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Hospital Information Systems in Iranian Military Hospitals: A Multiple Case Analysis

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Background: Hospitals are regarded as the most important part of each healthcare system. At present, all hospitals are using hospital information system (HIS) as an infrastructure in recording, retrieval, and transmission of data, facilitation of decision-making processes, and other healthcare-related domains. However, its position, maturity, and boarder of its coverage are not quite clear. The hospitals affiliated with military healthcare in Iran are facing the same challenges. On the other hand, Electronic Medical Record Adoption Model (EMRAM) is a worldwide-recognized stage-based model that is used to assess the maturity of HISs in the hospitals.
Objectives: This study aimed to assess the maturity and applicability of HISs in Iranian hospitals.
Materials and Methods: Two Iranian military hospitals were selected for HIS maturity assessment. Data were collected through interviewing related experts and the use of some software and documentation analysis. Then the data were compared with the EMRAM.
Results: The results revealed that the HISs in these military hospitals had reached different stages of EMRAM while they could reach upper HIS maturity stages.
Conclusions: The maturity of HISs in Iranian military hospitals was almost the same as that of Iranian nonmilitary hospitals. The HISs in these hospitals did not utilize full potentials advantages of HIS and were placed at up to third stages of EMRAM.

Keywords: Information System; Hospital; Military; Electronic Medical Record; Iran

1. Background

Computerization of medical information was introduced about 30 years ago and under different names (1). Up to this date, there is no universally accepted definition for e-Health (2, 3), but one of the most comprehensive definitions refers to e-Health as the cost-effective and secure use of information and communications technology (ICT) in support of health and health-related fields including healthcare services, health surveillance, health literature, and health education, knowledge, and research (4). The utilization of e-Health systems in hospitals is almost new. It should be highlighted that hospitals represent the essential components of healthcare systems (5) and are one of the main targets of governments to implement e-Health applications. The applications that are provided through e-Health initiatives within hospitals include hospital management information systems (HMIS), telemedicine services, and internet services (6), which are collectively known as hospital information system (HIS). The importance of HIS becomes clear when the great complexity of the medical practice nature and the large number of interventions that each patient receives cause a high rate of errors in healthcare organizations (7). It is believed that the use of HIS in hospitals is driven by the needs to reduce medical errors (8-10) and healthcare costs (11). Nevertheless, the challenges associated with the use of such systems in the hospitals are due to their content complexity, availability of standards for the integration of various workflows, communication of databases, and involved people (12); however, Jaana et al. (13) believe that hospitals are continually exploring opportunities for investing in information technology (IT) to improve efficiency, promote patient safety, and provide better quality of care (14). Currently, IT priorities are mostly related to reducing medical errors, upgrading/replacing in-patient clinical systems, and implementing HISs in the hospitals (15). Although the potential benefits of HISs in military hospitals are highlighted, no standard maturity assessment of HISs in military hospitals is done. This paper aimed to design a strategy to implement proper HISs in the military hospitals.

2. Objectives

Considering that there was no comprehensive study on the HIS maturity and professional knowledge in this area of expertise in the Iranian army, this study was designed to evaluate the operational HISs in two different military hospitals and to provide enough suggestions to enhance their HIS capabilities.

3. Materials and Methods

To perform this study, two military hospitals were selected. The selection method was convenient sampling and the main selection criteria were based on the feasibility of data gathering from hospitals affiliated with army and their potential to share the required information. The first hospital had 300 beds, which were expanded in different wards including emergency department, operation room, dialysis, and other wards. The second one was one of the oldest army hospitals, which was established more than 140 years ago. This hospital was serving patients with different facilities and almost 100 beds. This research was performed in two rounds. During the first round, using a meta data and laboratory search with the thesaurus terms "information technology," "e-Health," "e-Health Information Technology," "hospital information systems", "HIS", and "e-Health strategy", a general Internet search was done in the different databases, including MEDLINE, IEEE, Emerald, Scopus, Springer, Elsevier, and PubMed, and also some physical repositories including the medical journals and books. The aim of the first round was to identify the definition, coverage, opportunities, and challenges of e-Health and e-Health utilization, as well as HIS-associated issues. During the second round, the Electronic Medical Record Adoption Model (EMRAM) was used as a benchmark model to evaluate the current maturity of HISs in the selected hospitals. The focused groups in these hospitals were IT staff who were working in computer unit/department/center in these hospitals and had enough information about all the aspects of HISs, particularly their related experiences in these hospitals. The meeting sessions were appointed and held several times and lasted between 30 to 50 minutes to reach the expected results. The first round lasted from January to March 2014. Then the process continued to analyze the collected data using the descriptive approach and continued until June 2014.

4. Results

4.1. The Hospital Case "A"

The computer center was responsible for maintenance and enhancement of HIS in this hospital. The HIS, which has been operating since seven years ago, was the third installed software. The previous HISs were not capable enough to cover all or major needs of users and operators. Thus, the hospital authorities decided to uninstall them one after another and finally, the third one was installed and operated adequately. This HIS included more than 20 subsystems. Almost all hospital areas including the dental ward, pharmacy, laboratory, medical document, and blood laboratory were equipped with professional software tools, which were handling all activities adequately. A checklist was provided based on EMRAM (Table 1) (16). This checklist is included in Appendix 1. According to the first stage of this model, radiology, pharmacies, and all laboratories of the respective hospital case were equipped with the adequate software tools, which manage all related activities. Some software tools went further and managed different and more sophisticated activities in comparison with similar tools in other hospitals. Moreover, in this stage, the software was expected to automate some clinical activities. The reception section and some other wards of this hospital were automated. Thus, the expectations of this stage were provided by different available subsystems that were active in different areas and wards of the hospital. The second stage of EMRAM expected the following criteria (refer to Appendix 1): (a) an automated system for medical vocabulary control, which was available in the medical document center in this hospital. (b) A system as repository for clinical data that were on different servers in this hospital case; these servers were strong enough to process a huge amount of data. They saved the whole medical and non-medical data of this hospital from the beginning of new HIS installation. (c) A decision support system to produce different types of reports, which were expected by hospital managers. The users and staff were glad to have all expected reports prepared automatically with no need for the personnel to make them manually. (d) The capacity of health data exchange between different wards of hospital; fortunately, the network was expanded in all areas of the hospital and the users exchanged clinical and non-clinical data. (e) A documentation system for medical images in the hospital, which was also an expectation of this model. The related unit was in charge to record all medical images to provide the feasibility of the image retrieval in future. The secondary clinical system sent data to databases to be retrieved by medical doctors, but did not necessarily need the patient's history and summary of documents in the system. The hospital had a sophisticated and comprehensive IT facility, which was connected to central servers located in the computer center. These facilities provided a suitable platform to record the whole data from different available repositories on the servers. Thus, there was the possibility of data retrieval and observation. However, the system of medical documentation of the patients by medical doctors and nurses had not been modernized yet. Therefore, although there was enough information about patients on hospital servers, the authorities did not retrieve and use them for future subsequent references. This hospital had all the above-mentioned criteria and expectations. Thus, the expectations of this stage complied with this hospital, too. As the third stage, it was expected that the hospital must had a documentation system for clinical

or nurse activities. The hospital had this software system, but it had not been installed yet. The weakness of network structure, particularly the low capacity of the network, did not let installation of a heavy tool on it. Therefore, the hospital authorities had decided to change the network structure including hospital network backbone within the next few months. Moreover, it was expected to have a clinical decision support system (CDSS) to detect *Pharmaceutical and medication errors*. This system was one of the most important software tools to prevent hospital authorities, particularly medical doctors and nurses, from making Pharmaceutical prescription mistakes. Lack of such system was clear in each hospital, especially in this hospital. Finally, it was expected to access medical images via picture archiving and communication system (PACS) on intranet within the whole area of the hospital. As was stated before, lack of high- capacity network infrastructure did not let running a heavy software tools with a high-capacity network in the hospitals. Thus, this criterion was not available in this hospital. As the fourth stage, it was expected to have a computerized physician order entry (CPOE) system and a more sophisticated CDSS, which was not available in the hospital. In addition, it was expected to equip the hospitals with radio frequency identification (RFID) technologies and fully automated *pharmaceutical* prescription environment in one or more wards of the hospital, which was not fully implemented. The next stage of this model (stage 6) was expected to have fully automated documentation system for medical doctors in one of the service providing areas and an radiology PACS (R-PACS) system on intranet for medical doctors who were not available in the hospital. The final stage of EMRAM also expected a fully digitalized electronic medical record (EMR) and the possibility to share patients' information on a healthcare network with other hospitals, insurance companies, clinics, etc. These expectations were not available in this hospital. The final outcome of the above discussion is shown in Figure 1.

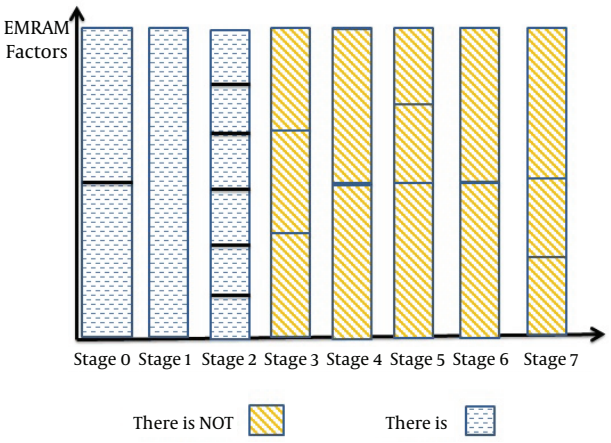

Figure 1. Status of Hospital Case "A" Hospital Information System in Accordance With Electronic Medical Record Adoption Model (Each column is Presented According to Expectations Stated in Table 1)

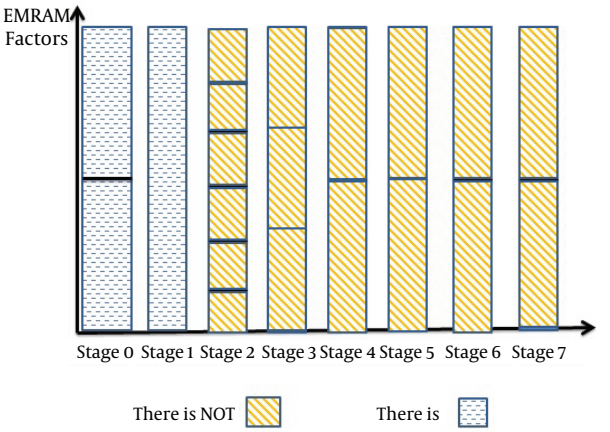

Figure 2. The Stage of Hospital Case "B" According to Electronic Medical Record Adoption Model (Each Column is Presented According to Expectations Stated in Table 1)

4.2. The hospital Case "B"

This hospital case had no specific center or office to manage IT and computer-related activities. However, several computers were used in different offices to assist patients, managers, and staff to handle their activities and responsibilities. To meet their needs, different software tools were installed, which were operating routinely. Nevertheless, there was no person in charge of maintaining computers and HIS software in this hospital. According to the first stage of EMRAM, all laboratories, radiology department, and pharmacies in each hospital must have some sort of information systems. In addition, some clinical activities in different wards of the hospital had to be automated. The interviews along with observation of activities showed that the mentioned centers had information systems one of which was used in the reception. Thus, the first stage of this model was passed by this hospital. Moreover, none of the second-stage expectations of this model existed in this hospital. Thus, this hospital could only be positioned on the first stage of EMRAM (Figure 2). The hospital analysis reveals that both hospitals had some sort of operating information systems to facilitate hospital activities. It was evident that all units, wards, centers, and laboratories in hospital "A" were equipped with some sort of IT facilities. Thus, the influence rate of IT was high in hospital "A" but not in hospital "B" where even some of the activities were done manually. More than 20 software tools were handling different responsibilities and major activities in hospital "A". Therefore, based on EMRAM, this hospital had satisfied some expectations of an ideal HIS whereas the hospital "B" suffered from a lack of major expectations of an optimal HIS. It would be beneficial to introduce EMRAM expectations to such hospitals as a roadmap to HIS enhancement. Both hospitals were placed on elementary stages of EMRAM due to the major weaknesses of their

HIS. Hospital "A" could be placed on stage 3 and hospital "B" could be placed on stage 2. However, the clarification of the HIS status of these hospitals suggested that firstly, the management authorities of these two army hospitals were always under human and non-human (technical) supervision that prevented them from paying attention, persisting, or emphasizing on important decisions made during their meetings or based on their development programs. The effect of such considerations would be losing the motivation of staff, particularly top and middle managers. Secondly, hospital "A" tended to explore possibilities of the use of e-health to improve the quality of patients' and staff's services while such efforts could not be observed in hospital "B". It seems that the distance of hospitals from the capital had a direct impact on management decisions, budgets, and technology access. The nearest cases to the capital benefited from more facilities and services from top authorities. Finally, both hospital cases suffered from lack of suitable and strategic-based decisions. The situation could be compared to the decisions made for patients. Wherever the patient was affected by some physical problem, the required prescription would be made. In these cases, for each problem related to hired IT technologies, the required short-term solution was provided. Such decisions were not suitable for IT-related activities. This area needs the long-term and strategic approaches. However, none of the hospital cases used mid or long-term strategic plans for IT decisions.

5. Discussion

There is no statistical result for military hospitals in other countries to compare with those from our study but this situation can be compared with other hospitals under the supervision of the Ministry of Health and Medical Education. According to Himss (17), none of the hospitals in Middle Eastern countries has reached the seventh stage of HIS maturity and also there is no paperless hospital in this area. However, the United Arab Emirates and Saudi Arabia have developed some proper plans and there are hospitals that have reached to sixth stage of HIS maturity. In addition, the current maturity of civil hospital cases in Iran gives a more clear viewpoint. In Sharifi et al. study (18), 11 civil hospitals were evaluated and all of these hospitals were placed in first and second stages of the EMRAM. These results emphasize the similarity of maturity status of different hospitals in Iran, but more researches are needed to come out with a comprehensive view to HIS maturity of Iranian hospitals as a whole. Hospitals are the heart of healthcare systems. Healthcare system of Iranian military is not an exception and the same issues are faced there. HIS has a growing importance in hospitals management in the Iranian military healthcare system. The analysis of two military hospital cases showed the incremental use of different HISs in these hospitals. It was found that EMRAM expectations in these hospitals did not reach the stage 4; a status that was not favorable for armies' healthcare system. The lack of strategic plan for the whole military healthcare system along with lack of professional experts, proper training, excellent HIS system, and inability of external parties to equip them with digital facilities have hampered progression of HIS systems in military hospitals. The use of EMRAM in this context will let the chief information officers (CIOs) and top managers to design a proper and well-defined strategy for HIS development and enhancement in military hospitals. However, to compensate for the use of immature HIS in military hospitals, some solutions were provided.

Table 1. The Checklist of Electronic Medical Record Adoption Model [a]

Stage	Cumulative Capabilities	Yes/No
7	Complete Electronic Medical Record (EMR)	
	Continuity of Care (CCD) transactions to share data	
	Data warehousing	
	Data continuity with ED	
	Ambulatory	
	OP	
6	Physician documentation	
	Full CDSS	
	Full R-PACS	
5	Closed loop medical documentation	
4	Computerised Practitioner Order Entry (CPOE)	
	Clinical Decision Support (clinical protocols)	
	Nursing/Clinical documentation	
	Clinical Decision Support System (CDSS)	
	PACS available outside Radiology	
2	Clinical Data Repository CDR	
	Controlled Medical Vocabulary	
	Clinical Decision Support/Rules Engine (CDS)	
	Document Imaging System (may)	
	Health Information Exchange (HIE) Capable	
	Data repository	
1	Ancillaries (Laboratory, Radiology, Pharmacy) not installed	
0	All three ancillaries not installed	
	Some clinical activities are automated	

[a] Abbreviations: EMR, electronic medical record; CCD, Continuity of Care to share Data ; ED, emergency department; OP, Outpatient; CDSS, clinical decision support system; R-PACS, Radiology- Picture Archiving and Communication System ; CPOE, computerized physician order entry; CDR, Clinical Data Repository; CDS, Clinical Decision Support/Rules; and HIE, hospital information system.

Appendix 1. EMR Adoption Model [a]

Stage	Cumulative Capabilities
7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED; ambulatory; OP
6	Physician documentation (structured templates); full CDSS (variance and compliance); Full PACS
5	Closed loop medication administration
4	CPOE; Clinical Decision Support (clinical protocols)
3	Nursing/clinical documentation (flow sheets); CDSS(error checking); PACS available outside Radiology
2	CDR; Controlled Medical Vocabulary; CDS; may have Document Imaging; HIE Capable
1	Ancillaries-Lab, Red, and Pharmacy-All Installed
0	All Three Ancillaries Not Installed

[a] Abbreviations: EMR, electronic medical record; ED, emergency department; OP, operating room; CDSS, clinical decision support system; CPOE, computerized physician order entry; HIE, hospital information system; CCD, Continuity of Care to share Data; R-PACS, Radiology- Picture Archiving and Communication System; CDR, Clinical Data Repository; CDS, Clinical Decision Support/Rules; HIE, hospital information system.

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Authors' Contributions

Dr. Ramin Hamidi Farahani was the main contributor to managing the case study meetings and getting required certificates and managing the whole line of the research. Dr Mohammad Sharifi and Dr. Masarat Ayat had directly *contributed* to the research and had collected and analyzed the data. Dr Nader Markazi Moghadam also helped us to conduct this research.

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