Forecasting Patient Empowered Health Information Technologies

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Abstract

The growth and implementation of electronic health records (EHR) are progressing in many countries. Though adoption within Healthcare often lacks momentum amidst privacy and security concerns. This paper uses an interrupted time series (ITS) analysis of OECD data related to EHRs from many countries to make predictions about EHR adoption. The ITS model can be used to explore the impact of various health information technologies on adoption. Assumptions about the impact of Information Accountability are entered into the model to generate projections if information accountability technologies are developed. In this way, the OECD data and ITS analysis can be used to perform simulations for improving EHR adoption to ultimately reduce healthcare costs, while improving healthcare services and the management of healthcare records.

Keywords: Electronic health records, intervention study, information accountability

1. Introduction

The healthcare sector plays a significant role in any country's productivity and economic development. Healthcare sector expenses are astronomical. Factors associated with healthcare service deliveries and products directly impact on 'quality of life'. Healthcare professionals, patients and other stakeholders generate and consume enormous quantities of information. In this information intensive sector, the research challenges include discovering ways of measuring, linking and utilizing health information appropriately within the confines of prevailing privacy and security constraints (Information Accountability) (Gajanayakeet al., 2016; Gajanayake et al., 2011)

With around 72% of the world's population interacting with online information daily, processes requiring public input and interactions is making its way to online workflows (Internet Society, n.d.; PEW Internet Research, 2004; United State Census Bureau, 2018). Electronic health records (EHR) capture healthcare information from prior to the inception of an individual's birth, through their life span until after death. These records are either captured in paper format or are electronic in nature. Thus, the records, should, and would, empower the consumer in their families' and their own care. Indeed, the comprehensive unified longitudinal records aids in improving 'quality of life'. With technological maturity (Nugawela, & Sahama, 2011; Podichetty et al., 2006; Purcell et al., 2002), EHRs constitute evidence of online records from interactions between professionals (physicians and general practitioners), the public (consumers and patients) and healthcare service providers (healthcare policy makers and funding agencies). Furthermore, "EHRs consist of patient information such as demographics, medications, laboratory test results, diagnosis codes, and procedures" (Yadav et al., 2018, p.85).

Health information technologies (HIT) that enable EHR, represent significant infrastructure, contributes to the improvement of healthcare information exchange (Walker, 2005; Walker et al., 2005), prevents medical errors (Office of the National Coordinator for Health Information Technology, 2015, 2018a), avoids delays in care (Office of the National Coordinator for Health Information Technology, 2015), facilitates informed medical decision-making (Office of the National Coordinator for Health Information Technology, 2016), and reduces administrative burdens (Office of the National Coordinator for Health Information Technology, 2015; Yasnoff, 2016). Furthermore, several studies (Office of the National Coordinator for Health Information Technology, 2018b, 2018c) demonstrate critical HIT infrastructure facilitates a gateway that opens wider access to patient information sharing. Thereby, it improves healthcare services. The HIT development is crucial and helpful for people who have reduced access to healthcare professional services. For instance, in developing countries with poor resource settings, some patients are serviced by, at the very least, mobile telephone coverage. Additionally, some areas in developed countries are supported by minimum

healthcare professional services (Hersh et al., 2010).

Despite the technological, political and legislative viabilities, the growth and implementation of EHRs are progressing. While its adoption rate is lagging behind, lacking energy and momentum. One of the topical and critical hindering factors of this sluggish adoption of EHR is privacy and security of the personal and medical information where both professionals (physicians and medical experts) and the public (patients and consumers) are seriously concerned. While privacy and security terms are mutually exclusive in the socio-technological context, their mechanics and concepts are mutually inclusive. These are fuzzy approaches most service providers have difficulties realizing when shared EHRs are proposed.

However, 'privacy' is not a clearly defined concept, being subject to several culturally dependent variables (Sahama et al., 2013). The security measures support and warrant the 'privacy' breaches technically. Nevertheless, there are rules, regulations, data sharing policies and protocols that require further attention, awareness and knowledge sharing when the EHRs are fully functional (Yasnoff, 2016). On the other hand, this is the development area under "data governance" (Smith, 2007), healthcare service providers and policy makers should consider building upon. Subsequently, electronic data storage is becoming more feasible. Yet, the exponential growth of computational power in the wake of the "big data" conundrum in data governance is rarely addressed in health informatics literature (Office of the National Coordinator for Health Information Technology, 2015; Organisation for Economic Cooperation and Development, 2017). Nonetheless, the right governance frameworks on personal health data creates massive opportunities for health system improvement, research and disease surveillance (Organisation for Economic Cooperation and Development, 2017).

Realization of the health information flow and contextual awareness of EHR sharing capabilities are vital for meaningful and quality healthcare decision making (Sahama et al., 2013). Illustrated in Figure 1 below, this sociotechnical, information accountability driven, conceptual EHR knowledge-based information sharing model is considered for this study (Sahama et al., 2013).

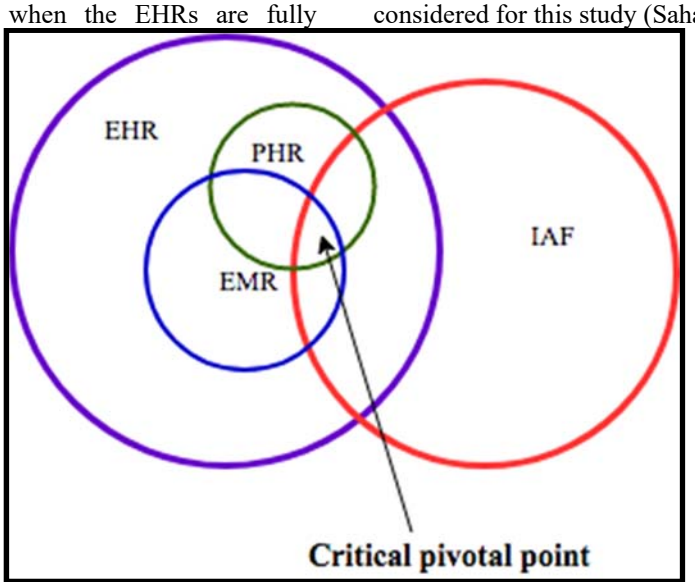

Figure 1: Information Accountability Driven EHR Model (Sahama et al., 2013)

2. Literature Review

(1) EMR (Electronic Medical Record) – covers information that authorized clinicians and healthcare organizations amend (the professional view), including managing the updated personal health records (PHRs). While the information stored in this area is vital for the clinical decision-making process, simultaneously the PHR will be managed to link the 'Patient' for specific information sharing.

(2) PHR (Patient Health Record) – comprises the recognizable individual information stored, collected, shared and controlled by the individual patient (the public view). This set of information supports the individual 'Patient' healthcare journey. The Healthcare Information Exchange (HIE) requires meaningful linkage of the EHR to complete the 'Patient' journey (Adler-Milstein et al., 2013)

(3) EHR (Electronic Health Record) – is a recognizable key element of the model (Gajanayake et al., 2016; Gajanayake et al., 2011). It comprises "comprehensive interconnected health information records that can capture and share a variety of information about people's health status, their history of encounters with the healthcare system, the results of all diagnostic and therapeutic interventions, and (ideally) their key social and demographic characteristics"

(Organisation for Economic Cooperation and Development, 2017, p.38).

(4) IAF – encompasses the Information Accountability Framework, the principle defined (Weitzner et al., 2008) and implanted (Gajanayake et al., 2016; Gajanayake et al., 2011) for the model. The governing principles of information accountability is "that information usage should be transparent, so it is possible to determine whether a use is appropriate under a given set of rules" (Weitzner et al., 2008, p.84) .

(5) Ω (Omega) – this pivotal point is a significant balance (Qian et al., 2018) [30] between healthcare service providers (healthcare policy makers and funding agencies), professionals (physicians and general practitioners) and the public (consumers and patients) to be maintained transparently when sharing the EHR.

The aim of this paper is to establish a socio-technical, information accountability driven, conceptual EHR knowledge-based information sharing model demonstrated in the preceding section. While the following sections present the data set retrieved, based on infodemiological discoveries, organized and analyzed using an intervention study using Interrupted Time Series Analysis. The paper closes with the discussion of the findings.

3. Methods

The OECD (Organization for Economic Co-operation and Development) has assessed the Technological Operational Readiness (TOR) and the Data Governance Readiness (DGR) of countries through a series of surveys and assessments between 2015 and 2017. These are illustrated in Table 1.

Table 1: OECD Assessed TOR and DGR of Countries Between 2015 and 2017

CTR	TOR	DGR	Int*	Pop*
Australia	5	0	86.1	25.0
Austria	7	0	88.8	8.7
Canada	7	2	83.9	36.9
Chile	4	1	87.5	18.2
Croatia	5.5	1	70.1	4.2
Czech Rep.	3	0	83.2	10.6
Denmark	7	2	97.0	5.7
Estonia	7.5	0.5	88.3	1.3
Finland	8.5	2.5	94.4	5.5
France	4.5	0	86.4	65.2
Greece	3.5	0.5	71.0	11.2
Iceland	5.5	3	97.9	0.4
Ireland	2	1	88.4	4.8
Israel	7	1	75.4	8.4
Japan	2	2	78.8	127.2
Latvia	5	1	78.6	1.9
Luxembourg	6	1	97.2	0.6
Mexico	3	1.5	50.9	130.7
New Zealand	6	2	86.7	4.7
Norway	5.5	3	96.7	5.4
Poland	5	3	81.9	38.1
Singapore	8	2	75.2	5.7
Slovakia	7.5	0	81.3	5.4
Spain	5.5	1	83.4	46.4
Sweden	6	2	94.7	9.9
Switzerland	4	1	93.1	8.5
UK England	7.5	2	94.0	63.1
UK and Ireland	3	0	77.7	4.8
UK Scotland	7	2	78.1	5.3
USA	6.5	2	78.4	326.7

Given that the variables DGR and TOR represent a 3-year period, it is reasonable to employ ITS regression models in order to project a post-2017 readiness for each of the countries included in the OECD data collection. This projection is regarded as indicative of patient empowerment and will depend on assumptions about and the impact of health information technologies, such as information accountability technologies. These assumptions were built into the ITS regression models. A Quasi–Poisson model determined the variances were proportional to each other, rather than equal to the mean (Kontopantelis et al., 2015; Bernal et al., 2017). Figure 2 represents the active data linkage and information sharing between databases of those OECD countries selected.

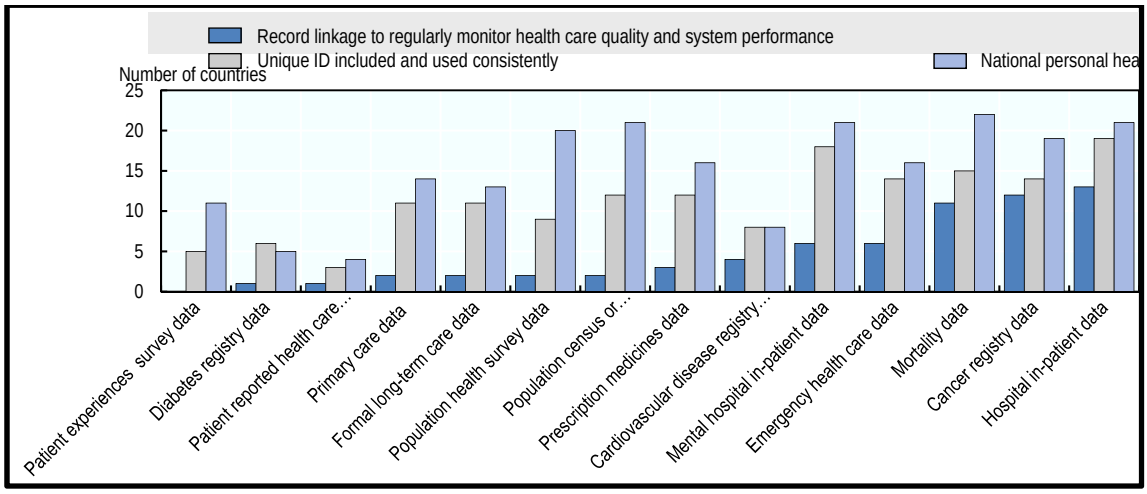

Figure 2: Extent of Linkage Across Relevant Databases in OECD Countries, 2013/14

Interaction and intersections of the DGR and TOR were visualized in Figure 3, namely 'Data governance and technical operational readiness to develop national information from EHRs' in those OECD countries.

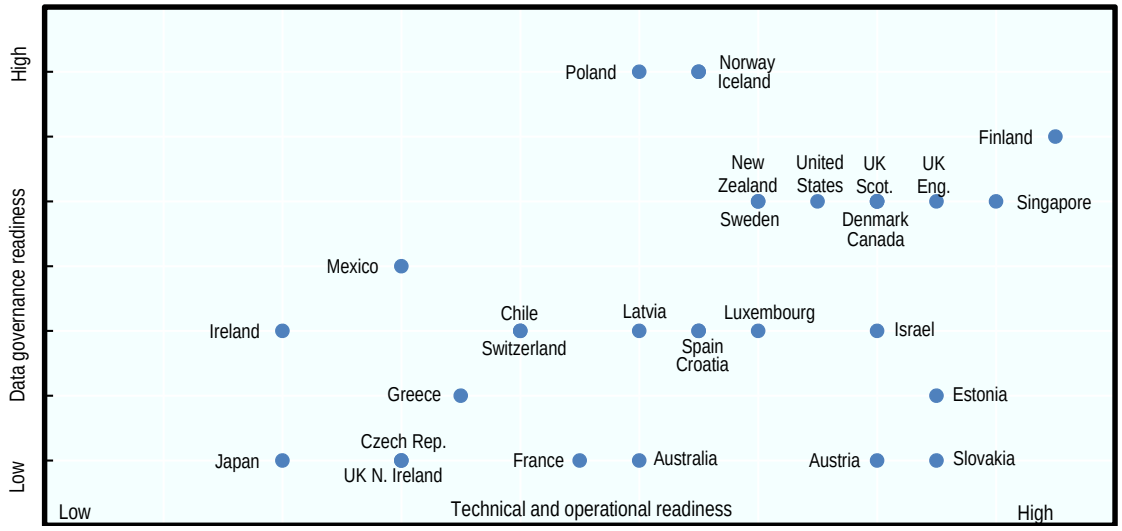

Figure 3: DGR and TOR to Develop National Information from EHRs

The statistical analysis was carried out using the R function generalized linear model. Necessary adjustments were accommodated to estimate time seasonality. It is useful to understand the quasi-experimental design, and ITS analyzes, in this example, because it provides potential of 'real world' data collected over a timeframe. While acknowledging that this experimental approach is bound by a few limitations, quasi-experimental studies are confounded with autocorrelation and time varying external factors. Having an ITS analysis for publicly available data supports cost effective data collection analysis. However, it is also associated with some form of risk where the purpose of the data collection may be for different purposes.

4. Results

Figure 4 presents the prediction of the countries' readiness ($P > 0.001$) to accommodate the 'Patient-Empowerment'. The dispersion parameter for the Quasi-Poisson family is taken to be 0.1840893. Figure 4 illustrates the 2015/2017 TOR (upper end of bar) and DGR (lower end of bar) score for each country. The ITS generated post 2015 projection is illustrated as a solid line. For some countries this is within the TOR/DGR bar, for example Finland and Singapore, and for others it is not, for instance Ireland and Japan. This illustrates that using assumptions about the impact of information accountability technology, some countries are ready (Singapore and Finland) to accommodate this HIT, whereas others are not (Japan and Ireland).

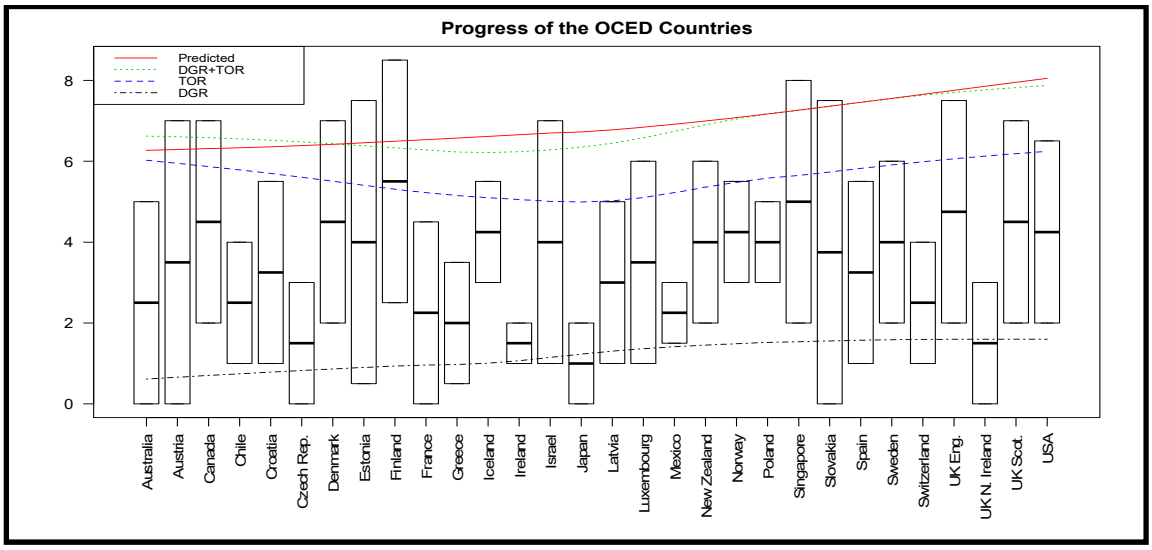

Figure 4: Outcome of the ITS Intervention Analysis

An adoption of EHR associated technologies provides sustainability of healthcare systems and enables population-based outcomes. Furthermore, 'modern' healthcare systems affordability and equity depend on its performance. While managing to achieve the maximum benefits of health data (better care, greater value, more knowledge), critical is encompassing, the risk associated with privacy use, and/or misuse of information. These benefits, risks, use and/or misuse of health data are the mechanics of the Ω–pivotal point of the model depicted in Figure 1.

The proposed model (Figure 1) (Sahama et al., 2013) allows consumer-directed exchange of health information, empowering patients to collect their health information into one application to access and share with providers. Users submit health records to a local, regional and central data repository that allows patient and physician access. These HIE interactions demand effective and meaningful interfacing between the health information exchange (Adler-Milstein et al., 2013) and information accountability (Gajanayake et al., 2011) of such changes.

With the patient–empowerment principle in the background, it is reasonable and practicable to search for the coexistence of HIT infrastructure facilitating the model's capabilities, possibilities and opportunities to establish the patient controlled EHR system. Countries that have attempted to implement EHR for several decades have yet to realize the return on investment (ROI). In the absence of valid and reasonable longitudinal studies of the shared EHR and on the brink of this topical "Digital Health" episode, exploring countries advancing on HIT infrastructure (infodemiological discoveries) is a worthwhile exercise. In this endeavor, the search for countries within the Commonwealth, OECD and G20 were emphasized. Available information and published data from those countries was a difficult task to search and find.

This study describes an infodemiological exploration of patient empowerment measured through EHR adoption using OECD data analyzed through ITS models. Therefore, this approach would help and "could shed light on unmet medical needs and research priorities for the future and provide guidance for the decision making in public policy" (Huang et al., 2018, 1). An alternate approach would be to employ a randomized control trial (RCT), however this exercise would be impractical and difficult to generalize to "real world" settings.

5. Conclusions

Use of personal health data creates opportunities for health system improvement, research and disease surveillance. However, to realize these benefits, while managing risks, requires the right governance frameworks. Patient–empowerment facilitates and provides HIT factors, including 1) sharing electronic health records; 2)providing functional data interoperability and; 3) offering meaningful use to minimize the security and privacy concerns. This paper investigates the electronic health records (EHR) adoption through an interrupted time series (ITS) analysis of OECD data, an intervention study. Its prediction diagnosis for the opportunities and usefulness are based on recent developments of the EHR on two readiness factors, namely, Technical Operational (TOR), and Data Governance (DGR) Readiness (Slawomirski et al., 2017).

Forecasting patient empowered HIT hold many implications for practitioners and researchers. The results can enhance our understanding about the impact of various health information technologies. Predicting patient empowered HIT readiness provides data highlighting who is not or who is ready to adopt HIT. Consequently, leading to more effective governance to expand the adoption, implementation and use of HIT. Thus,

ensuring better use of health data in this exponential growth of digital technologies, which is warranted to establish the support of Patient–empowerment. Sharing data under a thorough functional data interoperability regime would support other community benefits. For example, support should include migrant inflow to the health watch of the communities (Qian et al., 2018), and to establish 'quality of care' among such community elements (Yanamadala et al., 2016). Healthcare expenditure and health policy implementation is controversial and troubling (Lorenzoni et al., 2014). Healthcare spending might be managed and reduced by use of HIT (Anderson et al., 2006). However, long–term planning on studies like this and longitudinal experiments on the use of **shared EHR** should benefit most countries requiring immediate healthcare support. Based on the information available from OECD countries (Smith, 2007), employing and implementing an intervention study of interrupted time series regression analysis (**ITS**) (Kontopantelis et al., 2015; Bernal et al., 2017) on available and practicable HIT infrastructure information is a promising start. Predicting patient empowered HIT has flexible and widespread research and practical forecast application in other sectors, like the Financial Services (Shaw, 2006) and Public sectors in terms of research methods and data analysis.

Acknowledgements

The authors acknowledge that this paper neither analyze the situation by each country nor provided predictions for a country. This analysis is out of the scope of this paper since the granularity of the data is complex and unknown.

Data sources for the work was obtained from OECD iLibrary and appreciated support rendered by iLibrary team. The first three columns (CTR, TOR and DGR) of the data table (Table 1) and Figures 2 and 3 were extracted based on data from OECD (2017), *New Health Technologies: Managing Access, Value and Sustainability*, OECD Publishing, Paris, https://doi.org/10.1787/9789264266438en. There is no financial transaction involved in this endeavor.

References

Adler-Milstein, J., Bates, D. W., & Jha, A. K. (2013). Operational health information exchanges show substantial growth, but long-term funding remains a concern. *Health Affairs (Project Hope), 32*(8), 1486-1492. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=23840051&site=ehost-live&scope=site. doi:10.1377/hlthaff.2013.0124

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*(3), 819-831. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=heh&AN=20935287&site=ehost-live&scope=site. doi:10.1377/hlthaff.25.3.819

Bernal, J. L., Cummins, S., & Gasparrini, A. (2017). Interrupted time series regression for the evaluation of public health interventions: a tutorial. *International Journal of Epidemiology, 46*(1), 348-355. doi:10.1093/ije/dyw098

Gajanayake, R., Iannella, R., & Sahama, T. (2016). An insight into the adoption of accountable-eHealth systems – An empirical research model based on the Australian context. *IRBM, 37*(4), 219-231. doi:10.1016/j.irbm.2016.01.002

Gajanayake, R., Iannella, R., & Sahama, T. (2011). Sharing with care: An information accountability perspective. *IEEE Internet Computing, 15*(4), 31-38. doi:10.1109/MIC.2011.51

Hersh, W., Margolis, A., Quirós, F., & Otero, P. (2010). Building a health informatics workforce in developing countries. *Health Affairs (Project Hope), 29*(2), 274-277. doi:10.1377/hlthaff.2009.0883

Huang, M., ElTayeby, O., Zolnoori, M., & Yao, L. (2018). Public opinions toward diseases: Infodemiological study on news media data. *Journal of Medical Internet Research, 20*(5), e10047-e10047. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=29739741&site=ehost-live&scope=site. doi:10.2196/10047

Internet Society. (n.d.). Paths to our digitial future. Internet. Retrieved from http://internetsociety.org

Kontopantelis, E., Doran, T., Springate, D. A., Buchan, I., & Reeves, D. (2015). Regression based quasi-experimental approach when randomisation is not an option: interrupted time series analysis. *BMJ (Clinical Research Ed.), 350*, h2750-h2750. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=26058820&site=ehost-live&scope=site. doi:10.1136/bmj.h2750

Lorenzoni, L., Belloni, A., & Sassi, F. (2014). Healthcare expenditure and health policy in the USA versus other highspending OECD countries. *The Lancet, 384*(9937), 83-92.

Nugawela, S., & Sahama, T. R. (2011). *Internet usage trends in medical informatics.* Paper presented at the Statistical Concepts and Methods for the Modern World An international conference organised by the Applied Statistical Association of Sri Lanka.

Office of the National Coordinator for Health Information Technology. (2015). *Connecting health and care for the nation: A shared*

nationwide interoperability roadmap. Technical report. Retrieved from https://www.healthit.gov/sites/default/files/hie-interoperability/nationwide-interoperability-roadmap-final-version-1.0.pdf

Office of the National Coordinator for Health Information Technology. (2016). *Report to Congress on Health IT Progress. Technical Report*. Retrieved from Washington, D.C.: https://www.healthit.gov/sites/default/files/2016_report_to_congress_on_healthit_progress.pdf

Office of the National Coordinator for Health Information Technology. (2018a). *Draft 1 Trusted Exchange Framework. Technical Report*. Retrieved from Washington, D.C.: https://www.healthit.gov/topic/interoperability/trusted-exchange-framework-and-common-agreement

Office of the National Coordinator for Health Information Technology. (2018b). *A user's guide to understanding the draft Trusted Exchange Framework. Technical Report*. Retrieved from Washington, D.C.: https://www.healthit.gov/sites/default/files/draft-guide.pdf

Office of the National Coordinator for Health Information Technology. (2018c). *What Is HIE? Technical Report*. Retrieved from Washington, D.C.:

Organisation for Economic Cooperation and Development. (2017). *New health technologies: Managing access, value and sustainability*. Retrieved from https://doi.org/10.1787/9789264266438en

PEW Internet Research. (2004). The internet and daily life. Internet. Retrieved from http://www.pewinternet.org 2022960019

Podichetty, V. K., Booher, J., Whitfield, M., & Biscup, R. S. (2006). Assessment of internet use and effects among healthcare professionals: a cross sectional survey. *Postgraduate Medical Journal, 82*(966), 274. doi:10.1136/pgmj.2005.040675

Purcell, G. P., Wilson, P., & Delamothe, T. (2002). The quality of health information on the internet. *BMJ (Clinical Research Ed.), 324*(7337), 557-558. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=11884303&site=ehost-live&scope=site.

Qian, Y., Ge, D., Zhang, L., Sun, L., Li, J., & Zhou, C. (2018). Does Hukou origin affect establishment of health records in migrant inflow communities? A nation-wide empirical study in China. *BMC Health Services Research, 18*(1), 704-704. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=30200941&site=ehost-live&scope=site. doi:10.1186/s12913-018-3519-6

Sahama, T., Simpson, L., & Lane, B. (2013). *Security and privacy in eHealth: Is it possible?* Paper presented at the 2013 IEEE 15th International Conference on e-Health Networking, Applications and Services (Healthcom 2013).

Shaw, N. (2006). Banking and the electronic health record: what lessons can be learned? *Journal of Innovation in Health Informatics, 14*(2), 81-83. doi:10.14236/jhi.v14i2.617

Slawomirski, L., Smith, S. W., & Oderkirk, J. (2017). Digital technology: Making better use of health data. In *New health technologies: Managing access, value and sustainability.* (pp. 185–218). Paris: OECD Press.

Smith, A. (2007). Data governance best practices: The beginning. *EIM Insight 1:1*. Retrieved from http://www.eiminstitute.org/library/eimi-archives/volume-1-issue-1-march-2007-edition/data-governance-best-practices-2013-the-beginning

United State Census Bureau. (2018). Online Community Data. Internet. Retrieved from http://www.census.gov

Walker, J. (2005). Electronic medical records and health care transformation. *Health Affairs, 24*(5), 1118-1120.

Walker, J., Pan, E., Johnston, D., Adler-Milstein, J., Bates, D. W., & Middleton, B. (2005). The value of health vare information exchange and interoperability: There is a business case to be made for spending money on a fully standardized nationwide system. *Health Affairs, 24*(Suppl1), W5-10-W15-18. doi:10.1377/hlthaff.W5.10

Weitzner, D. J., Abelson, H., BernersLee, T., Feigenbaum, J., Hendler, J., & Sussman, G. J. (2008). Information accountability. *Communications of the Association for Computing Machinery, 51*(6), 82-87.

Yadav, P., Steinbach, M., Kumar, V., & Simon, G. (2018). Mining electronic health records (EHRs): A Survey. *ACM Computing Surveys (CSUR), 50*(6), 1-40. doi:10.1145/3127881

Yanamadala, S., Morrison, D., Curtin, C., McDonald, K., & Hernandez-Boussard, T. (2016). Electronic health records and quality of care: An observational study modeling impact on mortality, readmissions, and complications. *Medicine, 95*(19), e3332-e3332. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=mnh&AN=27175631&site=ehost-live&scope=site. doi:10.1097/MD.0000000000003332

Yasnoff, W. A. (2016). A secure and efficiently searchable health information architecture.

Journal of Biomedical Informatics, 61, 237-246. doi:10.1016/j.jbi.2016.04.004

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