also become an indispensable part of an individual. Providing a secure way of accessing the information stored on the card can be a challenge. A combination of a fingerprint scan along with a swipe of the UMRAA card at health care facilities should suffice for the security of the stored information. In order to access the information and/or synchronize with the UMRAA card, the patient will have to provide a fingerprint scan along with swipes of the healthcare providers ID card and the UMRAA card itself. Although, fingerprint technology for security has been around for ages, it is still considered one of the many key methods of providing reliable security features to a smart card (Butler, A. 2016). Moreover, this transaction can only be completed at healthcare facilities, thus preventing unauthorized access.

Restricting access of the UMRAA information to only essential healthcare providers (i.e. Physicians, Nurse Practitioners, etc.) will ensure that the information stored on the UMRAA card remain confidential between the patient and doctor. Therefore, non-essential healthcare providers who would not need access to a patient's entire medical history such as a pharmacist or a licensed practical nurse should not be allowed into the UMRAA database. Only a physician and possibly a nurse practitioner should have unlimited access to the UMRAA information.

The overall integration of patient health records is the main success factor of UMRAA. However, there is a need for the healthcare system stakeholders to realize that it is important to either have a single payer system or a federal mandated multi payer system for the proposed plan to be adopted and implemented nationwide. Besides the factors that were discusses earlier, the main factor that stops different healthcare organizational silos from adopting something like this is that they fear losing patients to their competitors. This paper has highlighted this fundamental deterrent that needs to be addressed in order to have buy-in from the payers and providers of healthcare. If not there may be a need to make it a federal mandate, just as it was done in the case of the "Affordable Care ACT."

Finally, there are a number of countries that have implemented a healthcare smart card system. Many US healthcare organizations have also implemented smart card pilot programs with their organizations. However, most of these programs are implemented with the idea of stream lining the reimbursement system as well as obtaining medical information and also for the purpose of biometric authentication. Although the implementation of smart card technology has been discussed in the US for many years, its adoption in the US has been slow due to key issues, such as privacy, interoperability, and security of patients' data. However, some healthcare institutions such as Mt Sinai Hospital in New York have incorporated the use of storing medical information, health insurance contact details, and even electrocardiogram results on a secure and private smart card (Smith, & Barefield, 2007). In spite of all these efforts, the US feels the need to conduct more research on the use of smart card technology due to previously mentioned reasons.

Smart Card Alliance which is a non-profit organization whose purpose is to develop an understanding and explain the use of smart card technology is trying to bring awareness and therefore stays connected to industry leaders through educational programs, marketing research, and open forums (Alliance 2015). They have also been trying to ease the industries fear that revolves around the security and privacy issues that come with it. However, Smart Card Alliance fails to understand that in US, it is going to be very difficult to implement such a system due to a multiple payers (Hussey & Anderson 2003), in spite of all the benefits that have been discussed already in this paper.

There are healthcare smart cards in the US that are currently being proposed for nationwide implementation. However, the players proposing such smart card implementation are failing to take into account the biggest barrier to nationwide system implementation: the multi payer system. The US healthcare system is comprised of multiple payers. Medicare is the single largest payer in the US and the rest are multiple private insurers. Therefore, the US healthcare has been mostly working in silos up until the affordable care act (ACA) came into play.

9. CONCLUSION

The use of heterogeneous patient information system in various health care facilities can make it a challenge to report and analyse patient data. The data integrity and completeness can be challenging for the employers, clinicians, and researchers. The UMRAA card distributed information system approach can combine and integrate the pertinent patient data in all the healthcare facilities to support quality of health care, reporting, treatment and management. Besides the innumerable benefits of this system, there are challenges to overcome. These challenges come in the shape of privacy, security, and costs associated with the initiation, implementation, and maintenance of this system.

Smart cards are not new to the healthcare industry. Current health smart card is in use in many parts of Europe as well as here in the US such as the one that was implemented by the Mount Sinai health system in New York. Most of these health smart cards are used of reimbursement feasibility. In addition to making reimbursement easy, there are a few that are more geared towards improving the care of patients as well as improving quality and reducing cost.

There are endless possibilities and benefits that could come along with this program, such as globalization of healthcare and uniformity in the quality of services offered to the patients. An UMRAA system has the potential to reduce malpractices, delayed decision making, etc. which usually occur as a result of healthcare providers not having enough information. Other future possibilities in health care with UMRAA would be with the use of analytics. Analytics for research purposes using the data derived from the widespread use of UMRAA card would potentially lead to better health care process reengineering. The initiation and implementation of this program is indeed a herculean task, but the advantages far outweigh the disadvantages. All in all the UMRAA system is at the center of providing the most efficient and standardized patient care

within the United States (Raghupathi & Raghupathi 2014).

In addition to traditional analytics, emerging and innovative applications and platforms such as Big Data Analytics, Real-time Business Intelligence, Internet of Things and Smart Cities are frameworks that would most benefit from the UMRAA program. UMRAA has the potential to generate data from numerous patient care points of contact and integrate it with global healthcare communities. Various innovative platforms mentioned earlier may stumble into potential pitfalls without a well-engineered data integration support system. However, UMRAA program with its current robust design can act as a promising instrument for laying the foundation and widespread realization future mass data-centric applications.

This paper proposes an ambitious plan to assist in the modern day US healthcare landscape that is currently undergoing a swift transformation from the traditional volume based to a value based model of care. Some of the benefits and challenges discussed in this paper are extremely pertinent to the evolving US healthcare cosmos. We need to have a targeted vision in terms of what tools and techniques that can be helpful to us to be able to provide the best in class value based care to our patients. The paper lays ground work to continue the discussion around the technical as well as logistical functions involve in the actual implementation of the UMRAA. There is a need for ongoing research in this space; specifically, on security as well as system integration. The information provided hereprovides an outlook on the continuum of care afforded to patients and how UMRAA intersects at various points throughout the continuum. It can help in the development of a stream of research that shows how healthcare can go the distances in bringing about excellence in providing cost effective quality healthcare.

10. REFERENCES

Agha, L. (2014). The effects of health information technology on the costs and quality of medical care. *Journal of health economics*, *34*, 19-30.

Aggarwal, C. C., Ashish, N., & Sheth, A. (2013). The internet of things: A survey from the data-centric perspective. In *Managing and mining sensor data* (pp. 383-428). Springer US.

Alliance, S. C. (2015). Smart Card Alliance.". *INSIDE Contactless Offers Free, Downloadable, Open NFC API and Source Code on SourceForge*.

Amarasingham, R., Moore, B. J., Tabak, Y. P., Drazner, M. H., Clark, C. A., Zhang, S., ... & Halm, E. A. (2010). An automated model to identify heart failure patients at risk for 30-day readmission or death using electronic medical record data. *Medical care*, *48*(11), 981-988.

Anderson, G. F., Frogner, B. K., Johns, R. A. & Reinhardt, U. E. (2006). Health Care Spending And Use Of Information Technology In OECD Countries. Health Affairs, 25, no.3 (2006):819-831

Armony, M., Israelit, S., Mandelbaum, A., Marmor, Y. N., Tseytlin, Y., & Yom-Tov, G. B. (2015). On patient flow in hospitals: A data-based queueing-science perspective. *Stochastic Systems*, *5*(1), 146-194.

Ash, J. S., Berg, M., &Coiera, E. (2014). Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. Journal of the American Medical Informatics Association, 11(2), 104-112.

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer networks*, *54*(15), 2787-2805.

Azvine, B., Cui, Z., & Nauck, D. D. (2005). Towards real-time business intelligence. *BT Technology Journal*, *23*(3), 214-225.

Barnett III, E. H. (1991). *U.S. Patent No. 4,989,144*. Washington, DC: U.S. Patent and Trademark Office.

Bates, D. W., Saria, S., Ohno-Machado, L., Shah, A., & Escobar, G. (2014). Big data in health care: using analytics to identify and manage high-risk and high-cost patients. *Health Affairs*, *33*(7), 1123-1131.

Banerjee, A., Bandyopadhyay, T., & Acharya, P. (2013). Data analytics: Hyped up aspirations or true potential. *Vikalpa*, *38*(4), 1-11.

Brown, L. D. (2003). Comparing health systems in four countries: lessons for the United States. *American Journal of Public Health*, *93*(1), 52-56.

Butler, A. (2016). *U.S. Patent No. 20,160,104,161*. Washington, DC: U.S. Patent and Trademark Office.

Chen, W., & Shih, C. C. (2012). Architecture of portable electronic medical records system integrated with streaming media. *Journal of medical systems*,*36*(1), 25-31.

Cresswell, K. M., Bates, D. W., & Sheikh, A. (2013). Ten key considerations for the successful implementation and adoption of large-scale health information technology. *Journal of the American Medical Informatics Association : JAMIA*, *20*(e1), e9–e13. http://doi.org/10.1136/amiajnl-2013-001684

Dick, R. S., & Steen, E. B. (1991). The computer-based patient record: an essential technology for health care: Natl Academy Pr. Eberhardt, S. P. (1998). U.S. Patent No. 5,832,488. Washington, DC: U.S. Patent and Trademark Office.

Foshay, N., & Kuziemsky, C. (2014). Towards an implementation framework for business intelligence in healthcare. *International Journal of Information Management*, *34*(1), 20-27.

Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, *29*(7), 1645-1660.

Haren, M. C., McConnell, K., & Shinn, A. F. (2009). Increased patient cost-sharing, weak US economy, and poor health habits: implications for employers and insurers. *American health & drug benefits*, *2*(3), 134.

Heathfield, H., Pitty, D., & Hanka, R. (1998).Evaluating information technology in health care: barriers and challenges. BMJ: British Medical Journal, 316(7149), 1959.

Himss A (2014) State of the U.S. Healthcare Information Technology Industry [White paper], retrieved from http://apps.himss.org/foundation/docs/FINAL%20COPY%20STATE%20OF%20THE%20ART%20REPORT.pdf

Hopkins, R. (1990). Exeter Care Card evaluation report. London: HMSO. Frolick, M. (2005).Using electronic medical records to improve patient care: The St. Jude Children's Research Hospital Case. Information Science Today.

Hussey, P., & Anderson, G. F. (2003). A comparison of single-and multi-payer health insurance systems and options for reform. *Health policy*, *66*(3), 215-228

IOM (2009). America's Uninsured Crisis: Consequences for Health and Health Care [White paper]. Retrieved January 23, 2016, from http://iom.nationalacademies.org/Activities/HealthServices/InsuranceStatus.aspx

Jacobus, C. J., Braun, J. C., & Cobb, P. (2014). *U.S. Patent Application No. 14/282,949*.

Jensen, P. B., Jensen, L. J., & Brunak, S. (2012). Mining electronic health records: towards better research applications and clinical care. *Nature Reviews Genetics*, *13*(6), 395-405.

Jones, S. S., Rudin, R. S., Perry, T., & Shekelle, P. G. (2014). Health information technology: an updated systematic review with a focus on meaningful use. *Annals of internal medicine*, *160*(1), 48-54.

Kardas, G. & Tunali, E. T. (2006). Design and implementation of a smart card based healthcare information system. Computer Methods and Programs in Biomedicine. 81(3), 66-78.

Kayyali, B., Knott, D., & Van Kuiken, S. (2013). The big-data revolution in US health care: Accelerating value and innovation. *Mc Kinsey & Company*, 1-13.

Koebnick, C., Langer-Gould, A. M., Gould, M. K., Chao, C. R., Iyer, R. L., Smith, N., & Jacobsen, S. J. (2012). Sociodemographic characteristics of members of a large, integrated health care system: comparison with US Census Bureau data. *The Permanente Journal*, *16*(3), 37

Liu, C., Yang, P., Yeh, Y. & Wang, B. (2006). The impacts of smart cards on hospital information systems - An investigation of the first phase of the national health insurance smart card project in Taiwan. International Journal of Medical Informatics. 75(2), 173-181.

Lenz, R., Beyer, M., & Kuhn, K. A. (2007). Semantic integration in healthcare networks. *International journal of medical informatics*, *76*(2), 201-207.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity.

Marschollek, M. &Demirbilek, E. (2006).Providing longitudinal health care information with the new German health Card - a pilot system to track patient pathways. Computer Methods and Programs in Biomedicine. 81(3), 266-271.

Mayes, R. (2011). Moving (realistically) from volume-based to value-based health care payment in the USA: starting with Medicare payment policy.*Journal of Health Services Research & Policy*, *16*(4), 249-251.

McGregor, C., Steadman, A., Percival, J., & James, A. (2012).A Method for Modeling Health Informatics Capacity in Patient Journeys Supported by Interprofessional Teams. Paper presented at the System Science (HICSS), 2012 45th Hawaii International Conference on.

Mettler, T., & Vimarlund, V. (2009). Understanding business intelligence in the context of healthcare. *Health informatics journal*, *15*(3), 254-264.

Monegain, B. (2013, December 30). Big growth forecast for health IT market. Retrieved January 22, 2016, from http://www.healthcareitnews.com/news/big-growth-forecast-health-it-market

Naszlady, A. &Naszlady, J. (1998), Patient Health Record on A Smart Card. International Journal of Medical Informatics. 48(1-3), 191-194.

Neame, R. (1997). Smart cards - the key to trustworthy health information systems. Information in practice, BMJ: British Medical Journal. 314, 573-577.

Ou, Y. Y., Shih, P. Y., Chin, Y. H., Kuan, T. W., Wang, J. F., & Shih, S. H. (2013, October). Framework of ubiquitous healthcare system based on cloud computing for elderly living. In *Signal and Information Processing Association Annual Summit and Conference (APSIPA), 2013 Asia-Pacific* (pp. 1-4). IEEE.

Poon, E. G., Jha, A. K., Christino, M., Honour, M. M., Fernandopulle, R., Middleton, B., ... & Kaushal, R. (2006). Assessing the level of healthcare information technology adoption in the United States: a snapshot. *BMC Medical Informatics and Decision Making*, *6*(1), 1.

Race, Ethnicity, and Language Data: Standardization for Health Care Quality Improvement. (2006). Retrieved January 23, 2016, from http://www.ahrq.gov/research/findings/final-reports/iomracereport/reldata5.html

Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health Information Science and Systems*, *2*(1), 1.

Shekelle, P., Morton, S. C., & Keeler, E. B. (2006).Costs and benefits of health information technology.Shelfer, K. M., &Procaccino, J. D. (2002).Smart card evolution. Communications of the ACM, 45(7), 83-88.

Shi, L., & Singh, D. A. (2014). *Delivering health care in America*. Jones & Bartlett Learning.

Smith, S. P., & Barefield, A. C. (2007). Patients meet technology: The newest in patient-centered care initiatives. *The health care manager*, *26*(4), 354-362.

Solanas, A., Patsakis, C., Conti, M., Vlachos, I. S., Ramos, V., Falcone, F., ... & Martínez-Ballesté, A. (2014). Smart health: a context-aware health paradigm within smart cities. *IEEE Communications Magazine*, *52*(8), 74-81.

Appendices and Annexures

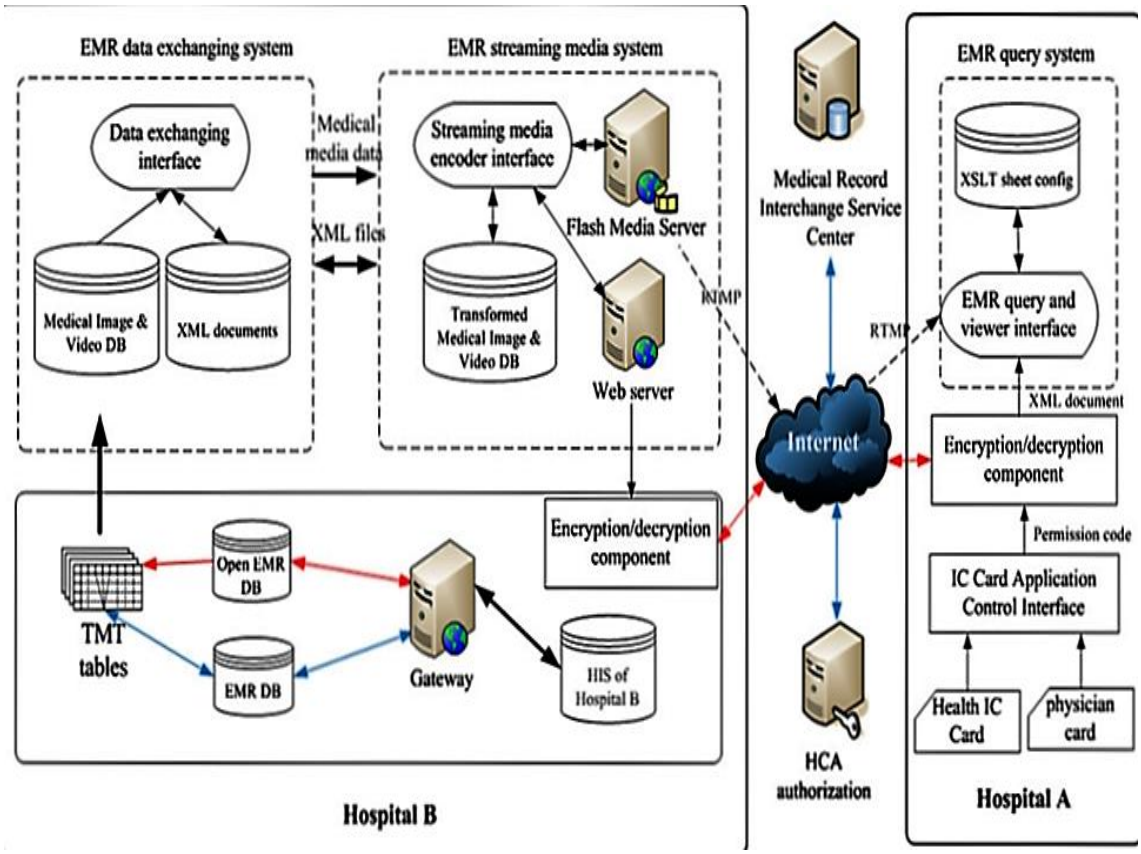

Figure 1: System architecture that integrates streaming media into portable EMR system (Wei Chen, 2010)

Cloud-based health records	Personal health records	Blockchain
○ Internet required for access. ○ Interoperability would be a question. ○ Ownership of complete health record not in the hands of patients as in the case of smart card.	○ Integration of complete medical history ○ Portability barrier Internet needed.	○ Portability barrier ○ Irreversible transactions, even on incorrect ones

Table 1: Alternative means of storing healthcare records other than smart cards

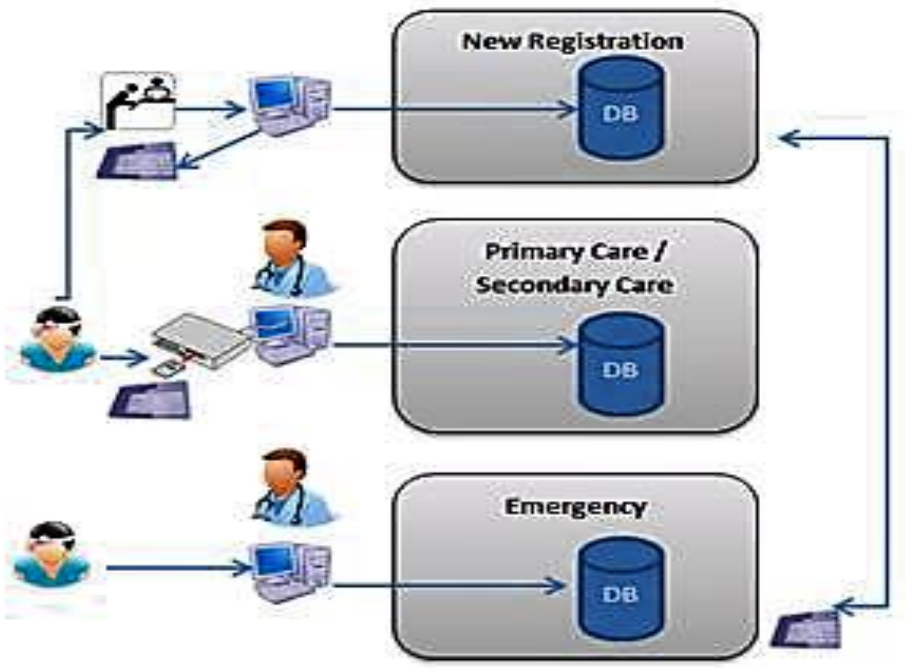

Figure 2.Data flow in the proposed distributed information systemn[UMRAA]

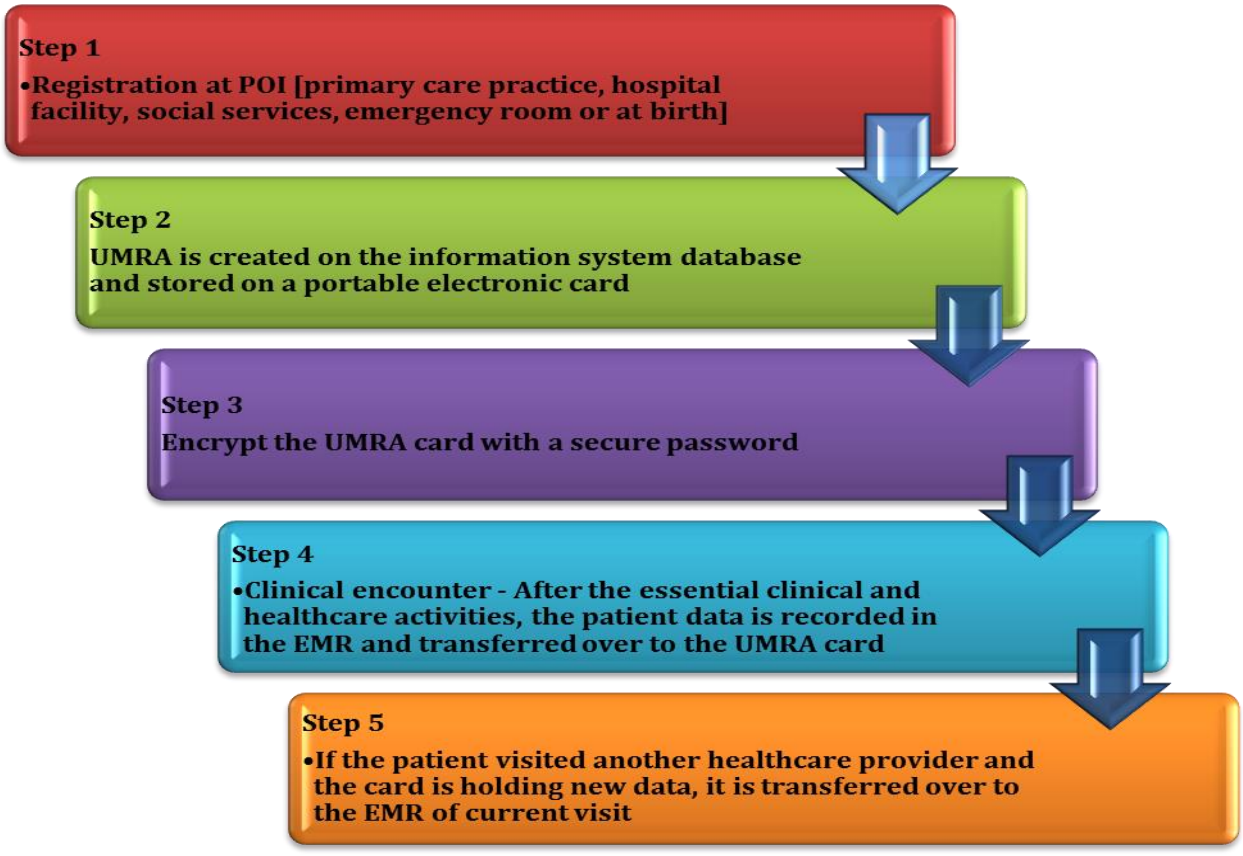

Figure 3: Steps by step illustration of UMRAA process

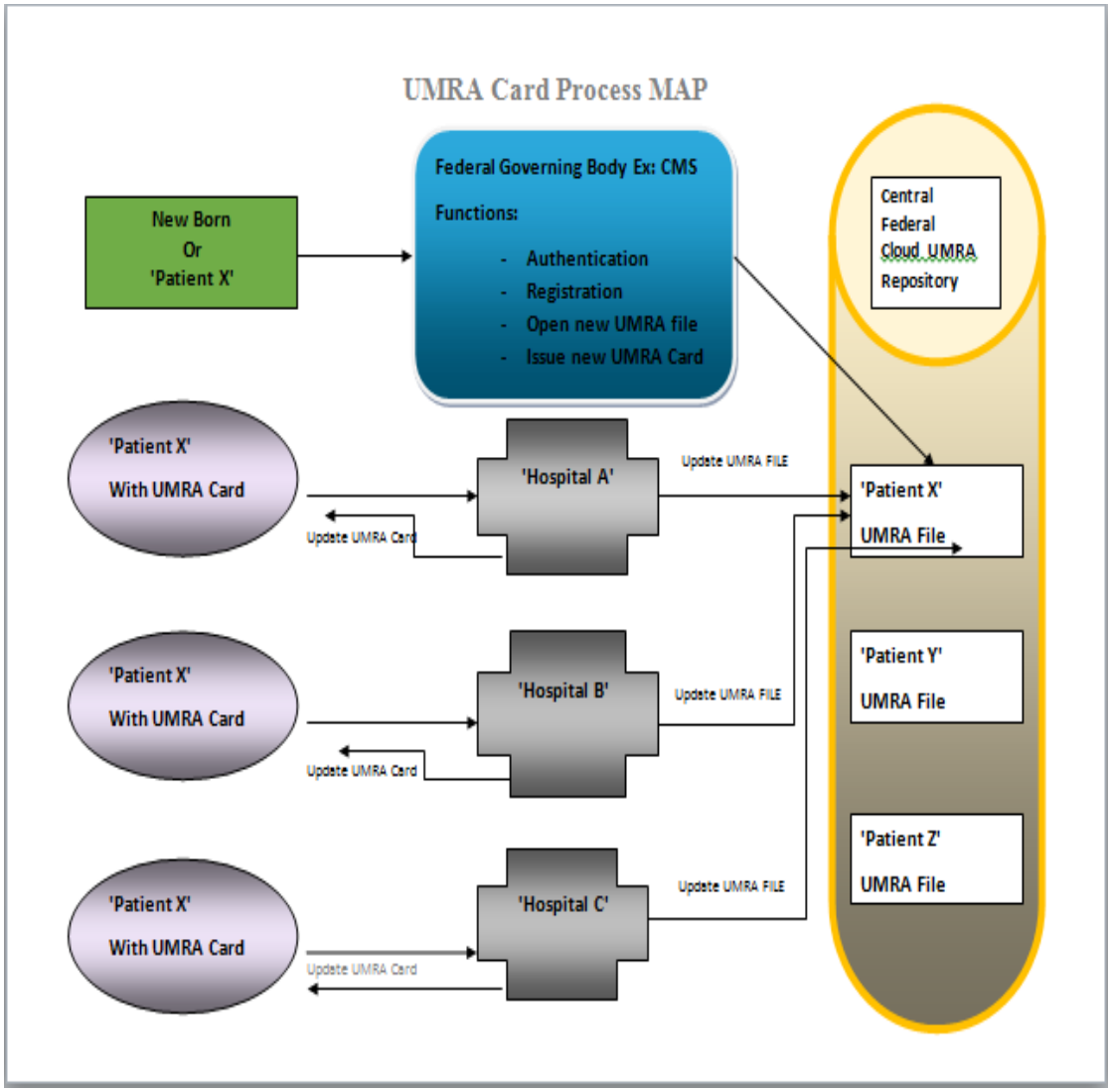

Figure 4: The Overall UMRAA Process Map