# Using Smart Card and Integrated Medical Record System (IMRS) for Improving Health System in Saudi Arabia

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***Abstract***

This paper is concerned to improve the Kingdom of Saudi Arabia health system. This is to integrate the database of the hospitals information, healthcare centers and patient's medical history for reviewing, updating, inserting and booking/making appointments online. The patient's medical history can be extracted from patient's digital identification card or fingerprint of the patient. This promotes organization, efficiency, and convenience and avoids the rate of medical errors, waste of time, money and effort.

***Key words:***

*Healthcare, Integrated Medical Record System (IMRS), Electronic Medical Record (EMR), smart card, Saudi Ministry of Health, Kingdom of Saudi Arabia.*

## 1. Introduction

According to World Health Organization's (WHO) [1] annual assessment, Saudi Arabia ranked 26th of having a progressive health system. Despite this achievement, much remains to be done to meet the demands of a fast-changing society and use the fast-growing advantages of the technology. [2] identifies the factors that is providing facilitation and difficulties. Implementation of electronics system database started in 1988 in Saudi Arabia. This has been adopted successfully by a number of hospitals, but EMR has been inadequate until now in Saudi Arabia. Traditional programs tend to focus on admission and discharge times, rather than on patient care issues. [3] presents current and future EMR user awareness and preferences at seven hospitals in three cities in the west of Saudi Arabia. The purpose of the analysis is to assess whether the preference for health workers for the use of EMR systems varies from category of job to digital record learning. In hospitals there were 480 questionnaires distributed and 333 participants attempted it. The majority of health workers are in favour, irrespective of the hospital they operate, of the use of electronic health records as IMRS. Government take steps to teach and enhance technical aspects of EMRs. This offers a variety of options, such as analysing and comparing different test results and other information, to create an effective framework for data management and to facilitate consistency and rapid solutions that can certainly improve patient health care across interconnected health centres around the world. It is important to use effective EMR software before healthcare can show productive use and economic signals. One of the major threats you face following the introduction of the EMR is the unforeseen cost of software acquisition, training and support. Lack of skills is also a risk, but the program will significantly improve by pre-planning employee feedback and reducing time of making them understand the system by recruiting a specialist. Safety issues that are addressed in this paper are an important reminder to protect patient information from online fraud and other hackers. The main objective of this paper is to determine the efficiency and effectiveness of the program crux, using the experience of only a selection of high and low-level countries as illustrated in the following sections.

### 1.1 CANADA (Electronic Health Record "EMR" or Electronic Medical Record "EMR")

Canada's healthcare industry [4] has reached its peak since it used data base (Electronic Medical Record) to save all necessary medical details of each patient [5] see Figure 1. Each data file is categorized into different medical cases relevant to background viewing and references. [6] The current system has solved previous problems from traditional paper chart recording system which has an intricate and elaborative way of saving and inquiring patient's record. It adds to public convenience for improving the quality of health services, securing safety and privacy, and inculcating health involvement. Though Canada has been utilizing the said system on most provinces, it's capability to exchange and make use of information/file is still being discussed.

Manuscript received March 5, 2020
Manuscript revised March 20, 2020

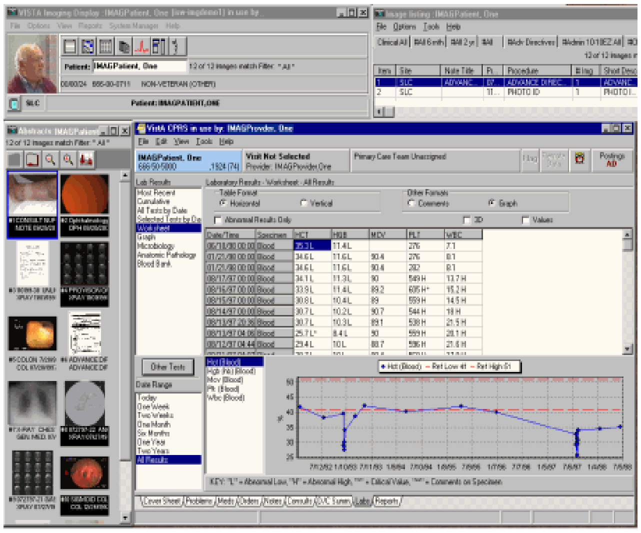

Figure 1. Sample of Electronic Health Record (EMR) **[7]**

### 1.2 BANGLADESH (E-Health System)

The WHO (2003) [8] elaborated e-Health system as vivid evidence of growth of information and communication technology (ICT) website (http://www.emro.who.int/ehealth) a bridge between patients, providers and government, and a tool for constant progress in healthcare services. And Bangladesh has been portraying satisfaction for implementing the e-Health system. [9, 10] Private and public sectors are both taking their part to solve existent problems within health services such as healthcare providers incoordination, and purchasing medicine without proper prescription from professionals. Furthermore, this eradicates millennial system for it boosts the use of e-Health for patient's data and doctor's prescription.

### 1.3 UNITED STATES (Electronic Medical Record)

[11] United States, although equipped with technology struggled to completely perform tasks perfectly as what was expected. However, Electronic Medical Record began to portray the use of communication and technology on advancement of the system.

Even with the progress of EMR, analytics provided Electronic Medical Record Adoption Model (EMRAM) which is composed of seven stages to observe EMR's effectiveness. The first four stages are short of use of computer until seventh where the use of paper and charts are totally eradicated.

[11] Majority of the hospitals in US are implementing EMRAM while the rest are preparing for it. Continual use of this system helps the states to meet public expectations and needs and improves healthcare services.

## 2. Literatre review

Smart card and IMRS analysis- Currently, innovating healthcare condition is one of the focuses of Kingdom of Saudi Arabia and its prominent tool is Electronic Medical Record (EMR) [12] [3]. Despite of collective advantages the Kingdom had, it is still on amidst of fluctuating scenario because of various barriers. [13] Main reasons of this difficulty are loose of communication among providers, English language incompetency and lack of orientation and trainings for the system [2]. Research findings also showed that staff's acceptance of EMR system against paper-based system is not based on how big the hospital is. [2, 3]. Although this system was capable of sharing health information across different organizations, hospitals have been noted with a gradual progress. Investigation revealed that there are a number of reasons leading to poor EMRs in Saudi Arabia. Ministry of Health (MOH) in Saudi Arabia has identified the importance of adopting an information system that will ultimately link all hospitals in the Kingdom. That was what this paper aim for.

Risks, limitations and advantages of the EMR- [14] integrates that quick access and quantity of data available. The main advantages of the EMR are the available data, especially in a very short time. Medical personnel have access to information that could otherwise be ignored and can be effectively filtered by series, date or medication according to the research criteria.

The resulting simplicity and efficiency allow quick methods of linking for example, recorded data to classify pharmacological incompatibilities or conditions that cause recurrence in patients. The EMR helps to prevent medical errors by allowing for a more reliable estimate, for example of the dosage of prescribed drugs; predicts the effects of contact with other drugs; ensures a higher accuracy of Effect calculation like an anesthetic body mass index. Actually, the information given is readable without handwriting problems and easy to interpret because the vocabulary is consistent. Moreover, the EMR encourages and teamwork helps. It allows more than one specific person in a medical database to work on, and not only with members of the medical team, but also with labs and other hospitals thus creating a mega network of specialists. if not properly managed the program can have errors even when the system runs normal without any outside attacks or malware for example, suppose the case of a patient who has been seeking cancer treatment for many years because the procedure referred to an old report without any irregular results, rather than referring the doctor to the last test performed can cause serious life threatening consequences. There is another problem that at the same time there are two medical histories, the one converted to computer based from a paper format and another at the start of the EMR adoption, which means that a patient will have dual reports making it difficult to diagnose the correct one or may mislead/overlooked by the specialist. Presents a case study of the physician [15] who twice claimed that the state of patient health was not severe and returned him back home, but patient died of heart attack in another hospital due to inadequate diagnosis of his medical condition. It than ruled that the medical record be recorded in both the paper and the EMR.

New Studies- Relates numerous episodes of computer-related medical accidents[16] such as in the case where Health and human services EMR software has contributed to the mismanagement of possible medication. The damage caused to patients during EMR use are caused by incorrect prescribing and administration of medications or naive diagnosis due to a lack of information required by the EMR for the correct diagnosis. Acknowledges that new additions into the realm of personal health records [17] would probably contribute to the use of Personal health record, as permission of cross-site information is allowed for multiple applications. Google (Google Health) and Microsoft (HealthVault) introduced an opportunity for consumers to gain access to their newly developed organizational agreements on health information so users can have personal health related technologies. This is a great prospect for both the business community that owns health care institutions and the development of human health monitoring by implementing new technologies to improve human quality of life. Personal health records (PHRs) [18] may enhance patient care. A PHR study has been performed, there it is compared between who agree and who do not. The number of logins and the number of messages sent to doctors is analyzed. 43% of 75 056 patients are using this since 2002. The PHRs were less likely to be used in Black and Hispanic people compared with White. The probability of adopters being adoptive was greater than two comorbidities compared with non-adopters. A strong marketing campaign for PHR registration has almost 3-folded adoptions. [19] introduces a concept which is installed on a modern wearable device. The device outlines many uses, including dietary and physical activity assessment, assistance for people who are blind or visually impaired, sedentary behavior, and elderly person care who are suffering from dementia. This system can also operate with back-end SQL servers so that serious health issues can be tracked live. Although technologies are very reliable in there are code glitches due to cyber-attacks [14] which can leave the system lagging or cause operational errors. Misuse in authority is sufficient to cause system issues, as it can fake EMR records therefore inhibits wrong medical practice on the patient. Another study explains a portable application [20] that uses AR can help with choosing the right medicine using the current health profile by informing the patient its use, side effects and dosage with a simple hovering the phone camera over the medicine package is an effective alternative. With the technique of cloud database, the data is iterated and stored in the servers so It can avoid drug interaction, wrong therapy of taking drugs, the misguidance of doses, side effects and other drug consumption related issues with high accuracy. Other study has developed of a patient reported result collection system and incorporation of findings into a digital medical record file. In documents obtained from program integration sessions, medical experiences and written reviews with physicians, stakeholders and the researchers analyzed statistical data. Five emerging topics were found uncertain There were two obstacles: inexact health gain and Time, efficiency and energy constraints. The compilation of the patient records [22] and statistics analysis can take time and prevent their utilization. researcher tested the programmability in digital medical records of basic clinical formulas for optimization. Manually, clinical computers were analyzed for diagnosis, medical history and evaluation of finding advanced data recovery options from non-structured data sources were listed. Find out that machine learning [23] is used to eliminate diagnostics. An analytical algorithm could extract and analyze information in the health record. Combination with automation of health record help clinical judgment such as computerized warnings or diagnosis deliver focused and accurate details to medical practitioners to enhance clinical decisions. Yet programs for machine learning could also be biased. The question is there is a worry that faults and weaknesses in the information used in machine learning models could lead to medical care societal inequalities. Investigated that the client's prescription information and medical history [24] are found in the digital health records. Due to high level of vital data in medical records, the perpetrators can try to steal it which is a big issue. failure in correct digitalization of records can result in inaccurate prescription or operation.

## 3. Problem Definition

Moreover, health system in the Kingdom in its current form is below the potential quality and efficiency. It does little to promote and maintain people's health before they get sick. Then they have trouble accessing the service and spend too much time in hospitals when they are sick and need health care. The treatment they are given also does not meet the required quality standards or their satisfaction. Current medical field is still facing various drawbacks that has remarkably caused waste of time, money and efforts. These problems include lack of a centralized database on web, and absence of unity between all healthcare centres, failure of recording patient’s identity in emergency cases, waste of time on and repetition of same process, misdiagnosis resulting to wrong medication, difficulties in using EMR system, lack of semi-permanent fast and efficient communication tool between the doctor and patient, and request of same requirements and analysis when transferring to another hospital. Although technologies are very reliable in their current state, but hackers can cause significant implications may leave the system lagging or cause operational errors. The misuse of authority is sufficient to lead to system problems as it prevents and thus inhibits the right medical attention from using EMR and its data. Similarly, naive diagnosis is the major damage done to patients during EMR use because of a lack of information relevant to the correct diagnosis by the EMR. Also, sometimes the patients have dual report, which makes it difficult to identify the correct one. These are some main issues need to be solved in order for this prototype to be implemented.

Saudi Arabia's ministry [25] is provided with e-service, as the government also acknowledges digital medical record importance. This program allows clients to administer medicines by accessing the remote MOH networks from licensed dispensaries. The patient will call the 937 Service Center or use the' Mawid' program to request an e-prescription from the next pharmacy without the need to see a doctor. The response time is a free-of-charge 24/7 operation. In addition, they have an awareness program and online health care tools i.e. BMI Calculator, Calorie Calculator, IBW Calculator and Pregnancy Date Calculator to tell the masses the severity of their health.

## 4. Proposed Solution

The proposed solution focuses on a web application with central database that links all health centers and hospitals information and also for an access of patients' medical files (medical events, basic data, and diagnosis) maintained in a Smart Card. This card is also used for patients' benefit by booking/making appointments on a specific hospital and doctor online. [26] analyzed Smart card in contrast to simple printed cards. Smart cards offer far better safety. The reason for the increased protection in smart cards is because the system's users have access to the smart card. The smart card in the user's hands is vulnerable to cyber-attacks, malicious groups of people or even committed and well-funded rivals making it the best choice for such a sensitive life impacting data. Finger print is also taken in case of ambulatory cases. [27] found out that Percent of Biometric Market by Technology in 2006 have fingerprint biometric at the most widely used method of biometric authentication of 44%. To build the pattern, the technology uses distinctive characteristics from the fingerprints. Such characteristics are called minutiae that incorporate ridge divergences and ridge ends. The blueprint uses only recorded data to define the fingerprints detail and not the entire fingerprint image. This is worth noting, because the information stored in the database can certainly not create an image of the fingerprint thus providing security at the same time to the patient for a specific identity theft by wither the healthcare center or the person in charge of taking data. With a lot of patient records that are needed to be put into the system when EMR software is installed, it gets time consuming to decipher paper documents into the EMR framework. Somebody has to enter it, and health professionals take the potential risk of ensuring that no data is overlooked. The duration of the process is indeed time consuming, but with such a large network of integration, all data is readily available to any health care provider connected to the database. With these progressions the unavertable mismanagement of patient's data is taken care of.

### 4.1 Proposed Solution Goals

The main objective of the proposed solution is to enhance humanitarian message and provide initial endeavour to improve development of health condition in the Kingdom. The proposed solution (integrated web application in medical field) promotes utilization of identification card and finger prints which aims to provide the core idea of Medical Data Bank (Online) for saving files in a card, find solutions for ambulatory cases by taking the patient's fingerprint; facilitate accurate data saving and updates, maximize time; reduce errors in diagnosis and provide appropriate medication to benefit medical research facilities for further studies, adopt the philosophy of total quality, avoid repetition of task during moving between hospitals and booking online in any facility or hospital for a specific doctors available.

## 5. Saudi Arabia of Smart Card and Integrated Medical Record System (IMRS) DESIGN

### 5.1 Model Design

The model is designed according to various solutions and initiatives at various levels, including all aspects of health, to keep people healthy before taking care of them as patients, to ensure healthy people are kept safe and patients are cared for their disease. This allows to handle the symptoms of their disease first. The new model is keen to instil processes and explore experiences. It seeks to use resources wisely and effectively, and to make the most of technology and cutting-edge products. (https://www.moh.gov.sa/en/Ministry/vro/The-New-Model-of-Care/Pages/FAQs.aspx)

5.2 System Architecture And Program Flow

ASP.NET environment and SQL are used on implementing the system and transform all of the diagrams to real functions and virtual interfaces to real web pages which interact with users and connect with database. See Figure 2 for more detail.

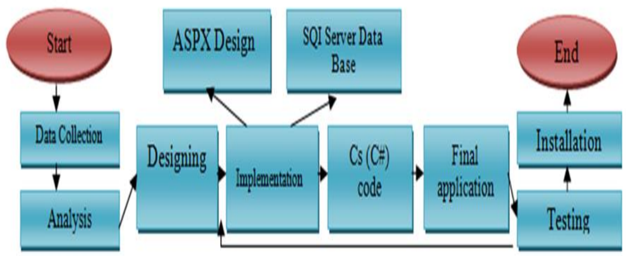


Fig. 2 Work Flow Diagram

## 6. Deployment Diagram

The illustration is a static view of the run-time configuration of hardware elements (nodes) and shows how software elements and artifacts are mapped onto them. See Figure 3 and figure 4

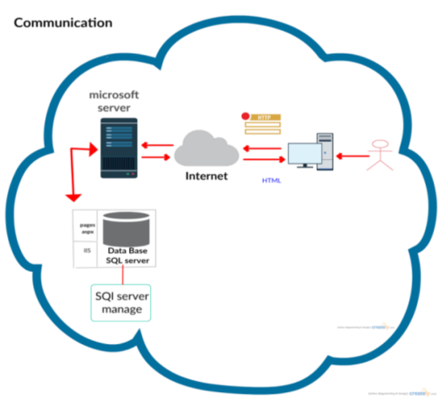


Fig. 3 Deployment Diagram

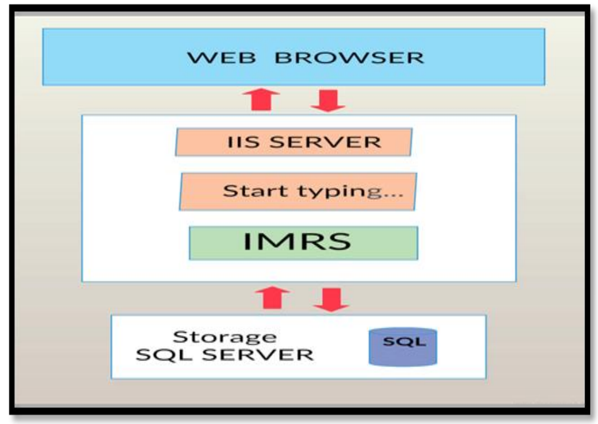


Fig. 4 Deployment of all System Diagram

Figure 5, Illustrates the data transmission and system interactions with all the clients. The iterations in patient records are performed in the database through the IMRS.

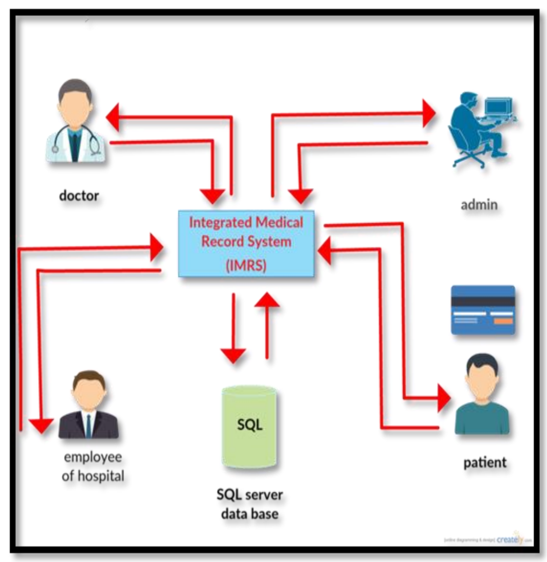


Fig. 5 System and Clients Interaction Diagram

## 7. Results

The results below illustrated some of the system's interfaces, which were built in several stages: planning, analysis, design, testing and implementation.

7.1 Outcome

Surveillance has been put on the system to see how the software works with the built-in algorithm. Card and finger biometry, as expected, provides the security intended, most importantly security from identity theft and data theft for malicious activities. In the same way, the website provides easy navigation of data stored on SQL servers. This is iterated successively to update patient records. The most unforeseen benefit observed is the system's autonomous control, as it monitors patient records with continuous update and informs the severity of their health conditions. The algorithm has a solid foundation, and the only issues that need to be resolved by the administration are the use of the platform, mostly in elderly people who are illiterate with computer machines. Some other problems that may occur are the loss of a smart card, in which case the user is advised to contact the administration to disable the card in case it goes into the wrong hand. By simply reviewing the patient's files / reports, the doctor has a high chance of detecting and curing the severity of the problem. Consumer health profiles have never been taken into account when purchasing the drug either by him or by someone else. As a result, the end users of the medications are faced with various health consequences. People do Self-medication which is the use of drugs by individuals or family members to treat self-recognized or self-diagnosed illnesses or disorders. When someone uses self-medication, he or she is unaware of proper therapy, appropriate dosage, drug interaction and may therefore pose a serious risk. The continuous data monitoring of patients has helped monitor their allergies and has helped doctors administer the correct drug and dosage rates.

### 7.2 Smart Card

Figure 6 demonstrates the visual presentation of smart card for specific patient. When a doctor or a patient smart card is inserted into the card authorization device, the key exchange authentication between the card and the server database is carried out at the back end. The card access PIN is then requested from the card owner and the entered PIN is checked by the smart card itself.


Fig. 6 Smart Card

### 7.3 Welcome Page

It shows to the user, a welcome message and short information about the site. Also shows all the services that the user can do in the navigation panel. Figure 7 shows the welcome page of the site first encountered by the user.


Fig. 7 Welcome Page Interface

### 7.4 Login Page

Authenticated users can enter their credentials to sign in the site and use all services embedded.

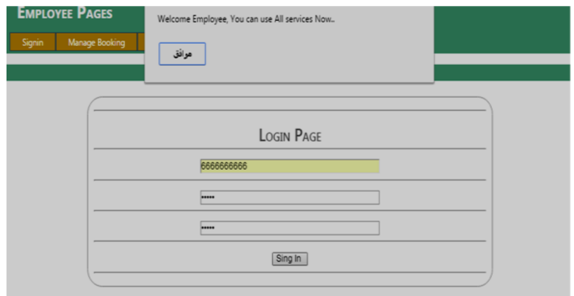


Fig. 8 Log in Page Interface

### 7.5 Search Page

Users can observe all the search results and request any healthcare establishment by just navigating to the Search bar and typing specific name of city or name of the hospital.


Fig. 9 Search Page Interface

### 7.6 Sign Out Page

For security purposes and also accomplishing one of the objectives of this paper, user is requested to sign out from site after he finished his work otherwise the site will not close on its own.

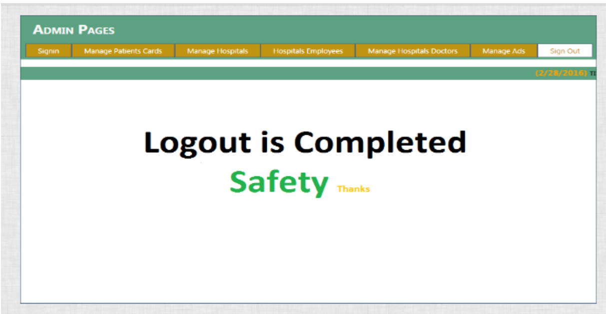


Fig. 10 Sign out Page Interface

### 7.7 Contact Page

This page for shows some information about the system or contact information of the admin which will allow suggestion or issue about site. The contact page as with all proper websites, have contact details of the administration (providing physical location of technical department, their phone numbers, email and fax) in case of any error in application or any other software usage complication and security.


Fig. 11 Contact Page Interface

## 8. Discussion

The Integrated Medical Record System can help the Ministry of Health to offer effective health care services throughout the kingdom in a smooth manner, by allowing all the hospitals in the Kingdom to communicate and use available information about patients through the website, anywhere and at any time. On the other hand, the patients would benefit from the system by using the smart card with unique number for availing the services from the hospitals without needing to undergo tests again while changing the health care center or location. IMRS has been developed to help health care providers to identify patients in emergency situations accurately and efficiently. ASP.NET along with SQL server database has been used to develop the IMRS system. Despite all these benefits of the system, its implementation needs a lot of efforts and it is already a challenge. Awareness of the public in taking care of their cards and to use only when visiting hospitals, training of medical staff and administrative and patience if the system implementations one by factors of success.
Coming to the front end of system, when provided smart card is inserted into the card authorization unit the key exchange authentication between the card and the server database, is performed at the back end. This adds to the safety of the user and provides a strong barrier between a potential identity theft and leak of personal data. Finger print is also taken in case of ambulatory cases which is again uses the technology that takes distinctive characteristics from the fingerprints, called minutiae. This makes the information stored in the database certainly not to create an image of the fingerprint, which ensures the patient's security simultaneously for a specific identity theft by the health care center or the data collector. Moving towards the site which actually is visible to the user, here only authenticated users can enter their login credentials and use all entrenched services. All search results are available to users and any health care facility can be accessed only by navigating to the search bar and choosing the city or hospital name. For safety reasons and in order to achieve one of the purposes of this article, users are requested to sign off after their work has been completed.

## 9. Conclusion

This short paper developed an integrated medical record system (IMRS) for the implementation of hospital services in Saudi Arabia in low cost in ministry of health. The system accepts the smart card of the patient and registers all patient history and also Connecting all the hospitals to each other’s with Central database system, thus each patient has one unique file. The doctor does not need to repeat the tests in cases of emergencies and accidents, he can view the patient’s medical history through the patient's E-medical file. The IMRS can be used to check the patient who is unconscious by taking a fingerprint to view his E-medical file and see his blood group, medical history, medications he takes, which make fast analysis of the severity of the patient. A lot of effort is put in this system for its proper implementation and the obvious result is the security considerations that are made such as smart card, special biometric fingerprint identification and authorized user site login credentials to name a few.

## References


[1] M. Almalki, G. Fitzgerald and M. Clark, "Health care system in Saudi Arabia: an overview," Eastern Mediterranean Health Journal, 2011.

[2] R. Hasanain, K. Vallmuur and M. Clark, "Progress and Challenges in the Implementation of Electronic Medical Records in Saudi Arabia: A Systematic Review," Health Informatics - An International Journal, 2014.

[3] R. A. Hasanain, K. Vallmuur and M. Clark, "Electronic Medical Record Systems in Saudi Arabia : Knowledge and Preferences of Healthcare Professionals," Journal of Health Informatics in Developing Countries www.jhidc.org, 2015.

[4] Nupge.ca, "Canada overwhelmingly supports public health care," 13 August 2009. [Online]. Available: https://nupge.ca/node/2486. [Accessed 2 2020].

[5] T. D. Gunter and N. P. Terry, The emergence of national electronic health record architectures in the United States and Australia: Models, costs, and questions, 2005.

[6] Top Mobile Trends, "Mobile Tech Contributions to Healthcare & Patient Experiences," 22 May 2014. [Online]. Available: topmobiletrends.com/mobile-technology-contributions-patient-experience-parmar/. [Accessed January 2020].

[7] T. Rowland, "8 Countries Doing Electronic Health Records Right," 3 April 2012. [Online]. Available: https://blog.soliant.com/healthcare-news/8-countries-doing-electronic-health-records-right/. [Accessed January 2020].

[8] M. R. Hoque, M. F. A. Mazmum and Y. Bao, "e-Health in Bangladesh: Current Status, Challenges, and Future Direction," The International Technology Management Review, 2014.

[9] N. Ikhu-Omoregbe, "DESIGNING E-EDUCATION SUPPORTS IN E-HEALTH BASED SYSTEMS," Turkish Online Journal of Distance Education-TOJDE July 2008, vol. Volume: 9 Number: 3 Article 11 , July 2008.

[10] T. Gerber, V. Olazabal, K. Brown and A. Pablos-Mendez, An agenda for action on global e-health, 2010.

[11] Adam wolfe ; Farrington Ryan, "Maximizing Electronic Medical Records: The Electronic Medical Record Adoption Model and the Health-System Pharmacist," pharmacytimes, 20 05 2016. [Online]. Available: https://www.pharmacytimes.com/publications/health-system-edition/2016/May2016/Maximizing-Electronic-Medical-Records-The-Electronic-Medical-Record-Adoption-Model-and-the-Health-System-Pharmacist.

[12] S. Mitchell and U. Yaylacicegi, "Analysis of Electronic Health Record Implementation and Usage in Texas Acute Care Hospitals," in 2012 Proceedings of the Conference on Information Systems Applied Research New Orleans Louisiana, USA, Wilmington Wilmington, NC 28403, USA, 2012.

[13] A. Alkraiji, T. Jackson and I. Murray, "Barriers to the widespread adoption of health data standards: An exploratory qualitative study in tertiary healthcare organizations in Saudi Arabia," Journal of Medical Systems, 2013.

[14] V. L. Raposo, "Electronic health records: Is it a risk worth taking in healthcare delivery?," GMS health technology assessment, 2015.

[15] D. S. Rohlman, W. K. Anger, P. J. Lein, G. a. Jamal,. McDevitt, T. M. Macdonald, I. Loubinoux, D. Tombari, X. Franceries, E. Cassol, O. Rascol, J. Lundberg, R. Mcconnell, E. Delgado, Y. Nishiwaki, K. Maekawa, Y. Ogawa, N. Asukai, M. Minami, K. Omae, D"A double-blind trial of bupropion versus desipramine for bipolar depression," Journal of Clinical Psychiatry, 1994.

[16] P. Liability, E. Health and R. Systems, "E-HEALTH HAZARDS : PROVIDER LIABILITY AND ELECTRONIC HEALTH RECORD SYSTEMS Sharona Hoffman and Andy Podgurski Case Research Paper Series in Legal Studies," Social Science Research, 2009.

[17] J. S. Kahn, V. Aulakh and A. Bosworth, "What it takes: Characteristics of the ideal personal health record," Health Affairs, vol. 28, no. 2, pp. 369-376, 3 2009.

[18] C. K. Yamin, S. Emani, D. H. Williams, S. R. Lipsitz, A. S. Karson, J. S. Wald and D. W. Bates, "The digital divide in adoption and use of a personal health record," Archives of Internal Medicine, vol. 171, no. 6, pp. 568-574, 28 3 2011.

[19] M. Sun, L. E. Burke, Z. H. Mao, Y. Chen, H. C. Chen, Y. Bai, Y. Li, C. Li and W. Jia, "Ebutton: A wearable computer for health monitoring and personal assistance," in Proceedings - Design Automation Conference, 2014.

[20] E. Zhu, A. Lilienthal, L. A. Shluzas, I. Masiello and N. Zary, "Design of Mobile Augmented Reality in Health Care Education: A Theory-Driven Framework," JMIR Medical Education, vol. 1, no. 2, p. e10, 18 9 2015.

[21] C. A. Harle, A. Listhaus, C. M. Covarrubias, S. O. Schmidt, S. Mackey, P. J. Carek, R. B. Fillingim and R. W. Hurley, "Overcoming barriers to implementing patient-reported outcomes in an electronic health record: A case report," Journal of the American Medical Informatics Association, vol. 23, no. 1, pp. 74-79, 2016.

[22] C. Aakre, M. Dziadzko, M. T. Keegan and V. Herasevich, "Automating clinical score calculation within the electronic health record: A Feasibility Assessment," Applied Clinical Informatics, vol. 8, no. 2, pp. 369-380, 2017.

[23] M. A. Gianfrancesco, S. Tamang, J. Yazdany and G. Schmajuk, Potential Biases in Machine Learning Algorithms Using Electronic Health Record Data, 2018.

[24] B. L. Radhakrishnan, A. Sam Joseph and S. Sudhakar, "Securing Blockchain based Electronic Health Record using Multilevel Authentication," in 2019 5th International Conference on Advanced Computing and Communication Systems, ICACCS 2019, 2019.

[25] Ministry of Health – Kingdom of Saudi Arabia, "Ministry of Health," 2020. [Online]. Available: https://www.moh.gov.sa/en/Pages/default.aspx. [Accessed 2020].

[26] H. Taherdoost and N. Jalaliyoon, "Smart Card Security ; Technology and Adoption," Neda Jalaliyoon International Journal of Security, 2011.

[27] D. Laux, "A study of biometric authentication adoption in the credit union industry," 2007.