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Electronic Health Records Adoption in China's Hospitals: A Narrative Review

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Abstract

This paper sought to review the usage of China's hospital electronic information systems. It brought to light the usage levels of hospitals and employees and some of the challenges of implementation. The health record of a patient or client to a hospital is the data source regarding the variations of health status and received health services throughout a client's life. All-inclusive electronic medical records (EMR) have been recognized to be an active tool for improving the quality and safety of healthcare services in China. Reaching a state of a personal healthcare information system that covers the whole population is one of the main goals of China by the year 2020. Digital databases have been established by most hospitals, counties and provinces in China for managing electronic health records and patient/client data. The main goal of Chinese digitization reform is to build integrated strong health information platforms at the city, county, provincial and national levels. Regardless of the largest inhabitants and huge discrepancies among diverse regions, China has set a determined goal to complete the execution of a nationwide interoperable health information system that allows healthcare facilities to share residents' healthcare information by the end of 2020. The findings obtained from the various literature reviewed indicate that China is doing very well in the implementation and usage of hospital electronic information systems (EHR, EMR etc.)

Keywords: Electronic Health Records; Medical Health Records; Health Information Management; Health Information Technology; China

INTRODUCTION

China is the second biggest world economy in terms of GDP since 2010 due to over 30 years of the rapid growth of the economy [1]. China's growth rate of permanent inhabitants reached 56.1% and senior residents (that is aged 60 and above) exceeded 220 million in 2015, that is 16.1% of the total populace [1]. This demographic transformation causes an endless increase in healthcare request for quality services. This cannot be efficiently provided due to fragmented healthcare service systems and irregular distribution of healthcare service resources in China. Since the beginning of the Chinese Hospital Authority (CHA) in 1990, it has steadily reinforced the development and enactment of the Health Information System (HIS). The purpose is to improve the distribution of healthcare and to make improved electronic information available to managers for better decision making [2]. The healthcare electronic record is storehouse information regarding the changes in health status and medical care services given to a patient in his/her lifetime [3]. According to Garets & Mike, (2006), most people in the American health care industry: the press and the government use the terms Electronic Health Records (EHRs) and Electronic Medical Records (EMRs) interchangeably [4]. On the contrary, these expressions refer to

entirely different conceptions. Both terms are essential to the attainment of local, regional, and national aims to increase and improve the quality and effectiveness of patient care, and reduce healthcare delivery costs and safety of patients. EHRs depends on the existence of EMRs. EMRs will not attain its full potential without integrated EHRs system in place [4]. Although in the USA, these terms are often used interchangeably, it should be noted that in China, EHRs and EMRs express distinctive implications. In China, EMRs link to systems that manage patient records for medical purposes whiles EHRs refer to systems that manage 'longitudinal' health data for the population, usually controlled by public health organizations [5]. The definition of EHRs in China's Hospital settings was adopted from the EHRs Functional Specification which was published by the Ministry of Health (MoH) of China in 2010. The Chinese definition of EHRs is not from definitions used by other nations which define EHRs as computerized information systems that support data collection, storage, and access in healthcare facilities which provide information and knowledge through different settings to increase healthcare quality, efficiency and safety [6].

Major effort to push medical systems started in 1994 with a clinical management system (CMS), which established a medical terminal for use in both ward and ambulatory care units [2]. The Government of P.R.C. proposed in 2009, a New Health Reform that joint manual health records should be gradually instituted for all Chinese inhabitants with the intention of achieving digitization in more than 80% of the citizens in 2015 [7]. The increasing amount of electronic data collected in medical healthcare organizations affords a great opportunity for digging out useful knowledge to expand and improve medical care services. The blend with medical data documented by EMRs systems makes the typical care strategies defined by medical pathways more unambiguous and exhaustive [8].

METHOD

Selection of Relevant Literature

Information used in this review paper was mainly obtained from scientific electronic academic journal search engines (database) websites such as; Web of Knowledge, Google Scholar, PubMed, Scopus, Science Direct, Springer, Sage, Biomed Central and other different sources of academic journals within the months of May and June 2018. The information gathered covers the most current and relevant academic articles. The paper primarily draws on a selection of peer-reviewed publications in English language and with Chinese settings which were available online from 1966-2018. Relevant articles were searched using the following keywords with Boolean method; TOPIC: (Electronic Health Record*) AND TOPIC: (implement*) AND TOPIC: (hospital in China*) – 34. TOPIC: ("Electronic Health Record*") AND TOPIC: (implement*) AND TOPIC: ("health care" in China) – 18. (Electronic Health Record*) AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 24. TOPIC: (Electronic Patient Record*) AND TOPIC: (implement*) AND TOPIC: (hospital* in China)
– 29. TOPIC: ("Electronic Patient Record*") AND TOPIC: (implement*) AND TOPIC: ("health care" in China) – 2. TOPIC: ("Electronic Patient Record*") AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 1. TOPIC: (Electronic Medical Record*) AND TOPIC: (implement*) AND TOPIC: (hospital* in China) – 16. TOPIC: (Electronic Medical Record*) AND TOPIC:
(implement*) AND TOPIC: ("health care" in China) – 27. TOPIC: (Electronic Medical Record*) AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 27. TOPIC: (Computerized* Patient Record*) AND TOPIC: (implement*) AND TOPIC: (hospital* in China) – 4. TOPIC: (Computerized* Patient Record*) AND TOPIC: (implement*) AND TOPIC: (health care in China*) – 5. TOPIC: (Computerized* Patient Record) AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 5. TOPIC: (Electronic Health Care Record*) AND TOPIC: (implement*) AND TOPIC: (hospital* in China) – 31. TOPIC: (Electronic Health Care Record*) AND TOPIC: (implement*)
AND TOPIC: (health care in China) – 41. TOPIC: (Electronic Health Care Record*) AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 20.

TOPIC: ("Computerized* Physician Order Entry") AND TOPIC: (implement*) AND TOPIC: (hospital* in China) – 1. TOPIC: (Computerized* Physician Order Entry) AND TOPIC: (implement*) AND TOPIC: ("health care" in China) – 3. TOPIC: (Computerized* Physician Order Entry) AND TOPIC: (implement*) AND TOPIC: (clinic* in China) – 5. Google Scholar and other databases (PubMed, Scopus, Science Direct, Medline, Springer, Sage, Biomed Central) also yielded about 480 results using the same text phrases. Relevant results of related literature were downloaded, sorted, read through and important information fished out and sifted. In the end, the final relevant information was put together to compose this paper with the use of Mendeley Referencing Software.

Exclusion Criteria

- Studies which were not published in English.
- Studies that were out of context
- Studies which were too old and not relevant to the topic.

Inclusion Criteria

- Articles published in English
- Studies must be relevant to the topic
- Studies must be relevant to Chinese EHRs/MHRs/HIMS/HIS Studies published within the recent five years
- Old but very relevant studies

Articles Included in the Review

The process for selecting articles for review is reported in Figure 1. After excluding duplicates and applying inclusion and exclusion criteria, a total of 46 articles were included in this review.

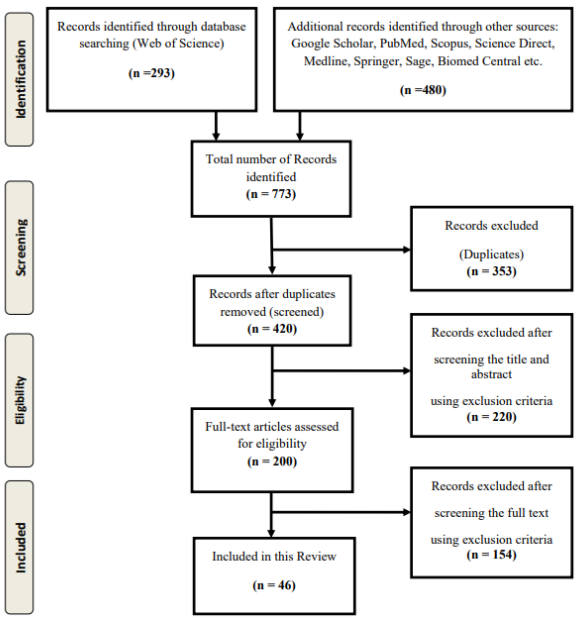

Figure 1 The PRISMA flow diagram [9] depicting articles selection.

RESULTS AND DISCUSSION

Hospitals and Employees usage of EMRs

There are about eighteen thousand seven hundred and three (18,703) general hospitals in China. All these hospitals have access to basic data management set-ups such as computers, self-service devices, intranet, and the Internet connection. Almost ten thousand (10,000) general hospitals have HIMS used for digital recording, retrieving and manipulating, as well as dissemination of patients records [10]. The new millennium comes with the challenge of speed and increasing change resulting in the creation of multifaceted healthcare structures in China hence, the paper-based medical record is no longer viable for today's modern healthcare atmosphere [2]. The EMRs is the storage of entire medical healthcare information and the clinical history of patients in an electronic format [11]. Current EMRs system assists Medical Doctors by facilitating order entry and reducing medical diagnosing errors. EMRs introduction in hospital facilities enhances Physicians work efficiency [12], and though EMRs cannot manage the whole medical process and the medical services quality, it can improve the safety and effectiveness of medical care services [13]. EMRs should be intended for all medical health professionals since clinical medical services cannot

be achieved by Doctors alone. It also requires the involvement of other medical professionals and Public Health workers (such as nurses, ward assistants, medical laboratory officers, pharmacist, health information officers, health record officers etc.) [13]. Complete EMRs have demonstrated to be an effective tool for enhancing the safety and medical diagnoses quality and general healthcare services. [14]. A research conducted by Shu et al., (2014) analysed the EHRs adoption levels in 848 hospitals in P.R.C. using 'Model of EHRs Grading (MEG)' and revealed that majority of them had only basic EHRs systems, around level two and zero. A few of the hospitals had higher marks and level of medical/clinical information management usage and exchanging with other hospitals [6]. The hospitals' scores in Eastern and Western China were more than hospitals in the central parts of China [6]. China's MoH in April 2010 endorsed the Chinese Society of Nephrology's launch of a web-based prospective renal data registration platform nationwide for the Chinese Renal Data System (CNRDS). This platform was used to gather structured demographic data, medical, and medical laboratory information for dialysis cases, as well as to generate a Kidney Disease Database for Scientists and Policy Makers [15]. The adoption of Health Information Exchange (HIE) in Shanghai, China resulted in better access to precise, comprehensive, and appropriate medical information in real-time. This helped the distribution of cost-effective, efficient and real-time medical care [16]. The cloud-based EHRs method enhanced the provision of care for village Doctors in rural China. This improved the productivity of the medical healthcare system to monitor the health status of the general public and enhanced the management of preventive care efforts [17]. According to Yang et al., (2014), a study using data from a nine-year period ranging from pre to post EMRs application in Chinese three top general hospitals were used to investigate the relationship between EMRs application and length of stay by clients. They concluded that regardless of department or disease, length of stay decreased after EMRs application was employed. The result indicated an influence on reduction of the length of stay at the general hospitals [12]. Most Nurses in Intensive Care Units (ICU) in Chinese hospitals were actively involved in the development of the Critical Care Information System (CCIS) and used it completely to document medical care records. Introduction of the CCIS led to substantial improvement in quality and efficiency in the documentation by Nurses, medication order transcription, and management. It enabled Nurses to devote more time to clients/patients in order to enhance the medical care quality, which led to excellence in overall nursing performance [18]. The EMRs application has been fully accepted by Physicians in Chinese hospitals and may be used as a maiden medical order screening guideline to reduce Pharmacists' workload. Chinese hospitals recognise this set of rules as an initial way for creating pharmaceutical systems of their own [19]. The findings from Wang et al., (2016) suggested that for medical healthcare facilities to increase the benefits of EHRs, the exertions of hospital management should focus on gratifying the Doctors and other clinical and public health staff who medical care the use of EHRs with passion and volition [20].

Nationwide HIMS Development Plan

The MoH of China proposed a 5year development plan (2011–2015) for the nationwide HIMS to promote the '3521 Project'. The '3521 Project' comprises building three HIMS platforms at municipal, provincial and national levels to improve public health, medical/clinical services, new rural cooperatives, basic drug systems, the integrated management of five business applications and the building of EHRs and MHRs, two basic databases and the construction of a dedicated network [21]. Centrally and locally managed EHRs ensure that continuous care is maintained [22]. A National Stroke Screening and Registry Database were built in China in 2015. At the China Stroke Conference held in the same year, the Chinese stroke prevention report for the year 2015 was announced to the society memberships and government representatives [23]. The first and largest Chinese HIE system was established in Shanghai in September 2010. By 2016, the system included all of Shanghai's thirty-eight tertiary top-level hospitals, six district hospitals, and forty community health centres, with coverage for thirty-nine million patients. The system presently offers a rich source of clients' information comprising medication history, radiology images and

reports, encounter history, clinical notes, and laboratory results [16]. Health Information Technology (HIT) has been implemented by clinical healthcare providers as an enabler to enhance medical healthcare services with reduced medical consultation costs and healthier health and care value [24].

Integration and interoperability of Health Information Management Systems (HIMS)

Research shows that it is very urgent and crucial for Chinese hospitals to integrate their HIMS in order to exchange across health agencies, especially in agencies responsible for communicable diseases [10]. Hospital Information System (HIS) is thriving strongly in China, but the hospital record is an isolated island, steered by application developers and operated separately in each hospital. The integration and interconnectivity of Hospital Information System nowadays have become a serious problem that has to be dealt with in the electronic hospital structure [25]. Patient medical healthcare information sharing between healthcare facilities is a major challenge which the Chinese healthcare 'informatization' expansion encounters [26]. The main integration challenge in the implementation of EHRs for continuousness of patient medical care is the identification of an appropriate scheme for sharing and exchanging of patient medical records among the various hospitals and medical healthcare givers [27]. Several paper-based health record documents were used in China as of 2012, which were not only dissimilar from each other but were also unreliable with the national guidelines. The health records information could have been managed by computers to encourage shareable EHRs across health facilities in China if these documents were made to be structured and electronically available [21]. The regional HIE became the attention of HIT in China. The HIT adopted a central architecture in which the medical documents were kept and exchanged on a unified platform based on the Chinese administration properties and specific requirements. It was critical to identify the patients in the HIE database domain distinctively in 2013 to integrate all the medical information of a patient [26]. A big challenge to meaningful use of HIT is to make sure that all medical health information from a healthcare provider could be shared easily with other healthcare service providers or another way round. Over a decade ago, many nations launched healthcare programmes which aimed at developing national interoperable HIS but run into many challenges like the lack of exchange of information standards, lack of business models that are sustainable, high risks HIT investments [28], [29]. The experiments conducted by Zhao et al., (2017) established that EMRs-based clinical knowledge network is a collective and simple technique of integrating different clinical knowledge from EMRs, which the clinical decision support can use [30].

EHRs Security Standards in China

Several countries have developed EHRs standards. There are international standards such as ISO/TS 18308 and ISO/IEC 11179, which helps to develop the structure and content of the EHRs [31]. The ISO/TS 18308 can be used to evaluate the conformance of EHRs models. The Chinese EHRs standard needs amendment to obtain improved conformance with the ISO/TS 18308 [31]. According to the Standards test conducted by Wei Xu et al., (2011), the Chinese EHRs Standards conformed to 62.1% out of the one hundred and twenty-four (124) prerequisite items in ISO/TS 18308 whiles the ASTM E 1384 Standard conformed to 89.5% [31]. The Chinese EHRs Standard conformed to 34 out of 50 Structure Necessities (68.0%), 22 out of 24 Process Necessities (91.7%), and 21 out of 50 Other Necessities (42.0%). The ASTM E 1384 Standard conformed to 49 of 50 Structure Necessities (98.0%), 23 of 24 Process Necessities (95.8%), and 39 of 40 Other Requirements (78.0%) [31]. China does not see America's Meaningful Use (MU) objectives as an excellent standard for comparison but the MU methods and objectives may offer China a model for measuring and assessing EMRs adoption [32]. China allotted more than 100 HIT standards from the years 2010 to 2011 but lacked standards like America's MU that is able to test and assess the level of EMRs implementation [32]. Open Prospective Clinical Research (openPCR) is an open-metadata-schema founded on Research Registration Standards, Clinical Data Interchange Standards Consortium (CDISC) and China's Medical Healthcare Related Standards, which need to be extensively accessible throughout

the country. It considers the imminent integration of EHRs and Clinical Research by putting in place information structure and terms in Chinese EHRs Standard [33]. Further extension of the Chinese EHRs Standard must concentrate on supporting privacy and security mechanism, more general and extensive lower-level data structures, several data types, and inter-relational features for data elements [31]. The accepted international health standards may be conceived, localised and stabilised through conceptualization and classification of those items for sharing and the execution of EMRs in Chinese health facilities [34]. China should not only implement an EMRs certificate program, which assures the specified functions of EMRs standards in the not too distant future but also an America's MUlike Standards and Certification to protect the quality of EMRs implementation [32].

Model of EHRs Grading (MEG) used in China

The Model of EHRs Grading (MEG) was initiated based upon earlier work on EHRs implementation measures (e.g. HIMSS' EMRAM) and EHRs functionality assessment [35]. The Authors combined and expanded these procedures to make room for changes in the hospital structure, clinical workflow, and guidelines exclusive to Chinese hospital facilities. In the early part of 2010, a group of Chinese HIT leaders and experts drafted MEG for the purpose of evaluating EHRs adoption of Chinese hospitals. By means of an interactive process, the model was subsequently reviewed and confirmed through a series of module-focused work sessions. The sessions concentrated on EHRs functionality across different hospital departments including pharmacy, laboratory, radiology, management and nursing. Sponsors from government, universities, hospitals, and vendors provided a reaction to further enhance the draft. Near the end of 2011, MEG was launched by the MoH of China. The National Institute of Hospital Administration (NIHA) established an information centre for the web-based collection of MEG and other similar data [6].

The Chinese EHRs Data Standard and Architecture

The Chinese EHRs Standard which was distributed recently reveals significant progress in electronic medical healthcare service in China that may be continuously improved in practical application. The research conducted by Watzlaf et al. (2004) identified challenges for the revisions of the Chinese EHRs Standard in future. They used the ASTM E 1384 Standard as a control to perform comparative research. 'The ASTM E 1384 Standard' was first accepted in 1991 with progress and modifications. It is now recognized as a vital standard for designing EHRs, particularly, longitudinal health records [36]. The Chinese EHRs Standard consists of the Basic Architecture and the Data Standard. The Basic Architecture describes the basic information on EHRs concepts, sources, and contents. The content was retrieved from the Basic Specification for writing MHRs [37]. It is prepared into transferring consultation record, medical summary, outpatient medical health record, inpatient medical health record, legal medical certificate and report, health examination record and health institution information. The most important portion of the Chinese EHRs Standard is the Data Standard. The plan is premised on National E-Health Transition Authority, Australia (NEHTA) Clinical Data Standards and IT– Metadata Registries (MDR) – Part 3: Registry metamodel and basic attributes (ISO/IEC 11179-3:2003(E)) and affected by HL7 Clinical Document Architecture (CDA) [31].

Policies on HIMS in China

The beginning of the HIT management system in Chinese hospitals provides a key motivation for China's government to pursue upgrading in the healthcare organisation [1]. To promote the implementation and the reasonable use of EMRs, effective provisions at a national level is vital to employ a well-planned strategy that includes innovation in the economic policy of hospitals, education, and investment in enhanced surveillance systems and prevention of sales of antibiotic in retail pharmacies [38]. The Institute of Medicine in 1991 distributed a white paper arguing, that the EMRs could be a crucial health technology for the future of

healthcare delivery [39]. Two of China's major hospitals, situated in Beijing, implemented EMRs systems among several vendors in agreement with China's National Health Reform Plan of 2009. [5]. To set standards for the contents of health records management systems for residents throughout the nation, the MoH of China in 2010 issued the Basic Public Health Service Specifications (BPHSS) [21]. The policy guide from the National Government and other relevant legal assurance are compulsory for the implementation of regional and national HISs interconnection [25]. The National Government of China has made efforts to create HIS including electronic health/medical records [40]. It is very essential to protect privacy by sharing clinical information of patients [41]. Irrespective of the largest inhabitants and huge inconsistencies among diverse regions, China is determined to complete the execution of a national interoperable HIS that permits healthcare facilities to share residents' healthcare information by the end of 2020. The project depicts a way of achieving global access to medical data, through which the integrity and continuity of patients' health information can be maintained [1]. China's policy reforms have excellently augmented community healthcare centres exploitation among diabetic patients [42]. National standards for some healthcare databases, for example, children's and women's health maintenance information, and a hospital data platform have been developed [43].

Construction of Personal Electronic Healthcare Records

The Chinese MoH initiated a framework to develop a model in 2009 for coordinated regional integrated healthcare services based on EHRs of residents [5]. "Regulation on MHR management in medical institutions" demands that all medical institutions at any level must establish the medical record management system using a unique MHR identification (ID) number. The medical record ID number should also be linked with the ID number of patients [5]. In 2011, 9.5 billion Yuan was allocated to promote HIT in hospitals, including the creation of EMRs, which refer to patient records for clinical purposes, or EHRs, which refer to longitudinal health data on the population across care settings [40]. The MoH instituted a Standards Bureau Office and series of standards in reference to architecture, regulations, and function profiles of EMRs. Most of the health care service providers have set up its own EHRs system [40]. In hospitals, EHRs are connected to health insurance systems for settlement of claims with the special ID number for patients. However, the EHRs systems are usually not interoperable and they vary substantially between hospitals. If patients liked to see doctors in different hospitals, they often had to bring along printed health records [40]., the MoH started to execute the "Resident Health Card" project in 2011. The card connects the individual's HER and MHR and provides a special connection for inter-institutional and trans-regional data sharing [40].

Financial Benefits of EMRs System Implementation in Hospitals in China

An amount of $9.5 billion was invested by the MoH in 2012 for the development of medical data and the improvement of information systems in public Chinese hospitals [44]. EMRs system was proposed as a technology, which improves patient care quality, decreases medical errors, controls and reduces medical expenditure but its financial repercussions have not yet been well documented in China [45]. Implementing an EMRs system for a period 6-year accrued a totally assessed net benefit of $559,025 in the general hospitals. The benefits accrued basically from savings in new EMR creation, minimised full-time-equivalent employees, saving of adverse drug events (ADEs) and dose errors, improved charge capture and minimised billing errors [45]. An analysis of cost and benefit of EMRs system implemented in hospitals portrays a positive return on investment. The quantum of the return is sensitive to many principal factors [45]. According to Yu et al. (2016), initial outcomes of implementing HIE system in the city of Shanghai, China, indicate a crucial reduction in medical errors and duplication of tests, saving at least 48 million RMB per year with overall growth in the care quality following implementation [16]. The MoH on Healthy China 2020 Strategic Report initiated a $9.8 billion budget to regulate (IT) systems in key hospitals by creating a public EMRs system and medical information platform of the regions [44]. The central government's financial authorities from 2010 have devoted 84.28 million

Yuan to support 22 Midwestern provinces in mounting up telemedicine systems [44].

International EHRs/EMRs (Global Dolphin)

Presently, a lot of clinical data are traded between organizations within the regional systems of China. However, people who travel outside the country may visit a health facility, which makes the international exchange of clinical data very useful [46]. The pilot test in Global Dolphin indicates that patient information could be shared across nations through global health data exchange. The project depicts a way to achieve global access to medical data whereby the authenticity and continuity of patients' health information can be sustained [46].

CONCLUSION

The findings obtained from the various literature reviewed indicate that China is doing very well in the implementation and usage of hospital electronic information systems (EHRs, EMRs etc.). They have covered the greater part of the country with good policies backing the implementation. The patronage level of hospitals, employees and clients or patients in a hospital electronic information system is high.

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