

An International Review and Study on Perceptions of Security, Adoption, and Implementation of Electronic Health Records

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ABSTRACT

The transformation of the healthcare system has generated volumes of electronic data available to patients, healthcare workers, and researchers. Personal health information is paramount to the success of implementation of electronic health records (EHRs). Adoption and implementation of EHRs has been strong in the United States of America (USA) and yet varies among countries in the world. This study seeks to determine the factors that individuals, particularly those outside of the USA deem important when considering providing information for EHRs. Survey results indicated that intent of international citizens to provide personal health information depends on more on trust, risk, privacy, and perceived benefits. The outcome from this study can be helpful for other countries and organization seeking to create, establish, or augment an EHR system.

Keywords: International, electronic health records, security, healthcare information technology

1 INTRODUCTION

The aim of healthcare organizations is to provide patients with utmost patient care. EHRs have

been proven to be interactive as it helps with proper documentation of medical history with up to date information. An EHR is the systematized collection of patient and population electronically-stored health information in a digital format.

(Gunter 2005). More specifically EHRs can be defined as digitally stored healthcare information throughout an individual's lifetime with the purpose of supporting continuity of care, education, and research (Ajami, 2013b). EHRs consists of multiple types and ranges of data such as lab reports, x-rays, photographs, chart, drugs administered, measurement of patient progress, and even audio of note dictations. Over the last 27 years huge advances in information technology (IT) and particularly in the areas of health, various forms of electronic records have been discussed, designed or implemented (Ajami 2013a, Cuk, Wimmer, Powell, Rebman, 2018).

The use of EHR's are now widespread, transforming the healthcare sector, delivering top notch service to patients with emphasis on patients' health and well-being. (Cuk et al, 2018; Wheatley 2013) The EHRs have 8 major functions which are; health information and data, result management, order management, decision support, electronic communication and connectivity, patient support, administrative processes and reporting population health (Woo 2013).

EHR technology made patients information easily accessible as records became portable and comprehensive. In addition, proponents proclaimed how EHR and Health IT would offer the following benefits; increased quality of healthcare, reduction of medication errors, improvement of patient health outcomes, reduction in health disparities, cost savings, improved patient safety, and augmented chronic disease management (Bowens 2010).

Patient care and satisfaction are what many health organizations offer their clients and EHR are one tool providers can use to achieve that goal (Cuk, Wimmer, Powell, 2017). Old EHR systems used manual paper-based data entry and were used to gather information for research and administrative purposes. The EHR records were not easily accessed and readily available to a large number of users. This caused a lot of delays in processing, updating, and utilization of records. In terms of security, these EHR systems were not that secure preventing unauthorized access and limiting scope of access (Cuk et al., 2018).

The implementation of EHR technology comes with challenges that include patient privacy and security, errors in data capture, errors in data interpretation, and legal and technology compatibility costs with current design of EMR systems (Palabindala et al., 2016, Sittig and Singh, 2011). Patients in general are wary of how

their data is used and shared for research and development purposes (Bresnick 2018).

This study examines privacy, confidentiality and security with EHR systems and investigates patient's perceived security of online medical records, particularly of international patients. The format of this study is as follows. First is a discussion of a relevant literature followed by methodology discussion and test results. The manuscript concludes with results, limitations, and future research.

2. LITERATURE REVIEW

History and Evolution of Electronic Health Records

The concept of the EHR needs to be fully absorbed by physicians and the general public. The term EHR has been used in recent healthcare literature without a proper definition of its structure, usage and effect on the healthcare industries. Häyrynen et al. (2008) Investigated the structure of the EHRs as a whole. The objective was to find out how these records are being used, in what context and who has access to these records. A literature search was conducted on healthcare databases to discover the content of EHRs. The results showed that the EHRs consists of various types of data systems in various forms and they were used across all forms of healthcare from primary to tertiary. The information in the EHRs are recorded by different types of healthcare professionals and some by the patients but usually authorized by physicians.

Fragidis and Chatzoglou (2018) examined best practices for implementing EHR systems across 13 countries. Countries participating were largely European complimented by the US, New Zealand, and South Korea. Authors state it is important to consider each country's health system as well as their system of reimbursement and payment. The administrative and bureaucratic structure is also an important consideration. The primary contribution is valuable input from experts in the aforementioned countries who explain challenges and barriers to EHR adoption (Fragidis & Chatzoglou, 2018).

Types of Electronic Health records

Patient's perceived access to their personal health information is an issue of utmost concern, although effective communication between healthcare providers and patients lead to high – quality healthcare service, in the past this has been done in person or over the phone. But with the introduction of IT, patients can now communicate with healthcare providers

electronically and hold meetings or schedule appointments online (Baratam, Abdul, & Powell, 2020). Both patients and healthcare providers make use of a computer on a daily basis, either for personal or business reasons.

Hassol et al. (2004) Described the use of a linked web messaging which is linked to a patient's EHR to schedule appointments with healthcare providers, making a seamless communication between healthcare providers and patients. This study conducted an online survey of 4,282 members of the Geisinger health system who are registered users of the My Chart app, an app which makes patients communicate with their healthcare providers. A survey of focus groups was also conducted with 25 patients who are active users of the system. Age groups of users ranged from 18- 65 and older. Results were analyzed based on user satisfaction, ease of use, communication preferences and accuracy of patient EHR. On a scale of 1-100, most users indicated the system was easy to use with mean scores ranging from 78-85, users indicating how meaningful their medical records were ranged with mean scores between 65 -85. A small number of users were worried about the confidentiality of their health records or abnormality with their records. In conclusion, according to this study, patient's attitude towards the use of web messages and online EHR were positive.

There is on-going research on how patients view EHR and how this affects healthcare organizations. Many individuals have been affected by health information breaches over the years, and cases of data breaches in the healthcare industry and has a cost of about \$5.6 billion per year (Millman 2014). According to the UIC health blog, 1 in 3 Americans have experienced some form of data breach in their healthcare records last year (Landi, 2020). Healthcare records can be accessed through the desktop and mobile devices making these records more vulnerable to attacks. These attacks came from various sources, hacking, theft, loss, improper/un-authorized access and un-professional data disposal. As most healthcare providers now adapt the EHR technology, the consumers (patients) are left with no choice than to familiarize themselves with the technology. But the worries that come with the security of patients' EHR make the acceptance of this technology slow. Most consumers have different fears about the security of their EHR, for example the fear of identity theft, personal information leaked online; especially for high dignitaries, the

risk of employers knowing about their sensitive health issues amongst others may arise.

Reasons for disclosing Health records.

The need to disclose health records is important Bansal and Gefen (2010) Discussed the effect of patients disclosing their personal health information online with the sensitivity, privacy and trust concerns patients have towards their records being available online. All of which could be traced to personal characters and traits, information sensitivity, health status, experience and risk beliefs that fill in for trust. The unwillingness to provide health information by patients can hinder the implementation of online healthcare services. Most patients are concerned on how their health information is being used and accessed online. The privacy of their sensitive health information is of major fear as the internet can easily be accessed by anyone from anywhere. But on the other hand, patients must disclose their personal health information in order to receive proper care, the issue of this privacy might make some patients refuse healthcare in extreme cases.

Patients concern on Security of EHR's

The loss of information has been a problem due to changes in technology used in health care. A lot of analysis has been done to make health information accessible to various healthcare providers without conflicting patient's perception on confidentiality and autonomy. Cases of patient's information being stolen, lost, misplaced or released without authorization were reported in the UK, with 186 data breaches being reported at the department of health between July 2011 and June 2012 (Caldicott, 2013).

Papoutsi et al. (2015) examined views from patients and the public about information sharing and the concerns it raises about the security and privacy of EHR's used for providing healthcare. A cross sectional survey was conducted, with focus group discussions, the survey participants were gotten from primary and secondary care settings, a total of 5,331 participants were recruited but 2761 participants were used for final analysis in this research. Survey results showed that 79% of participants are worried or have concerns over the security of their health records if it was a national EHR system, 71% were of the opinion that the National Health System (NHS) cannot provide EHR safety at the time of the survey. The population sample that worried about the security of data supports the development of EHR, but 12% didn't support and 33% were wavering. The issue of integrated EHR's raises worries on the

security risks linked with the system, hence the need for a proper recognition of the EHR by the public and the creation of dependable security technique for sharing health data.

Agaku, Adisa, Ayo-Yusuf, and Connolly (2013) evaluated the perception of adults in the US towards the security of their health information. The need to protect patient's data is imminent as most patients express fear over the loss or mismanagement of their health records, with the rise in data breaches being reported annually. This study examined the fourth wave in the first cycle of the health information national trends survey, this was done to determine respondents concern about personal health information breaches.

With the inception of new technological advancements, like cloud-based services, and file sharing apps, health information becomes more vulnerable and exposed to risks, due to the rate and volume at which information can be shared. At times, patients may authorize the disclosure of their health information unknowingly which makes them feel violated when they hear about it. Health laws like The Health Insurance Portability and Accountability Act of 1996 (HIPAA) have laws where a patient's health information should not be disclosed without proper authorization from patient. However, patient's notion about health records security has not been deeply explored, and its effect on relationship between their healthcare providers. From the survey, it was discovered that people had concerns about data breaches when there is a transfer of health records between healthcare providers, by fax 67%-69% , electronically 64.5-67% and 12% -13 % did not disclose their Personal health information due to security , because they did not have an idea on how their records were being used. A multivariable logistic regression was used to evaluate the effect of security and privacy concerns on divulging personal health information to healthcare providers.

Fernández-Alemán, Señor, Lozoya, and Toval (2013) documented the findings from a systematic literature review on the security and privacy of EHR. The use of paper-based health records caused a lengthy paper trail, hence the need to move to EHR is inevitable. The benefits of an EHR are so numerous, especially when they are integrated, there is a huge reduction in costs, improved quality of care and an efficient record keeping. All of these benefits are based on the EHR's ability to meet some standard requirements, an effective EHR should be resilient to failure and be consistent with data integrity.

The implementation of the EHR system has been hindered by patient's attitude, funding, organizational aspects and technology. A systematic literature review was carried out and data was extracted from 775 articles using a predefined search string, the data sources were from articles found in the ACM digital library, IEEE, science direct amongst others. The results showed that out of 49 articles selected, 26 used standards relating to privacy and security of EHR data. The HIPAA and the European data protection directive were the most widely used regulations, some articles discussed symmetric and asymmetric key schemes, 13 used a pseudo anonymity technique while 11 articles introduced the use of digital signature scheme rooted in public key infrastructure and 13 introduced a login/password with digital certificate or PIN for authentication. Some access control appeared to be role based as seen in 27 studies, 10 explained who should define HER system roles, and 11 discussed who provides access to EHR and some suggested access policies should be over ridden in emergency situations.

3. RESEARCH QUESTIONS

Implementation and adoption of EHRs quite well in the United States and varies in other countries. This study sought to examine and determine what perceptions might have influence against adoption of EHR by international citizens. The factors of privacy, security, trust, and perceived benefits were examined.

Privacy was defined as the right individuals have to withhold information about themselves from being leaked to others. Clinical information is considered private and should be protected, it could be in form of treatment, test results, diagnoses that can be stored on various media where patient's identity cannot be confirmed. This data should be released only with the patient's permission or law, physicians can however gain access to this information for treatment and other administrative purposes. To preserve confidentiality, only authorized individuals should access this information.

Information security on the other hand is the safe guarding of data Confidentiality, integrity and availability. The HIPAA and HITECH also enforce the protection of health data, with serious consequences for violations. The need to secure EHR's are due to the increased use of various technological devices most of which are mobile. Data exchange between different health organizations also poses a threat to EHR's It was discovered that healthcare providers often text other providers about work, the security of this

messages are of huge concern; as the level of detail in this information exchange could be ambushed. An encryption of devices used to exchange health information is valuable, also awareness programs should take place to educate users of EHR's on the threats in the system. The use of audit trails to monitor those who have access to patient information.

Trust is the understanding that the data shared will be used for the intended purpose and by only those authorized individuals. Perceived benefits are the gain in individual health and quality of life by the sharing of an EHR.

4. METHODOLOGY

A structured survey was utilized, a questionnaire was used as a measure to gather data. The questionnaire had 12 sections. The first section was designed to collect demographic data from the participants, data relating to educational level, age, gender, and race and job field. The other sections had relating to the factors affecting an individual's perception on the security of EHRs and their intent to disclose sensitive health information to healthcare providers.

The survey had 42 questions and respondents could access via their phones or desktops. The survey is available upon request. The survey tool was acquired from existing constructs and was revised for the purpose of this paper. Six questions were used to measure Risk and the constructs were acquired from Bansal and Gefen (2010) and Malhotra et al. (2004). The questions measuring trust (one question) was adapted from Bansal and Gefen (2010) and (five questions) from Malhotra et al. (2004) to reveal the extent of trust patients have in EHRs. Also, the one (1) item measuring privacy was adapted from Bansal and Gefen (2010), one (1) item used to measure intent to disclose was adapted from Bansal and Gefen (2010) to develop the construct Intention to disclose. To know how much individuals are concerned about the privacy of their information one item was adapted from Bansal & Gefen, 2010, to develop the construct Privacy. Most users are also concerned and want to know how beneficial the EHR's are to them, therefore 3 items were adapted from Ng, Kankanhalli, and Xu (2009) to develop the construct perceived benefits.

The population of this study was built for international students at Georgia Southern University. The survey was delivered via an online survey tool called Qualtrics. The study is an IRB approved study and a factor analysis was used to

select significant variables that was used in the analysis.

On an average it took respondents 10 minutes to completely answer all questions in the survey. A total of 44 validated copies were collected, in the distribution 43% were male and 54% were female, and the age range of the participants were from 18-50 years old. Most of the respondents were graduate students and some were faculty members at the university. Most respondents held a bachelor's degree or above.

5. RESULTS

The dataset had 6 survey constructs and each construct had at least one question measuring patients perceived security of EHRs. These constructs are Demographics, Risk, Perceived Benefits, Trust, and Privacy. Intention to Disclose, which is a derivative of perception of EHRs (DEPENDENT VARIABLE) that depends on trust, risk, privacy, perceived benefits.

Linear regression was conducted with SPSS, with all the variables included. The intention to disclose, which the dependent variable, is had three questions which were all analyzed using the factor analysis, all variables that loaded more than 0.5 were considered significant and were used in the linear regression analysis. During the factor analysis, ITD2, had the highest score of 0.7 compared to ITD1 and ITD3. Factors that loaded less than 0.5 were removed from the analysis. For the independent variables used in this analysis, the following variables loaded more than 0.5 and were used in the analysis: PB3, T1, T2, T3, T4, T5, PL1, PL2, R3, R4, R5.

The Output of a linear Regression Analysis is in SPSS produces some tables, but two tables are of major concern; The Model Summary and the Anova. During the first set of analysis all constructs were included with "Intention to disclose" (ITD2) as the dependent variable and the other constructs mentioned above as the independent variables. The analysis generated results that are explained as follows:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.887 ^a	.786	.573	.916

a. Predictors: (Constant), PL2, T3, PB1, R3, T1, PB3, R1, T5, P1, R6, T2, R5, R4, PL3, PL1, T4

The Model Summary – This table shows the R, R square and adjusted r –square and the standard error of the estimate. The R value shows the simple correlation between the observed and

predicted values of the dependent variable. The R square which is known as the co-efficient of determination is 0.786, this explains that the regression modeled ITD2 (Intention to disclose 2) strongly as 78.6% of the variation in ITD2 is explained by the independent variables.

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	49.472	16	3.092	3.682	.006 ^b
	Residual	13.437	16	.840		
	Total	62.909	32			

a. Dependent Variable: ITD2

b. Predictors: (Constant), PL2, T3, PB1, R3, T1, PB3, R1, T5, P1, R6, T2, R5, R4, PL3, PL1, T4

ANOVA shows the how well the regression equation fits the data, it predicts the dependent variable, in this analysis, the regression model predicts the dependent variable properly. Statistically a p value is a number between 0 and 1, and typically a p value that is < 0.05 indicates a strong evidence against a null hypothesis, but a p value of > 0.05 indicates a weak evidence against the null hypothesis. The p value here which is stated in the sig. section of the ANOVA table is 0.006, which indicates a strong support from our declared alpha value for the analysis.

6. DISCUSSION

The international survey respondents indicated that when risk was low, they were more willing to trust the EHR system, and thus more willing to disclose information. Thoughts and concerns for privacy were also quite high and when satisfied respondents were not as concerned with potential error loss. Survey participants did indicate a difference between health privacy and overall internet privacy. Respondents did not consider their own health condition to be a strong enough factor to adopt nor did they indicate they could be influenced by social norms. Perceived benefits of the EHR also played a strong role in willingness to disclose. Familiarity with EHRs neither detracted nor supported the respondent’s decision.

This study had several limitations. First, it utilized international college students as surrogates for international decisions. Students are generally younger and in better health than the average international patient. The sample size was small and could not account for differences in countries. Many reports have indicated various levels of adoption among countries so results from this study might not be as generalizable. Future research should replicate this study with separate populations from specific countries. Additionally, future work will look at theoretical models which employ structural equation modeling.

7.CONCLUSION

The healthcare sector has experienced many advances in terms of patient’s recordkeeping and welfare. This study sought to aid the health organizations on how to implement the EHR in health institutions. As most patients struggle with providing healthcare information due to increase in healthcare data breaches an analysis was been carried out and from results it can be concluded that what motivates patients to provide their sensitive health information to health providers are includes trust, risk, privacy and perceived benefits. Even though the EHR is fully utilized and mandatory in the US, it is still in its developing stage in countries like Nigeria, Bangladesh and India. This study can help countries who wish to pursue the adoption of EHR. The social implications point what factors influence trust and behavioral intentions to disclose information online. These factors can be considered when enlightening patients on the use of EHRs.

8. REFERENCES

Agaku, I. T., Adisa, A. O., Ayo-Yusuf, O. A., & Connolly, G. N. (2013). Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. *Journal of the American Medical Informatics Association, 21*(2), 374-378.

Ajami, S., & Arab-Chadegani, R. (2013a). Barriers to implement electronic health records (EHRs). *Materia socio-medica, 25*(3), 213.

Ajami, S., & Bagheri-Tadi, T. (2013b). Barriers for adopting electronic health records (EHRs) by physicians. *Acta Informatica Medica, 21*(2), 129.

Bansal, G., & Gefen, D. (2010). The impact of personal dispositions on information sensitivity, privacy concern and trust in disclosing health information online. *Decision Support Systems, 49*(2), 138-150.

Baratam, S. S., Abdula, C. & Powell, L. (2020). health-related mobile applications for smart devices on insurance providers: aiding customer retention. *Issues of Information Systems. 21*(1), 30-36.

Bowens, F. M., Frye, P. A., & Jones, W. A. (2010). Health information technology: Integration of clinical workflow into meaningful use of electronic health records. *Perspectives in health information management, 7*. Retrieved

- from
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2966355/>
- Bresnick, J. (2018). Are Universal EHRs Key to Healthcare Value, Trust, and AI Adoption? *HealthIT Analytics*, Retrieved from <https://healthitanalytics.com/news/are-universal-ehrs-key-to-healthcare-value-trust-and-ai-adoption>
- Caldicott, F. (2013). Information: To share or not to share. *Information Governance Review*, Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/192572/2900774_InfoGovernance_accv2.pdf
- Cuk, S., Wimmer, H. & Powell, L. (2017). Problems associated with patient care reports and transferring data between ambulance and hospitals from the perspective of emergency medical technicians. *Issues in Information Systems*. 18(4), 16-26.
- Culk, B., Wimmer, H. Powell, L. & Rebman Jr., C. (2018). Electronic emergency medical technician reports – testing perceptions of a prototype. *Issues in Information Systems*. 19(3), 81-91.
- Fernández-Alemán, J. L., Señor, I. C., Lozoya, P. Á. O., & Toval, A. (2013). Security and privacy in electronic health records: A systematic literature review. *Journal of Biomedical Informatics*, 46(3), 541-562.
- Fragidis, L. L., & Chatzoglou, P. D. (2018). Implementation of a nationwide electronic health record (EHR). *International Journal of Health Care Quality Assurance*, 31(2), 116-130.
- Gunter, T. D., & Terry, N. P. (2005). The emergence of national electronic health record architectures in the United States and Australia: models, costs, and questions. *Journal of Medical Internet Research*, 7(1), e3. Retrieved from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550638/>
- Hassol, A., Walker, J. M., Kidder, D., Rokita, K., Young, D., Pierdon, S., Ortiz, E. (2004). Patient experiences and attitudes about access to a patient electronic health care record and linked web messaging. *Journal of the American Medical Informatics Association*, 11(6), 505-513.
- Häyrynen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *International Journal of Medical Informatics*, 77(5), 291-304.
- Hur, H., Lee, S. R., Xuan, Y., Kim, Y. B., Lim, Y., Cho, Y. K., & Han, S. U. (2012). The effects of helicobacter pylori on the prognosis of patients with curatively resected gastric cancers in a population with high infection rate. *Journal of the Korean Surgical Society*, 83(4), 203-211.
- Kose, I., Rayner, J., Birinci, S., Ulgu, M. M., Yilmaz, I., & Guner, S. (2020). The adoption level of electronic health records in Turkish hospitals and the relation with hospital sizes. Retrieved from <https://assets.researchsquare.com/files/rs-8500/v1/manuscript.pdf>
- Landi, H. (2020). Number of patient records breached nearly triples in 2019. *Fierce Healthcare*. Retrieved from <https://www.fiercehealthcare.com/tech/number-patient-records-breached-2019-almost-tripled-from-2018-as-healthcare-faces-new-threats>
- Malhotra, N. K., Kim, S. S., & Agarwal, J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model. *Information Systems Research*, 15(4), 336-355.
- Millman, J. (2014). Health care data breaches have hit 30M patients and counting. *Washington Post*, Retrieved from <https://www.washingtonpost.com/news/wonk/wp/2014/08/19/health-care-data-breaches-have-hit-30m-patients-and-counting>
- Ng, B.-Y., Kankanhalli, A., & Xu, Y. (2009). Studying users' computer security behavior: A health belief perspective. *Decision Support Systems*, 46(4), 815-825.
- Palabindala, V., Pamarthy, A., & Jonnalagadda, N. R. (2016). Adoption of electronic health records and barriers. *Journal of Community Hospital Internal Medicine Perspectives*, 6(5), 32643.
- Papoutsis, C., Reed, J. E., Marston, C., Lewis, R., Majeed, A., & Bell, D. (2015). Patient and public views about the security and privacy of electronic health records (EHRs) in the UK: Results from a mixed methods study. *BMC*

- Medical Informatics and Decision Making*, 15(1), 86.
- Sittig, D. F., & Singh, H. (2011). Legal, ethical, and financial dilemmas in electronic health record adoption and use. *Pediatrics*, 127(4), 1042-1047.
- Thakkar, M., & Davis, D. C. (2006). Risks, barriers, and benefits of EHR systems: a comparative study based on size of hospital. *Perspectives in Health Information Management*, 3(5). Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2047303/>
- Wheatley, B. (2013). Transforming care delivery through health information technology. *The Permanente Journal*, 17(1), 81.
- Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information Systems Research*, 16(1), 85-102.
- Woo, H. E., & Pfeffer, M. A. (2013). A brief introduction to electronic health records and associated terminology. *Proceedings of UCLA Healthcare*, 17, 1-3.